

# DATA HANDBOOK

Surface mounted  
semiconductors

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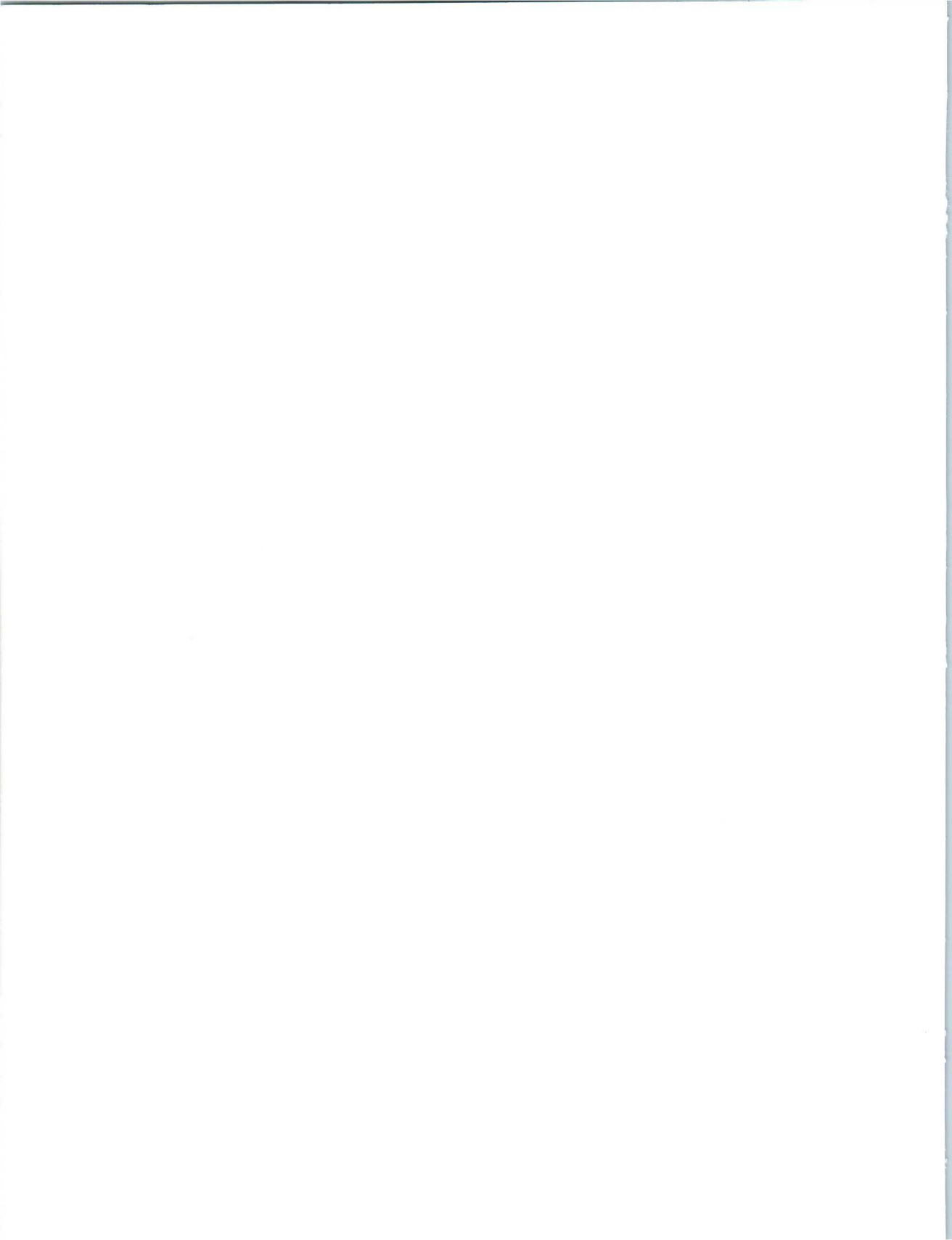
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**PHILIPS**





**Surface mounted  
semiconductors****Contents****PART A**

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## Selection guide



# Surface mounted semiconductors

## Selection guide

### GENERAL PURPOSE TRANSISTORS in SOT23/SOT89\*/SOT143\*\*/SOT223Δ

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                    |                                           |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |
| BC817          | 45                      | 45                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.7                                | 500/50                                    | 200                             | 229  |
| BC818          | 25                      | 25                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.7                                | 500/50                                    | 200                             | 229  |
| BC846          | 65                      | 65                      | 100                    | 250                      | 220             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 235  |
| BC847          | 45                      | 45                      | 100                    | 250                      | 220             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 235  |
| BC848          | 30                      | 30                      | 100                    | 250                      | 220             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 235  |
| BC868*         | 20                      | 20                      | 1000                   | 1000                     | 85              | 375  | 500                       | 1                            | 0.5                                | 1000/100                                  | 60                              | 275  |
| BCP54Δ         | 45                      | 45                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 311  |
| BCP55Δ         | 60                      | 60                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 311  |
| BCP56Δ         | 100                     | 80                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 311  |
| BCP68Δ         | -                       | 20                      | 1000                   | 1500                     | 85              | 375  | 500                       | 1                            | 0.5                                | 1000/100                                  | 60                              | 315  |
| BCV27          | 40                      | 30                      | 300                    | 250                      | 20000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 329  |
| BCV29*         | 40                      | 30                      | 500                    | 1000                     | 20000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 333  |
| BCV47          | 80                      | 60                      | 500                    | 250                      | 4000            | -    | 10                        | 5                            | 1.0                                | 100/0.1                                   | 220                             | 329  |
| BCV49*         | 80                      | 60                      | 500                    | 1000                     | 10000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 333  |
| BCV71          | 80                      | 60                      | 100                    | 250                      | 110             | 220  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 353  |
| BCV72          | 80                      | 60                      | 100                    | 250                      | 200             | 450  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 353  |
| BCW31          | 32                      | 32                      | 100                    | 250                      | 110             | 220  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 361  |
| BCW32          | 32                      | 32                      | 100                    | 250                      | 200             | 450  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 361  |
| BCW33          | 32                      | 32                      | 100                    | 250                      | 420             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 361  |
| BCW60A         | 32                      | 32                      | 200                    | 250                      | 120             | 220  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 367  |
| BCW60B         | 32                      | 32                      | 200                    | 250                      | 180             | 310  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 367  |
| BCW60C         | 32                      | 32                      | 200                    | 250                      | 250             | 460  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 367  |
| BCW60D         | 32                      | 32                      | 200                    | 250                      | 380             | 630  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 367  |
| BCW71          | 50                      | 45                      | 100                    | 250                      | 110             | 220  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 381  |
| BCW72          | 50                      | 45                      | 100                    | 250                      | 220             | 450  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 381  |
| BCW81          | 50                      | 45                      | 100                    | 250                      | 450             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 387  |
| BCX19          | 50                      | 45                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.62                               | 500/50                                    | 200                             | 395  |
| BCX20          | 30                      | 25                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.62                               | 500/50                                    | 200                             | 395  |
| BCX54*         | 45                      | 45                      | 1000                   | 1000                     | 45              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 403  |
| BCX55*         | 60                      | 60                      | 1000                   | 1000                     | 40              | 160  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 403  |
| BCX56*         | 100                     | 80                      | 1000                   | 1000                     | 40              | 160  | 150                       | 2                            | 0.5                                | 500/50                                    | 130                             | 403  |
| BCX70G         | 45                      | 45                      | 200                    | 250                      | 120             | 220  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 407  |
| BCX70H         | 45                      | 45                      | 200                    | 250                      | 180             | 310  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 407  |

## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                    |                                           |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |
| BCX70J         | 45                      | 45                      | 200                    | 250                      | 250             | 460  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 407  |
| BCX70K         | 45                      | 45                      | 200                    | 250                      | 380             | 630  | 2                         | 5                            | 0.35                               | 10/0.25                                   | 250                             | 407  |
| BSP40Δ         | 70                      | 60                      | 1000                   | 1500                     | 40              | 120  | 100                       | 5                            | 0.25                               | 150/15                                    | 100                             | 905  |
| BSP41Δ         | 70                      | 60                      | 1000                   | 1500                     | 100             | 300  | 100                       | 5                            | 0.25                               | 150/15                                    | 100                             | 905  |
| BSP42Δ         | 90                      | 80                      | 1000                   | 1500                     | 40              | 120  | 100                       | 5                            | 0.25                               | 150/15                                    | 100                             | 905  |
| BSP43Δ         | 90                      | 80                      | 1000                   | 1500                     | 100             | 300  | 100                       | 5                            | 0.25                               | 150/15                                    | 100                             | 905  |
| PMBT4401       | 60                      | 40                      | 600                    | 250                      | 100             | 300  | 150                       | 1                            | 0.75                               | 500/50                                    | 250                             | 1233 |
| PMBT5550       | 160                     | 140                     | 600                    | 300                      | 60              | 250  | 10                        | 5                            | 0.25                               | 50/5                                      | 200                             | 1247 |
| PMBT6428       | 60                      | 50                      | 200                    | 350                      | 250             | 650  | -                         | -                            | 0.2                                | 10/0.5                                    | 300                             | 1251 |
| PMBT6429       | 55                      | 45                      | 200                    | 350                      | 500             | 1250 | -                         | -                            | 0.2                                | 10/0.5                                    | 300                             | 1251 |
| PMBTA05        | 60                      | 60                      | 500                    | 300                      | 50              | -    | 10                        | 1                            | 0.25                               | 100/10                                    | 100                             | 1255 |
| PMBTA06        | 80                      | 80                      | 500                    | 300                      | 50              | -    | 10                        | 1                            | 0.25                               | 100/10                                    | 100                             | 1255 |
| PMBTA13        | 30                      | 30                      | 300                    | 300                      | 5000            | -    | 10                        | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1257 |
| PMBTA14        | 30                      | 30                      | 300                    | 300                      | 10000           | -    | 10                        | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1257 |
| PXT4401*       | 60                      | 40                      | 600                    | 1000                     | 100             | 300  | 150                       | 1                            | 0.75                               | 500/50                                    | 250                             | 1313 |
| PXTA14*        | 30                      | 30                      | 300                    | 1000                     | 20000           | -    | 100                       | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1321 |
| PXTA27*        | -                       | 60                      | 500                    | 1000                     | 10000           | -    | 100                       | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1323 |
| PZTA05Δ        | 60                      | 60                      | 500                    | 1500                     | 50              | -    | 100                       | 1                            | 0.25                               | 100/10                                    | 100                             | 1347 |
| PZTA06Δ        | 80                      | 80                      | 500                    | 1500                     | 50              | -    | 100                       | 1                            | 0.25                               | 100/10                                    | 100                             | 1347 |
| PZTA13Δ        | 30                      | 30                      | 300                    | 1500                     | 5000            | -    | 10                        | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1351 |
| PZTA14Δ        | 30                      | 30                      | 300                    | 1500                     | 10000           | -    | 10                        | 5                            | 1.5                                | 100/0.1                                   | 125                             | 1351 |
| PZTA42Δ        | 300                     | 300                     | 500                    | 1500                     | 40              | -    | 10                        | 10                           | 0.5                                | 20/2                                      | 50                              | 1353 |
| PZTA43Δ        | 200                     | 200                     | 500                    | 1500                     | 40              | -    | 10                        | 10                           | 0.5                                | 20/2                                      | 50                              | 1353 |
| PNP            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |
| BC807          | 45                      | 45                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.7                                | 500/50                                    | 100                             | 223  |
| BC808          | 25                      | 25                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.7                                | 500/50                                    | 100                             | 223  |
| BC856          | 65                      | 65                      | 100                    | 250                      | 75              | 475  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 257  |
| BC857          | 45                      | 45                      | 100                    | 250                      | 75              | 800  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 257  |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

Δ Types in SOT223 package.

## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE-sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                    |                                           |                                 |      |
| PNP            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |
| BC858          | 30                      | 30                      | 100                    | 250                      | 75              | 800  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 257  |
| BC869*         | 20                      | 20                      | 1000                   | 1000                     | 85              | 375  | 500                       | 1                            | 0.5                                | 1000/100                                  | 60                              | 281  |
| BCP51Δ         | 45                      | 45                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 307  |
| BCP52Δ         | 60                      | 60                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 307  |
| BCP53Δ         | 100                     | 80                      | 1000                   | 1500                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 307  |
| BCP69Δ         | -                       | 25                      | 1000                   | 1500                     | 85              | 375  | 500                       | 1                            | 0.5                                | 1000/100                                  | 60                              | 321  |
| BCV26          | 40                      | 30                      | 250                    | 350                      | 20000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 327  |
| BCV28*         | 40                      | 30                      | 500                    | 1000                     | 20000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 331  |
| BCV46          | 80                      | 60                      | 250                    | 300                      | 4000            | -    | 10                        | 5                            | 1.0                                | 100/0.1                                   | 220                             | 327  |
| BCV48*         | 80                      | 60                      | 500                    | 1000                     | 10000           | -    | 100                       | 5                            | 1.0                                | 100/0.1                                   | 220                             | 331  |
| BCW29          | 32                      | 32                      | 100                    | 250                      | 120             | 260  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 355  |
| BCW30          | 32                      | 32                      | 100                    | 250                      | 215             | 500  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 355  |
| BCW61A         | 32                      | 32                      | 200                    | 250                      | 120             | 220  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 371  |
| BCW61B         | 32                      | 32                      | 200                    | 250                      | 180             | 310  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 371  |
| BCW61C         | 32                      | 32                      | 200                    | 250                      | 250             | 460  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 371  |
| BCW61D         | 32                      | 32                      | 200                    | 250                      | 380             | 630  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 371  |
| BCW69          | 50                      | 45                      | 100                    | 250                      | 120             | 260  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 375  |
| BCW70          | 50                      | 45                      | 100                    | 250                      | 120             | 500  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 375  |
| BCW89          | 80                      | 60                      | 100                    | 250                      | 120             | 260  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 389  |
| BCX17          | 50                      | 45                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.62                               | 500/50                                    | 100                             | 391  |
| BCX18          | 30                      | 25                      | 500                    | 250                      | 100             | 600  | 100                       | 1                            | 0.62                               | 500/50                                    | 100                             | 391  |
| BCX51*         | 45                      | 45                      | 1000                   | 1000                     | 40              | 250  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 399  |
| BCX52*         | 60                      | 60                      | 1000                   | 1000                     | 40              | 160  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 399  |
| BCX53*         | 100                     | 80                      | 1000                   | 1000                     | 40              | 160  | 150                       | 2                            | 0.5                                | 500/50                                    | 50                              | 399  |
| BCX71G         | 45                      | 45                      | 200                    | 250                      | 120             | 220  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 411  |
| BCX71H         | 45                      | 45                      | 200                    | 250                      | 180             | 310  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 411  |
| BCX71J         | 45                      | 45                      | 200                    | 250                      | 250             | 460  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 411  |
| BCX71K         | 45                      | 45                      | 200                    | 250                      | 380             | 630  | 2                         | 5                            | 0.25                               | 10/0.25                                   | 180                             | 411  |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

Δ Types in SOT223 package.



## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                                    |                                           |                                 |      |
| BSP30Δ         | 70                      | 60                      | 1000                   | 1500                     | 40              | 120  | 100                       | 5                         | 0.25                               | 150/15                                    | 100                             | 901  |
| BSP31Δ         | 70                      | 60                      | 1000                   | 1500                     | 100             | 300  | 100                       | 5                         | 0.25                               | 150/15                                    | 100                             | 901  |
| BSP32Δ         | 90                      | 80                      | 1000                   | 1500                     | 40              | 120  | 100                       | 5                         | 0.25                               | 150/15                                    | 100                             | 901  |
| BSP33Δ         | 90                      | 80                      | 1000                   | 1500                     | 100             | 300  | 100                       | 5                         | 0.25                               | 150/15                                    | 100                             | 901  |
| PMBT4403       | 40                      | 40                      | 600                    | 250                      | 100             | 300  | 150                       | 2                         | 0.75                               | 500/50                                    | 200                             | 1237 |
| PMBTA55        | 60                      | 60                      | 500                    | 250                      | 50              | -    | 10                        | 1                         | 0.25                               | 100/10                                    | 50                              | 1263 |
| PMBTA56        | 80                      | 80                      | 500                    | 250                      | 50              | -    | 10                        | 1                         | 0.25                               | 100/10                                    | 50                              | 1263 |
| PMBTA63        | 30                      | 30                      | 500                    | 250                      | 5000            | -    | 10                        | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1265 |
| PMBTA64        | 30                      | 30                      | 500                    | 250                      | 5000            | -    | 10                        | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1265 |
| PXT4403*       | 40                      | 40                      | 600                    | 1000                     | 100             | 300  | 150                       | 2                         | 0.4                                | 150/15                                    | 200                             | 1317 |
| PXTA64*        | 30                      | 30                      | 300                    | 1000                     | 20000           | -    | 100                       | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1325 |
| PXTA77*        | -                       | 60                      | 500                    | 1000                     | 10000           | -    | 100                       | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1327 |
| PXTA92*        | 300                     | 300                     | 500                    | 1500                     | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1329 |
| PXTA93*        | 200                     | 200                     | 500                    | 1500                     | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1329 |
| PZTA55Δ        | 60                      | 60                      | 500                    | 1500                     | 50              | -    | 100                       | 1                         | 0.25                               | 100/10                                    | 50                              | 1357 |
| PZTA56Δ        | 80                      | 80                      | 500                    | 1500                     | 50              | -    | 100                       | 1                         | 0.25                               | 100/10                                    | 50                              | 1357 |
| PZTA63Δ        | 30                      | 30                      | 500                    | 1500                     | 10000           | -    | 100                       | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1361 |
| PZTA64Δ        | 30                      | 30                      | 500                    | 1500                     | 10000           | -    | 100                       | 5                         | 1.5                                | 100/0.1                                   | 125                             | 1361 |
| PZTA92Δ        | 300                     | 300                     | 500                    | 1500                     | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1363 |
| PZTA93Δ        | 200                     | 200                     | 500                    | 1500                     | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1363 |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

Δ Types in SOT223 package.

## Surface mounted semiconductors

## Selection guide

## HIGH-FREQUENCY TRANSISTORS in SOT23

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                   |               |                                 |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|-------------------|---------------|---------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | F<br>typ.<br>(dB) | at f<br>(MHz) | f <sub>T</sub><br>typ.<br>(MHz) | C <sub>re</sub><br>typ.<br>(pF) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                   |               |                                 |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                           |                   |               |                                 |                                 |      |
| BF570          | 40                      | 15                      | 100                    | 250                      | 40              | -    | 10                        | 1                         | -                 | -             | > 490                           | 1.6                             | 497  |
| BF840          | 40                      | 40                      | 25                     | 250                      | -               | -    | -                         | -                         | -                 | -             | 380                             | 0.3                             | 549  |
| BF841          | 40                      | 40                      | 25                     | 250                      | -               | -    | -                         | -                         | -                 | -             | 380                             | 0.3                             | 549  |
| BFS18          | 30                      | 20                      | 20                     | 250                      | 35              | 125  | 1                         | 10                        | 4                 | 100           | 200                             | 0.85                            | 839  |
| BFS19          | 30                      | 20                      | 30                     | 250                      | 65              | 225  | 1                         | 10                        | 4                 | 100           | 260                             | 0.85                            | 839  |
| BFS20          | 30                      | 20                      | 25                     | 250                      | 40              | 85   | 7                         | 10                        | -                 | -             | 450                             | -                               | 845  |
| PNP            |                         |                         |                        |                          |                 |      |                           |                           |                   |               |                                 |                                 |      |
| BF550          | 40                      | 40                      | 25                     | 250                      | 50              | -    | 1                         | 10                        | 2                 | 0.1           | 325                             | 0.5                             | 493  |
| BF569          | 40                      | 35                      | 30                     | 250                      | 25              | -    | 3                         | 10                        | 4.5               | 800           | 900                             | 0.33                            | 495  |
| BF579          | 20                      | 20                      | 25                     | 250                      | 20              | -    | 10                        | 10                        | 4.5               | 800           | 1350                            | 0.46                            | 501  |
| BF660          | 40                      | 30                      | 25                     | 250                      | 30              | -    | 3                         | 10                        | -                 | -             | 650                             | 0.65                            | 513  |
| BF824          | 30                      | 30                      | 25                     | 250                      | -               | -    | -                         | -                         | 3                 | 100           | 450                             | 0.1                             | 543  |

## BROADBAND TRANSISTORS in SOT23/SOT89\*/SOT143\*\*/SOT223Δ

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                 |               |                                 |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|---------------------------------|---------------|---------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | d <sub>lm</sub><br>typ.<br>(dB) | at f<br>(MHz) | f <sub>T</sub><br>typ.<br>(GHz) | C <sub>re</sub><br>typ.<br>(pF) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                 |               |                                 |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                              |                                 |               |                                 |                                 |      |
| BF747          | 30                      | 20                      | 50                     | 150                      | 40              | 250  | 2                         | 10                           | -                               | -             | 1.2                             | 0.5                             | 523  |
| BFG16AΔ        | 40                      | 25                      | 150                    | 1000                     | 25              | -    | 50                        | 5                            | -                               | -             | 1.5                             | 1.8                             | 591  |
| BFG17A**       | 25                      | 15                      | 50                     | 300                      | 20              | -    | 2                         | 1                            | 60                              | 793.25        | 2.8                             | 0.6                             | 599  |
| BFG25AX**      | 8                       | 5                       | 6.5                    | 32                       | 50              | 200  | 0.5                       | 1                            | -                               | -             | 5                               | 0.22                            | 607  |
| BFG33**        | 9                       | 7                       | 20                     | 300                      | 50              | -    | 14                        | 5                            | -                               | -             | 12                              | -                               | 617  |
| BFG33X**       | 9                       | 7                       | 20                     | 300                      | 50              | -    | 14                        | 5                            | -                               | -             | 12                              | -                               | 617  |
| BFG35Δ         | 25                      | 18                      | 150                    | 1000                     | 25              | -    | 100                       | 10                           | 60                              | 793.25        | 4                               | 1.2                             | 619  |
| BFG67**        | 20                      | 10                      | 50                     | 300                      | 60              | 100  | 15                        | 5                            | -                               | -             | 7.5                             | 0.5                             | 637  |
| BFG67X**       | 20                      | 10                      | 50                     | 300                      | 60              | -    | 15                        | 5                            | -                               | -             | 7.5                             | 0.5                             | 637  |
| BFG92A**       | 20                      | 15                      | 25                     | 300                      | 40              | -    | 14                        | 10                           | -                               | -             | 5                               | 0.35                            | 641  |
| BFG92AX**      | 20                      | 15                      | 25                     | 300                      | 40              | -    | 14                        | 10                           | -                               | -             | 5                               | 0.35                            | 641  |
| BFG93A**       | 15                      | 12                      | 35                     | 300                      | 40              | -    | 30                        | 5                            | -                               | -             | 6                               | 0.6                             | 647  |
| BFG93AX**      | 15                      | 12                      | 35                     | 300                      | 40              | -    | 30                        | 5                            | -                               | -             | 6                               | 0.6                             | 647  |
| BFG94Δ         | 15                      | 12                      | 60                     | 700                      | 45              | -    | 30                        | 5                            | 60                              | 793.25        | 6                               | 0.5                             | 653  |
| BFG97Δ         | 20                      | 15                      | 100                    | 1000                     | 25              | -    | 70                        | 10                           | 60                              | 793.25        | 5.5                             | 1.0                             | 665  |

## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                 |               |                                 |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|---------------------------------|---------------|---------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | d <sub>im</sub><br>typ.<br>(dB) | at f<br>(MHz) | f <sub>T</sub><br>typ.<br>(GHz) | C <sub>ro</sub><br>typ.<br>(pF) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                 |               |                                 |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                              |                                 |               |                                 |                                 |      |
| BFG135Δ        | 25                      | 15                      | 150                    | 1000                     | 80              | -    | 100                       | 10                           | 60                              | 793.25        | 7.0                             | 1.2                             | 675  |
| BFG197**       | 20                      | 10                      | 100                    | 300                      | 40              | -    | 50                        | 5                            | -                               | -             | 7.5                             | 0.85                            | 687  |
| BFG197X**      | 20                      | 10                      | 100                    | 300                      | 40              | -    | 50                        | 5                            | -                               | -             | 7.5                             | 0.85                            | 687  |
| BFG198Δ        | 20                      | 10                      | 100                    | 1000                     | 40              | -    | 50                        | 5                            | 60                              | 793.25        | 8.0                             | 0.8                             | 721  |
| BFQ17*         | 40                      | 25                      | 150                    | 1000                     | 25              | -    | 150                       | 5                            | -                               | -             | 1.2                             | 1.9                             | 731  |
| BFQ18A         | 25                      | 15                      | 150                    | 1000                     | 25              | -    | 100                       | 10                           | 60                              | 793.25        | 3.6                             | 1.2                             | 737  |
| BFQ19*         | 20                      | 15                      | 75                     | 500                      | 25              | -    | 75                        | 10                           | -                               | -             | 5.0                             | 1.3                             | 741  |
| BFQ67          | 20                      | 10                      | 50                     | 180                      | 100             | -    | 15                        | 5                            | -                               | -             | 7.5                             | 0.5                             | 747  |
| BFR53          | 18                      | 10                      | 50                     | 250                      | 25              | -    | 50                        | 5                            | 60                              | 217           | 2.0                             | 0.9                             | 767  |
| BFR92          | 20                      | 15                      | 25                     | 200                      | 25              | -    | 14                        | 10                           | 60                              | 493.25        | 5.0                             | 0.7                             | 775  |
| BFR92A         | 20                      | 15                      | 25                     | 200                      | 40              | -    | 14                        | 10                           | 60                              | 793.25        | 5.0                             | 0.35                            | 783  |
| BFR93          | 15                      | 12                      | 35                     | 200                      | 25              | -    | 30                        | 5                            | 60                              | 493.25        | 5.0                             | 0.8                             | 795  |
| BFR93A         | 15                      | 12                      | 35                     | 250                      | 40              | -    | 30                        | 5                            | 60                              | 793.25        | 5.0                             | 0.6                             | 803  |
| BFR106         | 20                      | 15                      | 100                    | 350                      | -               | -    | -                         | -                            | -                               | -             | 3.7                             | 1.2                             | 817  |
| BFS17          | 25                      | 15                      | 25                     | 250                      | 20              | 150  | 2                         | 1                            | 45                              | 217           | 1.3                             | 0.65                            | 827  |
| BFS17A         | 25                      | 15                      | 25                     | 300                      | 20              | 150  | 2                         | 1                            | -                               | -             | 2.8                             | 0.6                             | 833  |
| BFT25          | 8                       | 5                       | 2.5                    | 50                       | 20              | -    | 1                         | 1                            | -                               | -             | 2.3                             | 0.45                            | 851  |
| BFT25A         | 8                       | 5                       | 6.5                    | 50                       | -               | -    | -                         | -                            | -                               | -             | 5                               | 0.22                            | 859  |
| PNP            |                         |                         |                        |                          |                 |      |                           |                              |                                 |               |                                 |                                 |      |
| BFG31Δ         | 20                      | 15                      | 100                    | 1000                     | 25              | -    | 100                       | 10                           | 60                              | 848.25        | 5                               | 1.6                             | 611  |
| BFG55Δ         | 25                      | 18                      | 150                    | 1000                     | 25              | -    | 100                       | 10                           | 60                              | 848.25        | 4                               | 1.7                             | 631  |
| BFQ149*        | 20                      | 15                      | 75                     | 1000                     | 20              | -    | 50                        | 10                           | -                               | -             | 4.2                             | 1.7                             | 751  |
| BFT92          | 20                      | 15                      | 25                     | 200                      | 20              | -    | 14                        | 10                           | 60                              | 493.25        | 5                               | 0.7                             | 869  |
| BFT93          | 15                      | 12                      | 35                     | 200                      | 20              | -    | 30                        | 5                            | 60                              | 493.25        | 5                               | 1.0                             | 875  |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

Δ Types in SOT223 package.



## Surface mounted semiconductors

## Selection guide

## SWITCHING TRANSISTORS in SOT23/SOT89/SOT223A

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                                    |                                           |                                                   |                                           | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|------------------------------------|-------------------------------------------|---------------------------------------------------|-------------------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>(V)<br>max. | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | t <sub>on</sub> /t <sub>off</sub><br>(ns)<br>max. | at I <sub>C</sub> /I <sub>B</sub><br>(mA) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                                    |                                           |                                                   |                                           |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                                   |                                           |      |
| BSP50Δ         | 60                      | 45                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                        | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 909  |
| BSP51Δ         | 80                      | 60                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                        | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 909  |
| BSP52Δ         | 90                      | 80                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                        | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 909  |
| BSR13          | 60                      | 30                      | 800                    | 250                      | 100             | 300  | 150                       | 10                        | 1.6                                | 500/50                                    | 35/285                                            | 150/-                                     | 991  |
| BSR14          | 75                      | 40                      | 800                    | 250                      | 100             | 300  | 150                       | 10                        | 1.0                                | 500/50                                    | -                                                 | -                                         | 991  |
| BSR17A         | 60                      | 40                      | 200                    | 250                      | 100             | 300  | 10                        | 1                         | 0.3                                | 50/5                                      | 70/250                                            | 10/1                                      | 999  |
| BSR40*         | 70                      | 60                      | 1000                   | 1000                     | 40              | 120  | 100                       | 5                         | 0.5                                | 500/50                                    | 250/1000                                          | 100/5                                     | 1019 |
| BSR41*         | 70                      | 60                      | 1000                   | 1000                     | 100             | 300  | 100                       | 5                         | 0.5                                | 500/50                                    | 250/1000                                          | 100/5                                     | 1019 |
| BSR42*         | 90                      | 80                      | 1000                   | 1000                     | 40              | 120  | 100                       | 5                         | 0.5                                | 500/50                                    | 250/1000                                          | 100/5                                     | 1019 |
| BSR43*         | 90                      | 80                      | 1000                   | 1000                     | 100             | 300  | 100                       | 5                         | 0.5                                | 500/50                                    | 250/1000                                          | 100/5                                     | 1019 |
| BSS64          | 120                     | 80                      | 100                    | 250                      | 20              | 80   | 10                        | 1                         | 0.2                                | 50/15                                     | -/1000                                            | 15/1                                      | 1033 |
| BST50*         | 60                      | 45                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                        | 1.3                                | 500/50                                    | 400/1500                                          | 500/0.5                                   | 1067 |
| BST51*         | 80                      | 60                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                        | 1.3                                | 500/50                                    | 400/1500                                          | 500/0.5                                   | 1067 |
| BST52*         | 90                      | 80                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                        | 1.3                                | 500/50                                    | 400/1500                                          | 500/0.5                                   | 1067 |
| BSV52          | 20                      | 12                      | 100                    | 250                      | 40              | 120  | 10                        | 1                         | 0.2                                | 50/5                                      | 12/18                                             | 10/3                                      | 1099 |
| PMBT2222       | 60                      | 30                      | 600                    | 250                      | 100             | 300  | 150                       | 10                        | 0.4                                | 150/15                                    | 10/225                                            | 150/-                                     | 1215 |
| PMBT2222A      | 75                      | 40                      | 600                    | 250                      | 100             | 300  | 150                       | 10                        | 0.3                                | 150/15                                    | 10/225                                            | 150/-                                     | 1215 |
| PMBT2369       | 40                      | 40                      | 500                    | 250                      | 40              | 120  | 10                        | 1                         | 0.25                               | 10/1                                      | 12/18                                             | 10/3                                      | 1219 |
| PMBT3904       | 60                      | 40                      | 200                    | 300                      | 100             | 300  | 10                        | 1                         | 0.3                                | 50/5                                      | 35/200                                            | 10/1                                      | 1225 |
| PXT2222*       | 60                      | 30                      | 600                    | 1000                     | 100             | 300  | 150                       | 10                        | 0.4                                | 150/15                                    | 10/225                                            | 150/15                                    | 1297 |
| PXT2222A*      | 75                      | 40                      | 600                    | 1000                     | 100             | 300  | 150                       | 10                        | 0.4                                | 150/15                                    | 10/225                                            | 150/15                                    | 1297 |
| PXT3904*       | 60                      | 40                      | 200                    | 1000                     | 100             | 300  | 10                        | 1                         | 0.3                                | 50/5                                      | 35/200                                            | 10/1                                      | 1305 |
| PZT2222Δ       | 60                      | 30                      | 600                    | 1500                     | 100             | 300  | 150                       | 10                        | 0.4                                | 150/15                                    | -                                                 | -                                         | 1331 |
| PZT2222AΔ      | 75                      | 40                      | 600                    | 1500                     | 100             | 300  | 150                       | 10                        | 0.3                                | 150/10                                    | 10/225                                            | 150/15                                    | 1331 |
| PZT3904Δ       | 60                      | 40                      | 200                    | 1500                     | 100             | 300  | 10                        | 1                         | 0.3                                | 10/1                                      | 35/200                                            | 10/1                                      | 1339 |

## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                    |                                           |                                                   |                                           | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|------------------------------------|-------------------------------------------|---------------------------------------------------|-------------------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>(V)<br>max. | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | t <sub>on</sub> /t <sub>off</sub><br>(ns)<br>max. | at I <sub>C</sub> /I <sub>B</sub><br>(mA) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                    |                                           |                                                   |                                           |      |
| PNP            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                                   |                                           |      |
| BSP60Δ         | 60                      | 45                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 913  |
| BSP61Δ         | 80                      | 60                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 913  |
| BSP62Δ         | 90                      | 80                      | 500                    | 1500                     | 2000            | -    | 500                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 913  |
| BSR12          | 15                      | 15                      | 100                    | 250                      | 30              | 120  | 50                        | 1                            | 0.45                               | 100/10                                    | 20/30                                             | 30/3                                      | 985  |
| BSR15          | 60                      | 40                      | 600                    | 250                      | 100             | 300  | 150                       | 10                           | 1.6                                | 500/50                                    | 45/100                                            | 150/15                                    | 995  |
| BSR16          | 60                      | 60                      | 600                    | 250                      | 100             | 300  | 150                       | 10                           | 1.6                                | 500/50                                    | 45/100                                            | 150/15                                    | 995  |
| BSR18A         | 40                      | 40                      | 200                    | 250                      | 100             | 300  | 10                        | 1                            | 0.4                                | 50/5                                      | 70/300                                            | 10/1                                      | 1003 |
| BSR30*         | 70                      | 60                      | 1000                   | 1000                     | 40              | 120  | 100                       | 5                            | 0.5                                | 500/50                                    | 500/650                                           | 100/5                                     | 1015 |
| BSR31*         | 70                      | 60                      | 1000                   | 1000                     | 100             | 300  | 100                       | 5                            | 0.5                                | 500/50                                    | 500/650                                           | 100/5                                     | 1015 |
| BSR32*         | 90                      | 80                      | 1000                   | 1000                     | 40              | 120  | 100                       | 5                            | 0.5                                | 500/50                                    | 500/650                                           | 100/5                                     | 1015 |
| BSR33*         | 90                      | 80                      | 1000                   | 1000                     | 100             | 300  | 100                       | 5                            | 0.5                                | 500/50                                    | 500/650                                           | 100/5                                     | 1015 |
| BSS63          | 110                     | 100                     | 100                    | 250                      | 30              | -    | 25                        | 1                            | 0.25                               | 25/2.5                                    | -                                                 | -                                         | 1027 |
| BST60*         | 60                      | 45                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 1071 |
| BST61*         | 80                      | 60                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 1071 |
| BST62*         | 90                      | 80                      | 500                    | 1000                     | 1000            | -    | 150                       | 10                           | 1.3                                | 500/0.5                                   | 400/1500                                          | 500/0.5                                   | 1071 |
| PMBT2907       | 60                      | 40                      | 600                    | 250                      | 30              | 50   | 500                       | 10                           | 0.4                                | 150/15                                    | 45/100                                            | 150/15                                    | 1221 |
| PMBT2907A      | 60                      | 60                      | 600                    | 250                      | 30              | 50   | 500                       | 10                           | 0.4                                | 150/15                                    | 45/100                                            | 150/15                                    | 1221 |
| PMBT3906       | 40                      | 40                      | 200                    | 250                      | 100             | 300  | 10                        | 1                            | 0.25                               | 10/1                                      | 35/225                                            | 10/1                                      | 1229 |
| PXT2907*       | 60                      | 40                      | 600                    | 1000                     | 100             | 300  | 150                       | 10                           | 0.4                                | 150/10                                    | 45/100                                            | 150/15                                    | 1301 |
| PXT2907A*      | 60                      | 60                      | 600                    | 1000                     | 100             | 300  | 150                       | 10                           | 0.4                                | 150/10                                    | 45/100                                            | 150/15                                    | 1301 |
| PXT3906*       | 40                      | 40                      | 200                    | 1000                     | 100             | 300  | 10                        | 1                            | 0.25                               | 10/1                                      | 35/225                                            | 10/1                                      | 1309 |
| PZT2907Δ       | 60                      | 40                      | 600                    | 1500                     | 100             | 300  | 150                       | 10                           | 0.4                                | 150/15                                    | 45/100                                            | 150/15                                    | 1335 |
| PZT2907AΔ      | 60                      | 60                      | 600                    | 1500                     | 100             | 300  | 150                       | 10                           | 0.4                                | 150/15                                    | 45/100                                            | 150/15                                    | 1335 |
| PZT3906Δ       | 40                      | 40                      | 200                    | 1500                     | 100             | 300  | 10                        | 1                            | 0.4                                | 50/5                                      | 35/225                                            | 10/1                                      | 1343 |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

Δ Types in SOT223 package.

## Surface mounted semiconductors

## Selection guide

## POWER TRANSISTORS FOR SWITCHING in SOT223

| TYPE<br>NUMBER | RATINGS                 |                         |                       |                         | CHARACTERISTICS         |                          |                              |                                    |                          |                           |                         |                          |                          |                           | PAGE |
|----------------|-------------------------|-------------------------|-----------------------|-------------------------|-------------------------|--------------------------|------------------------------|------------------------------------|--------------------------|---------------------------|-------------------------|--------------------------|--------------------------|---------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(A) | P <sub>tot</sub><br>(W) | h <sub>FE</sub><br>min. | at I <sub>C</sub><br>(A) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>(V)<br>max. | at I <sub>C</sub><br>(A) | at I <sub>B</sub><br>(mA) | t <sub>on</sub><br>max. | t <sub>off</sub><br>max. | at I <sub>C</sub><br>(A) | at I <sub>B</sub><br>(mA) |      |
| NPN            |                         |                         |                       |                         |                         |                          |                              |                                    |                          |                           |                         |                          |                          |                           |      |
| BDS61          | 60                      | 60                      | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 2                       | 8                        | 1.5                      | 6000                      | 421  |
| BDS61A         | 80                      | 80                      | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 2                       | 8                        | 1.5                      | 6000                      | 421  |
| BDS61B         | 100                     | 100                     | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 2                       | 8                        | 1.5                      | 6000                      | 421  |
| BDS61C         | 120                     | 120                     | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 2                       | 8                        | 1.5                      | 6000                      | 421  |
| BDS77          | 100                     | 80                      | 3                     | 8                       | 30                      | 2                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 427  |
| BDS201         | 60                      | 45                      | 3                     | 8                       | 40                      | 3                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 427  |
| BDS203         | 60                      | 60                      | 3                     | 8                       | 30                      | 2                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 427  |
| BDS643         | 60                      | 45                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 439  |
| BDS645         | 80                      | 60                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 439  |
| BDS647         | 100                     | 80                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 439  |
| BDS649         | 120                     | 100                     | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 1                       | 10                       | 3                        | 12                        | 439  |
| BDS651         | 140                     | 120                     | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 439  |
| BDS933         | 45                      | 45                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 1                       | 3                        | 1                        | 100                       | 451  |
| BDS935         | 60                      | 60                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 1                       | 3                        | 1                        | 100                       | 451  |
| BDS937         | 100                     | 80                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 1                       | 3                        | 1                        | 100                       | 451  |
| BDS939         | 120                     | 100                     | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 1                       | 3                        | 1                        | 100                       | 451  |
| BDS941         | 140                     | 120                     | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 1                       | 3                        | 1                        | 100                       | 451  |
| BDS943         | 22                      | 22                      | 3                     | 8                       | 50                      | 2                        | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 463  |
| BDS945         | 32                      | 32                      | 3                     | 8                       | 50                      | 2                        | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 463  |
| BDS947         | 45                      | 45                      | 3                     | 8                       | 40                      | 0.25                     | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 463  |
| BDS949         | 60                      | 60                      | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 475  |
| BDS951         | 80                      | 80                      | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 475  |
| BDS953         | 100                     | 100                     | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 475  |
| BDS955         | 120                     | 120                     | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 475  |
| PNP            |                         |                         |                       |                         |                         |                          |                              |                                    |                          |                           |                         |                          |                          |                           |      |
| BDS60          | 60                      | 60                      | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 1.5                     | 5                        | 1.5                      | 6000                      | 415  |
| BDS60A         | 80                      | 80                      | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 1.5                     | 5                        | 1.5                      | 6000                      | 415  |
| BDS60B         | 100                     | 100                     | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 1.5                     | 5                        | 1.5                      | 6000                      | 415  |
| BDS60C         | 120                     | 120                     | 4                     | 8                       | 1000                    | 1.5                      | 3                            | 1.6                                | 1.5                      | 6                         | 1.5                     | 5                        | 1.5                      | 6000                      | 415  |
| BDS78          | 100                     | 80                      | 3                     | 8                       | 40                      | 3                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 433  |
| BDS202         | 60                      | 45                      | 3                     | 8                       | 40                      | 3                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 433  |
| BDS204         | 60                      | 60                      | 3                     | 8                       | 40                      | 3                        | 2                            | 1.8                                | 6                        | 600                       | 1                       | 3                        | 2                        | 200                       | 433  |
| BDS644         | 60                      | 45                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 445  |
| BDS646         | 80                      | 60                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 445  |



## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS                 |                         |                       |                         | CHARACTERISTICS         |                          |                              |                                    |                          |                           |                         |                          |                          |                           | PAGE |
|----------------|-------------------------|-------------------------|-----------------------|-------------------------|-------------------------|--------------------------|------------------------------|------------------------------------|--------------------------|---------------------------|-------------------------|--------------------------|--------------------------|---------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(A) | P <sub>tot</sub><br>(W) | h <sub>FE</sub><br>min. | at I <sub>C</sub><br>(A) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>(V)<br>max. | at I <sub>C</sub><br>(A) | at I <sub>B</sub><br>(mA) | t <sub>on</sub><br>max. | t <sub>off</sub><br>max. | at I <sub>C</sub><br>(A) | at I <sub>B</sub><br>(mA) |      |
| PNP            |                         |                         |                       |                         |                         |                          |                              |                                    |                          |                           |                         |                          |                          |                           |      |
| BDS648         | 100                     | 80                      | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 445  |
| BDS650         | 120                     | 100                     | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 445  |
| BDS652         | 140                     | 120                     | 3                     | 8                       | 1000                    | 3                        | 3                            | 1.8                                | 5                        | 50                        | 2                       | 10                       | 3                        | 12                        | 445  |
| BDS934         | 45                      | 45                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 0.6                     | 2.4                      | 1                        | 100                       | 457  |
| BDS936         | 60                      | 60                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 0.6                     | 2.4                      | 1                        | 100                       | 457  |
| BDS938         | 100                     | 80                      | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 0.6                     | 2.4                      | 1                        | 100                       | 457  |
| BDS940         | 120                     | 100                     | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 0.6                     | 2.4                      | 1                        | 100                       | 457  |
| BDS942         | 140                     | 120                     | 3                     | 8                       | 25                      | 1                        | 2                            | 0.5                                | 1                        | 100                       | 0.6                     | 2.4                      | 1                        | 100                       | 457  |
| BDS944         | 22                      | 22                      | 3                     | 8                       | 50                      | 2                        | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 469  |
| BDS946         | 32                      | 32                      | 3                     | 8                       | 50                      | 2                        | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 469  |
| BDS948         | 45                      | 45                      | 3                     | 8                       | 40                      | 2                        | 1                            | 0.5                                | 2                        | 200                       | -                       | -                        | -                        | -                         | 469  |
| BDS950         | 60                      | 60                      | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 481  |
| BDS952         | 80                      | 80                      | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 481  |
| BDS954         | 100                     | 100                     | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 481  |
| BDS956         | 120                     | 120                     | 3                     | 8                       | 20                      | 2                        | 4                            | 1                                  | 2                        | 200                       | -                       | -                        | -                        | -                         | 481  |



## Surface mounted semiconductors

## Selection guide

LOW-NOISE TRANSISTORS in SOT23 ( $F > 4$  dB at  $f = 1$  kHz;  $B = 200$  Hz)

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                              |                                    |                                           |                                 |      | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|------------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at<br>V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                              |                                    |                                           |                                 |      |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |      |
| BC849          | 30                      | 30                      | 100                    | 250                      | -               | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 245  |      |
| BC850          | 45                      | 45                      | 100                    | 250                      | -               | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 245  |      |
| BCF32          | 32                      | 32                      | 100                    | 250                      | 200             | 450  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 293  |      |
| BCF33          | 32                      | 32                      | 100                    | 250                      | 420             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 293  |      |
| BCF81          | 50                      | 45                      | 100                    | 250                      | 420             | 800  | 2                         | 5                            | 0.25                               | 10/0.5                                    | 300                             | 305  |      |
| PMBT5088       | 35                      | 30                      | 50                     | 250                      | 350             | -    | 1                         | 5                            | 0.5                                | 10/1                                      | 200                             | 1241 |      |
| PNP            |                         |                         |                        |                          |                 |      |                           |                              |                                    |                                           |                                 |      |      |
| BC859          | 30                      | 30                      | 100                    | 250                      | 125             | 800  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 265  |      |
| BC860          | 45                      | 45                      | 100                    | 250                      | 125             | 800  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 265  |      |
| BCF29          | 32                      | 32                      | 100                    | 250                      | 120             | 260  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 287  |      |
| BCF30          | 32                      | 32                      | 100                    | 250                      | 215             | 500  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 287  |      |
| BCF70          | 50                      | 45                      | 100                    | 250                      | 215             | 500  | 2                         | 5                            | 0.3                                | 10/0.5                                    | 150                             | 299  |      |

## HIGH-VOLTAGE TRANSISTORS in SOT23/SOT89/SOT223Δ

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                                    |                                           |                                 |      |
| NPN            |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                 |      |
| BF620*         | 300                     | -                       | 50                     | 1000                     | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 505  |
| BF622*         | 250                     | 250                     | 50                     | 1000                     | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 505  |
| BF720Δ         | 300                     | -                       | 50                     | 1500                     | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 515  |
| BF722Δ         | 250                     | 250                     | 50                     | 1500                     | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 515  |
| BF820          | 300                     | -                       | 50                     | 310                      | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 535  |
| BF822          | 250                     | 250                     | 50                     | 310                      | 50              | -    | 25                        | 20                        | 0.6                                | 30/5                                      | 60                              | 535  |
| BSP19Δ         | 400                     | 350                     | 1000                   | 1500                     | 40              | -    | 10                        | 20                        | 1.3                                | 50/4                                      | 70                              | 899  |
| BSP20Δ         | 300                     | 250                     | 1000                   | 1500                     | 40              | -    | 10                        | 20                        | 1.3                                | 50/4                                      | 70                              | 899  |
| BSR19          | 160                     | 140                     | 600                    | 350                      | 60              | 250  | 10                        | 5                         | 0.25                               | 50/5                                      | 100                             | 1007 |
| BSR19A         | 180                     | 160                     | 600                    | 360                      | 80              | 250  | 10                        | 5                         | 0.2                                | 50/5                                      | 100                             | 1007 |
| BST39*         | 400                     | 350                     | 1000                   | 1000                     | 40              | 160  | 20                        | 10                        | 0.5                                | 50/4                                      | 70                              | 1063 |
| BST40*         | 300                     | 250                     | 1000                   | 1000                     | 40              | 160  | 20                        | 10                        | 0.5                                | 50/4                                      | 70                              | 1063 |
| PMBT5551       | 180                     | 160                     | 600                    | 250                      | 80              | 250  | 10                        | 5                         | 0.2                                | 50/5                                      | 100                             | 1249 |
| PMBTA42        | 300                     | 300                     | 500                    | 250                      | 40              | -    | 30                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1259 |
| PMBTA43        | 200                     | 200                     | 500                    | 250                      | 40              | -    | 30                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1259 |

## Surface mounted semiconductors

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HIGH-VOLTAGE TRANSISTORS in SOT23/SOT89\*/SOT223 $\Delta$ 

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                                    |                                           |                                 |      |
| PNP            |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                 |      |
| BF621*         | 300                     | -                       | 20                     | 1000                     | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 509  |
| BF623*         | 250                     | 250                     | 20                     | 1000                     | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 509  |
| BF721Δ         | 300                     | -                       | 50                     | 1500                     | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 519  |
| BF723Δ         | 250                     | 250                     | 50                     | 1500                     | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 519  |
| BF821          | 300                     | -                       | 50                     | 250                      | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 539  |
| BF823          | 250                     | 250                     | 50                     | 250                      | 50              | -    | 25                        | 20                        | 0.8                                | 30/5                                      | 60                              | 539  |
| BSP15Δ         | 200                     | 200                     | 1000                   | 1500                     | 30              | 150  | 10                        | 50                        | 2.5                                | 50/5                                      | 15                              | 897  |
| BSP16Δ         | 350                     | 300                     | 1000                   | 1500                     | 30              | 120  | 10                        | 50                        | 2.0                                | 50/5                                      | 15                              | 897  |
| BSR20          | 130                     | 120                     | 600                    | 250                      | 40              | 180  | 10                        | 5                         | 0.5                                | 50/5                                      | 100                             | 1011 |
| BSR20A         | 160                     | 150                     | 600                    | 250                      | 60              | 240  | 10                        | 5                         | 0.5                                | 50/5                                      | 100                             | 1011 |
| BST15*         | 200                     | 200                     | 1000                   | 1000                     | 30              | 150  | 50                        | 10                        | 2.5                                | 50/5                                      | 15                              | 1059 |
| BST16*         | 350                     | 300                     | 1000                   | 1000                     | 30              | 120  | 50                        | 10                        | 2.0                                | 50/5                                      | 15                              | 1059 |
| PMBT5401       | 160                     | 150                     | 500                    | 250                      | 60              | 240  | 10                        | 5                         | 0.5                                | 50/5                                      | 100                             | 1245 |
| PMBTA92        | 300                     | 300                     | 500                    | 250                      | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1267 |
| PMBTA93        | 200                     | 200                     | 500                    | 250                      | 40              | -    | 10                        | 10                        | 0.5                                | 20/2                                      | 50                              | 1267 |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

 $\Delta$  Types in SOT223 package.FIELD-EFFECT TRANSISTORS in SOT23/SOT89\*/SOT143\*\*/SOT223 $\Delta$ 

| TYPE<br>NUMBER | RATINGS             |                   |               |                   | CHARACTERISTICS            |                   |      |                             |                            |                          |                             | PAGE |
|----------------|---------------------|-------------------|---------------|-------------------|----------------------------|-------------------|------|-----------------------------|----------------------------|--------------------------|-----------------------------|------|
|                | $\pm V_{DS}$<br>(V) | $-V_{GSO}$<br>(V) | $I_D$<br>(mA) | $P_{tot}$<br>(mW) | $-I_{GSS}$<br>(nA)<br>max. | $I_{DSS}$<br>(mA) |      | $-V_{(P)GS}$<br>(V)<br>max. | $ Y_{fs} $<br>(ms)<br>min. | $C_{rs}$<br>(pF)<br>max. | $V_n$<br>( $\mu$ V)<br>max. |      |
|                |                     |                   |               |                   |                            | min.              | max. |                             |                            |                          |                             |      |
| BF510          | 20                  | -                 | 30            | 250               | 10                         | 0.7               | 3    | 0.8                         | 2.5                        | 0.4                      | -                           | 487  |
| BF511          | 20                  | -                 | 30            | 250               | 10                         | 2.5               | 7    | 1.5                         | 4                          | 0.4                      | -                           | 487  |
| BF512          | 20                  | -                 | 30            | 250               | 10                         | 6                 | 12   | 2.2                         | 6                          | 0.4                      | -                           | 487  |
| BF513          | 20                  | -                 | 30            | 250               | 10                         | 10                | 18   | 3                           | 7                          | 0.4                      | -                           | 487  |
| BF989**        | 20                  | -                 | 20            | 200               | 50                         | 2                 | 20   | 2.7                         | 9.5                        | 0.025                    | -                           | 551  |
| BF990A**       | 18                  | -                 | 30            | 200               | 25                         | -                 | -    | 1.3                         | 17                         | 0.025                    | -                           | 555  |
| BF991**        | 20                  | -                 | 20            | 200               | 50                         | 4                 | 25   | 2.5                         | 10                         | 0.020                    | -                           | 559  |
| BF992**        | 20                  | -                 | 40            | 200               | 25                         | -                 | -    | 1.3                         | 20                         | 0.04                     | -                           | 563  |

## Surface mounted semiconductors

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| TYPE<br>NUMBER  | RATINGS             |                   |               |                   | CHARACTERISTICS            |                   |        |                             |                            |                          |                             | PAGE |
|-----------------|---------------------|-------------------|---------------|-------------------|----------------------------|-------------------|--------|-----------------------------|----------------------------|--------------------------|-----------------------------|------|
|                 | $\pm V_{DS}$<br>(V) | $-V_{GSO}$<br>(V) | $I_D$<br>(mA) | $P_{tot}$<br>(mW) | $-I_{GSS}$<br>(nA)<br>max. | $I_{DSS}$<br>(mA) |        | $-V_{(P)GS}$<br>(V)<br>max. | $ Y_{fs} $<br>(ms)<br>min. | $C_{rs}$<br>(pF)<br>max. | $V_n$<br>( $\mu$ v)<br>max. |      |
|                 |                     |                   |               |                   |                            | min.              | max.   |                             |                            |                          |                             |      |
| BF994S**        | 20                  | -                 | 50            | 300               | 50                         | 4                 | 20     | 2.5                         | 15                         | 0.025                    | -                           | 569  |
| BF996S**        | 20                  | -                 | 30            | 300               | 50                         | 4                 | 20     | 2.5                         | 15                         | 0.025                    | -                           | 573  |
| BF997**         | 20                  | -                 | 30            | 300               | 10                         | 2                 | 20     | 2.5                         | 15                         | 0.025                    | -                           | 577  |
| BF998**         | 12                  | -                 | 30            | 200               | 50                         | 2                 | 18     | 2.5                         | 21                         | -                        | -                           | 581  |
| BFR30           | 25                  | 25                | 10            | 250               | 0.2                        | 4                 | 10     | 5                           | 1                          | 1.5                      | 0.5                         | 757  |
| BFR31           | 25                  | -                 | -             | -                 | -                          | 1                 | 5      | 2.5                         | 1.5                        | 1.5                      | 0.5                         | 757  |
| BFR101A**       | 30                  | 30                | 10            | 200               | 5                          | 0.2               | 1.5    | 1.0                         | 1.2                        | -                        | -                           | 815  |
| BFR101B**       | 30                  | 30                | 10            | 200               | 5                          | 1                 | 5      | 2.5                         | 2.5                        | -                        | -                           | 815  |
| BFR200**        | 30                  | 30                | 20            | 250               | .003                       | 0.2               | 3.5    | -                           | 1.3                        | -                        | -                           | 823  |
| BFT46           | 25                  | 25                | 10            | 250               | 0.2                        | 0.2               | 1.5    | 1.2                         | 1.0                        | 1.5                      | 0.5                         | 861  |
| BSD22**         | 20                  | -                 | 50            | 230               | 1                          | -                 | -      | 2.0                         | -                          | 0.6                      | -                           | 893  |
| BSP103 $\Delta$ | 35                  | 20                | 700           | 1500              | -                          | -                 | -      | -                           | -                          | -                        | -                           | 917  |
| BSP105 $\Delta$ | 60                  | 20                | 500           | 1500              | -                          | -                 | -      | -                           | -                          | -                        | -                           | 917  |
| BSP106 $\Delta$ | 60                  | 20                | 425           | 1500              | 10                         | -                 | 0.001  | -                           | 100                        | 10                       | -                           | 921  |
| BSP107 $\Delta$ | 200                 | 20                | 200           | 1500              | 10                         | -                 | .00003 | -                           | 90                         | 10                       | -                           | 929  |
| BSP108 $\Delta$ | 80                  | 20                | 500           | 1500              | 100                        | -                 | 0.001  | -                           | 150                        | 12                       | -                           | 937  |
| BSP109 $\Delta$ | 90                  | 20                | 450           | 1500              | -                          | -                 | -      | -                           | -                          | -                        | -                           | 917  |
| BSP110 $\Delta$ | 80                  | 20                | 325           | 1500              | 100                        | -                 | 0.001  | -                           | 75                         | 6                        | -                           | 941  |
| BSP120 $\Delta$ | 200                 | 20                | 250           | 1500              | 100                        | -                 | 0.001  | -                           | 125                        | 10                       | -                           | 945  |
| BSP121 $\Delta$ | 200                 | 20                | 350           | 1500              | 100                        | -                 | 0.001  | -                           | 200                        | 10                       | -                           | 949  |
| BSP126 $\Delta$ | 250                 | 20                | 350           | 1500              | 100                        | -                 | 0.001  | -                           | 200                        | 15                       | -                           | 955  |
| BSP205 $\Delta$ | 60                  | 20                | 275           | 1500              | 100                        | -                 | 0.001  | -                           | 60                         | 10                       | -                           | 961  |
| BSP206 $\Delta$ | 60                  | 20                | 350           | 1500              | 100                        | -                 | 0.001  | -                           | 100                        | 12                       | -                           | 965  |
| BSP220 $\Delta$ | 200                 | 20                | 225           | 1500              | 100                        | -                 | 0.001  | -                           | 100                        | 15                       | -                           | 969  |
| BSP225 $\Delta$ | 250                 | 20                | 225           | 1500              | 100                        | -                 | 0.001  | -                           | 100                        | 15                       | -                           | 977  |
| BSR56           | 40                  | 40                | -             | 250               | 1                          | 50                | -      | 10                          | -                          | 5                        | -                           | 1023 |
| BSR57           | 40                  | 40                | -             | 250               | 1                          | 20                | 100    | 6                           | -                          | 5                        | -                           | 1023 |
| BSR58           | 40                  | 40                | -             | 250               | 1                          | 8                 | 80     | 4                           | -                          | 5                        | -                           | 1023 |
| BSS83**         | 10                  | -                 | 50            | 230               | 10                         | -                 | -      | 2                           | -                          | 0.6                      | -                           | 1037 |
| BSS84           | 50                  | 20                | 130           | 360               | 6000                       | -                 | 0.06   | -                           | 50                         | -                        | -                           | 1041 |
| BSS87           | 200                 | 20                | 280           | 1000              | 100                        | -                 | 0.06   | -                           | 140                        | 10                       | -                           | 1045 |
| BSS131          | 240                 | 20                | 100           | 360               | 10                         | -                 | 0.06   | -                           | 60                         | -                        | -                           | 1049 |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.

 $\Delta$  Types in SOT223 package.



## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | RATINGS             |                   |               |                   | CHARACTERISTICS            |                   |       |                             |                            |                          |                              | PAGE |
|----------------|---------------------|-------------------|---------------|-------------------|----------------------------|-------------------|-------|-----------------------------|----------------------------|--------------------------|------------------------------|------|
|                | $\pm V_{DS}$<br>(V) | $-V_{GSO}$<br>(V) | $I_D$<br>(mA) | $P_{tot}$<br>(mW) | $-I_{GSS}$<br>(nA)<br>max. | $I_{DSS}$<br>(mA) |       | $-V_{(P)GS}$<br>(V)<br>max. | $ Y_{fs} $<br>(ms)<br>min. | $C_{rs}$<br>(pF)<br>max. | $V_n$<br>( $\mu v$ )<br>max. |      |
|                |                     |                   |               |                   |                            | min.              | max.  |                             |                            |                          |                              |      |
| BSS192*        | 200                 | 20                | 150           | 1000              | 100                        | -                 | 0.06  | -                           | 60                         | 15                       | -                            | 1053 |
| BST80*         | 80                  | 20                | 500           | 1000              | 100                        | -                 | 0.01  | 3.5                         | 300                        | 8                        | -                            | 1075 |
| BST82          | 80                  | 20                | 175           | 300               | 100                        | -                 | 0.001 | 3.5                         | 150                        | 3                        | -                            | 1079 |
| BST84*         | 200                 | 20                | 250           | 1000              | 100                        | -                 | 0.01  | 2.8                         | 250                        | 5                        | -                            | 1083 |
| BST86*         | 180                 | 20                | 300           | 1000              | 100                        | -                 | 0.01  | 2.4                         | 250                        | 6                        | -                            | 1087 |
| BST120*        | 60                  | 20                | 300           | 1000              | 100                        | -                 | 0.01  | 3.5                         | 200                        | 8                        | -                            | 1091 |
| BST122*        | 50                  | 20                | 250           | 1000              | 100                        | -                 | 0.01  | 3.5                         | 125                        | 8                        | -                            | 1095 |
| PMBF170        | 60                  | 20                | 250           | 300               | 10                         | -                 | 0.001 | -                           | 100                        | 10                       | -                            | 1191 |
| PMBF4391       | 40                  | 40                | -             | 250               | 1                          | 50                | 150   | 10                          | -                          | 3.5                      | -                            | 1195 |
| PMBF4392       | 40                  | 40                | -             | 250               | 1                          | 25                | 75    | 5                           | -                          | 3.5                      | -                            | 1195 |
| PMBF4393       | 40                  | 40                | -             | 250               | 1                          | 5                 | 30    | 3                           | -                          | 3.5                      | -                            | 1195 |
| PMBFJ108       | 25                  | 25                | -             | 250               | 3                          | 80                | -     | -                           | -                          | 15                       | -                            | 1199 |
| PMBFJ109       | 25                  | 25                | -             | 250               | 3                          | 40                | -     | -                           | -                          | 15                       | -                            | 1199 |
| PMBFJ110       | 25                  | 25                | -             | 250               | 3                          | 10                | -     | -                           | -                          | 15                       | -                            | 1199 |
| PMBFJ111       | 40                  | 40                | -             | 300               | 1                          | 20                | -     | -                           | -                          | -                        | -                            | 1205 |
| PMBFJ112       | 40                  | 40                | -             | 300               | 1                          | 5                 | -     | -                           | -                          | -                        | -                            | 1205 |
| PMBFJ113       | 40                  | 40                | -             | 300               | 1                          | 2                 | -     | -                           | -                          | -                        | -                            | 1205 |
| PMBFJ174       | 30                  | 30                | -             | 300               | 1                          | 20                | 135   | 10                          | -                          | 4                        | -                            | 1211 |
| PMBFJ175       | 30                  | 30                | -             | 300               | 1                          | 7                 | 70    | 6                           | -                          | 4                        | -                            | 1211 |
| PMBFJ176       | 30                  | 30                | -             | 300               | 1                          | 2                 | 35    | 4                           | -                          | 4                        | -                            | 1211 |
| PMBFJ177       | 30                  | 30                | -             | 300               | 1                          | 1.5               | 20    | 2.25                        | -                          | 4                        | -                            | 1211 |
| 2N7002         | 60                  | -                 | 180           | 300               | -                          | -                 | -     | -                           | -                          | -                        | -                            | 1365 |

## Notes

\* Types in SOT89 package.

\*\* Types in SOT143 package.



## SPECIAL TRANSISTORS IN SOT143

| TYPE<br>NUMBER | RATINGS                 |                         |                        |                          | CHARACTERISTICS |      |                           |                           |                                    |                                           |                                 | PAGE |
|----------------|-------------------------|-------------------------|------------------------|--------------------------|-----------------|------|---------------------------|---------------------------|------------------------------------|-------------------------------------------|---------------------------------|------|
|                | V <sub>CBO</sub><br>(V) | V <sub>CEO</sub><br>(V) | I <sub>C</sub><br>(mA) | P <sub>tot</sub><br>(mW) | h <sub>FE</sub> |      | at I <sub>C</sub><br>(mA) | at V <sub>CE</sub><br>(V) | V <sub>CE sat</sub><br>max.<br>(V) | at I <sub>C</sub> /I <sub>B</sub><br>(mA) | f <sub>T</sub><br>typ.<br>(MHz) |      |
|                |                         |                         |                        |                          | min.            | max. |                           |                           |                                    |                                           |                                 |      |
| PNP            |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                 |      |
| BCV62          | 30                      | 30                      | 100                    | 250                      | 100             | 800  | 2                         | 5                         | 0.65                               | 100/5                                     | 150                             | 339  |
| BCV64          | 30                      | 30                      | 100                    | 250                      | 100             | 900  | 2                         | 5                         | 0.3                                | 100/0.5                                   | 200                             | 347  |
| NPN            |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                 |      |
| BCV61          | 30                      | 30                      | 100                    | 250                      | 110             | 800  | 2                         | 5                         | 0.6                                | 100/5                                     | 300                             | 335  |
| BCV63          | 30                      | 30                      | 100                    | 250                      | 100             | 900  | 2                         | 5                         | 0.65                               | 100/5                                     | 200                             | 343  |
| NPN/PNP        |                         |                         |                        |                          |                 |      |                           |                           |                                    |                                           |                                 |      |
| BCV65          | 30                      | 30                      | 100                    | 250                      | 75              | 800  | 2                         | 5                         | 0.3                                | 10/0.5                                    | 100                             | 351  |

## TRIGGER DEVICES

| TYPE  | ENVELOPE | RATINGS                 |                       | CHARACTERISTICS     |                     | PAGE |
|-------|----------|-------------------------|-----------------------|---------------------|---------------------|------|
|       |          | $V_{GA}$<br>(V)<br>max. | $I_A$<br>(mA)<br>max. | $I_p$<br>( $\mu$ A) | $I_V$<br>( $\mu$ A) |      |
| BRY61 | SOT23    | 70                      | 175                   | 5/1                 | 30/50               | 881  |
| BRY62 | SOT143   | 70                      | 175                   | -                   | -                   | 887  |

## DIODES in SOT23/SOD80\*/SOT143\*\*

| TYPE<br>NUMBER | DESCRIPTION              | RATINGS      |               | CHARACTERISTICS          |              |                  |                       | PAGE |
|----------------|--------------------------|--------------|---------------|--------------------------|--------------|------------------|-----------------------|------|
|                |                          | $V_R$<br>(V) | $I_F$<br>(mA) | $t_{rr}$<br>max.<br>(ns) | $V_F$<br>(V) | at $I_F$<br>(mA) | $C_d$<br>max.<br>(pF) |      |
| BA423L*        | band switch              | 20           | 50            | -                        | 0.9          | 50               | 2.5                   | 89   |
| BA682*         | band switch              | 35           | 100           | -                        | 1            | 100              | 1.5                   | 91   |
| BA683*         | band switch              | 35           | 100           | -                        | 1            | 100              | 1.5                   | 91   |
| BAS16          | high-speed switch        | 75           | 250           | 6                        | 1.25         | 150              | 2                     | 93   |
| BAS17          | low-voltage stabilizer   | -            | 250           | -                        | 0.87-0.96    | 100              | 140                   | 97   |
| BAS19          | high-speed switch        | 100          | 200           | 50                       | 1.25         | 200              | 5                     | 101  |
| BAS20          | high-speed switch        | 150          | 200           | 50                       | 1.25         | 200              | 5                     | 101  |
| BAS21          | high-speed switch        | 200          | 200           | 50                       | 1.25         | 200              | 5                     | 101  |
| BAS28**        | fast switch double diode | 75           | 250           | 6                        | 1.25         | 150              | 2                     | 109  |
| BAS29          | switch                   | 90           | 250           | 50                       | 1.25         | 400              | 35                    | 113  |
| BAS31          | two diodes in series     | 90           | 250           | 50                       | 1.25         | 400              | 35                    | 113  |
| BAS32*         | high-speed switch        | 75           | 200           | 4                        | 1            | 100              | 2                     | 115  |
| BAS32L*        | high-speed switch        | 75           | 200           | 4                        | 1            | 100              | 2                     | 123  |

## Surface mounted semiconductors

## Selection guide

| TYPE<br>NUMBER | DESCRIPTION                          | RATINGS      |               | CHARACTERISTICS          |              |                  |                       | PAGE |
|----------------|--------------------------------------|--------------|---------------|--------------------------|--------------|------------------|-----------------------|------|
|                |                                      | $V_R$<br>(V) | $I_F$<br>(mA) | $t_{rr}$<br>max.<br>(ns) | $V_F$<br>(V) | at $I_F$<br>(mA) | $C_d$<br>max.<br>(pF) |      |
| BAS35          | common diode double diode            | 90           | 250           | 50                       | 1.25         | 400              | 35                    | 113  |
| BAS56**        | ultra-high speed switch double diode | 60           | 200           | 6                        | 1.25         | 500              | 2.5                   | 131  |
| BAS85*         | Schottky barrier                     | 30           | 200           | 5                        | 0.8          | 100              | 10                    | 135  |
| BAS86          | Schottky barrier                     | 50           | 200           | 4                        | 0.9          | 100              | -                     | 139  |
| BAT17          | Schottky barrier                     | 4            | 30            | -                        | 0.6          | 10               | 1                     | 143  |
| BAT18          | band switch                          | 35           | 100           |                          | 1.2          | 100              | 1                     | 147  |
| BAT54          | Schottky barrier                     | 30           | 200           | 5                        | 1            | 100              | 10                    | 151  |
| BAT54A;C;S     | Schottky barrier                     | 30           | 200           | 5                        | 1            | 100              | 10                    | 155  |
| BAT74**        | Schottky barrier double diode        | 30           | 200           | 5                        | 1            | 100              | 10                    | 157  |
| BAV23**        | two diodes                           | 200          | 200           | 50                       | 2.5          | 200              | 2.5                   | 161  |
| BAV70          | common cathode double diode          | 70           | 250           | 6                        | 1.25         | 150              | 1.5                   | 163  |
| BAV74          | two diodes                           | 50           | 250           | 4                        | 1            | 100              | 2                     | 167  |
| BAV99          | two diodes in series                 | 70           | 250           | 6                        | 1.25         | 150              | 1.5                   | 171  |
| BAV100*        | general purpose                      | 50           | 250           | 50                       | 1.25         | 200              | 5                     | 175  |
| BAV101*        | general purpose                      | 100          | 250           | 50                       | 1.25         | 200              | 5                     | 175  |
| BAV102*        | general purpose                      | 150          | 250           | 50                       | 1.25         | 200              | 5                     | 175  |
| BAV103*        | general purpose                      | 200          | 250           | 50                       | 1.25         | 200              | 5                     | 175  |
| BAV105*        | ultra high speed                     | 60           | 300           | 6                        | 1.25         | 500              | 2.5                   | 183  |
| BAW56          | common anode double diode            | 70           | 250           | 6                        | 1.25         | 150              | 2                     | 191  |
| PMBD914        | high speed switch                    | 70           | 200           | 15                       | 1            | 10               | 4                     | 1179 |
| PMBD6050       | high speed switch                    | 70           | 200           | 15                       | 1.1          | 100              | 2.5                   | 1183 |
| PMBD7000       | two diodes in series                 | 100          | 200           | 15                       | 1.1          | 100              | 1.5                   | 1187 |
| PMLL4148*      | general purpose                      | 75           | 200           | 4                        | 1            | 10               | 4                     | 1273 |
| PMLL4150*      | general purpose                      | 50           | 300           | 6                        | 1            | 200              | 2.5                   | 1277 |
| PMLL4151*      | general purpose                      | 50           | 200           | 2                        | 1            | 50               | 2                     | 1277 |
| PMLL4153*      | general purpose                      | 50           | 200           | 2                        | 0.88         | 20               | 2                     | 1277 |
| PMLL4446*      | general purpose                      | 75           | 200           | 4                        | 1            | 20               | 4                     | 1273 |
| PMLL4448*      | general purpose                      | 70           | 200           | 4                        | 1            | 100              | 4                     | 1273 |

## Notes

\* Types in SOD80 package.

\*\* Types in SOT143 package.

## VARIABLE CAPACITANCE DIODES

| TYPE<br>NUMBER | ENVELOPE | RATINGS      |               | CHARACTERISTICS |                 |                               |          |                       | PAGE |
|----------------|----------|--------------|---------------|-----------------|-----------------|-------------------------------|----------|-----------------------|------|
|                |          | $V_R$<br>(V) | $I_F$<br>(mA) | $C_d$<br>(pF)   | at $V_R$<br>(V) | $C_d$ ratio<br>( $f = 1$ MHz) | at $V_R$ | $r_D$<br>( $\Omega$ ) |      |
| BB215          | SOD80    | 30           | 20            | 1.8 - 2.2       | 28              | typ. 8.3                      | 1/28     | typ. 0.63             | 195  |
| BB219          | SOD80    | 30           | 20            | 2.6 - 3.2       | 28              | 12 - 15                       | 1/28     | typ. 0.7              | 197  |
| BB240          | SOD80    | 32           | 20            | 2.4 - 2.7       | 28              | min. 14                       | 0.5/28   | max. 1                | 199  |
| BB241          | SOD80    | 32           | 20            | 2.5 - 3.0       | 28              | min. 21                       | 0.5/28   | max. 2                | 201  |
| BB249          | SOD80    | 30           | 20            | 4 - 5           | 28              | 8 - 10                        | 1/28     | max. 0.6              | 203  |
| BB804          | SOT23    | 18           | 50            | 42 - 47.5       | 2               | 1.65 - 1.75                   | 2/8      | typ. 0.2              | 207  |
| BBY31          | SOT23    | 28           | 20            | 1.6 - 2         | 28              | typ. 9.7                      | 1/28     | max. 1.2              | 209  |
| BBY39          | SOT23    | 30           | 20            | 1 - 2           | 28              | min. 7.6                      | 1/28     | max. 0.75             | 213  |
| BBY40          | SOT23    | 28           | 20            | 3.8 - 4.8       | 28              | 8 - 12                        | 1/28     | max. 0.7              | 215  |
| BBY42          | SOT23    | 32           | 20            | 2.4 - 3         | 28              | 12 - 16                       | 1/28     | max. 1                | 219  |
| BBY62          | SOT143   | 28           | 20            | 1.6 - 2         | 28              | typ. 9.7                      | 1/28     | max. 1.2              | 221  |

## VOLTAGE REGULATOR DIODES

| TYPE<br>NUMBER               | ENVELOPE | RATINGS                 |                             |                   |                   |                   | CHARACTERISTICS      |                  | PAGE |
|------------------------------|----------|-------------------------|-----------------------------|-------------------|-------------------|-------------------|----------------------|------------------|------|
|                              |          | VOLTAGE<br>RANGE<br>(V) | VOLTAGE<br>TOLERANCE<br>(%) | $P_{tot}$<br>(mW) | $I_{ZRM}$<br>(mA) | $I_{FRM}$<br>(mA) | $V_F$<br>max.<br>(V) | at $I_F$<br>(mA) |      |
| BZD27                        | SOD87    | 7.5 to 510              | 5                           | 2300              | -                 | -                 | 1.2                  | 200              | 1125 |
| BZV49                        | SOT89    | 2.4 to 75               | 5                           | 1000              | note 1            | 250               | 1                    | 50               | 1131 |
| BZV55                        | SOD80    | 2.4 to 75               | 2, 3, 5                     | 500               | -                 | 250               | 0.9                  | 10               | 1141 |
| BZV80                        | SOD80    | 5.89 to 6.51            | -                           | 400               | 50                | -                 | -                    | -                | 1155 |
| BZV81                        | SOD80    | 5.89 to 6.51            | -                           | 400               | 50                | -                 | -                    | -                | 1155 |
| BZX84                        | SOT23    | 2.4 to 75               | 2.5                         | 350               | 250               | 250               | 0.9                  | 10               | 1161 |
| PMLL5225B<br>to<br>PMLL5267B | SOD80    | 3.0 to 75               | 5                           | 500               | -                 | 250               | 1.1                  | 200              | 1281 |

## Note

1.  $I_{ZRM}$  limited by  $P_{ZRM\ max}$ .



## Surface mounted semiconductors

## Selection guide

## TRANSIENT SUPPRESSION DIODES

| TYPE NUMBER | ENVELOPE | CHARACTERISTICS |                    |                        |                  | PAGE |
|-------------|----------|-----------------|--------------------|------------------------|------------------|------|
|             |          | $V_R$<br>(V)    | $V_{(CL)R}$<br>(V) | $I_{RSM}$<br>(A)       | $P_{RSM}$<br>(W) |      |
| BZD27       | SOD87    | 6.2 to 430      | 11.3 to 707        | 13.3 to 0.21<br>note 1 | 150<br>note 1    | 1125 |

## Note

1. Pulse according to IEC60-2, section 6: 10/1000  $\mu$ s exponential;  $T_j = 25^\circ\text{C}$  prior to the pulse.

## RECTIFIER DIODES

| TYPE NUMBER | ENVELOPE | RATINGS            |                  |              |                  |                  | CHARACTERISTICS |              |                 | PAGE |
|-------------|----------|--------------------|------------------|--------------|------------------|------------------|-----------------|--------------|-----------------|------|
|             |          | $I_{F(AV)}$<br>(A) | $V_{RRM}$<br>(V) | $V_R$<br>(V) | $I_{FRM}$<br>(A) | $I_{FSM}$<br>(A) | $t_T$<br>(ns)   | $V_F$<br>(V) | at $I_F$<br>(A) |      |
| BYD17D      | SOD87    | 1.5                | 200*             | 200          | 5.5              | 20               | -               | 1.05         | 1               | 1107 |
| BYD17G      | SOD87    | 1.5                | 400*             | 400          | 5.5              | 20               | -               | 1.05         | 1               | 1107 |
| BYD17J      | SOD87    | 1.5                | 600*             | 600          | 5.5              | 20               | -               | 1.05         | 1               | 1107 |
| BYD17K      | SOD87    | 1.5                | 800*             | 800          | 5.5              | 20               | -               | 1.05         | 1               | 1107 |
| BYD17M      | SOD87    | 1.5                | 1000*            | 1000         | 5.5              | 20               | -               | 1.05         | 1               | 1107 |
| BYD37D      | SOD87    | 1.5                | 200              | 200          | 12               | 20               | 250             | 1.3          | 1               | 1115 |
| BYD37G      | SOD87    | 1.5                | 400              | 400          | 12               | 20               | 250             | 1.3          | 1               | 1115 |
| BYD37J      | SOD87    | 1.5                | 600              | 600          | 12               | 20               | 250             | 1.3          | 1               | 1115 |
| BYD37K      | SOD87    | 1.5                | 800              | 800          | 12               | 20               | 300             | 1.3          | 1               | 1115 |
| BYD37M      | SOD87    | 1.5                | 1000             | 1000         | 12               | 20               | 300             | 1.3          | 1               | 1115 |
| BYD77A      | SOD87    | 2.0                | 50               | 50           | 15               | 25               | 25              | 0.95         | 1               | 1121 |
| BYD77B      | SOD87    | 2.0                | 100              | 100          | 15               | 25               | 25              | 0.95         | 1               | 1121 |
| BYD77C      | SOD87    | 2.0                | 150              | 150          | 15               | 25               | 25              | 0.95         | 1               | 1121 |
| BYD77D      | SOD87    | 2.0                | 200              | 200          | 15               | 25               | 25              | 0.95         | 1               | 1121 |
| BYD77E      | SOD87    | 1.85               | 250              | 250          | 13               | 25               | 50              | 1.05         | 1               | 1121 |
| BYD77F      | SOD87    | 1.85               | 300              | 300          | 13               | 25               | 50              | 1.05         | 1               | 1121 |
| BYD77G      | SOD87    | 1.85               | 400              | 400          | 13               | 25               | 50              | 1.05         | 1               | 1121 |

## Note

\*  $V_{RRM}$ .

## TEMPERATURE SENSORS

| TYPE NUMBER | TEMPERATURE RANGE<br>°C | RESISTANCE R at $T_{amb}$<br>( $\Omega$ )<br>note 1 | SENSOR CURRENT<br>(mA) | PAGE |
|-------------|-------------------------|-----------------------------------------------------|------------------------|------|
| KTY85-110   | -40 to 125              | $1000 \pm 1\%$                                      | 1                      | 1173 |
| KTY85-120   | -40 to 125              | $1000 \pm 2\%$                                      | 1                      | 1173 |
| KTY85-150   | -40 to 125              | $1000 \pm 5\%$                                      | 1                      | 1173 |

## Note

1.  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

**Device data**

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| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# BFG198

## NPN 7 GHz wideband transistor

### DESCRIPTION

NPN planar epitaxial transistor in a plastic SOT223 envelope, intended for wideband amplifier applications. The device features a high gain, and excellent output voltage capabilities.

### MECHANICAL DATA

SOT223.

### PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | emitter     |
| 2   | base        |
| 3   | emitter     |
| 4   | collector   |

### QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                 | CONDITIONS                                                                                                                                     | MIN. | TYP. | MAX. | UNIT               |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|--------------------|
| $V_{CBO}$ | collector-base voltage    | open emitter                                                                                                                                   | -    | -    | 20   | V                  |
| $V_{CEO}$ | collector-emitter voltage | open base                                                                                                                                      | -    | -    | 10   | V                  |
| $I_C$     | collector current (DC)    |                                                                                                                                                | -    | -    | 100  | mA                 |
| $P_{tot}$ | total power dissipation   | $T_{case} = 135\text{ }^{\circ}\text{C}$<br>note 1                                                                                             | -    | -    | 1    | W                  |
| $T_j$     | junction temperature      |                                                                                                                                                | -    | -    | 175  | $^{\circ}\text{C}$ |
| $h_{FE}$  | DC current gain           | $I_C = 50\text{ mA};$<br>$V_{CE} = 5\text{ V}$                                                                                                 | 40   | -    | -    |                    |
| $f_T$     | transition frequency      | $f = 1000\text{ MHz};$<br>$I_C = 50\text{ mA};$<br>$V_{CE} = 8\text{ V};$<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$                            | -    | 8.0  | -    | GHz                |
| $G_{UM}$  | maximum power gain        | $f = 500\text{ MHz};$<br>$I_C = 50\text{ mA};$<br>$V_{CE} = 8\text{ V}$                                                                        | -    | 18   | -    | dB                 |
| $G_{UM}$  | maximum power gain        | $f = 800\text{ MHz};$<br>$I_C = 50\text{ mA};$<br>$V_{CE} = 8\text{ V}$                                                                        | -    | 15   | -    | dB                 |
| $V_o$     | output voltage            | $d_{im} = -60\text{ dB};$<br>$I_C = 70\text{ mA};$<br>$V_{CE} = 8\text{ V};$<br>$R_L = 75\text{ }\Omega;$<br>$f_{(p+q-r)} = 793.25\text{ MHz}$ | -    | 700  | -    | mV                 |

### Note

1.  $T_{case}$  temperature measured on soldering point of collector tab.

**NPN 7 GHz wideband transistor****BFG198****ORDERING AND PACKAGE INFORMATION**

| EXTENDED<br>TYPE NUMBER | PACKAGE |                   |                     |
|-------------------------|---------|-------------------|---------------------|
|                         | CODE    | PACKING<br>METHOD | PACKING<br>QUANTITY |
| BFG198                  | SOT223  | bulk              | 500                 |
| BFG198                  | SOT223  | 12 mm reel        | 1000                |

**LIMITING VALUES**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

| SYMBOL    | PARAMETER                 | CONDITIONS                               | MIN. | MAX. | UNIT               |
|-----------|---------------------------|------------------------------------------|------|------|--------------------|
| $V_{CBO}$ | collector-base voltage    | open emitter                             | -    | 20   | V                  |
| $V_{CEO}$ | collector-emitter voltage | open base                                | -    | 10   | V                  |
| $V_{EBO}$ | emitter-base voltage      | open collector                           | -    | 2.5  | V                  |
| $I_C$     | collector current (DC)    |                                          | -    | 100  | mA                 |
| $P_{tot}$ | total power dissipation   | $T_{case} = 135\text{ }^{\circ}\text{C}$ | -    | 1    | W                  |
| $T_{stg}$ | storage temperature range |                                          | -65  | +150 | $^{\circ}\text{C}$ |
| $T_j$     | junction temperature      |                                          | -    | 175  | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER             | NOM. | UNIT |
|---------------|-----------------------|------|------|
| $R_{th\ j-c}$ | from junction to case | 40   | K/W  |

**NPN 7 GHz wideband transistor****BFG198****CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| SYMBOL    | PARAMETER                 | CONDITIONS                                                                                                             | MIN. | TYP. | MAX. | UNIT |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{CBO}$ | collector cut-off current | $I_E = 0$ ;<br>$V_{CB} = 10\text{ V}$                                                                                  | -    | -    | 100  | nA   |
| $h_{FE}$  | DC current gain           | $I_C = 50\text{ mA}$ ;<br>$V_{CE} = 5\text{ V}$                                                                        | 40   | -    | -    |      |
| $f_T$     | transition frequency      | $f = 1000\text{ MHz}$ ;<br>$I_C = 50\text{ mA}$ ;<br>$V_{CE} = 8\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ | -    | 8.0  | -    | GHz  |
| $C_c$     | collector capacitance     | $f = 1\text{ MHz}$ ;<br>$I_e = I_c = 0$ ;<br>$V_{CB} = 8\text{ V}$                                                     | -    | 1.5  | -    | pF   |
| $C_e$     | emitter capacitance       | $f = 1\text{ MHz}$ ;<br>$I_c = I_e = 0$ ;<br>$V_{EB} = 0.5\text{ V}$                                                   | -    | 4.0  | -    | pF   |
| $C_{re}$  | feedback capacitance      | $f = 1\text{ MHz}$ ;<br>$I_C = 0$ ;<br>$V_{CE} = 8\text{ V}$                                                           | -    | 0.8  | -    | pF   |
| $G_{UM}$  | maximum power gain        | $f = 500\text{ MHz}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;<br>$I_C = 50\text{ mA}$ ;<br>$V_{CE} = 8\text{ V}$  | -    | 18   | -    | dB   |
| $G_{UM}$  | maximum power gain        | $f = 800\text{ MHz}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;<br>$I_C = 50\text{ mA}$ ;<br>$V_{CE} = 8\text{ V}$  | -    | 15   | -    | dB   |
| $V_c$     | output voltage            | note 1                                                                                                                 | -    | 750  | -    | mV   |
| $V_o$     | output voltage            | note 2                                                                                                                 | -    | 700  | -    | mV   |

**Notes**

- $d_{im} = -60\text{ dB}$  (DIN 45004B);  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $I_C = 70\text{ mA}$ ;  
 $V_{CE} = 8\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $V_p = V_o$  at  $d_{im} = -60\text{ dB}$ ;  
 $V_q = V_o - 6\text{ dB}$ ;  $f_p = 445.25\text{ MHz}$ ;  
 $V_r = V_o - 6\text{ dB}$ ;  $f_q = 453.25\text{ MHz}$ ;  $f_r = 445.25\text{ MHz}$ ;  
measured at  $f_{(p+q-r)} = 443.25\text{ MHz}$
- $d_{im} = -60\text{ dB}$  (DIN 45004B);  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $I_C = 70\text{ mA}$ ;  
 $V_{CE} = 8\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $V_p = V_o$  at  $d_{im} = -60\text{ dB}$ ;  
 $V_q = V_o - 6\text{ dB}$ ;  $f_p = 795.25\text{ MHz}$ ;  
 $V_r = V_o - 6\text{ dB}$ ;  $f_q = 803.25\text{ MHz}$ ;  $f_r = 805.25\text{ MHz}$ ;  
measured at  $f_{(p+q-r)} = 793.25\text{ MHz}$



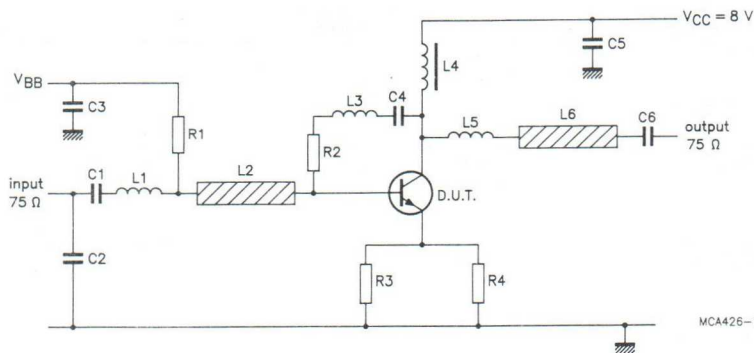
**NPN 7 GHz wideband transistor****BFG198**

Fig.1 Intermodulation and second harmonic test circuit.

**List of components:**

R1 = 10 k $\Omega$  metal film resistor (cat. no. 2322 180 73103)  
 R2 = 220  $\Omega$  metal film resistor (cat. no. 2322 180 73221)  
 R3 = R4 = 30  $\Omega$  metal film resistor (cat. no. 2322 180 73309)

C2 = C4 = C6 = C7 = 10 nF ceramic multilayer capacitor (cat. no. 2222 590 08627)  
 C1 = 1.2 pF ceramic multilayer capacitor (cat. no. 2222 851 12128)  
 C3 = 2.2 pF ceramic multilayer capacitor (cat. no. 2222 851 12128)  
 C5 = 10 nF miniature ceramic plate capacitor (cat. no. 2222 629 08103)  
 C8 = 1.5 pF ceramic multilayer capacitor (cat. no. 2222 851 12158)

L1 = 1.5 turn Cu wire (0.4 mm), internal diameter 3 mm, winding pitch 1 mm  
 L2 = 75  $\Omega$  microstripline (L = 22 mm; W = 2.5 mm)  
 L3 = 30 mm Cu wire (0.4 mm; L  $\approx$  24 nH)  
 L4 = 4 mm Cu wire (0.4 mm; L  $\approx$  3.6 nH)  
 L5 = 75  $\Omega$  microstripline (L = 19 mm; W = 2.5 mm)  
 L6 = 5  $\mu$ H Ferroxcube choke (cat. no. 3122 108 20153)

The circuit has been built on a double Cu clad printed circuit board with PTFE dielectric ( $\epsilon_r = 2.2$ ); thickness 1/16 inch; thickness of copper-sheet 2 x 35  $\mu$ m; see Fig.1.

The components L1, R2, L3, C5 and L4 are mounted on the underside of the PCB.

## NPN 7 GHz wideband transistor

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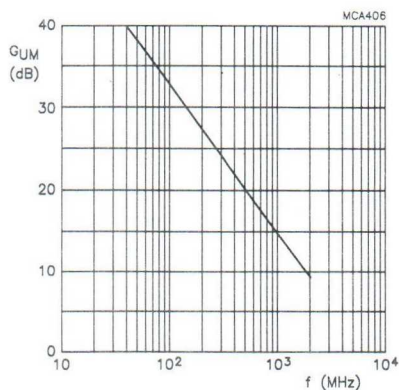


Fig.2 Maximum unilateral power gain;  
 $V_{CE} = 8$  V;  $I_C = 50$  mA;  $T_{amb} = 25$  °C; typical values.

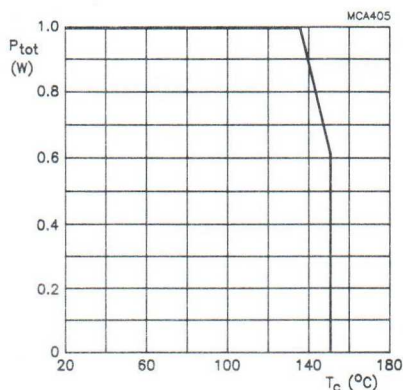


Fig.3 Power derating curve as a function of case temperature.

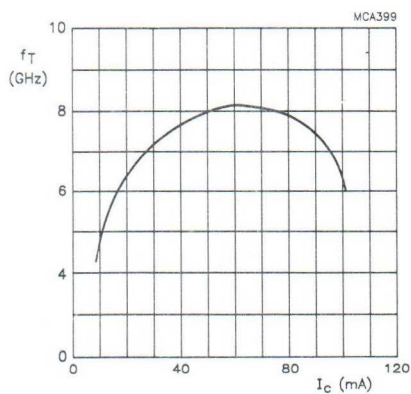


Fig.4 Transition frequency as a function of collector current;  $V_{CE} = 8$  V;  $f = 1$  GHz;  $T_j = 25$  °C; typical values.

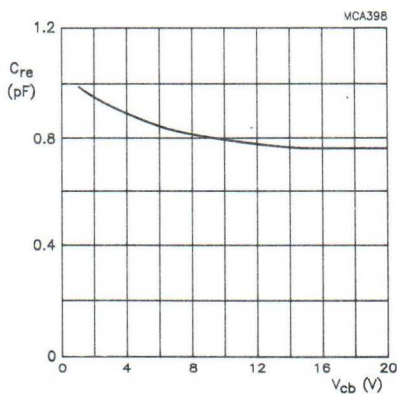


Fig.5 Feedback capacitance as a function of collector-base voltage;  $I_E = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C; typical values.

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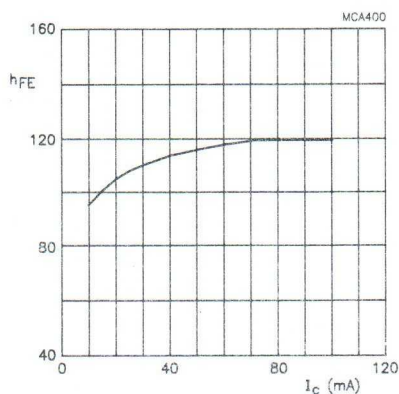


Fig.6 DC current gain as a function of collector current;  $V_{CE} = 5$  V;  $T_j = 25$  °C; typical values.

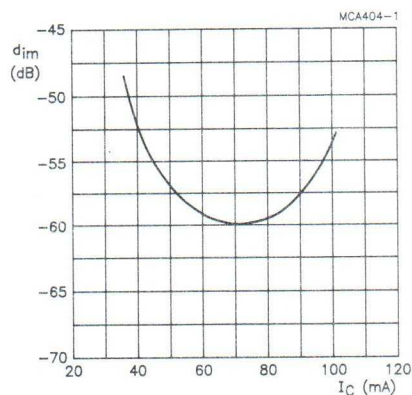


Fig.7 Intermodulation distortion;  $V_{CE} = 8$  V;  $V_o = 750$  mV;  $f_{(p+q-r)} = 443.25$  MHz;  $T_{amb} = 25$  °C; typical values.

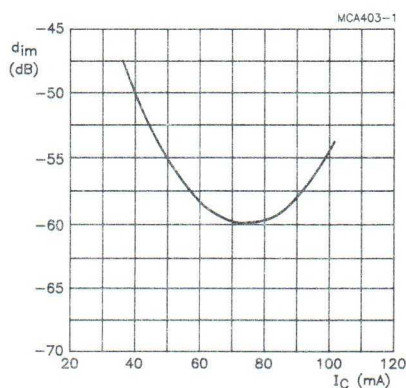


Fig.8 Intermodulation distortion;  $V_{CE} = 8$  V;  $V_o = 700$  mV;  $f_{(p+q-r)} = 793.25$  MHz;  $T_{amb} = 25$  °C; typical values.

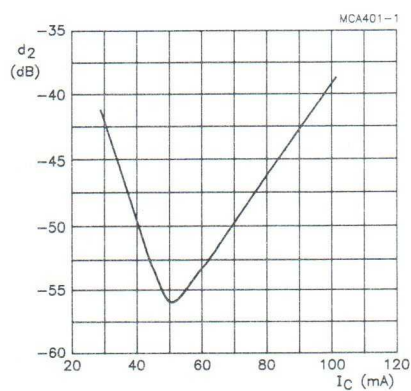


Fig.9 Intermodulation distortion;  $V_{CE} = 8$  V;  $V_o = 50$  dBmV;  $f_{(p+q)} = 450$  MHz;  $T_{amb} = 25$  °C; typical values.

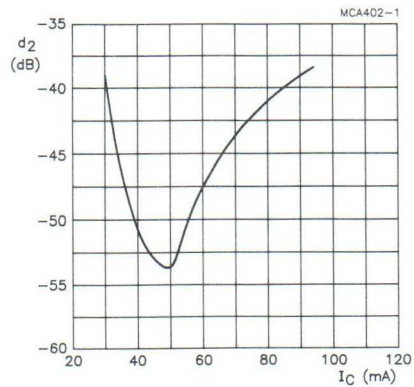
**NPN 7 GHz wideband transistor****BFG198**

Fig.10 Intermodulation distortion;  $V_{CE} = 8$  V;  $V_o = 50$  dBmV;  $f_{(p+q)} = 810$  MHz;  $T_{amb} = 25$  °C; typical values.

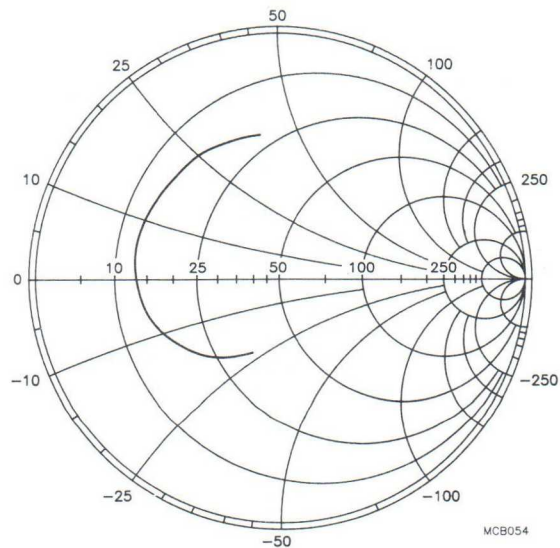


Fig.11 Input reflection coefficient  $S_{11}$ ;  $V_{CE} = 8$  V;  $I_C = 50$  mA;  $T_{amb} = 25$  °C; typical values.



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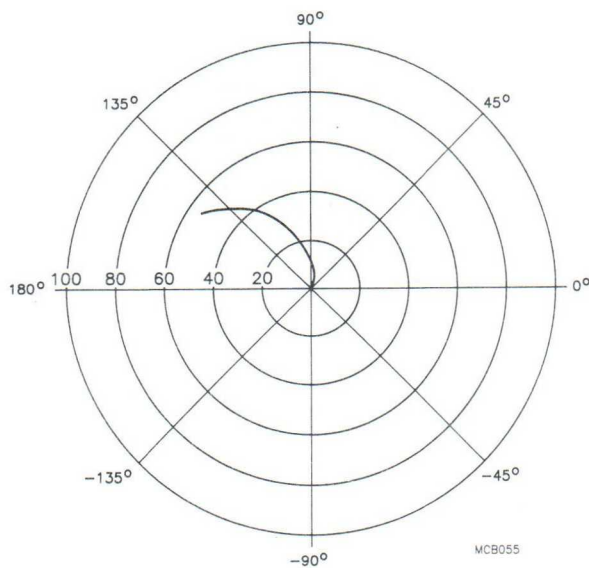


Fig.12 Forward transmission coefficient  $S_{21}$ ;  $V_{CE} = 8\text{ V}$ ;  $I_C = 50\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

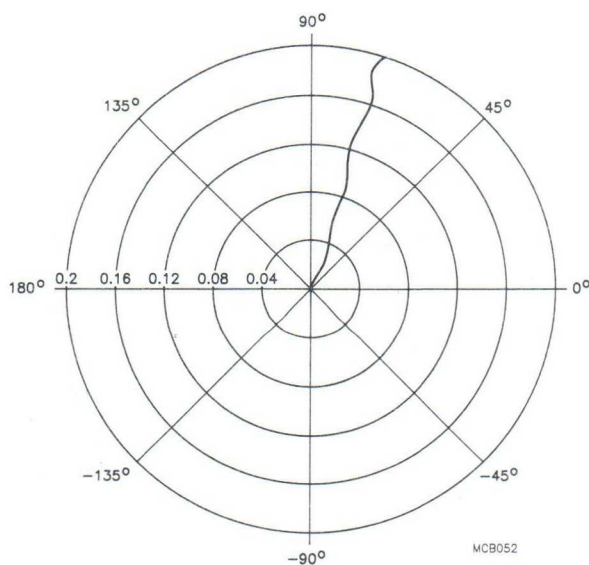


Fig.13 Reverse transmission coefficient  $S_{12}$ ;  $V_{CE} = 8\text{ V}$ ;  $I_C = 50\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

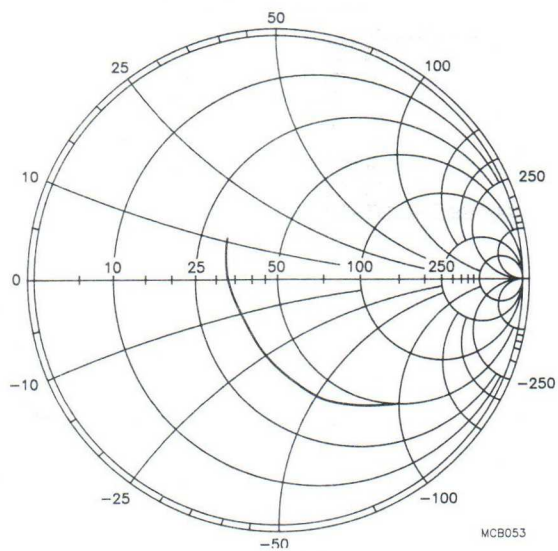
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Fig.14 Output reflection coefficient  $S_{22}$ ;  $V_{CE} = 8\text{ V}$ ;  $I_C = 50\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

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S-Parameters (common emitter) at  $V_{CE} = 8 \text{ V}$ ;  $T_{amb} = 25^\circ\text{C}$ ; typical values.

| $I_C$<br>(mA) | $f$<br>(MHz) | S11         | S21        | S12       | S22         | $G_{UM}$ (dB) |
|---------------|--------------|-------------|------------|-----------|-------------|---------------|
| 5             | 40           | 0.79/- 25.3 | 12.7/165.9 | 0.02/75.7 | 0.97/- 11.1 | 38.3          |
|               | 100          | 0.77/- 57.4 | 12.1/146.9 | 0.04/62.4 | 0.87/- 25.4 | 31.7          |
|               | 200          | 0.74/-100.7 | 9.0/125.7  | 0.06/46.1 | 0.69/- 41.2 | 25.3          |
|               | 500          | 0.70/-162.7 | 4.6/ 92.7  | 0.08/32.6 | 0.44/- 60.4 | 17.0          |
|               | 800          | 0.70/ 168.5 | 2.9/ 75.6  | 0.08/34.3 | 0.35/- 73.9 | 12.7          |
|               | 1000         | 0.69/ 154.0 | 2.4/ 65.9  | 0.08/41.3 | 0.34/- 82.6 | 10.8          |
|               | 1200         | 0.68/ 141.4 | 1.9/ 57.5  | 0.08/50.5 | 0.33/- 93.4 | 8.9           |
|               | 1500         | 0.67/ 124.7 | 1.5/ 48.5  | 0.09/61.3 | 0.32/-111.5 | 6.7           |
| 10            | 2000         | 0.64/ 100.0 | 1.1/ 34.3  | 0.41/76.3 | 0.32/-144.0 | 3.2           |
|               | 40           | 0.61/- 38.7 | 24.8/159.3 | 0.02/72.6 | 0.93/- 17.4 | 38.7          |
|               | 100          | 0.62/- 81.3 | 18.7/138.5 | 0.04/57.9 | 0.74/- 39.9 | 31.0          |
|               | 200          | 0.63/-127.1 | 13.1/115.7 | 0.05/45.3 | 0.53/- 56.9 | 25.9          |
|               | 500          | 0.64/ 174.8 | 6.0/ 88.8  | 0.06/44.4 | 0.32/- 72.4 | 18.3          |
|               | 800          | 0.63/ 159.5 | 3.7/ 74.8  | 0.07/54.9 | 0.22/- 91.6 | 13.9          |
|               | 1000         | 0.64/ 148.2 | 3.0/ 66.5  | 0.08/58.2 | 0.20/-103.6 | 11.9          |
|               | 1200         | 0.63/ 136.6 | 2.5/ 59.8  | 0.10/63.9 | 0.19/-114.9 | 10.2          |
| 30            | 1500         | 0.62/ 121.5 | 1.9/ 51.4  | 0.12/67.9 | 0.20/-135.1 | 8.0           |
|               | 2000         | 0.62/ 99.8  | 1.4/ 39.3  | 0.17/73.3 | 0.22/-167.3 | 5.1           |
|               | 40           | 0.36/- 83.2 | 44.8/148.9 | 0.01/69.2 | 0.82/- 33.1 | 38.4          |
|               | 100          | 0.49/-131.0 | 29.7/123.0 | 0.02/52.4 | 0.55/- 62.4 | 32.2          |
|               | 200          | 0.56/-159.8 | 17.3/104.4 | 0.03/55.6 | 0.33/- 86.9 | 26.9          |
|               | 500          | 0.58/ 169.9 | 7.3/ 84.9  | 0.05/68.7 | 0.18/-124.2 | 19.2          |
|               | 800          | 0.60/ 152.0 | 4.6/ 73.7  | 0.08/71.1 | 0.15/-147.1 | 15.2          |
|               | 1000         | 0.59/ 142.0 | 3.6/ 67.0  | 0.09/71.1 | 0.15/-160.5 | 13.1          |
| 50            | 1200         | 0.59/ 132.6 | 3.0/ 61.8  | 0.12/72.1 | 0.15/-174.7 | 11.4          |
|               | 1500         | 0.59/ 119.1 | 2.4/ 54.2  | 0.15/72.3 | 0.18/-170.8 | 9.4           |
|               | 2000         | 0.59/ 98.3  | 1.6/ 44.2  | 0.20/71.1 | 0.22/ 148.3 | 6.4           |
|               | 40           | 0.33/-117.0 | 53.4/143.7 | 0.01/73.3 | 0.76/- 39.7 | 38.8          |
|               | 100          | 0.49/-147.8 | 32.6/117.1 | 0.02/65.0 | 0.46/- 74.6 | 32.5          |
|               | 200          | 0.56/-169.3 | 18.2/101.0 | 0.03/66.7 | 0.28/-102.7 | 27.2          |
|               | 500          | 0.58/ 166.0 | 7.5/ 83.9  | 0.05/72.8 | 0.17/-141.6 | 19.4          |
|               | 800          | 0.59/ 149.8 | 4.7/ 73.2  | 0.08/73.2 | 0.16/-164.9 | 15.4          |
| 70            | 1000         | 0.59/ 140.1 | 3.7/ 66.8  | 0.10/72.2 | 0.17/-177.0 | 13.4          |
|               | 1200         | 0.58/ 131.1 | 3.0/ 61.9  | 0.12/73.9 | 0.17/-173.4 | 11.6          |
|               | 1500         | 0.58/ 117.9 | 2.4/ 54.5  | 0.15/71.8 | 0.20/ 161.2 | 9.7           |
|               | 2000         | 0.58/ 97.8  | 1.7/ 45.3  | 0.20/70.6 | 0.25/ 138.5 | 6.7           |
|               | 40           | 0.35/-130.4 | 58.2/140.3 | 0.01/59.3 | 0.70/- 44.7 | 38.8          |
|               | 100          | 0.50/-156.7 | 33.7/114.7 | 0.02/64.8 | 0.42/- 79.1 | 32.7          |
|               | 200          | 0.56/-173.5 | 18.4/ 99.3 | 0.03/67.8 | 0.26/-108.5 | 27.2          |
|               | 500          | 0.58/ 164.4 | 7.6/ 82.9  | 0.05/75.5 | 0.18/-150.7 | 19.5          |
|               | 800          | 0.59/ 148.8 | 4.7/ 72.7  | 0.08/74.8 | 0.17/-169.5 | 15.5          |
|               | 1000         | 0.59/ 139.4 | 3.7/ 66.3  | 0.10/75.8 | 0.18/-177.7 | 13.4          |
|               | 1200         | 0.58/ 130.5 | 3.0/ 61.7  | 0.12/74.6 | 0.18/-166.9 | 11.6          |
|               | 1500         | 0.58/ 117.5 | 2.4/ 54.4  | 0.16/73.2 | 0.21/ 156.6 | 9.8           |
|               | 2000         | 0.59/ 97.7  | 1.7/ 45.1  | 0.20/70.6 | 0.26/ 135.2 | 6.7           |

## NPN 1 GHz WIDEBAND TRANSISTOR

NPN multi-emitter transistor in a SOT89 plastic envelope intended for application in thick and thin-film circuits. The transistor has extremely good intermodulation properties and a high power gain. It is primarily intended for:

- Output and driver stages of channel and band serial amplifiers with high output power for bands I, II, III and IV/V (40–860 MHz).
- Output and driver stages of wideband amplifiers.

### QUICK REFERENCE DATA

|                                                                          |            |      |         |
|--------------------------------------------------------------------------|------------|------|---------|
| Collector-base voltage (open emitter; peak value)                        | $V_{CBOM}$ | max. | 40 V    |
| Collector-emitter voltage (open base)                                    | $V_{CEO}$  | max. | 25 V    |
| Collector current (peak value; $f > 1$ MHz)                              | $I_{CM}$   | max. | 300 mA  |
| Total power dissipation up to $T_{amb} = 25$ °C                          | $P_{tot}$  | max. | 1 W     |
| Junction temperature                                                     | $T_j$      | max. | 175 °C  |
| Transition frequency at $f = 500$ MHz<br>$I_C = 150$ mA; $V_{CE} = 15$ V | $f_T$      | typ. | 1.2 GHz |
| Feedback capacitance at $f = 1$ MHz<br>$I_C = 10$ mA; $V_{CE} = 15$ V    | $C_{re}$   | typ. | 1.9 pF  |

### MECHANICAL DATA

SOT89

See also *Soldering recommendations*.

### Marking code

BFQ17 = FA



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                |            |              |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------|----------------------|
| Collector-base voltage (open emitter; peak value)                                                                                              | $V_{CBOM}$ | max.         | 40 V                 |
| Collector emitter voltage ( $R_{BE} \leq 50 \Omega$ ; peak value)                                                                              | $V_{CERM}$ | max.         | 40 V*                |
| Collector-emitter voltage (open base)                                                                                                          | $V_{CEO}$  | max.         | 25 V*                |
| Emitter-base voltage (open collector)                                                                                                          | $V_{EBO}$  | max.         | 2 V                  |
| Collector current (DC)                                                                                                                         | $I_C$      | max.         | 150 mA               |
| Collector current (peak value; $f > 1$ MHz)                                                                                                    | $I_{CM}$   | max.         | 300 mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$<br>mounted on a ceramic substrate<br>area = $2.5 \text{ cm}^2$ ; thickness = 0.7 mm | $P_{tot}$  | max.         | 1 W                  |
| Storage temperature range                                                                                                                      | $T_{stg}$  | —65 to + 150 | $^\circ\text{C}$     |
| Junction temperature                                                                                                                           | $T_j$      | max.         | 175 $^\circ\text{C}$ |

**THERMAL RESISTANCE**

|                                                                                                                          |                 |   |         |
|--------------------------------------------------------------------------------------------------------------------------|-----------------|---|---------|
| From junction to collector tab                                                                                           | $R_{th\ j-tab}$ | = | 30 K/W  |
| From junction to ambient in free air<br>mounted on a ceramic substrate<br>area = $2.5 \text{ cm}^2$ ; thickness = 0.7 mm | $R_{th\ j-a}$   | = | 125 K/W |

\*  $I_C = 10 \text{ mA}$ .

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 20\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$

$I_{CBO}$  max.  $20\text{ }\mu\text{A}$

Saturation voltage

$I_C = 100\text{ mA}; I_B = 10\text{ mA}$

$V_{CEsat}$  max.  $0.5\text{ V}$

DC current gain

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE}$  min. 25

$I_C = 150\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE}$  min. 25

Transition frequency at  $f = 500\text{ MHz}^*$

$I_C = 150\text{ mA}; V_{CE} = 15\text{ V}$

$f_T$  typ.  $1.2\text{ GHz}$

Collector capacitance at  $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 15\text{ V}$

$C_c$  max.  $4\text{ pF}$

Feedback capacitance at  $f = 1\text{ MHz}$

$I_C = 10\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$

$C_{re}$  typ.  $1.9\text{ pF}$

Maximum unilateral power gain ( $S_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

$I_C = 60\text{ mA}; V_{CE} = 15\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$

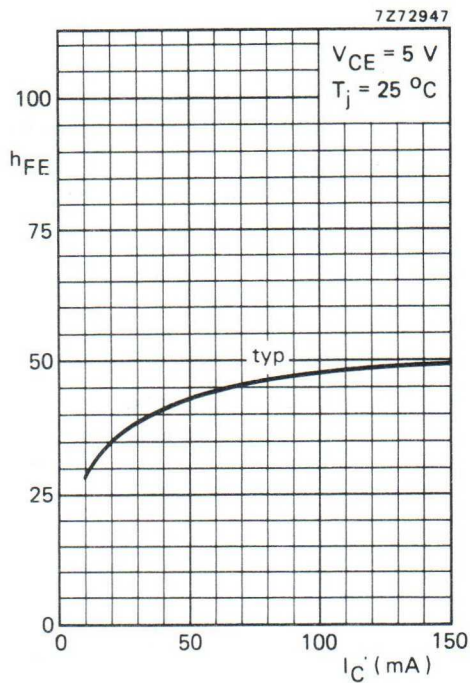
$f = 200\text{ MHz}$

$f = 800\text{ MHz}$

$G_{UM}$  typ. 16 dB

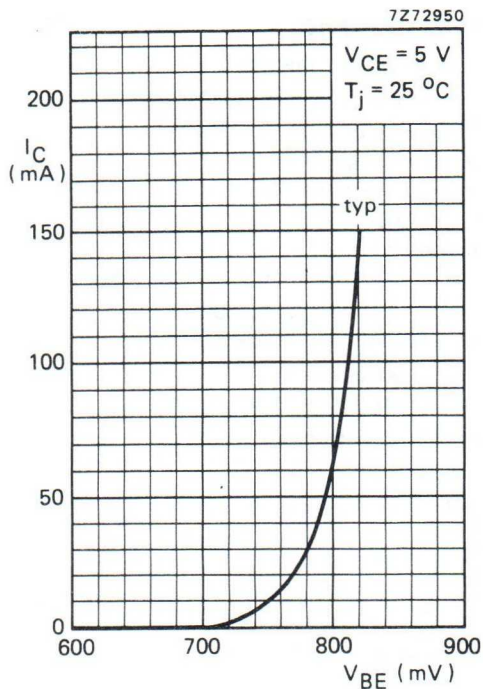
$G_{UM}$  typ. 6.5 dB

\* Measured under pulse conditions.



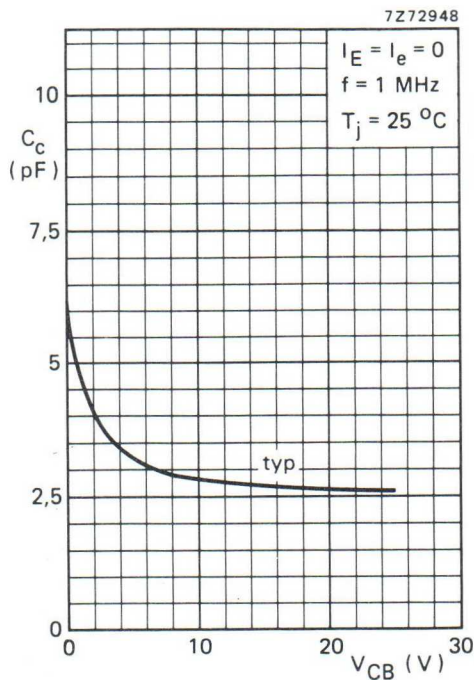
DC current gain as a function of collector current

Fig.1;  $V_{CE} = 5\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.



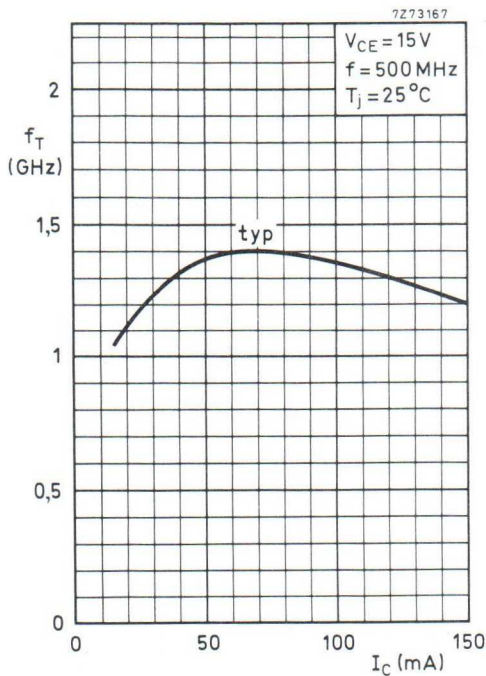
Collector current as a function of base-emitter voltage.

Fig.2;  $V_{CE} = 5\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.



Collector capacitance as a function of collector-base voltage.

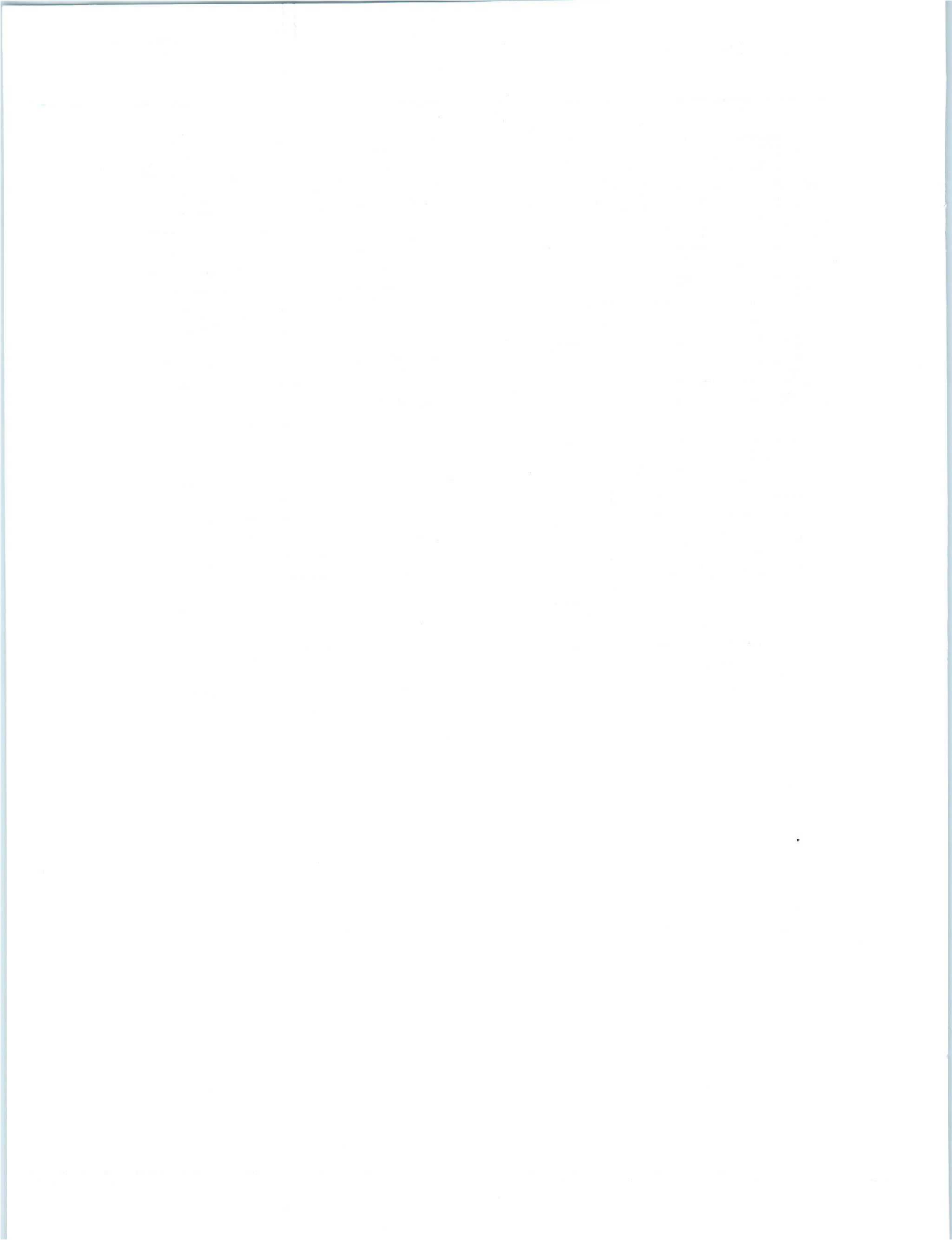
Fig.3;  $I_E = I_E = 0$ ;  $f = 1 \text{ MHz}$ ;  
 $T_j = 25^\circ\text{C}$ ; typical values.



Transition frequency as a function of collector current.

Fig.4;  $V_{CE} = 15 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  
 $T_j = 25^\circ\text{C}$ ; typical values.





## NPN 3 GHz WIDEBAND TRANSISTOR

NPN transistor in a plastic SOT89 envelope intended for application in thick and thin-film circuits. It is primarily intended for MATV purposes.

### QUICK REFERENCE DATA

|                                                                                                                                                         |           |      |                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                   | $V_{CBO}$ | max. | 25 V                   |
| Collector-emitter voltage (open base)                                                                                                                   | $V_{CEO}$ | max. | 15 V                   |
| Collector current (DC)                                                                                                                                  | $I_C$     | max. | 150 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                    | $P_{tot}$ | max. | 1 W                    |
| Junction temperature                                                                                                                                    | $T_j$     | max. | 175 $^{\circ}\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 100\text{ mA}$ ; $V_{CE} = 10\text{ V}$                                                          | $f_T$     | typ. | 3.6 GHz                |
| Feedback capacitance at $f = 10.7\text{ MHz}$<br>$I_C = 0$ ; $V_{CE} = 10\text{ V}$                                                                     | $C_{re}$  | typ. | 1.2 pF                 |
| Intermodulation distortion<br>$I_C = 80\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$<br>measured at $f_{(p+q-r)} = 793.25\text{ MHz}$ | $d_{im}$  | max. | -60 dB                 |

### MECHANICAL DATA

SOT89

See also soldering recommendations.

### Marking code

BFQ18A = FF

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |           |      |                                         |
|-------------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                         | $V_{CBO}$ | max. | 25 V                                    |
| Collector-emitter voltage (open base)                                         | $V_{CEO}$ | max. | 15 V                                    |
| Emitter-base voltage (open collector)                                         | $V_{EBO}$ | max. | 2 V                                     |
| Collector current (DC)                                                        | $I_C$     | max. | 150 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$ | max. | 1 W                                     |
| Storage temperature range                                                     | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$     | max. | $175\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                                               |                 |   |         |
|-----------------------------------------------|-----------------|---|---------|
| From junction to collector tab                | $R_{th\ j-tab}$ | = | 25 K/W  |
| From junction to ambient in free air (note 1) | $R_{th\ j-a}$   | = | 125 K/W |

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

DC current gain (note 2)

 $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$  $I_C = 100\text{ mA}; V_{CE} = 10\text{ V}$  $h_{FE}$  min. 25 $h_{FE}$  min. 25Transition frequency at  $f = 500\text{ MHz}$  (note 2) $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$  $I_C = 100\text{ mA}; V_{CE} = 10\text{ V}$  $f_T$  typ. 3.2 GHz $f_T$  typ. 3.6 GHzCollector capacitance at  $f = 1\text{ MHz}$  $I_E = I_e = 0; V_{CB} = 10\text{ V}$  $C_C$  typ. 2.0 pFEmitter capacitance at  $f = 1\text{ MHz}$  $I_C = I_c = 0; V_{EB} = 0.5\text{ V}$  $C_e$  typ. 11 pFFeedback capacitance at  $f = 10.7\text{ MHz}$  $I_C = 0; V_{CE} = 10\text{ V}$  $C_{re}$  typ. 1.2 pF

## Notes

1. The device mounted on a ceramic substrate area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.
2. Measured under pulse conditions.

Intermodulation distortion (see Fig. 1)

$$I_C = 80 \text{ mA}; V_{CE} = 10 \text{ V}; R_L = 75 \Omega$$

$$V_p = V_o = 700 \text{ mV at } f_p = 795.25 \text{ MHz}$$

$$V_q = V_o - 6 \text{ dB at } f_q = 803.25 \text{ MHz}$$

$$V_r = V_o - 6 \text{ dB at } f_r = 805.25 \text{ MHz}$$

$$\text{Measured at } f_{(p+q-r)} = 793.25 \text{ MHz}$$

$$d_{im} \quad \text{max.} \quad -60 \text{ dB}$$

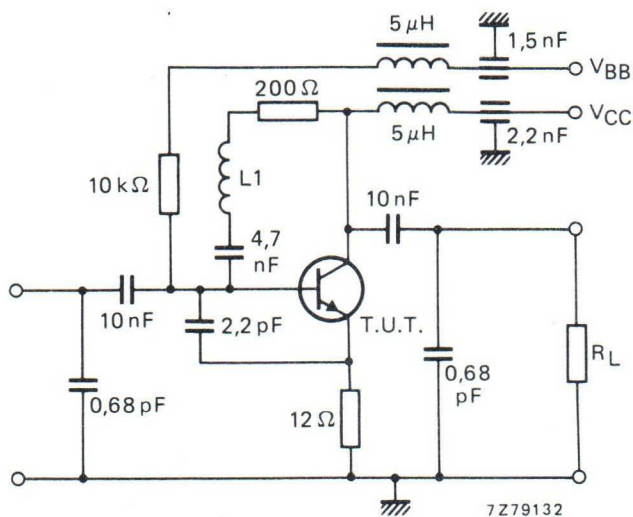


Fig.1 MATV test circuit (40–860 MHz).

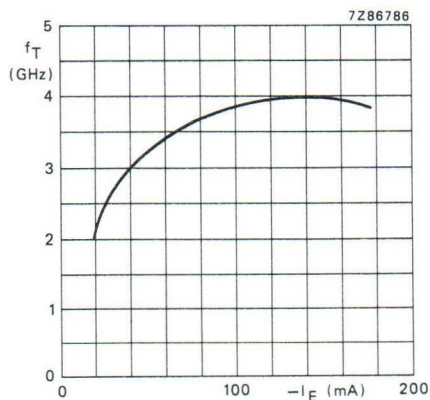


Fig.2 Transition frequency as a function of emitter current.

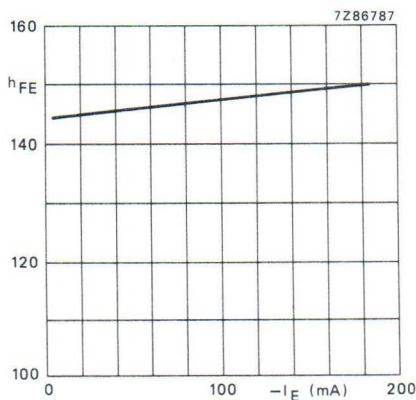


Fig.3 DC current gain as a function of emitter current.





## NPN 5 GHz WIDEBAND TRANSISTOR

NPN transistor in a SOT89 plastic envelope intended for application in thick- and thin-film circuits. It is primarily intended for use in UHF and microwave amplifiers such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc.

The transistor features very low intermodulation distortion and high power gain. Thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

### QUICK REFERENCE DATA

|                                                                                                                  |           |      |                        |
|------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                            | $V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage (open base)                                                                            | $V_{CEO}$ | max. | 15 V                   |
| Collector current (DC)                                                                                           | $I_C$     | max. | 75 mA                  |
| Total power dissipation up to $T_{amb} = 87.5\text{ }^{\circ}\text{C}$                                           | $P_{tot}$ | max. | 500 mW                 |
| Junction temperature                                                                                             | $T_j$     | max. | 175 $^{\circ}\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 50\text{ mA}$ ; $V_{CE} = 10\text{ V}$                    | $f_T$     | typ. | 5 GHz                  |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_C = 10\text{ mA}$ ; $V_{CE} = 10\text{ V}$                      | $C_{re}$  | typ. | 1.3 pF                 |
| Noise figure at optimum source impedance<br>$I_C = 50\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$ | $F$       | typ. | 3.3 dB                 |

### MECHANICAL DATA

SOT89

See also *Soldering recommendations*.

### Marking code

BFQ19 = FB

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                        |           |                 |        |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|--------|
| Collector-base voltage (open emitter)                                                                                                  | $V_{CBO}$ | max.            | 20 V   |
| Collector-emitter voltage (open base)                                                                                                  | $V_{CEO}$ | max.            | 15 V   |
| Emitter-base voltage (open collector)                                                                                                  | $V_{EBO}$ | max.            | 3.3 V  |
| Collector current (DC)                                                                                                                 | $I_C$     | max.            | 75 mA  |
| Collector current (peak value); $f > 1$ MHz                                                                                            | $I_{CM}$  | max.            | 150 mA |
| Total power dissipation up to $T_{amb} = 87.5$ °C<br>mounted on a ceramic substrate<br>area = 2.5 cm <sup>2</sup> ; thickness = 0.7 mm | $P_{tot}$ | max.            | 500 mW |
| Storage temperature                                                                                                                    | $T_{stg}$ | -65 to + 150 °C |        |
| Junction temperature                                                                                                                   | $T_j$     | max.            | 175 °C |

**THERMAL RESISTANCE**

|                                                                                                                           |                 |   |         |
|---------------------------------------------------------------------------------------------------------------------------|-----------------|---|---------|
| From junction to collector tab                                                                                            | $R_{th\ j-tab}$ | = | 40 K/W  |
| From junction to ambient in free air<br>mounted on a ceramic substrate<br>area = 2.5 cm <sup>2</sup> ; thickness = 0.7 mm | $R_{th\ j-a}$   | = | 125 K/W |

**CHARACTERISTICS** $T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 10\text{ V}$

$I_{CBO} \quad \text{max.} \quad 100\text{ nA}$

DC current gain (see note)

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} \quad \begin{array}{ll} \text{min.} & 25 \\ \text{typ.} & 50 \end{array}$

$I_C = 75\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} \quad \begin{array}{ll} \text{min.} & 25 \\ \text{typ.} & 52 \end{array}$

Transition frequency at  $f = 500\text{ MHz}$  (see note)

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$

$f_T \quad \begin{array}{ll} \text{min.} & 4.0\text{ GHz} \\ \text{typ.} & 5.0\text{ GHz} \end{array}$

$I_C = 75\text{ mA}; V_{CE} = 10\text{ V}$

$f_T \quad \begin{array}{ll} \text{min.} & 4.4\text{ GHz} \\ \text{typ.} & 5.5\text{ GHz} \end{array}$

Collector capacitance at  $f = 1\text{ MHz}$ 

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

$C_C \quad \text{typ.} \quad 1.6\text{ pF}$

Emitter capacitance at  $f = 1\text{ MHz}$ 

$I_C = I_e = 0; V_{EB} = 0.5\text{ V}$

$C_e \quad \text{typ.} \quad 5.0\text{ pF}$

Feedback capacitance at  $f = 1\text{ MHz}$ 

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{\text{amb}} = 25^\circ\text{C}$

$C_{re} \quad \text{typ.} \quad 1.3\text{ pF}$

Noise figure at optimum source impedance

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; f = 500\text{ MHz}; T_{\text{amb}} = 25^\circ\text{C}$

$F \quad \text{typ.} \quad 3.3\text{ dB}$

Maximum unilateral power gain ( $S_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

$I_C = 50\text{ mA}; V_{CE} = 10\text{ V}; T_{\text{amb}} = 25^\circ\text{C}$

$f = 200\text{ MHz}$

$G_{UM} \quad \text{typ.} \quad 18.5\text{ dB}$

$f = 500\text{ MHz}$

$G_{UM} \quad \text{typ.} \quad 11.5\text{ dB}$

$f = 800\text{ MHz}$

$G_{UM} \quad \text{typ.} \quad 7.5\text{ dB}$

Note: measured under pulse conditions.



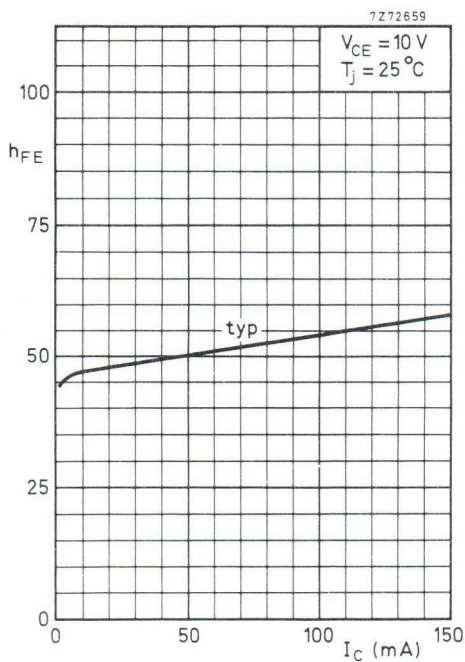


Fig.1 DC current gain as a function of collector current.

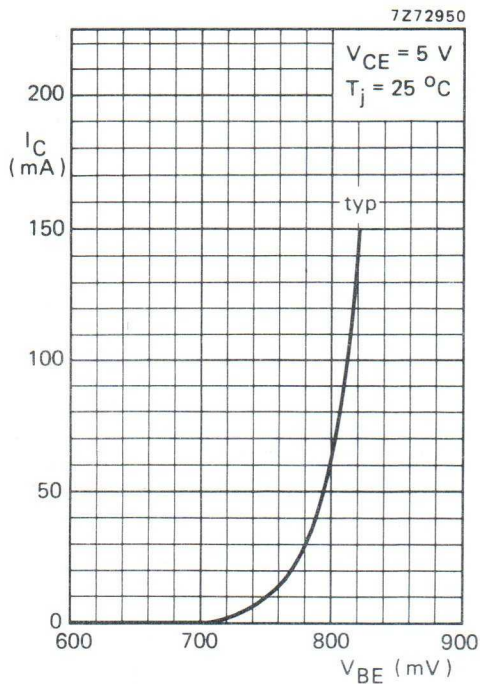


Fig.2 Collector current as a function of base-emitter voltage.

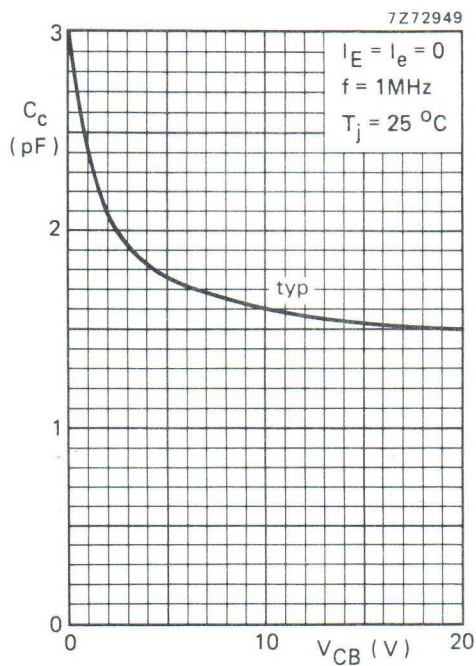


Fig.3 Collector capacitance as a function of collector-base voltage.

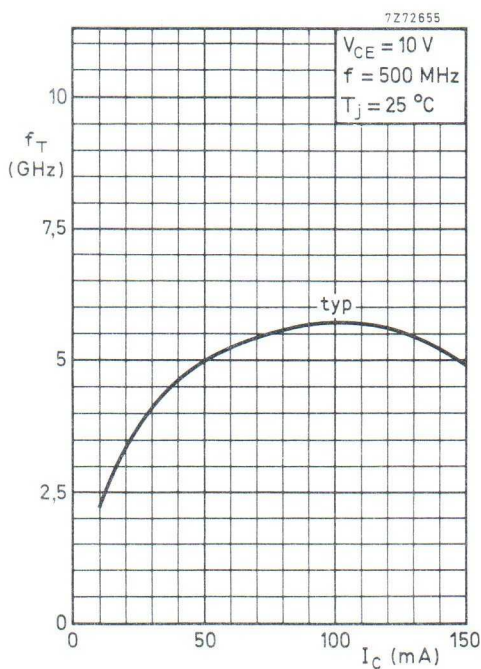


Fig.4 Transition frequency as a function of collector current.



## N-P-N 7.5 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope. It is designed for wideband application in the GHz range, such as satellite TV systems (SATV) and repeater amplifiers in fibre-optical systems. The device features a very high transition frequency and a very low noise figure up to high frequencies.

### QUICK REFERENCE DATA

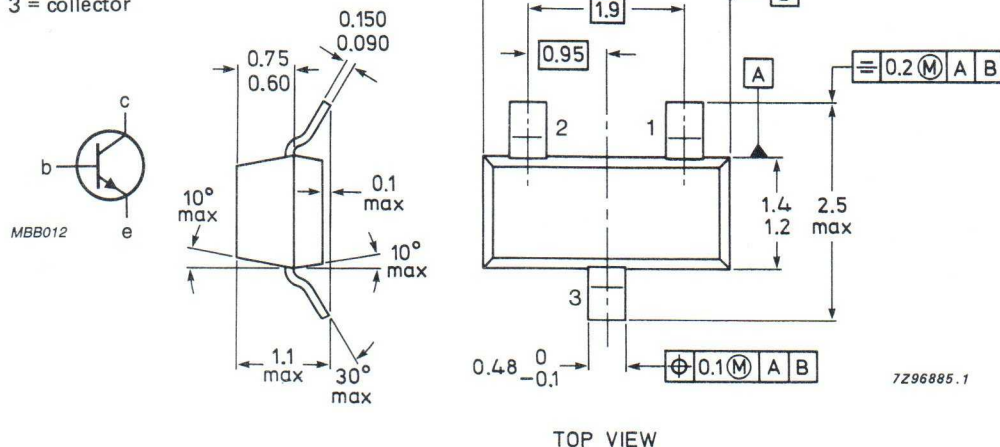
|                                                                                                  |           |      |                        |
|--------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage, open emitter                                                             | $V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage, open base                                                             | $V_{CEO}$ | max. | 10 V                   |
| Collector current (d.c.)                                                                         | $I_C$     | max. | 50 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                             | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                             | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain<br>$I_C = 15\text{ mA}; V_{CB} = 5\text{ V}$                                   | $h_{FE}$  | typ. | 100                    |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}$        | $f_T$     | typ. | 7,5 GHz                |
| Maximum unilateral power gain at $f = 2\text{ GHz}$<br>$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}$ | $G_{UM}$  | typ. | 8,0 dB                 |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning

- 1 = base
- 2 = emitter
- 3 = collector



If required, the R-version (reverse pinning) is available on request.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |           |              |                        |
|----------------------------------------------------------------------|-----------|--------------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max.         | 20 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max.         | 10 V                   |
| Emitter-base voltage (open collector)                                | $V_{EB0}$ | max.         | 2,5 V                  |
| Collector current (d.c.)                                             | $I_C$     | max.         | 50 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max.         | 300 mW                 |
| Storage temperature                                                  | $T_{stg}$ | —65 to + 150 | $^{\circ}\text{C}$     |
| Junction temperature                                                 | $T_j$     | max.         | 150 $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

From junction to ambient in free air\*

$$R_{th\ j-a} = 430\text{ K/W}$$

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 5\text{ V}$$

$$I_{CBO} \text{ max. } 50\text{ nA}$$

D.C. current gain

$$I_C = 15\text{ mA}; V_{CB} = 5\text{ V}$$

$$h_{FE} \text{ typ. } 100$$

Transition frequency at  $f = 500\text{ MHz}$ 

$$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}$$

$$f_T \text{ typ. } 7,5\text{ GHz}$$

Collector capacitance at  $f = 1\text{ MHz}$ 

$$I_E = i_e = 0; V_{CB} = 8\text{ V}$$

$$C_c \text{ typ. } 0,7\text{ pF}$$

Emitter capacitance at  $f = 1\text{ MHz}$ 

$$I_C = i_c = 0; V_{EB} = 0,5\text{ V}$$

$$C_e \text{ typ. } 1,3\text{ pF}$$

Feedback capacitance at  $f = 1\text{ MHz}$ 

$$I_C = 0; V_{CE} = 8\text{ V}$$

$$C_{re} \text{ typ. } 0,5\text{ pF}$$

Maximum unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}; f = 2\text{ GHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$$

$$G_{UM} \text{ typ. } 8,0\text{ dB}$$

Noise figure at  $f = 2\text{ GHz}$ ;  $Z_S = 60\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

$$I_C = 5\text{ mA}; V_{CE} = 8\text{ V}$$

$$F \text{ typ. } 2,5\text{ dB}$$

$$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}$$

$$F \text{ typ. } 3,0\text{ dB}$$

Noise figure at  $f = 800\text{ MHz}$ ;  $Z_S = \text{optimum}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

$$I_C = 5\text{ mA}; V_{CE} = 8\text{ V}$$

$$F \text{ typ. } 0,8\text{ dB}$$

$$I_C = 15\text{ mA}; V_{CE} = 8\text{ V}$$

$$F \text{ typ. } 1,5\text{ dB}$$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



s-parameters (common emitter) at  $V_{CE} = 8\text{ V}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $s_{11}$      | $s_{21}$     | $s_{12}$   | $s_{22}$     | $G_{UM}$<br>dB |
|-------------|----------|---------------|--------------|------------|--------------|----------------|
| 2           | 40       | 0,93/ -9,5°   | 7,07/174,6°  | 0,01/83,2° | 1,00/ -4,5°  | 46,7           |
|             | 100      | 0,90/ -22,8°  | 6,96/163,5°  | 0,03/76,3° | 0,97/ -10,4° | 36,4           |
|             | 200      | 0,84/ -42,1°  | 6,35/150,4°  | 0,06/66,4° | 0,91/ -17,9° | 29,2           |
|             | 500      | 0,61/ -90,7°  | 4,40/117,2°  | 0,10/45,7° | 0,67/ -32,6° | 17,5           |
|             | 800      | 0,55/ -118,0° | 3,24/102,6°  | 0,12/42,2° | 0,60/ -38,2° | 13,7           |
|             | 1000     | 0,54/ -135,5° | 2,76/ 93,5°  | 0,12/41,2° | 0,55/ -43,6° | 11,9           |
|             | 2000     | 0,47/ 177,3°  | 1,57/ 64,5°  | 0,15/60,0° | 0,47/ -65,3° | 6,1            |
| 5           | 40       | 0,84/ -14,9°  | 15,47/170,5° | 0,01/80,7° | 0,99/ -7,9°  | 44,5           |
|             | 100      | 0,78/ -36,1°  | 14,35/154,8° | 0,03/71,1° | 0,92/ -18,0° | 35,4           |
|             | 200      | 0,68/ -63,3°  | 11,97/137,7° | 0,05/60,6° | 0,79/ -29,0° | 28,5           |
|             | 500      | 0,45/ -119,8° | 6,74/106,1°  | 0,08/49,7° | 0,47/ -40,1° | 18,6           |
|             | 800      | 0,42/ -143,5° | 4,55/ 94,7°  | 0,09/53,8° | 0,41/ -41,5° | 14,8           |
|             | 1000     | 0,43/ -155,4° | 3,80/ 87,4°  | 0,10/56,1° | 0,37/ -46,7° | 13,1           |
|             | 2000     | 0,35/ 169,2°  | 2,04/ 63,5°  | 0,18/69,4° | 0,34/ -63,3° | 7,3            |
| 10          | 40       | 0,74/ -22,8°  | 25,66/165,6° | 0,01/77,5° | 0,96/ -12,1° | 43,0           |
|             | 100      | 0,65/ -51,2°  | 22,19/145,5° | 0,03/66,8° | 0,84/ -26,3° | 34,6           |
|             | 200      | 0,53/ -85,2°  | 16,35/126,4° | 0,04/58,1° | 0,64/ -38,4° | 28,0           |
|             | 500      | 0,38/ -144,4° | 8,01/ 99,5°  | 0,06/58,0° | 0,33/ -42,8° | 19,2           |
|             | 800      | 0,36/ -161,9° | 5,29/ 90,0°  | 0,09/64,0° | 0,30/ -41,2° | 15,5           |
|             | 1000     | 0,38/ 169,9°  | 4,27/ 84,0°  | 0,10/66,0° | 0,27/ -47,0° | 13,6           |
|             | 2000     | 0,30/ 160,0°  | 2,29/ 62,8°  | 0,20/72,6° | 0,27/ -61,2° | 7,9            |
| 15          | 40       | 0,67/ -28,3°  | 32,67/162,1° | 0,01/75,8° | 0,94/ -14,9° | 42,5           |
|             | 100      | 0,57/ -62,8°  | 26,66/139,6° | 0,02/64,6° | 0,78/ -31,4° | 34,2           |
|             | 200      | 0,46/ -99,5°  | 18,35/120,6° | 0,04/58,7° | 0,56/ -42,8° | 27,9           |
|             | 500      | 0,36/ -154,8° | 8,49/ 96,8°  | 0,06/62,9° | 0,27/ -42,8° | 19,5           |
|             | 800      | 0,34/ 169,3°  | 5,55/ 88,4°  | 0,09/68,4° | 0,26/ -39,7° | 15,7           |
|             | 1000     | 0,36/ 176,8°  | 4,47/ 82,5°  | 0,10/69,7° | 0,23/ -46,3° | 13,9           |
|             | 2000     | 0,29/ 155,7°  | 2,37/ 62,3°  | 0,21/73,4° | 0,25/ -59,8° | 8,2            |
| 20          | 40       | 0,63/ -32,5°  | 37,50/159,4° | 0,01/74,2° | 0,93/ -17,2° | 42,0           |
|             | 100      | 0,52/ -70,8°  | 29,23/135,5° | 0,02/63,4° | 0,73/ -34,7° | 34,0           |
|             | 200      | 0,42/ -108,8° | 19,22/117,4° | 0,03/59,7° | 0,50/ -45,0° | 27,8           |
|             | 500      | 0,35/ -162,0° | 8,69/ 95,0°  | 0,06/64,9° | 0,23/ -41,6° | 19,6           |
|             | 800      | 0,33/ -175,1° | 5,62/ 86,9°  | 0,09/70,7° | 0,24/ -38,1° | 15,7           |
|             | 1000     | 0,36/ -178,7° | 4,57/ 81,7°  | 0,10/71,6° | 0,21/ -45,0° | 14,0           |
|             | 2000     | 0,28/ -153,5° | 2,40/ 62,0°  | 0,21/73,8° | 0,24/ -58,9° | 8,2            |

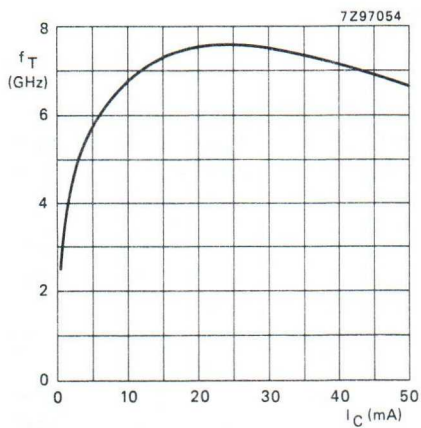


Fig. 2  $V_{CE} = 8\text{ V}$ ;  $f = 500\text{ MHz}$ ; typical values.

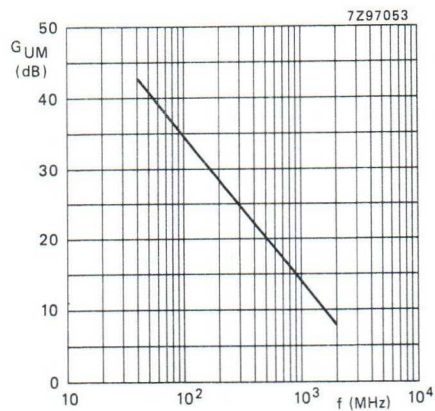


Fig. 3  $V_{CE} = 8\text{ V}$ ;  $I_C = 15\text{ mA}$ ;  
 $T_{amb} = 25^\circ\text{C}$ ; typical values.

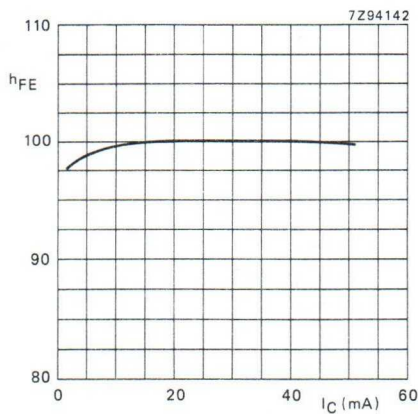


Fig. 4 DC current gain as a function of collector current.

## SILICON PLANAR EPITAXIAL TRANSISTOR

The BFQ149 is a PNP transistor in a SOT89 envelope, containing a BFQ32 crystal. The transistor is intended for use in UHF applications such as broadband aerial amplifiers (30 MHz to 860 MHz) and in microwave amplifiers such as radar systems, spectrum analyzers etc. using SMD technology.

### QUICK REFERENCE DATA

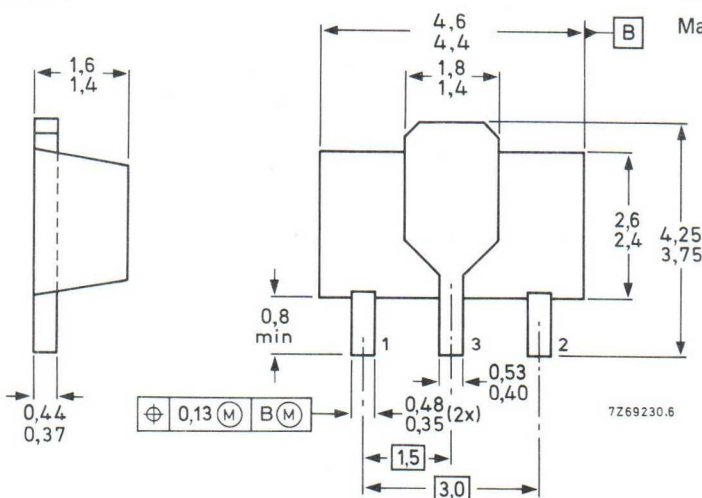
|                                                                                                                                                        |            |      |                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                  | $-V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage (open base)                                                                                                                  | $-V_{CEO}$ | max. | 15 V                   |
| Collector current (DC)                                                                                                                                 | $-I_C$     | max. | 75 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>mounted on a ceramic substrate, area $2.5\text{ cm}^2$ ,<br>thickness = 0.7 mm | $P_{tot}$  | max. | 1 W                    |
| Junction temperature                                                                                                                                   | $T_j$      | max. | 150 $^{\circ}\text{C}$ |
| DC current gain                                                                                                                                        |            |      |                        |
| $-I_C = 50\text{ mA}$ ; $-V_{CE} = 10\text{ V}$                                                                                                        | $h_{FE}$   | min. | 20                     |
| $-I_C = 75\text{ mA}$ ; $-V_{CE} = 10\text{ V}$                                                                                                        | $h_{FE}$   | min. | 20                     |
| Transition frequency at $f = 500\text{ MHz}$                                                                                                           |            |      |                        |
| $-I_C = 50\text{ mA}$ ; $-V_{CE} = 10\text{ V}$                                                                                                        | $f_T$      | min. | 3.6 GHz                |
|                                                                                                                                                        |            | typ. | 4.2 GHz                |
| $-I_C = 75\text{ mA}$ ; $-V_{CE} = 10\text{ V}$                                                                                                        | $f_T$      | min. | 4.0 GHz                |
|                                                                                                                                                        |            | typ. | 4.6 GHz                |
| Noise figure at $f = 500\text{ MHz}$ , $R_s = 60\text{ }\Omega$                                                                                        |            |      |                        |
| $-I_C = 50\text{ mA}$ ; $-V_{CE} = 10\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                               | F          | typ. | 3.75 dB                |
| Maximum unilateral power gain at $f = 500\text{ MHz}$                                                                                                  |            |      |                        |
| $-I_C = 50\text{ mA}$ ; $-V_{CE} = 10\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                               | $G_{um}$   | typ. | 12 dB                  |

### MECHANICAL DATA

Fig.1 SOT89.

#### Pinning

- 1 = emitter
- 2 = base
- 3 = collector



Dimensions in mm

Marking code: FG

BOTTOM VIEW

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134).

|                                                                                                                                                          |            |                                      |                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------|-------------------------------|
| Collector-base voltage (open emitter)                                                                                                                    | $-V_{CBO}$ | max.                                 | 20 V                          |
| Collector-emitter voltage (open base)                                                                                                                    | $-V_{CEO}$ | max.                                 | 15 V                          |
| Emitter-base voltage (open collector)                                                                                                                    | $-V_{EBO}$ | max.                                 | 3.0 V                         |
| Collector current (DC)                                                                                                                                   | $-I_C$     | max.                                 | 75 mA                         |
| Collector current (peak value); $f > 1$ MHz                                                                                                              | $-I_{CM}$  | max.                                 | 150 mA                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>mounted on a ceramic substrate, area = $2.5\text{ cm}^2$ ,<br>thickness = 0.7 mm | $P_{tot}$  | max.                                 | 1 W                           |
| Storage temperature range                                                                                                                                | $T_{stg}$  | -65 to $150\text{ }^{\circ}\text{C}$ |                               |
| Junction temperature                                                                                                                                     | $T_j$      | max.                                 | $175\text{ }^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

From junction to ambient mounted on a ceramic substrate, area = 2.5 cm<sup>2</sup>, thickness = 0.7 mm

$R_{thj-a}$  125 K/W

**CHARACTERISTICS**

$T_j = 25^\circ\text{C}$  unless otherwise specified.

Collector cut off current

$I_E = 0, -V_{CB} = 10\text{ V}$

$I_{CBO}$  max. 100 nA

DC current gain

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$

$h_{FE}$  min. 20

$-I_C = 75\text{ mA}; -V_{CE} = 10\text{ V}$

$h_{FE}$  min. 20

Transition frequency at  $f = 500\text{ MHz}$

$-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}; T_{amb} = 25^\circ\text{C}$

$f_T$  min. 3.6 GHz  
typ. 4.2 GHz

$-I_C = 75\text{ mA}; -V_{CE} = 10\text{ V}; T_{amb} = 25^\circ\text{C}$

$f_T$  min. 4.0 GHz  
typ. 4.6 GHz

Collector capacitance

$-V_{CB} = 10\text{ V}; I_E = 0; f = 1\text{ MHz}$

$C_c$  typ. 2.0 pF

Emitter capacitance

$-V_{EB} = 0.5\text{ V}; I_C = 0; f = 1\text{ MHz}$

$C_e$  typ. 4.0 pF

Feedback capacitance

$-V_{CE} = 10\text{ V}; I_C = 0; f = 1\text{ MHz}$

$C_{re}$  typ. 1.7 pF

Noise figure at  $f = 500\text{ MHz}; R_s = 60\ \Omega$

$-V_{CE} = 10\text{ V}; -I_C = 50\text{ mA}; T_{amb} = 25^\circ\text{C}$

$F$  typ. 3.75 dB

Maximum unilateral power gain

( $S_{12}$  assumed to be zero)

$-V_{CE} = 10\text{ V}; -I_C = 50\text{ mA}; f = 500\text{ MHz}; T_{amb} = 25^\circ\text{C}$

$$GUM = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

$GUM$  typ. 12 dB



Table 1 S-parameters (common emitter) at  $V_{CE} = 10$  V; typical values.

| $I_C$<br>mA | f<br>MHz | S <sub>11</sub><br>M(X)/ANG. | S <sub>21</sub><br>M(X)/ANG. | S <sub>12</sub><br>M(X)/ANG. | S <sub>22</sub><br>M(X)/ANG. | GUM<br>dB |
|-------------|----------|------------------------------|------------------------------|------------------------------|------------------------------|-----------|
| 10          | 40       | 0.42/-56.8                   | 18.15/153.9                  | 0.02/71.9                    | 0.90/-21.2                   | 33.3      |
|             | 100      | 0.48/-115.9                  | 12.21/123.6                  | 0.04/56.5                    | 0.64/-44.0                   | 25.1      |
|             | 200      | 0.49/-151.0                  | 6.99/103.3                   | 0.06/55.7                    | 0.40/-53.0                   | 18.8      |
|             | 500      | 0.51/-176.5                  | 2.99/78.0                    | 0.11/63.6                    | 0.27/-62.6                   | 11.1      |
|             | 800      | 0.52/159.3                   | 1.98/63.7                    | 0.17/66.1                    | 0.27/-70.6                   | 7.6       |
|             | 1000     | 0.54/149.0                   | 1.60/55.6                    | 0.20/66.2                    | 0.27/-76.0                   | 5.9       |
|             | 1200     | 0.57/137.7                   | 1.37/50.3                    | 0.24/66.7                    | 0.27/-82.1                   | 4.7       |
|             | 1500     | 0.53/129.6                   | 1.17/40.7                    | 0.30/63.2                    | 0.30/-89.4                   | 3.2       |
|             | 2000     | 0.56/104.4                   | 0.96/31.2                    | 0.41/58.9                    | 0.31/-104.4                  | 1.7       |
| 20          | 40       | 0.29/-88.4                   | 24.14/148.1                  | 0.02/70.4                    | 0.84/-28.7                   | 33.4      |
|             | 100      | 0.43/-139.9                  | 14.51/117.6                  | 0.03/61.0                    | 0.52/-54.8                   | 25.5      |
|             | 200      | 0.46/-164.5                  | 7.95/99.7                    | 0.05/65.6                    | 0.31/-64.8                   | 19.5      |
|             | 500      | 0.49/170.8                   | 3.31/77.5                    | 0.12/70.0                    | 0.20/-79.5                   | 11.7      |
|             | 800      | 0.50/155.9                   | 2.18/64.4                    | 0.18/68.6                    | 0.20/-85.6                   | 8.2       |
|             | 1000     | 0.51/146.2                   | 1.77/57.0                    | 0.22/67.1                    | 0.20/-91.5                   | 6.5       |
|             | 1200     | 0.54/135.0                   | 1.51/52.1                    | 0.26/66.3                    | 0.20/-95.1                   | 5.3       |
|             | 1500     | 0.50/128.5                   | 1.30/42.2                    | 0.32/61.3                    | 0.24/-100.2                  | 3.8       |
|             | 2000     | 0.52/103.8                   | 1.08/32.3                    | 0.42/56.1                    | 0.25/-112.2                  | 2.3       |
| 30          | 40       | 0.27/-111.5                  | 27.56/144.5                  | 0.02/69.9                    | 0.79/-33.3                   | 33.5      |
|             | 100      | 0.43/-151.5                  | 15.55/114.5                  | 0.03/64.3                    | 0.46/-60.8                   | 25.8      |
|             | 200      | 0.46/-170.6                  | 8.30/97.8                    | 0.05/70.2                    | 0.26/-71.5                   | 19.7      |
|             | 500      | 0.48/168.5                   | 3.42/77.0                    | 0.12/72.0                    | 0.17/-89.8                   | 11.9      |
|             | 800      | 0.49/154.4                   | 2.25/64.4                    | 0.19/69.6                    | 0.18/-94.2                   | 8.4       |
|             | 1000     | 0.51/145.0                   | 1.82/57.3                    | 0.22/67.3                    | 0.18/13.1                    | 6.7       |
|             | 1200     | 0.53/133.0                   | 1.56/52.4                    | 0.27/66.1                    | 0.17/-103.9                  | 5.5       |
|             | 1500     | 0.49/128.0                   | 1.34/42.7                    | 0.33/60.7                    | 0.22/-106.9                  | 4.0       |
|             | 2000     | 0.50/103.4                   | 1.11/32.6                    | 0.43/55.0                    | 0.23/-117.2                  | 2.4       |
| 50          | 40       | 0.29/-134.0                  | 30.36/140.3                  | 0.02/68.9                    | 0.73/-38.2                   | 33.3      |
|             | 100      | 0.44/-161.4                  | 16.10/111.3                  | 0.03/69.8                    | 0.40/-66.3                   | 25.8      |
|             | 200      | 0.46/-175.9                  | 8.44/95.8                    | 0.05/74.5                    | 0.22/-77.6                   | 19.8      |
|             | 500      | 0.48/166.6                   | 3.44/76.4                    | 0.12/73.9                    | 0.16/-98.7                   | 12.0      |
|             | 800      | 0.49/153.2                   | 2.27/64.0                    | 0.19/70.2                    | 0.17/-101.6                  | 8.4       |
|             | 1000     | 0.51/144.2                   | 1.84/57.0                    | 0.23/67.7                    | 0.17/-107.5                  | 6.7       |
|             | 1200     | 0.54/133.2                   | 1.58/52.3                    | 0.27/66.3                    | 0.16/-111.6                  | 5.5       |
|             | 1500     | 0.49/127.5                   | 1.36/42.5                    | 0.34/60.2                    | 0.21/-112.3                  | 4.0       |
|             | 2000     | 0.50/103.1                   | 1.12/32.5                    | 0.43/54.5                    | 0.22/-121.6                  | 2.5       |
| 70          | 40       | 0.32/-144.1                  | 31.28/137.7                  | 0.02/69.0                    | 0.68/-40.8                   | 33.0      |
|             | 100      | 0.46/-165.9                  | 15.91/109.3                  | 0.03/72.2                    | 0.36/-68.2                   | 25.6      |
|             | 200      | 0.47/-178.2                  | 8.24/94.5                    | 0.05/75.9                    | 0.20/-78.3                   | 19.6      |
|             | 500      | 0.49/165.8                   | 3.35/75.7                    | 0.12/74.6                    | 0.15/-99.6                   | 11.8      |
|             | 800      | 0.50/152.8                   | 2.21/63.2                    | 0.19/70.6                    | 0.17/-101.9                  | 8.2       |
|             | 1000     | 0.52/143.9                   | 1.78/56.3                    | 0.23/68.0                    | 0.17/-107.6                  | 6.5       |
|             | 1200     | 0.54/133.0                   | 1.53/51.6                    | 0.27/66.6                    | 0.16/-112.0                  | 5.4       |
|             | 1500     | 0.50/127.2                   | 1.32/41.7                    | 0.34/60.5                    | 0.21/-122.9                  | 3.9       |
|             | 2000     | 0.52/102.9                   | 1.09/32.0                    | 0.44/54.7                    | 0.23/-122.7                  | 2.3       |

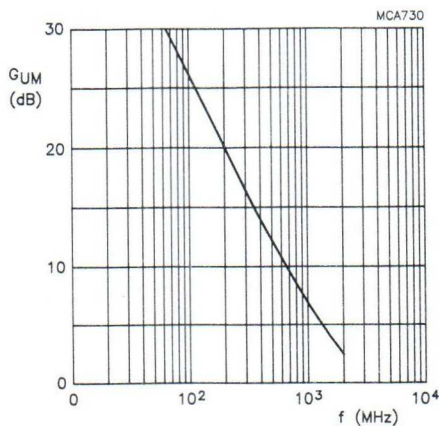


Fig.2 Maximum unilateral power gain as a function of frequency.  $-V_{CE} = 10$  V;  $I_C = 50$  mA;  $T_{amb} = 25$  °C.

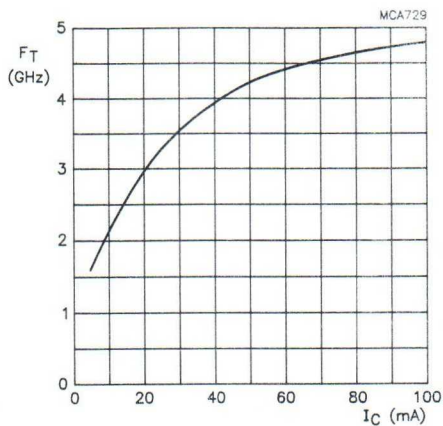


Fig.3 Transition frequency as a function of collector current.  $-V_{CE} = 10$  V;  $f = 500$  MHz;  $T_j = 25$  °C.

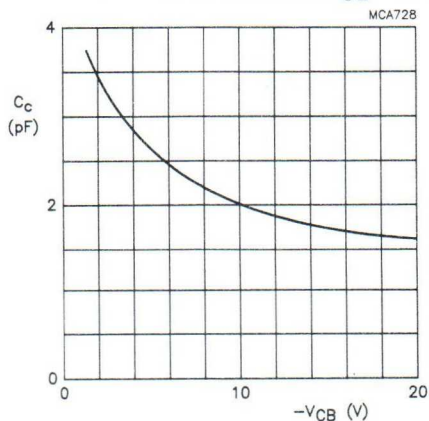


Fig.4 Collector capacitance as a function of collector base voltage.  $I_E = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C.



## N-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

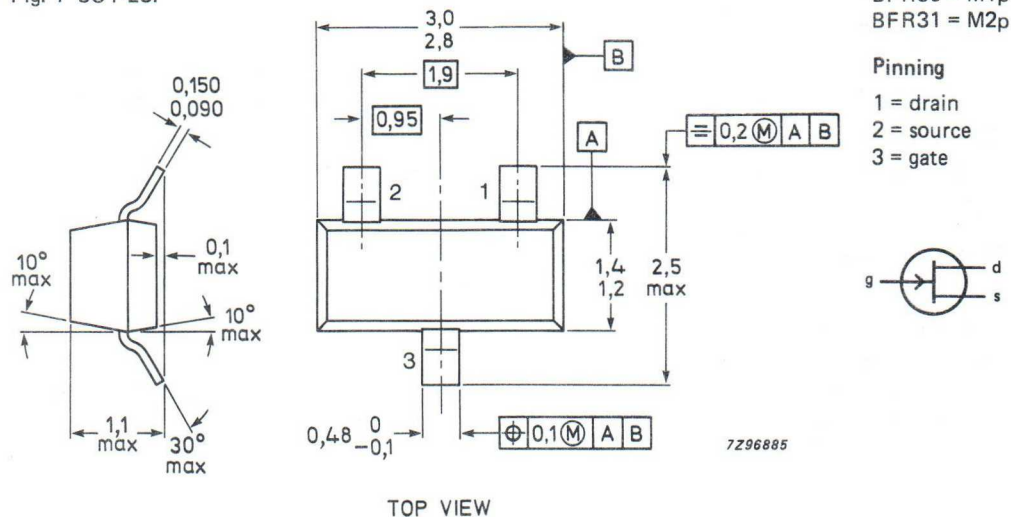
Planar epitaxial symmetrical junction field effect transistor in a microminiature plastic envelope. It is intended for low level general purpose amplifiers in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                                                                    |              |      |       |       |    |
|----------------------------------------------------------------------------------------------------|--------------|------|-------|-------|----|
| Drain-source voltage                                                                               | $\pm V_{DS}$ | max. | 25    | V     |    |
| Gate-source voltage (open drain)                                                                   | $-V_{GSO}$   | max. | 25    | V     |    |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}$                               | $P_{tot}$    | max. | 250   | mW    |    |
|                                                                                                    |              |      | BFR30 | BFR31 |    |
| Drain current<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                                | $I_{DSS}$    | min. | 4     | 1     | mA |
|                                                                                                    |              | max. | 10    | 5     | mA |
| Transfer admittance (common source)<br>$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}; f = 1\text{ kHz}$ | $ y_{fs} $   | min. | 1.0   | 1.5   | mS |
|                                                                                                    |              | max. | 4.0   | 4.5   | mS |

## MECHANICAL DATA

Fig. 1 SOT-23.



Note: Drain and source are interchangeable.

See also *Soldering recommendations*.

# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |              |      |              |                    |
|------------------------------------------------------------------------|--------------|------|--------------|--------------------|
| Drain-source voltage                                                   | $\pm V_{DS}$ | max. | 25           | V                  |
| Drain-gate voltage (open source)                                       | $V_{DGO}$    | max. | 25           | V                  |
| Gate-source voltage (open drain)                                       | $-V_{GSO}$   | max. | 25           | V                  |
| Drain current                                                          | $I_D$        | max. | 10           | mA                 |
| Gate current                                                           | $I_G$        | max. | 5            | mA                 |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}^*$ | $P_{tot}$    | max. | 250          | mW                 |
| Storage temperature range                                              | $T_{stg}$    |      | -65 to + 150 | $^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$        | max. | 150          | $^{\circ}\text{C}$ |

# **THERMAL RESISTANCE**

|                           |               |   |     |     |
|---------------------------|---------------|---|-----|-----|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 | K/W |
|---------------------------|---------------|---|-----|-----|

# **CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                              |              |              | BFR30      | BFR31      |               |
|------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|------------|------------|---------------|
| Gate cut-off current<br>$-V_{GS} = 10\text{ V}; V_{DS} = 0$                                                                  | $-I_{GSS}$   | max.         | 0.2        | 0.2        | nA            |
| Drain current<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                                                          | $I_{DSS}$    | min.<br>max. | 4<br>10    | 1<br>5     | mA<br>mA      |
| Gate-source voltage<br>$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$                                                             | $-V_{GS}$    | min.<br>max. | 0.7<br>3.0 | 0<br>1.3   | V<br>V        |
| $I_D = 50\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$                                                                          | $-V_{GS}$    | max.         | 4.0        | 2.0        | V             |
| Gate-source cut-off voltage<br>$I_D = 0,5\text{ nA}; V_{DS} = 10\text{ V}$                                                   | $-V_{(P)GS}$ | max.         | 5          | 2.5        | V             |
| <b>y parameters</b>                                                                                                          |              |              |            |            |               |
| Transfer admittance at $f = 1\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$<br>$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$ | $ Y_{fs} $   | min.<br>max. | 1.0<br>4.0 | 1.5<br>4.5 | mS<br>mS      |
| $I_D = 200\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$                                                                         | $ Y_{fs} $   | min.         | 0.5        | 0.75       | mS            |
| Output admittance at $f = 1\text{ kHz}$<br>$I_D = 1\text{ mA}; V_{DS} = 10\text{ V}$                                         | $ Y_{os} $   | max.         | 40         | 25         | $\mu\text{S}$ |
| $I_D = 200\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$                                                                         | $ Y_{os} $   | max.         | 20         | 15         | $\mu\text{S}$ |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



## y parameters (continued)

Input capacitance at  $f = 1$  MHz

$$I_D = 1 \text{ mA}; V_{DS} = 10 \text{ V}$$

$$I_D = 200 \text{ } \mu\text{A}; V_{DS} = 10 \text{ V}$$

Feedback capacitance at  $f = 1$  MHz;  $T_{\text{amb}} = 25^\circ\text{C}$ 

$$I_D = 1 \text{ mA}; V_{DS} = 10 \text{ V}$$

$$I_D = 200 \text{ } \mu\text{A}; V_{DS} = 10 \text{ V}$$

Equivalent noise voltage

$$I_D = 200 \text{ } \mu\text{A}; V_{DS} = 10 \text{ V}$$

$$B = 0.6 \text{ to } 100 \text{ Hz}$$

|          |      | BFR30 | BFR31 |               |
|----------|------|-------|-------|---------------|
| $C_{is}$ | max. | 4     | 4     | pF            |
| $C_{is}$ | max. | 4     | 4     | pF            |
| $C_{rs}$ | max. | 1.5   | 1.5   | pF            |
| $C_{rs}$ | max. | 1.5   | 1.5   | pF            |
| $V_n$    | max. | 0.5   | 0.5   | $\mu\text{V}$ |

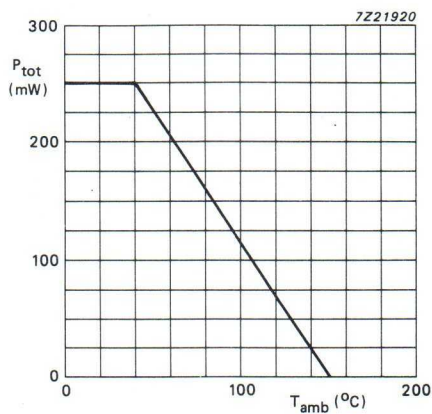


Fig.2 Power derating curve.

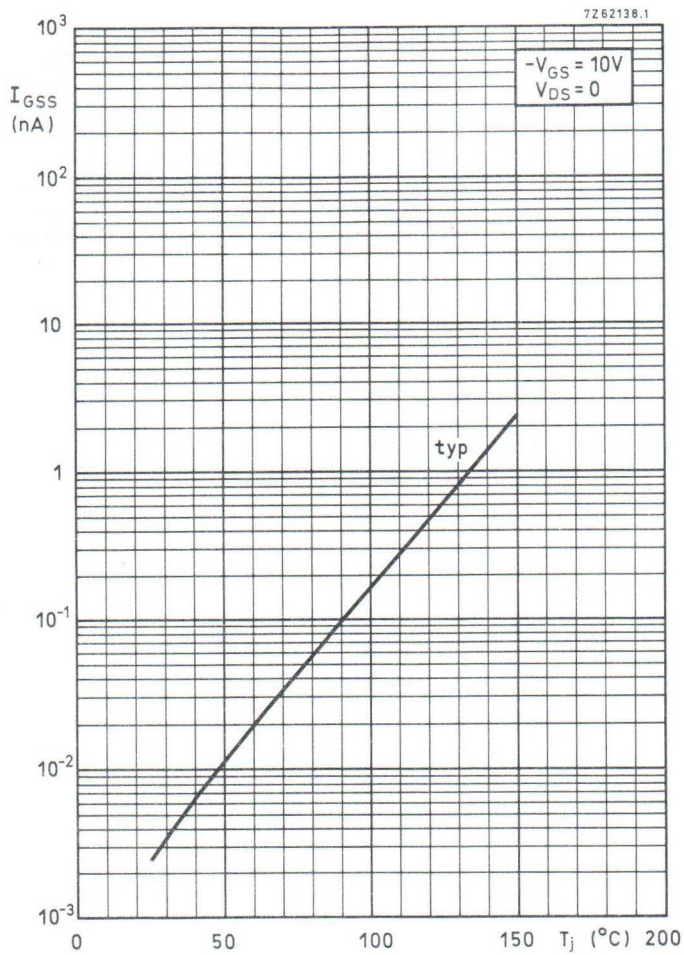


Fig.3.

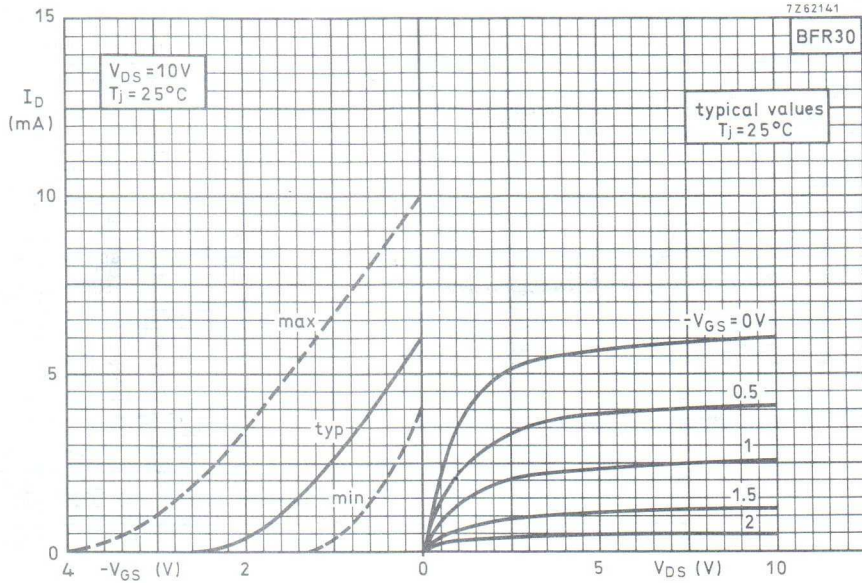


Fig.4.

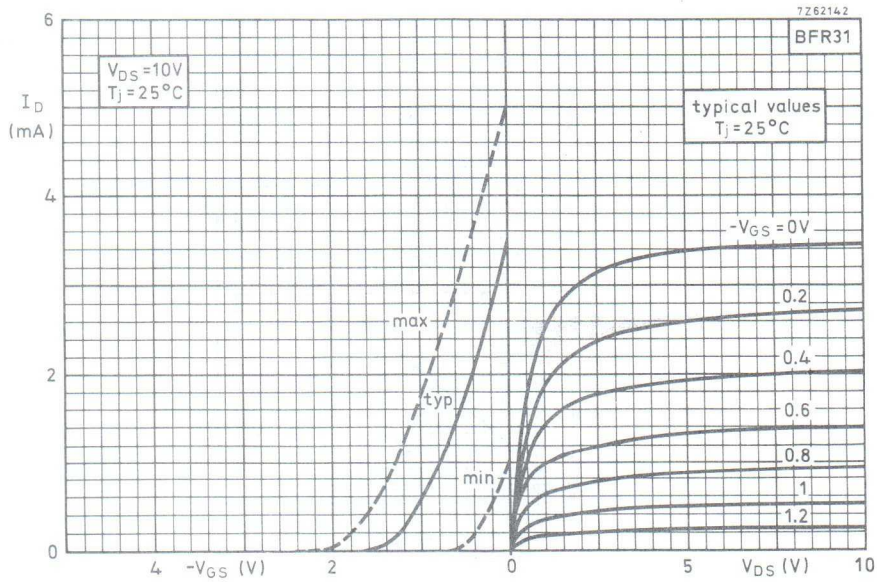


Fig.5.

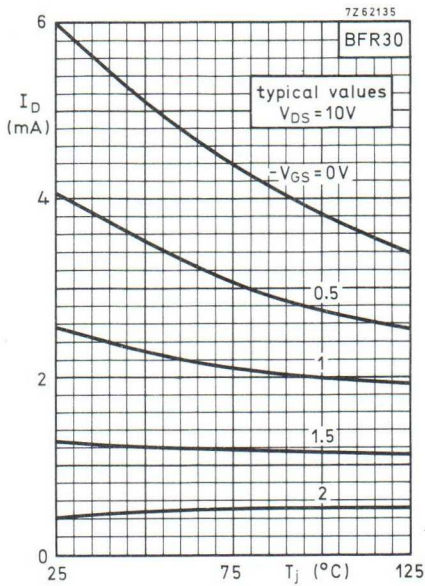


Fig.6.

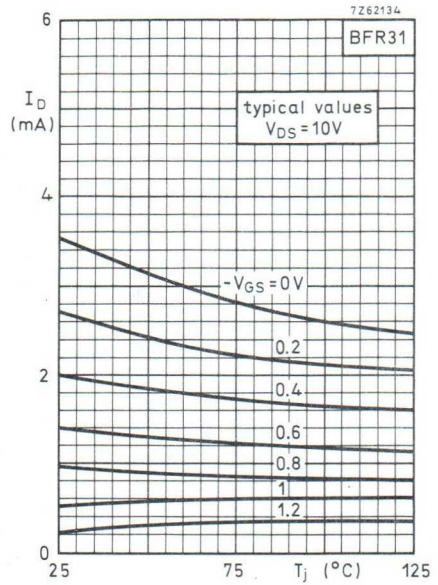


Fig.7.

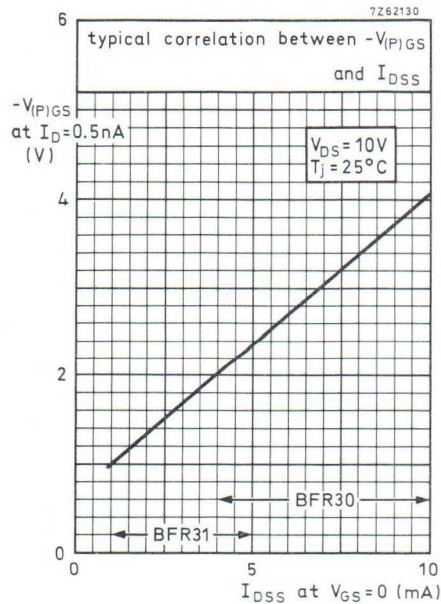


Fig.8.



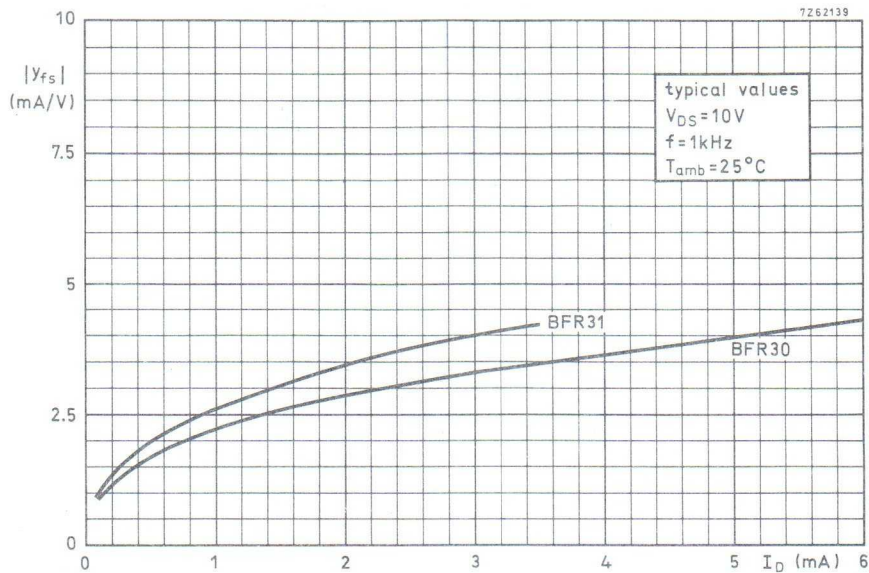


Fig.9.

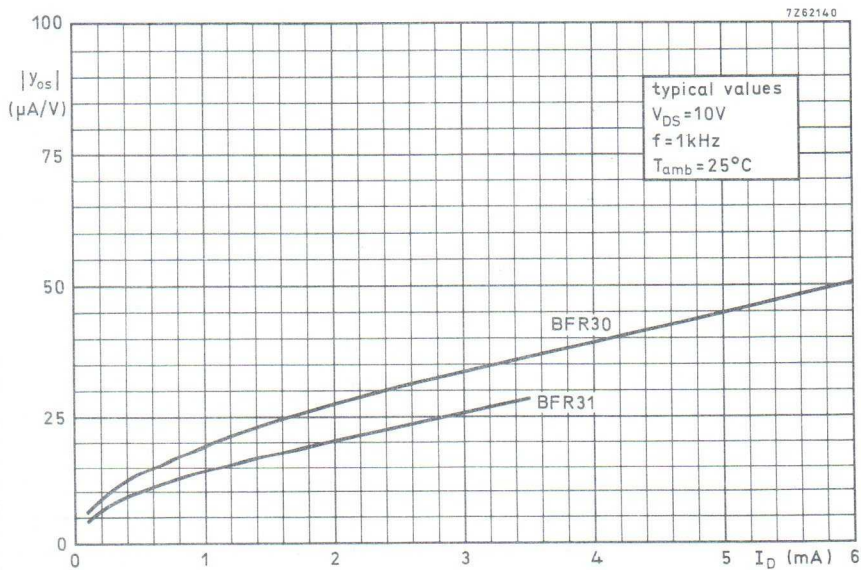


Fig.10.



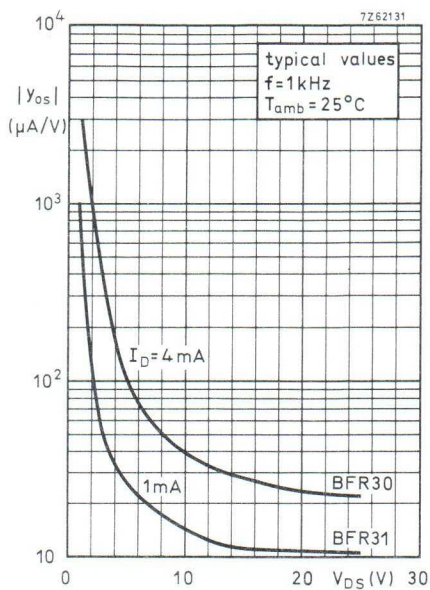


Fig.11.

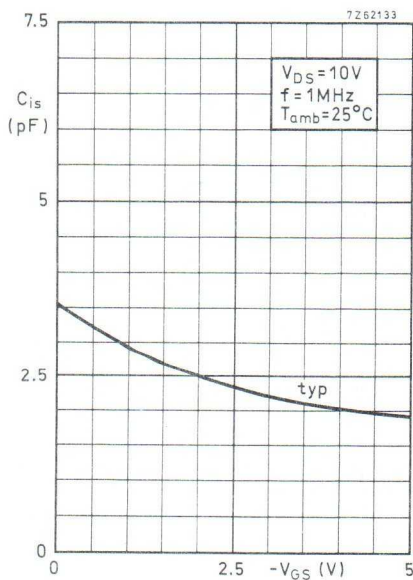


Fig.12.

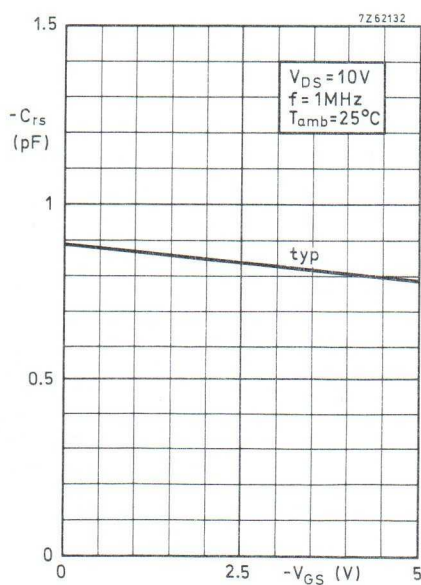


Fig.13.

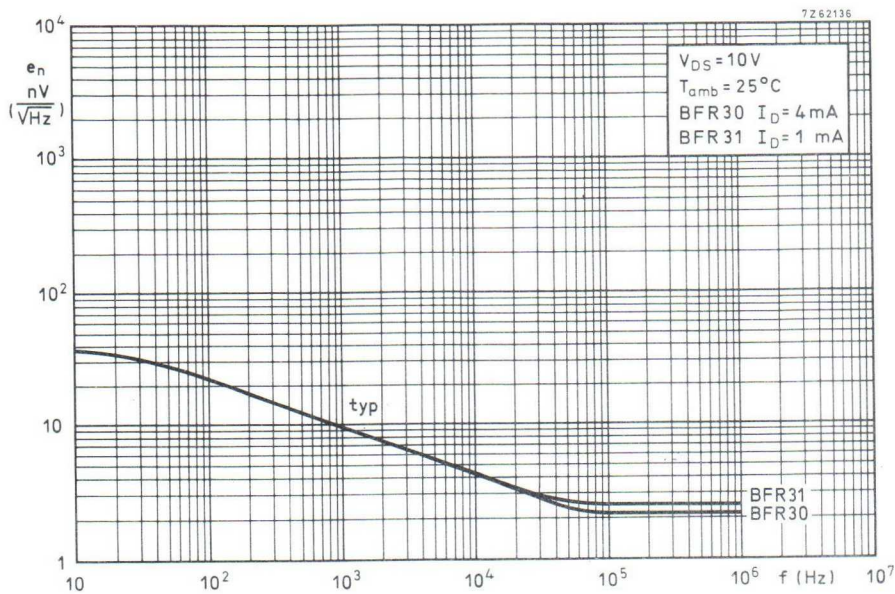


Fig.14.

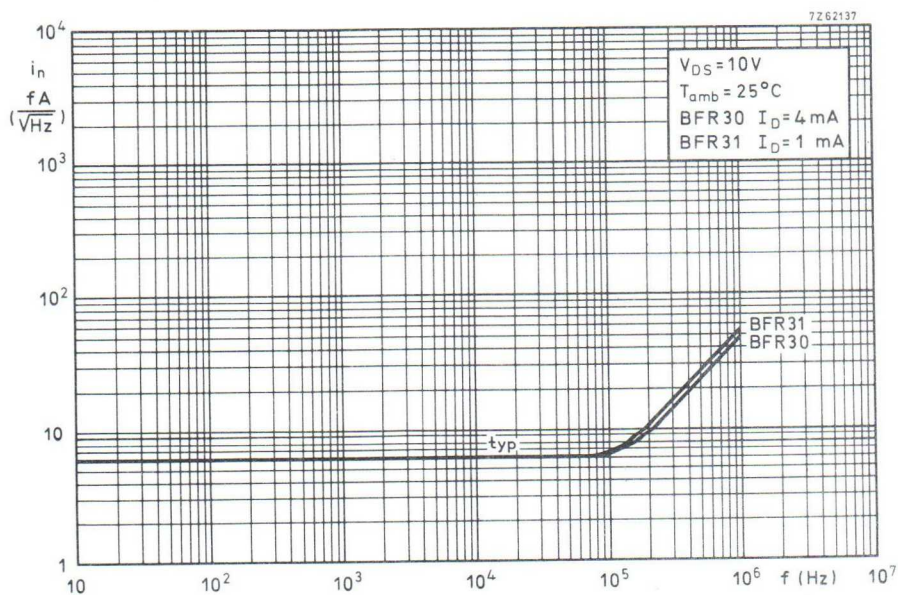


Fig.15.



## N-P-N 2 GHz WIDEBAND TRANSISTOR

N-P-N multi-emitter transistor in a plastic SOT-23 envelope intended for application in thick and thin-film circuits. The transistor has very low intermodulation distortion and very high power gain. It is primarily intended for:

- Wideband vertical amplifiers in high speed oscilloscopes.
- Television distribution amplifiers.

### QUICK REFERENCE DATA

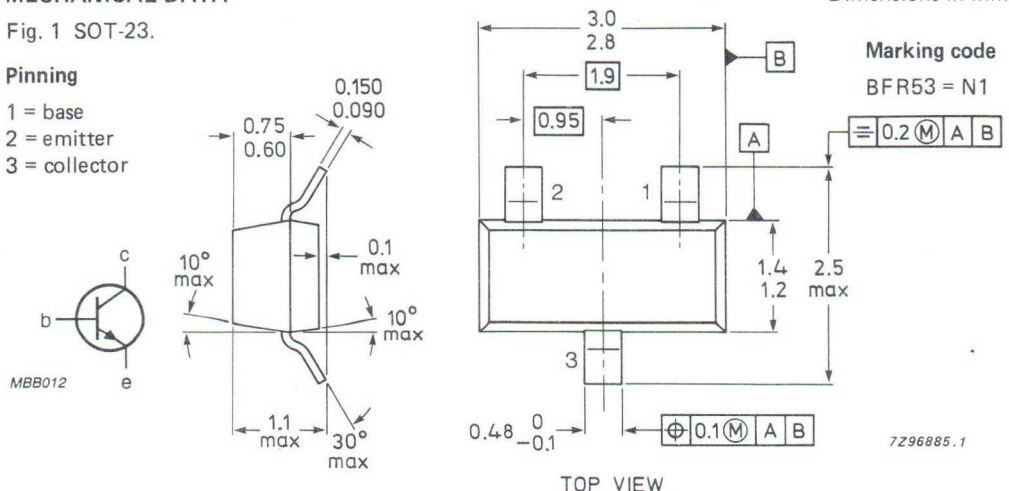
|                                                                                                                                                                                                                    |                      |      |                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|------------------|
| Collector-base voltage (open emitter)                                                                                                                                                                              | $V_{CBO}$            | max. | 18 V             |
| Collector-emitter voltage (open base)                                                                                                                                                                              | $V_{CEO}$            | max. | 10 V             |
| Collector current (peak value; $f > 1$ MHz)                                                                                                                                                                        | $I_{CM}$             | max. | 100 mA           |
| Total power dissipation up to $T_{amb} = 25$ °C                                                                                                                                                                    | $P_{tot}$            | max. | 300 mW           |
| Junction temperature                                                                                                                                                                                               | $T_j$                | max. | 150 °C           |
| Feedback capacitance at $f = 1$ MHz<br>$I_C = 2$ mA; $V_{CE} = 5$ V                                                                                                                                                | $C_{re}$             | typ. | 0,9 pF           |
| Transition frequency at $f = 500$ MHz<br>$I_C = 25$ mA; $V_{CE} = 5$ V                                                                                                                                             | $f_T$                | typ. | 2,0 GHz          |
| Max. unilateral power gain<br>$I_C = 30$ mA; $V_{CE} = 5$ V; $f = 200$ MHz<br>$I_C = 30$ mA; $V_{CE} = 5$ V; $f = 800$ MHz                                                                                         | $G_{UM}$<br>$G_{UM}$ | typ. | 22 dB<br>10,5 dB |
| Intermodulation distortion at $T_{amb} = 25$ °C<br>$I_C = 30$ mA; $V_{CE} = 5$ V; $R_L = 37,5 \Omega$<br>$V_O = 100$ mV at $f_p = 183$ MHz<br>$V_O = 100$ mV at $f_q = 200$ MHz<br>measured at $f(2q-p) = 217$ MHz | $d_{im}$             | typ. | -60 dB           |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning

- 1 = base  
2 = emitter  
3 = collector



If required, the R-version (reverse pinning) is available on request.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                 |           |      |                |
|-------------------------------------------------|-----------|------|----------------|
| Collector-base voltage (open emitter)           | $V_{CBO}$ | max. | 18 V           |
| Collector-emitter voltage (open base)           | $V_{CEO}$ | max. | 10 V           |
| Emitter-base voltage (open collector)           | $V_{EB0}$ | max. | 2,5 V          |
| Collector current (d.c.)                        | $I_C$     | max. | 50 mA          |
| Collector current (peak value: $f > 1$ MHz)     | $I_{CM}$  | max. | 100 mA         |
| Total power dissipation up to $T_{amb} = 25$ °C | $P_{tot}$ | max. | 300 mW         |
| Storage temperature                             | $T_{stg}$ | max. | -65 to +150 °C |
| Junction temperature                            | $T_j$     | max. | 150 °C         |

## THERMAL RESISTANCE

From junction to ambient\*

$$R_{th\ j-a} = 430\ K/W$$

## CHARACTERISTICS

 $T_j = 25$  °C unless otherwise specified

|                                                                                      |           |      |         |
|--------------------------------------------------------------------------------------|-----------|------|---------|
| Collector cut-off current<br>$I_E = 0; V_{CB} = 10\ V$                               | $I_{CBO}$ | max. | 50 nA   |
| D.C. current gain<br>$I_C = 25\ mA; V_{CE} = 5\ V$                                   | $h_{FE}$  | min. | 25      |
| $I_C = 50\ mA; V_{CE} = 5\ V$                                                        | $h_{FE}$  | min. | 25      |
| Transition frequency at $f = 500$ MHz<br>$I_C = 25\ mA; V_{CE} = 5\ V$               | $f_T$     | typ. | 2,0 GHz |
| Collector capacitance at $f = 1$ MHz<br>$I_E = I_e = 0; V_{CB} = 5\ V$               | $C_c$     | typ. | 0,9 pF  |
| Emitter capacitance at $f = 1$ MHz<br>$I_C = I_c = 0; V_{EB} = 0,5\ V$               | $C_e$     | typ. | 1,5 pF  |
| Feedback capacitance at $f = 1$ MHz<br>$I_C = 2\ mA; V_{CE} = 5\ V; T_{amb} = 25$ °C | $C_{re}$  | typ. | 0,9 pF  |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



**Noise figure at  $f = 500$  MHz \*** $I_C = 2$  mA;  $V_{CE} = 5$  V;  $T_{amb} = 25$  °C $G_S = 20$  mS;  $B_S$  is tuned

F      max.      5,0 dB

**Max. unilateral power gain ( $s_{12}$  assumed to be zero)**

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

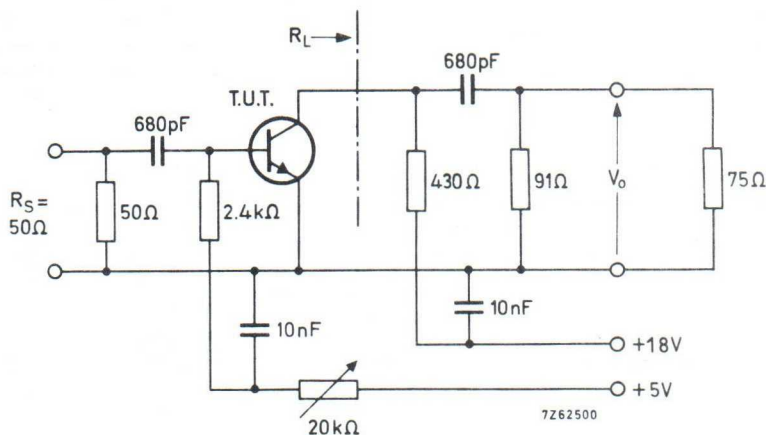
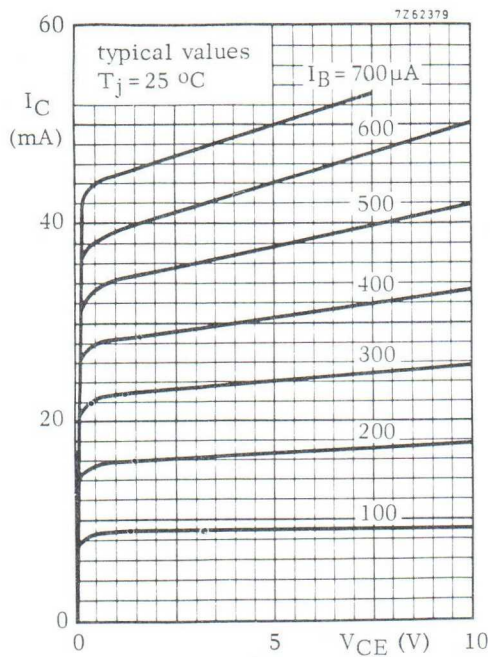
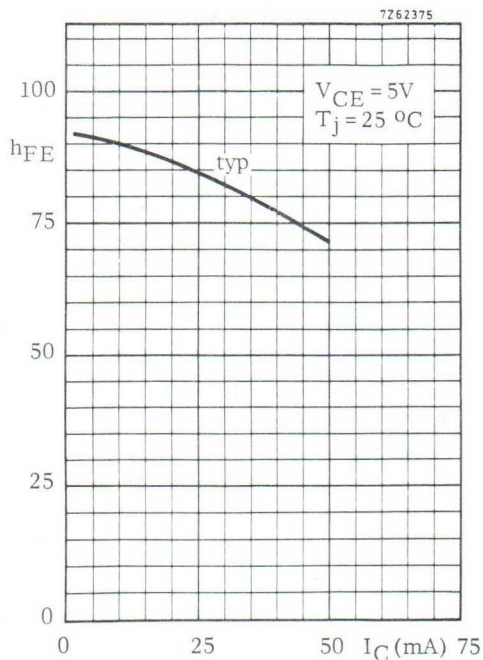
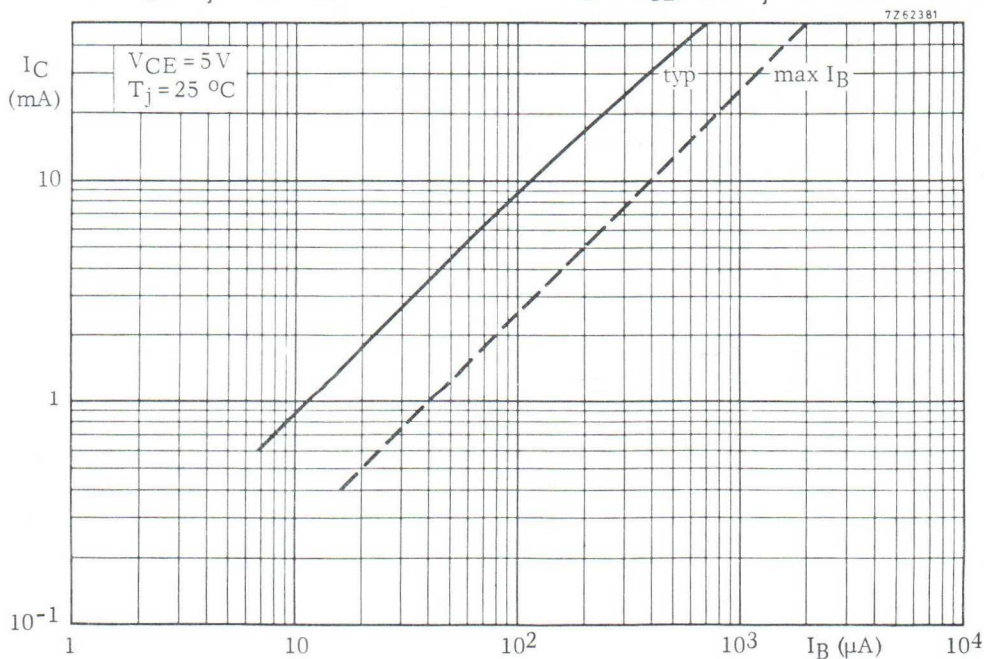
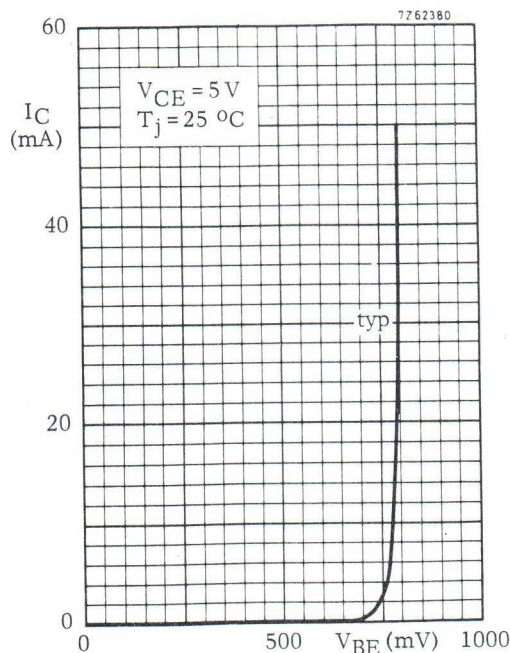
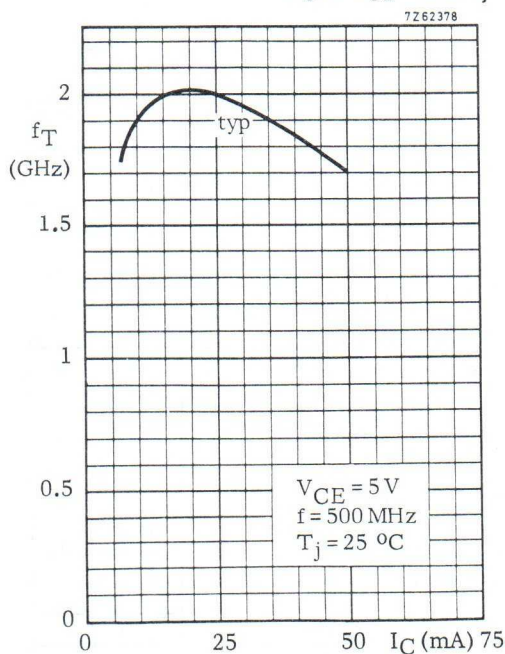
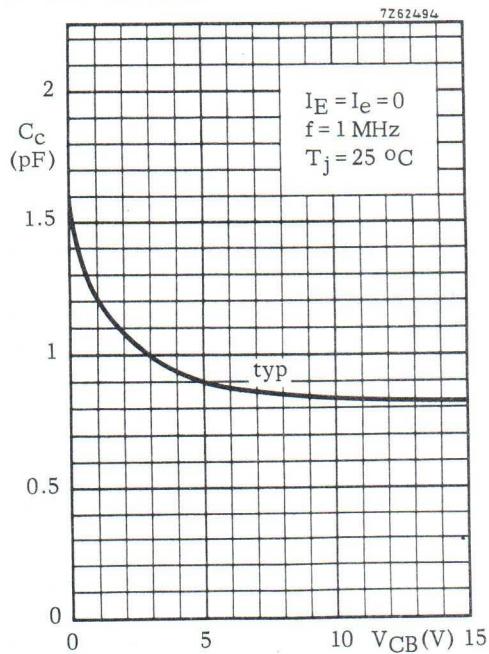
 $I_C = 30$  mA;  $V_{CE} = 5$  V;  $f = 200$  MHz;  $T_{amb} = 25$  °C $I_C = 30$  mA;  $V_{CE} = 5$  V;  $f = 800$  MHz;  $T_{amb} = 25$  °C $G_{UM}$       typ.      22 dB $G_{UM}$       typ.      10,5 dB**Intermodulation distortion \*** $I_C = 30$  mA;  $V_{CE} = 5$  V;  $R_L = 37,5$  Ω $V_O = 100$  mV at  $f_p = 183$  MHz $V_O = 100$  mV at  $f_q = 200$  MHzmeasured at  $f(2q-p) = 217$  MHz $d_{im}$       typ.      -60 dB

Fig. 2 Test circuit.

\* Crystal mounted in a BFW30 envelope.

Fig. 3  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 4  $V_{CE} = 5\text{V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 5  $V_{CE} = 5\text{V}$ ;  $T_j = 25^\circ\text{C}$ .

Fig. 6  $V_{CE} = 5 \text{ V}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$ ; typical values.Fig. 7  $V_{CE} = 5 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  
 $T_j = 25 \text{ }^{\circ}\text{C}$ ; typical values.Fig. 8  $I_E = I_e = 0$ ;  $f = 1 \text{ MHz}$ ;  
 $T_j = 25 \text{ }^{\circ}\text{C}$ ; typical values.

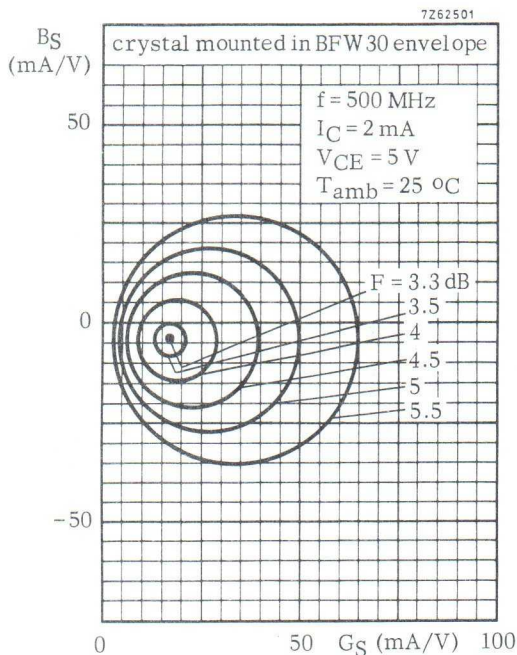


Fig. 9 Circles of constant noise figure;  $V_{CE} = 5 \text{ V}$ ;  $I_C = 2 \text{ mA}$ ;  $f = 500 \text{ MHz}$ ;  $T_{amb} = 25^\circ \text{C}$ ; typ. values.

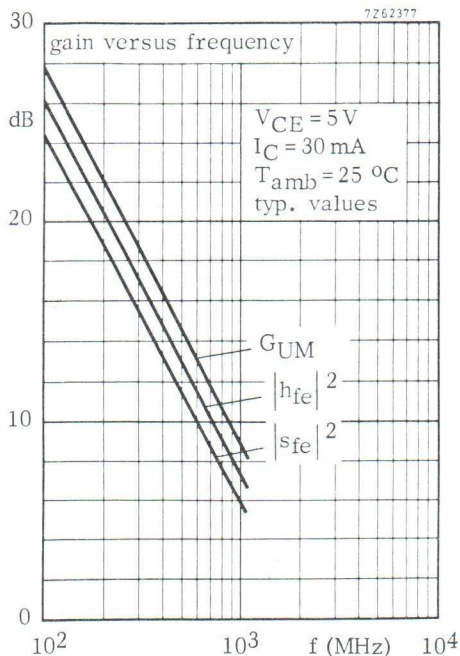


Fig. 10  $V_{CE} = 5 \text{ V}$ ;  $I_C = 30 \text{ mA}$ ;  $T_{amb} = 25^\circ \text{C}$ ; typical values.

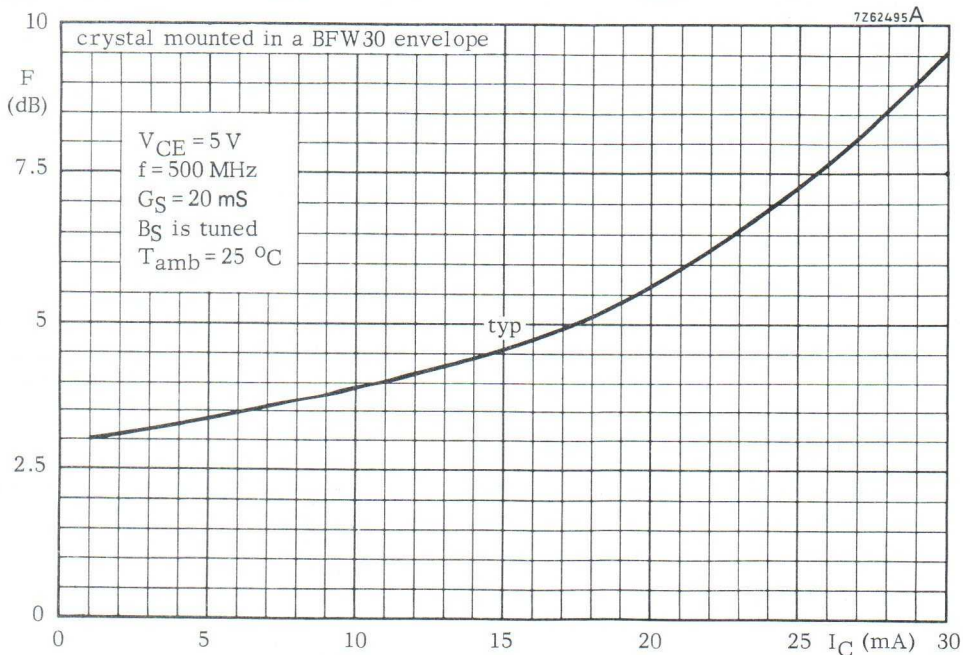


Fig. 11  $V_{CE} = 5 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $G_S = 20 \text{ mS}$ ;  $B_S$  is tuned;  $T_{amb} = 25^\circ \text{C}$ ; typical values.



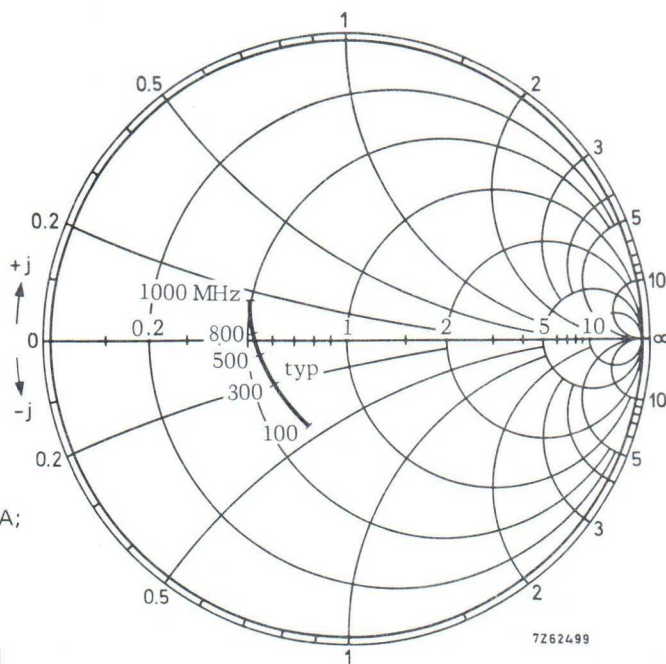


Fig. 12  $V_{CE} = 5\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Input impedance derived from  
 input reflection coefficient  $s_{11}$   
 coordinates in ohm  $\times 50$ .

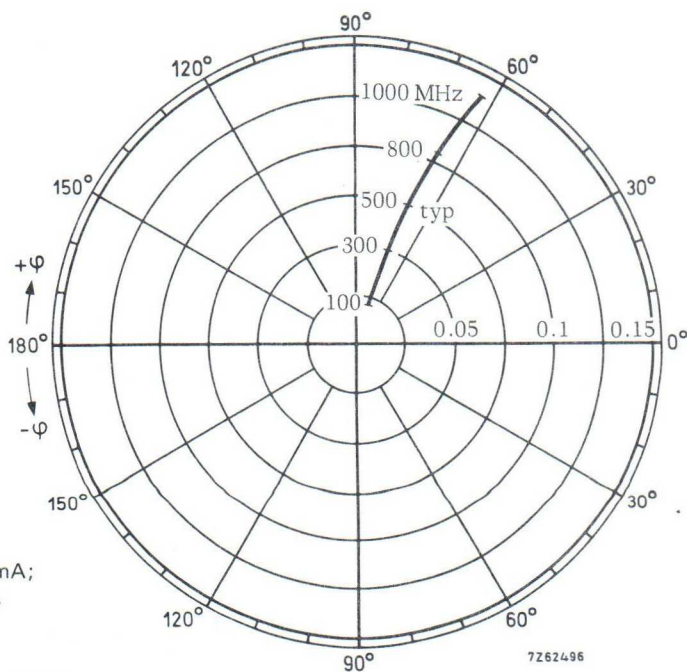
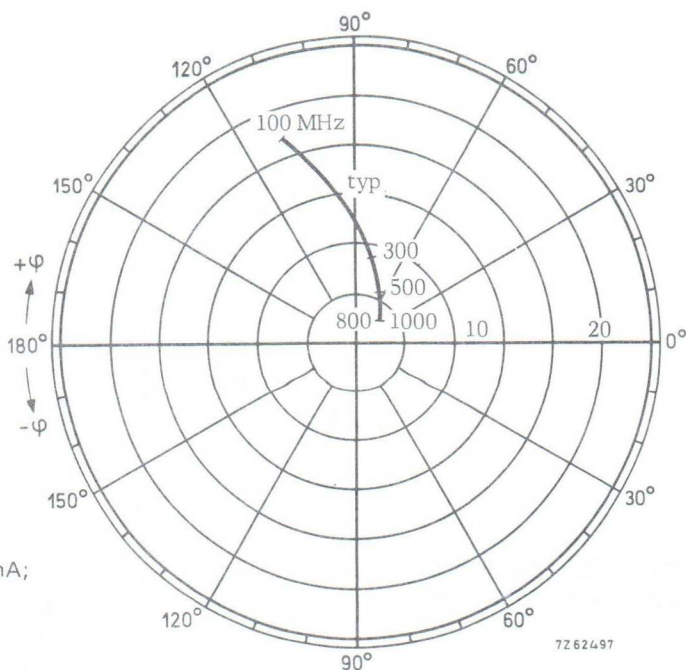
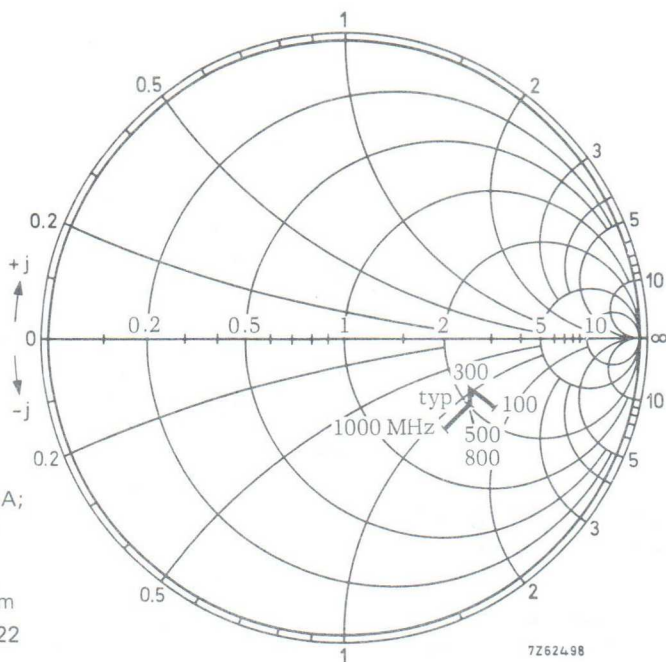


Fig. 13  $V_{CE} = 5\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Reverse transmission coefficient  $s_{12}$ .





## N-P-N 5 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope.\* It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc. The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

P-N-P complement is BFT92.

### QUICK REFERENCE DATA

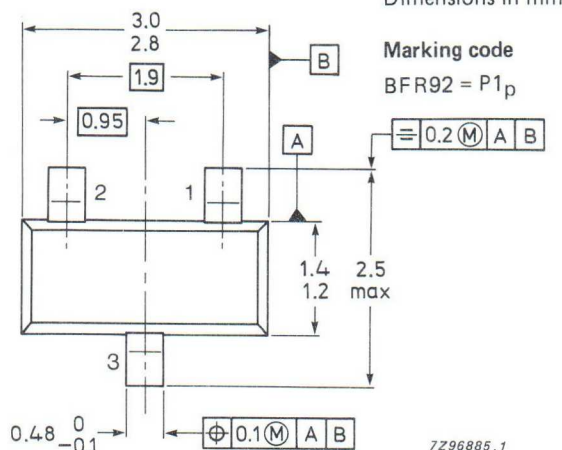
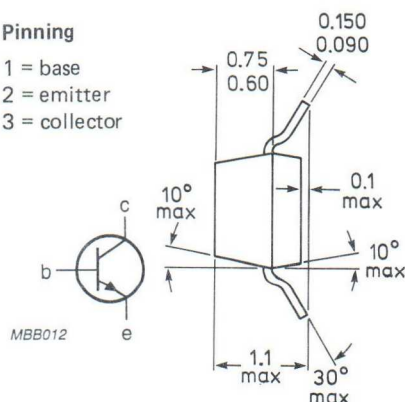
|                                                                                                                                                                                                                |           |      |                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                                                                          | $V_{CB0}$ | max. | 20 V                   |
| Collector-emitter voltage (open base)                                                                                                                                                                          | $V_{CEO}$ | max. | 15 V                   |
| Collector current (d.c.)                                                                                                                                                                                       | $I_C$     | max. | 25 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                                                                           | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                                                                                                                                           | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$                                                                                                                  | $f_T$     | typ. | 5,0 GHz                |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_C = 2\text{ mA}$ ; $V_{CE} = 10\text{ V}$                                                                                                                     | $C_{re}$  | typ. | 0,4 pF                 |
| Noise figure at optimum source impedance<br>$I_C = 2\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$                                                                                                | $F$       | typ. | 2,4 dB                 |
| Max. unilateral power gain<br>$I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$                                                                                                             | $G_{UM}$  | typ. | 18,0 dB                |
| Output voltage at $d_{im} = -60\text{ dB}$ (see Fig. 2)<br>$I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>$f(p+q-r) = 493,25\text{ MHz}$ | $V_o$     | typ. | 150 mV                 |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

\* If required, the R-version (reverse pinning) is available on request.  
TO92 version is also available on request: ref. ON4183.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |           |      |                                |
|----------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 20 V                           |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 15 V                           |
| Emitter-base voltage (open collector)                                | $V_{EBO}$ | max. | 2 V                            |
| Collector current (d.c.)                                             | $I_C$     | max. | 25 mA                          |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                         |
| Storage temperature                                                  | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                          |               |   |         |
|--------------------------|---------------|---|---------|
| From junction to ambient | $R_{th\ j-a}$ | = | 430 K/W |
|--------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

|                                 |           |      |       |
|---------------------------------|-----------|------|-------|
| $I_E = 0; V_{CB} = 10\text{ V}$ | $I_{CBO}$ | max. | 50 nA |
|---------------------------------|-----------|------|-------|

D.C. current gain

|                                            |          |              |          |
|--------------------------------------------|----------|--------------|----------|
| $I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$ | $h_{FE}$ | min.<br>typ. | 25<br>50 |
|--------------------------------------------|----------|--------------|----------|

Transition frequency at  $f = 500\text{ MHz}$ 

|                                            |       |      |         |
|--------------------------------------------|-------|------|---------|
| $I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$ | $f_T$ | typ. | 5,0 GHz |
|--------------------------------------------|-------|------|---------|

Collector capacitance at  $f = 1\text{ MHz}$ 

|                                       |       |      |         |
|---------------------------------------|-------|------|---------|
| $I_E = I_C = 0; V_{CB} = 10\text{ V}$ | $C_c$ | typ. | 0,75 pF |
|---------------------------------------|-------|------|---------|

Emitter capacitance at  $f = 1\text{ MHz}$ 

|                                        |       |      |        |
|----------------------------------------|-------|------|--------|
| $I_C = I_E = 0; V_{EB} = 0,5\text{ V}$ | $C_e$ | typ. | 0,8 pF |
|----------------------------------------|-------|------|--------|

Feedback capacitance at  $f = 1\text{ MHz}$ 

|                                                                                 |          |      |        |
|---------------------------------------------------------------------------------|----------|------|--------|
| $I_C = 2\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $C_{re}$ | typ. | 0,4 pF |
|---------------------------------------------------------------------------------|----------|------|--------|

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Noise figure at optimum source impedance\*

$I_C = 2 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $T_{\text{amb}} = 25^\circ \text{C}$

F typ. 2,4 dB

Max. unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$I_C = 14 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $T_{\text{amb}} = 25^\circ \text{C}$

$G_{UM}$  typ. 18,0 dB

Output voltage at  $d_{im} = -60 \text{ dB}$  (see Fig. 2)

(DIN 45004B; par. 6.3.: 3-tone)

$I_C = 14 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $R_L = 75 \Omega$

$V_p = V_o$  at  $d_{im} = -60 \text{ dB}$ ;  $f_p = 495,25 \text{ MHz}$

$V_q = V_o - 6 \text{ dB}$ ;  $f_q = 503,25 \text{ MHz}$

$V_r = V_o - 6 \text{ dB}$ ;  $f_r = 505,25 \text{ MHz}$

measured at  $f_{(p+q-r)} = 493,25 \text{ MHz}$

$V_o$  typ. 150 mV

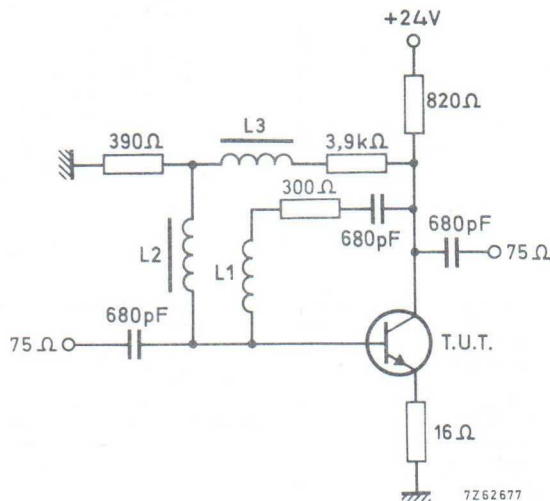


Fig. 2 Intermodulation test circuit.

$L1 = 4$  turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm

$L2 = L3 = 5 \mu\text{H}$  (code number: 3122 108 20150)

\* Crystal mounted in a BFR90 envelope.

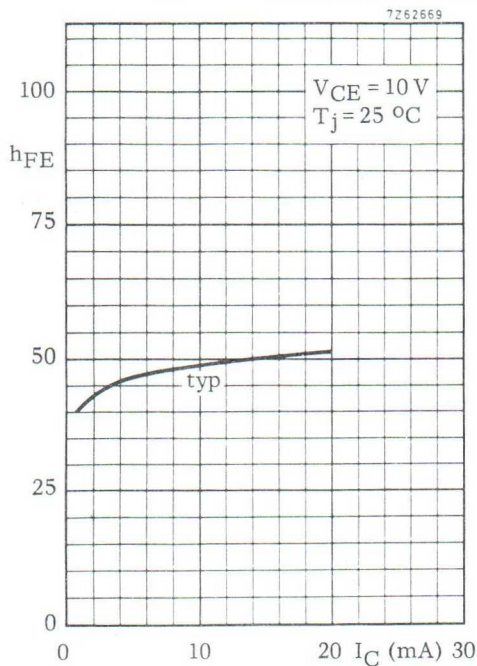


Fig. 3  $V_{CE} = 10\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

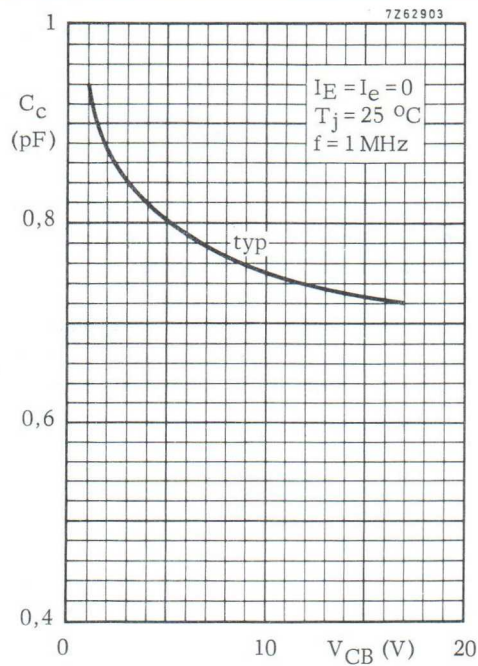


Fig. 4  $I_E = I_e = 0$ ;  $f = 1\text{ MHz}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

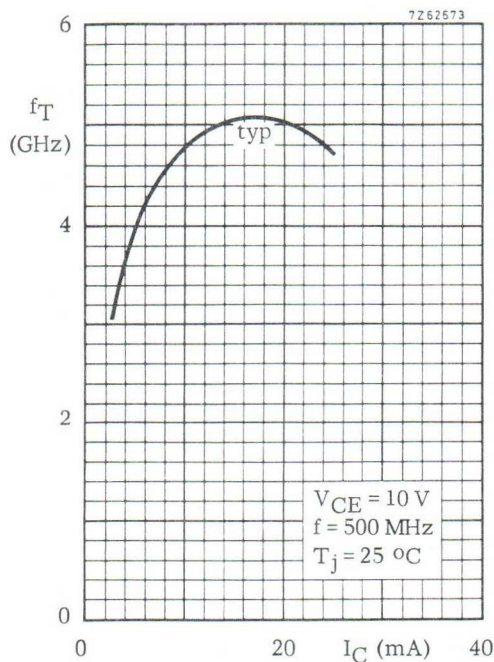


Fig. 5  $V_{CE} = 10\text{ V}$ ;  $f = 500\text{ MHz}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

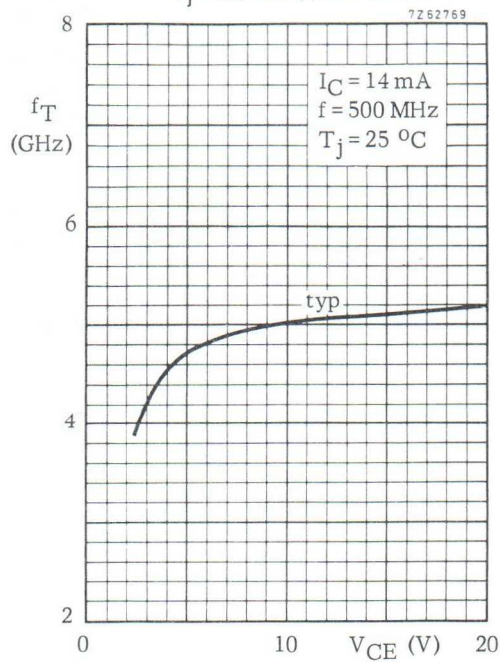


Fig. 6  $I_C = 14\text{ mA}$ ;  $f = 500\text{ MHz}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.



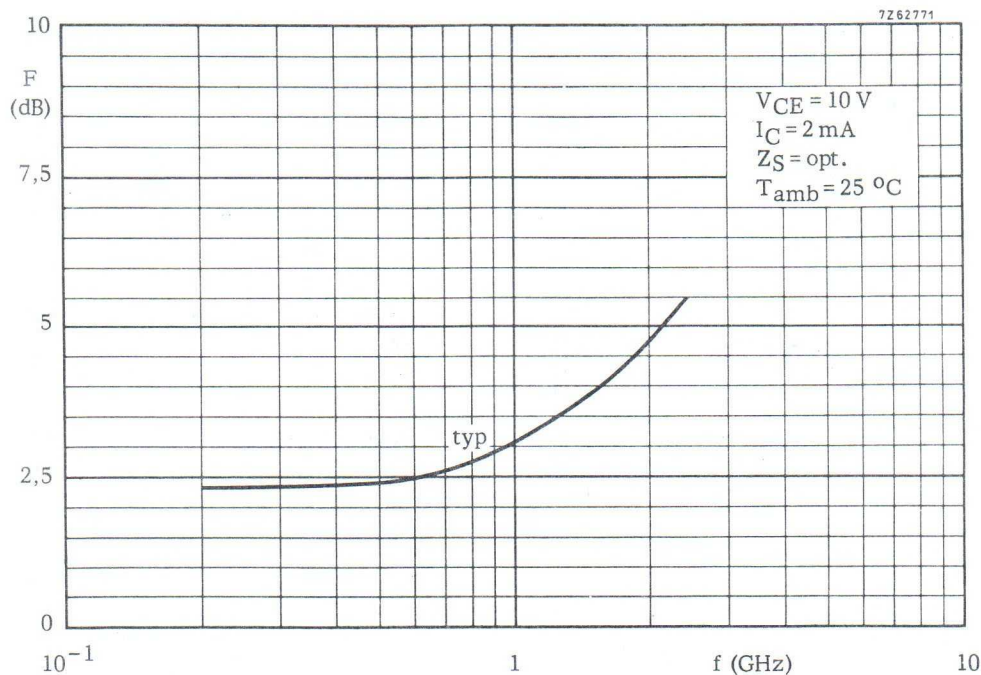


Fig. 7  $V_{CE} = 10 \text{ V}$ ;  $I_C = 2 \text{ mA}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

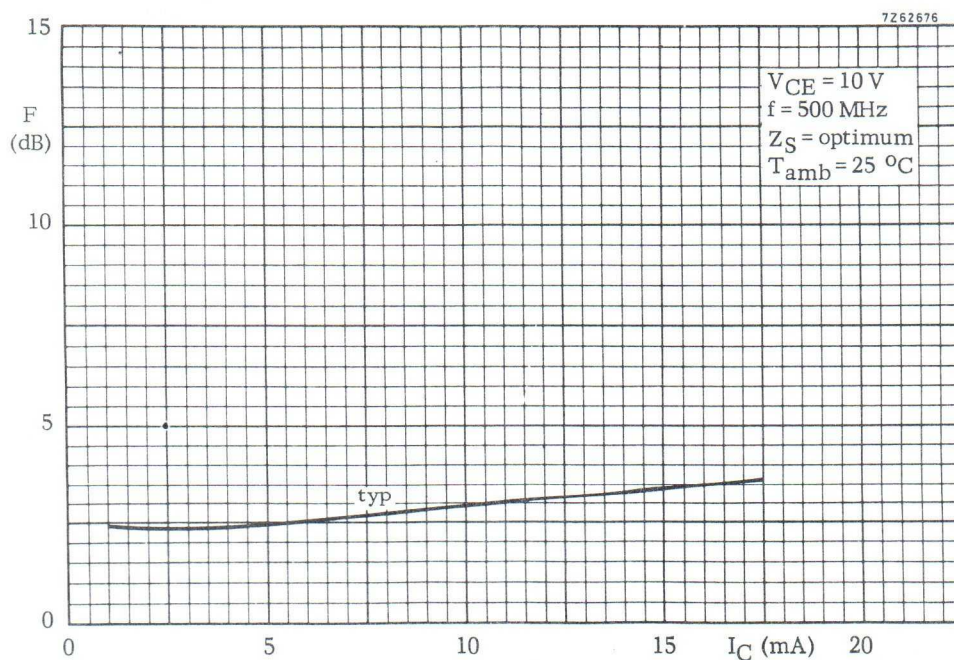


Fig. 8  $V_{CE} = 10 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

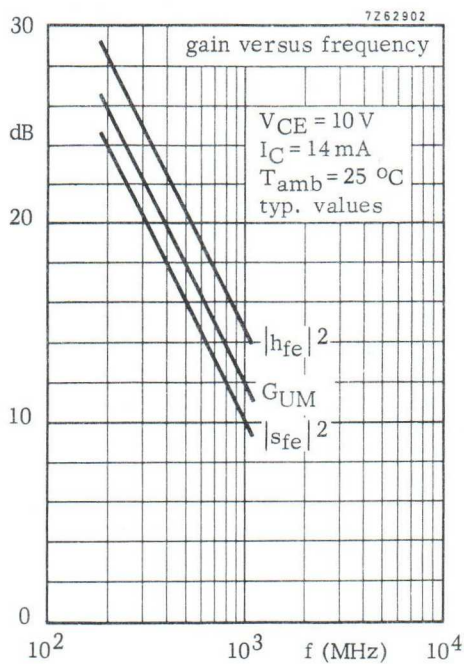


Fig. 9  $V_{CE} = 10\text{ V}$ ;  $I_C = 14\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

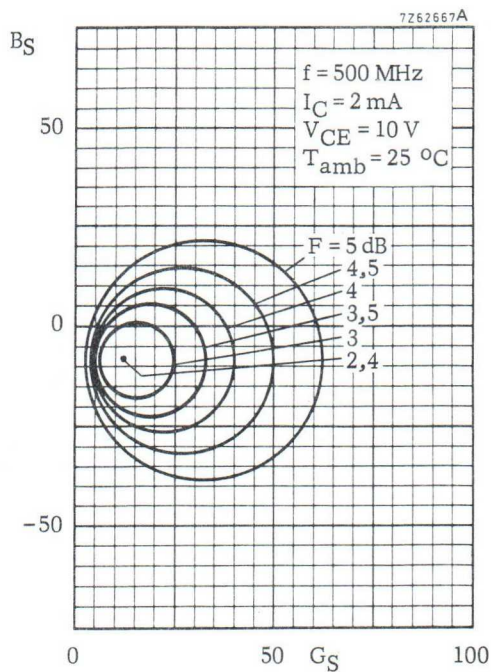


Fig. 10 Circles of constant noise figure;  
 $V_{CE} = 10\text{ V}$ ;  $I_C = 2\text{ mA}$ ;  $f = 500\text{ MHz}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

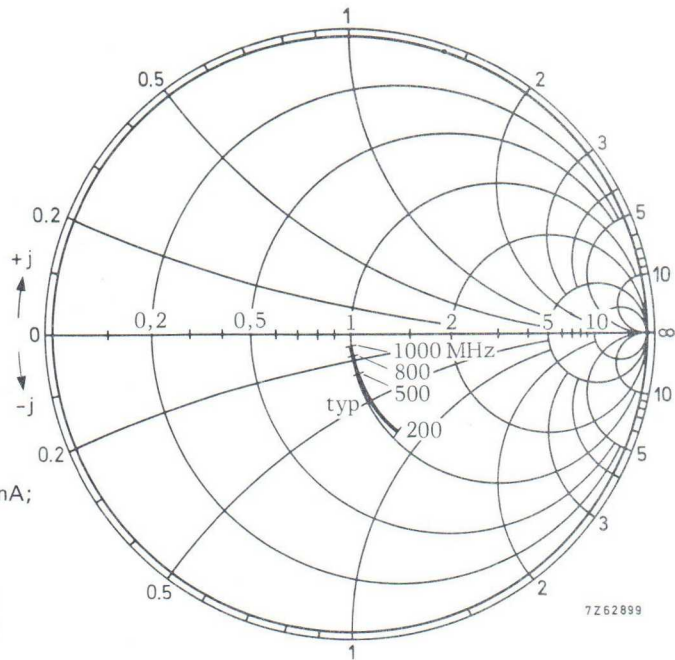


Fig. 11  $V_{CE} = 10\text{ V}$ ;  $I_C = 14\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Input impedance derived from  
 input reflection coefficient  $s_{11}$   
 coordinates in ohm  $\times 50$

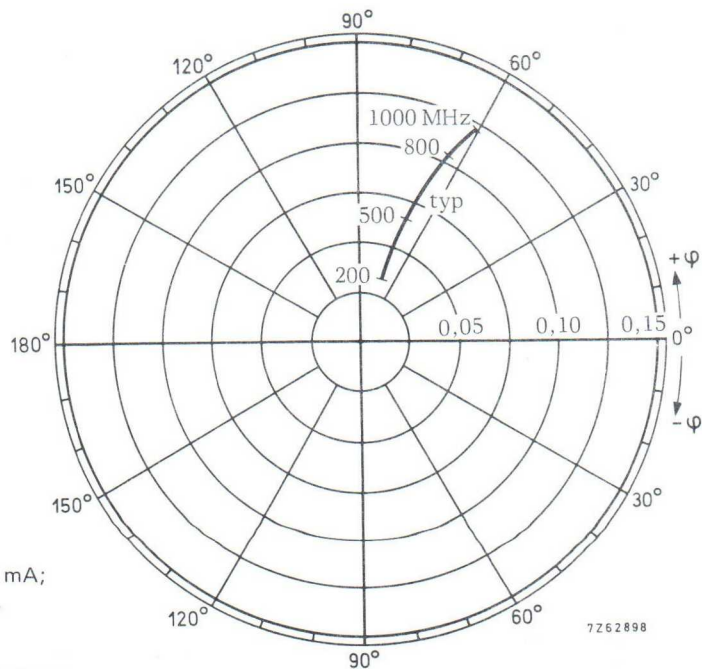
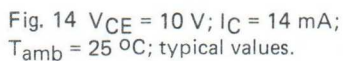
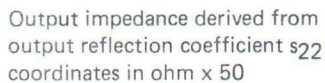


Fig. 12  $V_{CE} = 10\text{ V}$ ;  $I_C = 14\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Reverse transmission coefficient  $s_{12}$



Forward transmission coefficient  $s_{21}$



## N-P-N 5 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope.\* It is primarily intended for use in v.h.f./u.h.f. broadband amplifiers. The transistor features:

- low noise;
- low intermodulation distortion;
- high power gain.

P-N-P complement is BFT92

### QUICK REFERENCE DATA

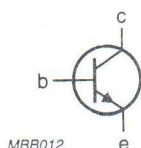
|                                                                                                                                                             |           |      |                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                       | $V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage (open-base)                                                                                                                       | $V_{CEO}$ | max. | 15 V                   |
| Collector current (d.c.)                                                                                                                                    | $I_C$     | max. | 25 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                        | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                                                                                        | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$                                                               | $f_T$     | typ. | 5,0 GHz                |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_C = 0$ ; $V_{CE} = 10\text{ V}$                                                                            | $C_{re}$  | typ. | 0,35 pF                |
| Noise figure at $R_S = 60\text{ }\Omega$<br>$I_C = 4\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 800\text{ MHz}$                                             | $F$       | typ. | 1,8 dB                 |
| Output voltage at $d_{im} = -60\text{ dB}$<br>$I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$<br>$f_{(p+q-r)} = 793,25\text{ MHz}$ | $V_O$     | typ. | 150 mV                 |

### MECHANICAL DATA

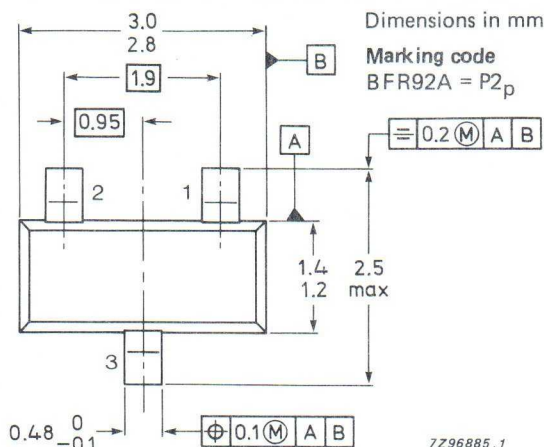
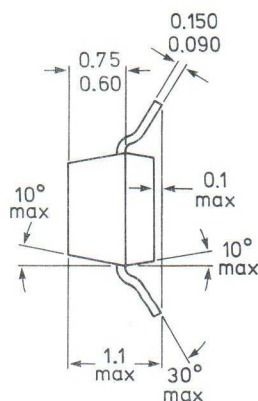
Fig. 1 SOT-23.

#### Pinning

- 1 = base  
2 = emitter  
3 = collector



MBB012



7Z96885.1

#### TOP VIEW

\* If required, the R-version (reverse pinning) is available on request.  
TO92 version is also available on request: ref. ON4184.



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |           |      |                                |
|----------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 20 V                           |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 15 V                           |
| Emitter-base voltage (open collector)                                | $V_{EBO}$ | max. | 2,0 V                          |
| Collector current (d.c.)                                             | $I_C$     | max. | 25 mA                          |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                         |
| Storage temperature                                                  | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

|                                 |           |      |       |
|---------------------------------|-----------|------|-------|
| $I_E = 0; V_{CB} = 10\text{ V}$ | $I_{CBO}$ | max. | 60 nA |
|---------------------------------|-----------|------|-------|

D.C. current gain

|                                            |          |              |          |
|--------------------------------------------|----------|--------------|----------|
| $I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$ | $h_{FE}$ | min.<br>typ. | 40<br>90 |
|--------------------------------------------|----------|--------------|----------|

Transition frequency at  $f = 500\text{ MHz}$ 

|                                            |       |      |         |
|--------------------------------------------|-------|------|---------|
| $I_C = 14\text{ mA}; V_{CE} = 10\text{ V}$ | $f_T$ | typ. | 5,0 GHz |
|--------------------------------------------|-------|------|---------|

Collector capacitance at  $f = 1\text{ MHz}$ 

|                                       |       |      |        |
|---------------------------------------|-------|------|--------|
| $I_E = I_e = 0; V_{CB} = 10\text{ V}$ | $C_c$ | typ. | 0,6 pF |
|---------------------------------------|-------|------|--------|

Emitter capacitance at  $f = 1\text{ MHz}$ 

|                                        |       |      |        |
|----------------------------------------|-------|------|--------|
| $I_C = I_c = 0; V_{EB} = 0,5\text{ V}$ | $C_e$ | typ. | 1,2 pF |
|----------------------------------------|-------|------|--------|

Feedback capacitance at  $f = 1\text{ MHz}$ 

|                                                                       |          |      |         |
|-----------------------------------------------------------------------|----------|------|---------|
| $I_C = 0; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $C_{re}$ | typ. | 0,35 pF |
|-----------------------------------------------------------------------|----------|------|---------|

Noise figure at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

|                                                                                       |     |      |        |
|---------------------------------------------------------------------------------------|-----|------|--------|
| $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}; R_S = 60\text{ }\Omega; f = 800\text{ MHz}$ | $F$ | typ. | 1,8 dB |
|---------------------------------------------------------------------------------------|-----|------|--------|

Maximum unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

|                                                                                                      |          |      |         |
|------------------------------------------------------------------------------------------------------|----------|------|---------|
| $I_C = 14\text{ mA}; V_{CE} = 10\text{ V}; f = 800\text{ MHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $G_{UM}$ | typ. | 15,5 dB |
|------------------------------------------------------------------------------------------------------|----------|------|---------|

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Output voltage at  $d_{im} = -60$  dB (see Figs 2 and 16)\*

(DIN 45004B, par. 6.3: 3-tone)

$I_C = 14$  mA;  $V_{CE} = 10$  V;  $R_L = 75 \Omega$ ;  $V_{SWR} < 2$ ;  $T_{amb} = 25$  °C

$V_p = V_o$  at  $d_{im} = -60$  dB;  $f_p = 795,25$  MHz

$V_q = V_o - 6$  dB ;  $f_q = 803,25$  MHz

$V_r = V_o - 6$  dB ;  $f_r = 805,25$  MHz

Measured at  $f_{(p+q-r)} = 793,25$  MHz

$V_o$  typ. 150 mV

Second harmonic distortion (see Figs 2 and 18)\*

$I_C = 14$  mA;  $V_{CE} = 10$  V;  $R_L = 75 \Omega$ ;  $V_{SWR} < 2$ ;  $T_{amb} = 25$  °C

$V_p = 60$  mV at  $f_p = 250$  MHz

$V_q = 60$  mV at  $f_q = 560$  MHz

measured at  $f_{(p+q)} = 810$  MHz

$d_2$  typ. -50 dB

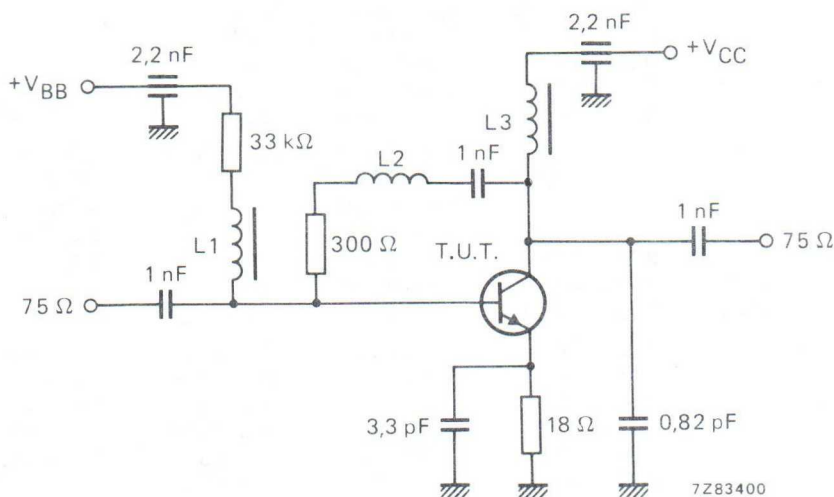


Fig. 2 Intermodulation distortion and second harmonic distortion MATV test circuit.

$L1 = L3 = 5 \mu$ H micro choke

$L2 = 3$  turns Cu wire (0,4 mm); internal diameter 3 mm; winding pitch 1 mm

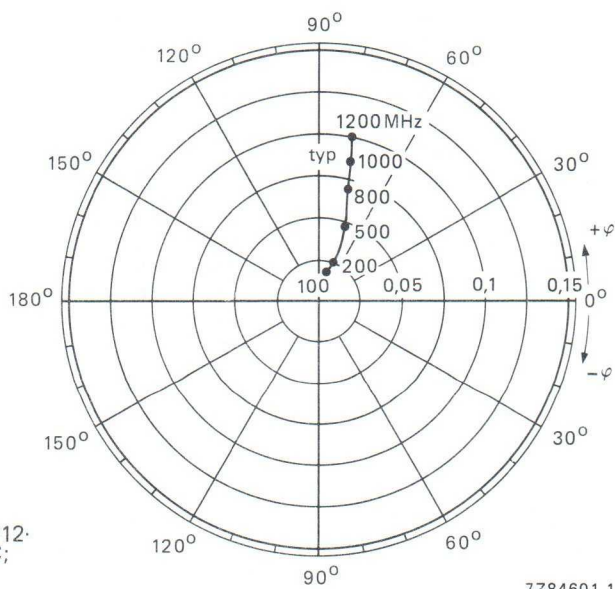
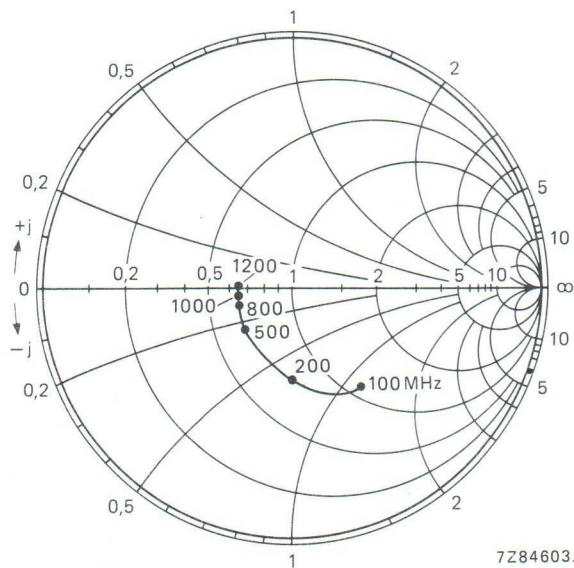
\* Measured on same crystal in a SOT-37 envelope (BFR90A).

s-parameters (common emitter) at  $V_{CE} = 5\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $s_{11}$                | $s_{12}$              | $s_{21}$              | $s_{22}$               |
|-------------|----------|-------------------------|-----------------------|-----------------------|------------------------|
| 2           | 40       | 0,88/ -8,9 $^{\circ}$   | 0,009/83,6 $^{\circ}$ | 6,7/174,2 $^{\circ}$  | 1,00/ -2,7 $^{\circ}$  |
|             | 100      | 0,86/ -21,9 $^{\circ}$  | 0,022/78,3 $^{\circ}$ | 6,5/164,2 $^{\circ}$  | 0,98/ -6,6 $^{\circ}$  |
|             | 200      | 0,80/ -42,2 $^{\circ}$  | 0,041/69,0 $^{\circ}$ | 6,0/149,2 $^{\circ}$  | 0,94/ -12,2 $^{\circ}$ |
|             | 500      | 0,61/ -87,2 $^{\circ}$  | 0,073/54,9 $^{\circ}$ | 4,2/119,1 $^{\circ}$  | 0,81/ -20,2 $^{\circ}$ |
|             | 800      | 0,48/ -117,4 $^{\circ}$ | 0,086/52,7 $^{\circ}$ | 3,1/100,5 $^{\circ}$  | 0,74/ -22,9 $^{\circ}$ |
|             | 1000     | 0,44/ -133,8 $^{\circ}$ | 0,092/54,2 $^{\circ}$ | 2,6/ 91,4 $^{\circ}$  | 0,71/ -24,2 $^{\circ}$ |
|             | 1200     | 0,41/ -147,6 $^{\circ}$ | 0,099/57,5 $^{\circ}$ | 2,2/ 84,3 $^{\circ}$  | 0,70/ -25,7 $^{\circ}$ |
| 5           | 40       | 0,75/ -14,4 $^{\circ}$  | 0,008/81,8 $^{\circ}$ | 14,4/170,2 $^{\circ}$ | 0,99/ -4,9 $^{\circ}$  |
|             | 100      | 0,70/ -34,0 $^{\circ}$  | 0,020/74,2 $^{\circ}$ | 13,3/155,3 $^{\circ}$ | 0,94/ -11,2 $^{\circ}$ |
|             | 200      | 0,60/ -61,7 $^{\circ}$  | 0,034/65,0 $^{\circ}$ | 10,9/135,8 $^{\circ}$ | 0,84/ -17,9 $^{\circ}$ |
|             | 500      | 0,40/ -111,1 $^{\circ}$ | 0,057/61,1 $^{\circ}$ | 6,2/106,9 $^{\circ}$  | 0,67/ -21,9 $^{\circ}$ |
|             | 800      | 0,32/ -139,7 $^{\circ}$ | 0,074/65,5 $^{\circ}$ | 4,2/ 92,4 $^{\circ}$  | 0,62/ -22,2 $^{\circ}$ |
|             | 1000     | 0,30/ -153,2 $^{\circ}$ | 0,086/68,2 $^{\circ}$ | 3,4/ 85,3 $^{\circ}$  | 0,61/ -22,8 $^{\circ}$ |
|             | 1200     | 0,29/ -166,2 $^{\circ}$ | 0,100/70,9 $^{\circ}$ | 2,9/ 79,6 $^{\circ}$  | 0,60/ -24,0 $^{\circ}$ |
| 10          | 40       | 0,61/ -21,1 $^{\circ}$  | 0,008/79,7 $^{\circ}$ | 22,9/165,2 $^{\circ}$ | 0,97/ -7,3 $^{\circ}$  |
|             | 100      | 0,54/ -48,5 $^{\circ}$  | 0,017/71,4 $^{\circ}$ | 19,8/145,8 $^{\circ}$ | 0,88/ -15,5 $^{\circ}$ |
|             | 200      | 0,42/ -82,1 $^{\circ}$  | 0,028/65,2 $^{\circ}$ | 14,4/124,7 $^{\circ}$ | 0,74/ -20,8 $^{\circ}$ |
|             | 500      | 0,30/ -132,3 $^{\circ}$ | 0,050/69,0 $^{\circ}$ | 7,1/ 99,6 $^{\circ}$  | 0,59/ -20,5 $^{\circ}$ |
|             | 800      | 0,26/ -158,0 $^{\circ}$ | 0,072/73,7 $^{\circ}$ | 4,7/ 87,8 $^{\circ}$  | 0,56/ -20,3 $^{\circ}$ |
|             | 1000     | 0,25/ -168,3 $^{\circ}$ | 0,088/75,2 $^{\circ}$ | 3,8/ 82,2 $^{\circ}$  | 0,56/ -20,9 $^{\circ}$ |
|             | 1200     | 0,25/ -179,3 $^{\circ}$ | 0,104/76,6 $^{\circ}$ | 3,2/ 77,5 $^{\circ}$  | 0,55/ -22,1 $^{\circ}$ |
| 14          | 40       | 0,53/ -26,0 $^{\circ}$  | 0,007/78,6 $^{\circ}$ | 27,7/162,4 $^{\circ}$ | 0,96/ -8,7 $^{\circ}$  |
|             | 100      | 0,45/ -58,1 $^{\circ}$  | 0,016/70,5 $^{\circ}$ | 22,6/140,7 $^{\circ}$ | 0,85/ -17,2 $^{\circ}$ |
|             | 200      | 0,36/ -94,4 $^{\circ}$  | 0,025/66,6 $^{\circ}$ | 15,6/119,7 $^{\circ}$ | 0,70/ -21,0 $^{\circ}$ |
|             | 500      | 0,27/ -142,8 $^{\circ}$ | 0,049/72,5 $^{\circ}$ | 7,3/ 96,9 $^{\circ}$  | 0,57/ -19,1 $^{\circ}$ |
|             | 800      | 0,25/ -166,0 $^{\circ}$ | 0,072/76,5 $^{\circ}$ | 4,7/ 86,1 $^{\circ}$  | 0,55/ -19,1 $^{\circ}$ |
|             | 1000     | 0,24/ -174,8 $^{\circ}$ | 0,088/77,4 $^{\circ}$ | 3,8/ 80,5 $^{\circ}$  | 0,55/ -19,9 $^{\circ}$ |
|             | 1200     | 0,24/ 174,8 $^{\circ}$  | 0,105/78,4 $^{\circ}$ | 3,2/ 76,2 $^{\circ}$  | 0,54/ -21,3 $^{\circ}$ |
| 20          | 40       | 0,45/ -33,1 $^{\circ}$  | 0,007/77,0 $^{\circ}$ | 32,3/158,8 $^{\circ}$ | 0,94/ -10,1 $^{\circ}$ |
|             | 100      | 0,38/ -71,8 $^{\circ}$  | 0,015/69,5 $^{\circ}$ | 24,7/135,0 $^{\circ}$ | 0,80/ -18,4 $^{\circ}$ |
|             | 200      | 0,31/ -110,6 $^{\circ}$ | 0,023/68,3 $^{\circ}$ | 16,0/114,6 $^{\circ}$ | 0,66/ -20,1 $^{\circ}$ |
|             | 500      | 0,26/ -154,5 $^{\circ}$ | 0,047/75,5 $^{\circ}$ | 7,2/ 94,3 $^{\circ}$  | 0,56/ -17,3 $^{\circ}$ |
|             | 800      | 0,25/ -174,2 $^{\circ}$ | 0,071/78,7 $^{\circ}$ | 4,7/ 84,3 $^{\circ}$  | 0,55/ -17,8 $^{\circ}$ |
|             | 1000     | 0,25/ 178,5 $^{\circ}$  | 0,088/79,3 $^{\circ}$ | 3,7/ 79,1 $^{\circ}$  | 0,54/ -18,9 $^{\circ}$ |
|             | 1200     | 0,26/ 169,9 $^{\circ}$  | 0,104/80,0 $^{\circ}$ | 3,2/ 74,9 $^{\circ}$  | 0,54/ -20,5 $^{\circ}$ |

s-parameters (common emitter) at  $V_{CE} = 10 \text{ V}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $s_{11}$      | $s_{12}$    | $s_{21}$    | $s_{22}$     |
|-------------|----------|---------------|-------------|-------------|--------------|
| 2           | 40       | 0,89/ -8,7°   | 0,008/83,6° | 6,8/174,4°  | 1,00/ -2,5°  |
|             | 100      | 0,86/ -21,2°  | 0,021/78,5° | 6,5/164,6°  | 0,98/ -6,1°  |
|             | 200      | 0,80/ -40,9°  | 0,038/69,5° | 6,0/149,6°  | 0,94/ -11,3° |
|             | 500      | 0,61/ -85,3°  | 0,069/55,8° | 4,3/119,8°  | 0,82/ -18,7° |
|             | 800      | 0,48/ -115,4° | 0,081/53,8° | 3,1/101,2°  | 0,75/ -21,3° |
|             | 1000     | 0,44/ -131,4° | 0,086/55,5° | 2,6/ 92,1°  | 0,73/ -22,5° |
|             | 1200     | 0,40/ -145,6° | 0,093/58,9° | 2,2/ 85,0°  | 0,72/ -23,9° |
| 5           | 40       | 0,77/ -13,6°  | 0,008/81,8° | 14,2/170,5° | 0,99/ -4,5°  |
|             | 100      | 0,73/ -32,3°  | 0,019/74,7° | 13,2/155,8° | 0,95/ -10,3° |
|             | 200      | 0,62/ -58,8°  | 0,032/65,6° | 11,0/136,8° | 0,85/ -16,6° |
|             | 500      | 0,41/ -107,2° | 0,054/61,4° | 6,3/107,7°  | 0,69/ -20,4° |
|             | 800      | 0,32/ -135,9° | 0,071/65,9° | 4,2/ 92,9°  | 0,64/ -20,8° |
|             | 1000     | 0,30/ -150,0° | 0,082/68,6° | 3,5/ 86,1°  | 0,63/ -21,3° |
|             | 1200     | 0,28/ -162,9° | 0,095/71,5° | 2,9/ 80,5°  | 0,62/ -22,4° |
| 10          | 40       | 0,66/ -19,4°  | 0,007/80,1° | 22,5/165,9° | 0,97/ -6,6°  |
|             | 100      | 0,58/ -44,7°  | 0,017/71,8° | 19,5/147,0° | 0,90/ -14,1° |
|             | 200      | 0,45/ -76,2°  | 0,027/65,4° | 14,5/126,0° | 0,76/ -19,3° |
|             | 500      | 0,29/ -125,1° | 0,049/68,7° | 7,2/100,6°  | 0,62/ -19,2° |
|             | 800      | 0,24/ -151,8° | 0,070/73,5° | 4,7/ 88,8°  | 0,59/ -19,0° |
|             | 1000     | 0,24/ -162,9° | 0,084/75,2° | 3,8/ 82,6°  | 0,58/ -19,7° |
|             | 1200     | 0,23/ -174,8° | 0,099/76,8° | 3,2/ 78,3°  | 0,58/ -20,9° |
| 14          | 40       | 0,60/ -23,2°  | 0,007/78,6° | 27,2/163,0° | 0,96/ -7,9°  |
|             | 100      | 0,51/ -52,5°  | 0,016/70,6° | 22,6/141,8° | 0,86/ -15,8° |
|             | 200      | 0,38/ -86,2°  | 0,025/66,4° | 15,7/120,7° | 0,72/ -19,6° |
|             | 500      | 0,26/ -134,3° | 0,047/72,0° | 7,5/ 97,8°  | 0,60/ -18,0° |
|             | 800      | 0,22/ -159,3° | 0,069/76,2° | 4,8/ 86,8°  | 0,57/ -18,0° |
|             | 1000     | 0,22/ -169,0° | 0,085/77,3° | 3,9/ 81,3°  | 0,57/ -18,7° |
|             | 1200     | 0,22/ 179,8°  | 0,100/78,5° | 3,3/ 76,8°  | 0,57/ -20,1° |
| 20          | 40       | 0,54/ -28,2°  | 0,007/77,4° | 31,7/159,9° | 0,95/ -9,1°  |
|             | 100      | 0,45/ -61,7°  | 0,015/69,5° | 24,7/136,8° | 0,82/ -16,8° |
|             | 200      | 0,33/ -97,5°  | 0,023/67,5° | 16,3/116,2° | 0,68/ -18,8° |
|             | 500      | 0,24/ -143,7° | 0,046/74,4° | 7,4/ 95,3°  | 0,59/ -16,4° |
|             | 800      | 0,22/ -166,4° | 0,069/78,0° | 4,8/ 85,2°  | 0,57/ -16,9° |
|             | 1000     | 0,22/ -174,7° | 0,084/78,7° | 3,8/ 80,1°  | 0,57/ -17,8° |
|             | 1200     | 0,22/ 176,3°  | 0,100/79,7° | 3,3/ 76,0°  | 0,57/ -19,4° |





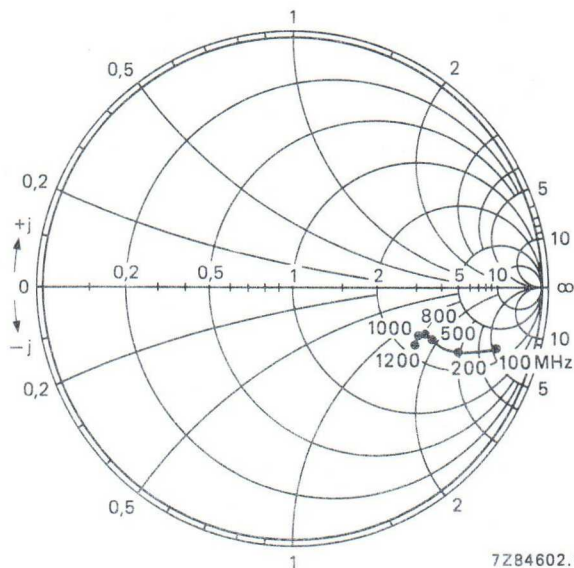


Fig. 5 Output impedance derived from output reflection coefficient  $s_{22}$  co-ordinates in ohm  $\times 50$ .  
 $V_{CE} = 10 \text{ V}$ ;  $I_C = 14 \text{ mA}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ; typical values.

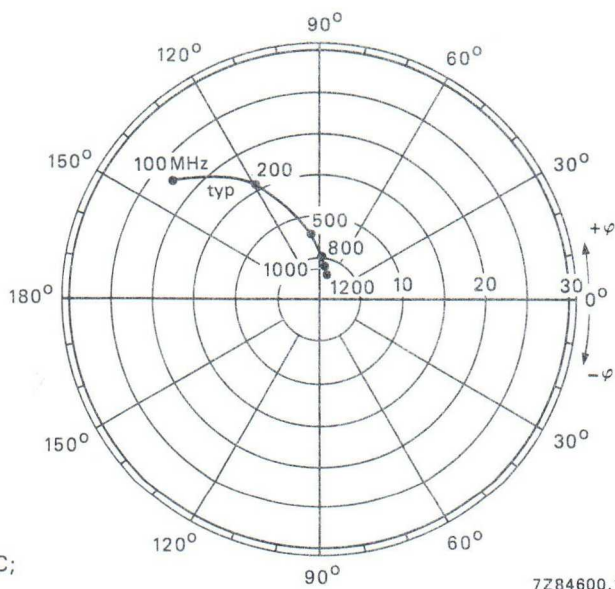


Fig. 6 Forward transmission coefficient  $s_{21}$ .  
 $V_{CE} = 10 \text{ V}$ ;  $I_C = 14 \text{ mA}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ; typical values.

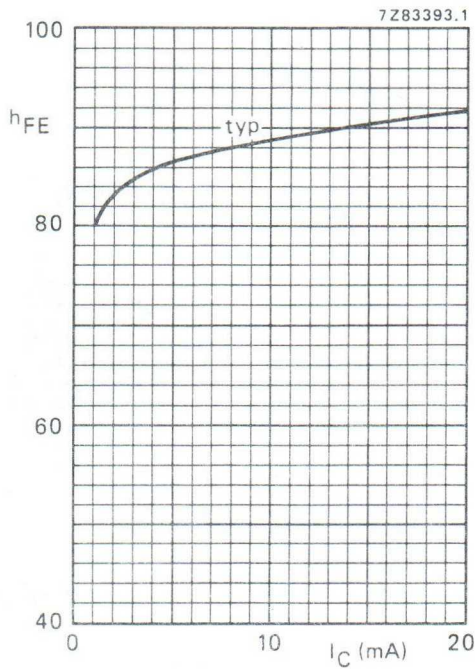


Fig. 7  $V_{CE} = 10$  V;  $T_j = 25$  °C;  
typical values.

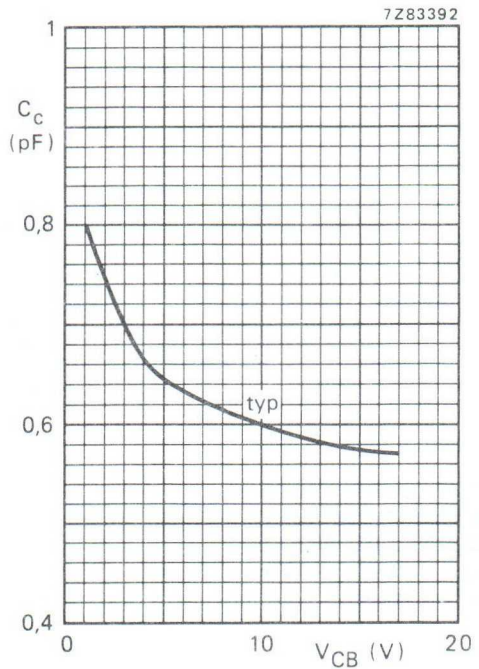


Fig. 8  $I_E = I_e = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C;  
typical values.

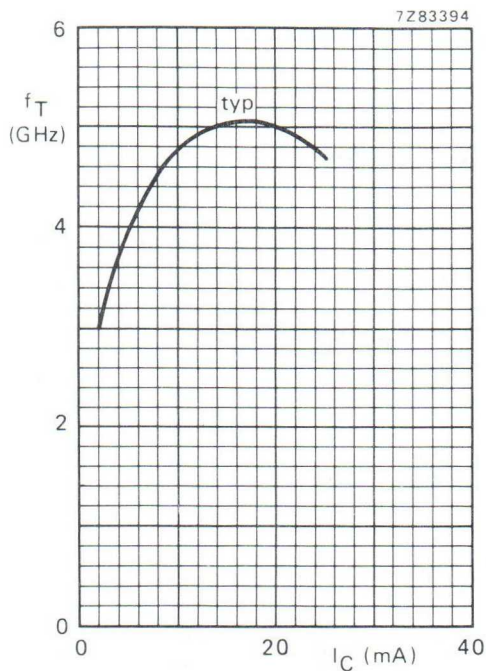


Fig. 9  $V_{CE} = 10$  V;  $f = 500$  MHz;  $T_j = 25$  °C; typical values.

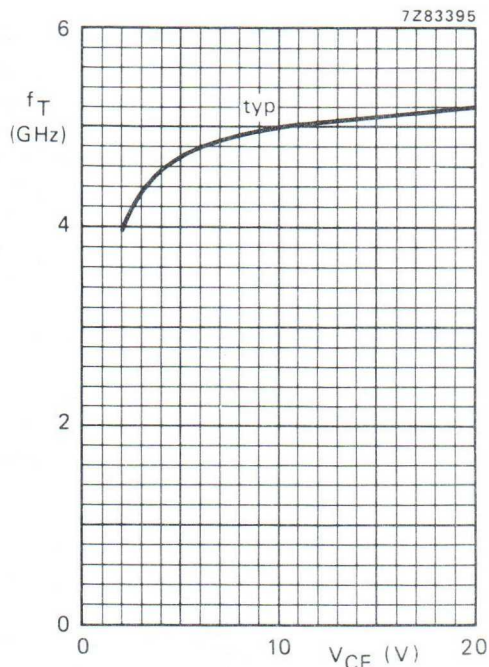


Fig. 10  $I_C = 14$  mA;  $f = 500$  MHz;  $T_j = 25$  °C; typical values.

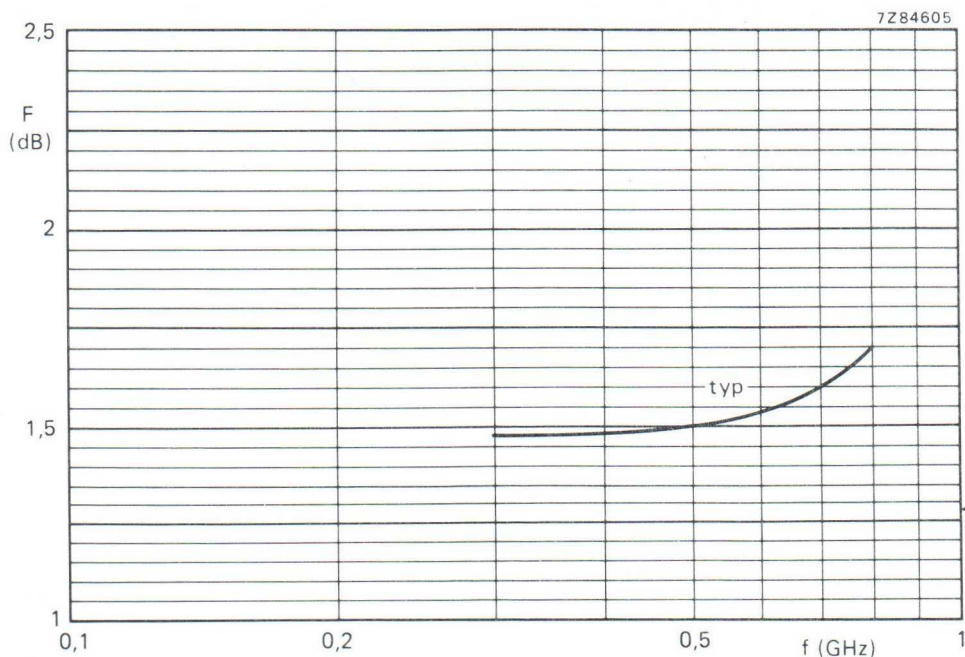


Fig. 11  $V_{CE} = 10$  V;  $I_C = 4$  mA;  $Z_S = \text{optimum}$ ;  $T_{amb} = 25$  °C; typical values.

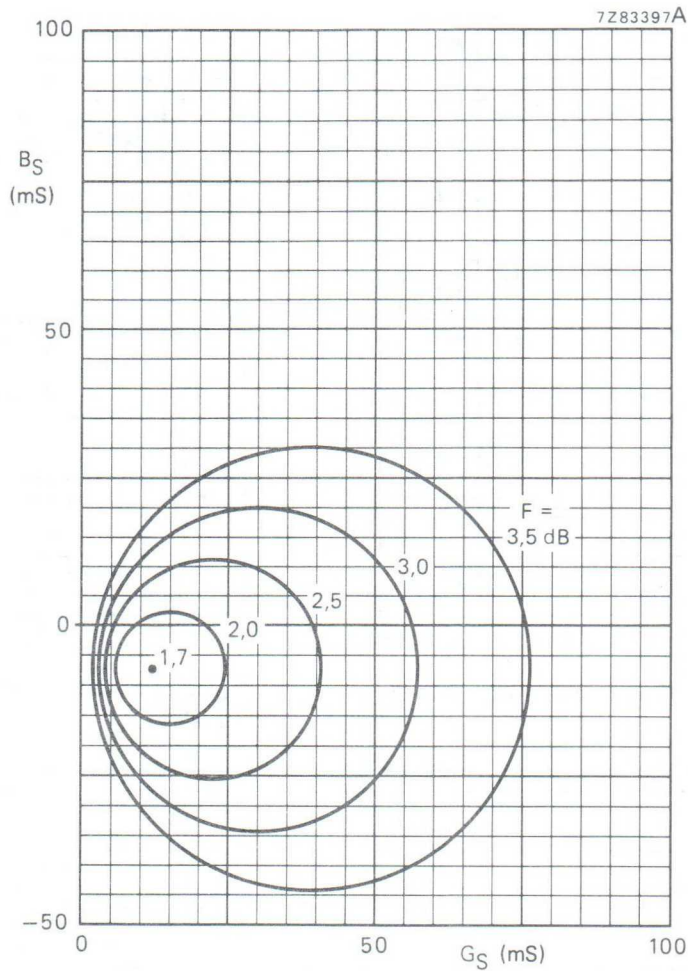


Fig. 12 Circles of constant noise figure.  
 $V_{CE} = 10$  V;  $I_C = 4$  mA;  $f = 800$  MHz;  $T_{amb} = 25$  °C;  
typical values.





Fig. 13  $V_{CE} = 10$  V;  $f = 800$  MHz;  $Z_S = \text{optimum}$ ;  $T_{\text{amb}} = 25$  °C; typical values.

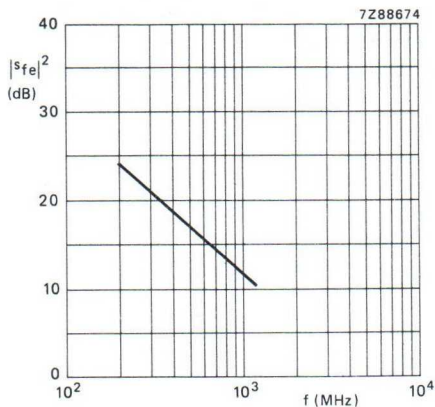


Fig. 14  $V_{CE} = 10$  V;  $I_C = 14$  mA;  
 $T_{\text{amb}} = 25$  °C; typical values.

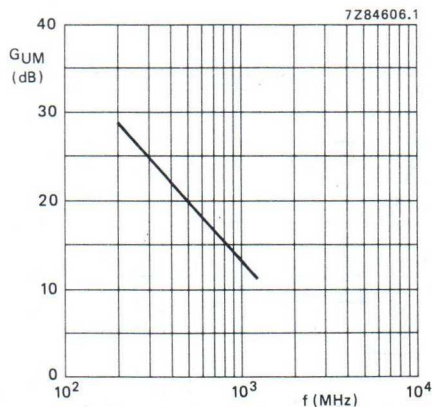


Fig. 15  $V_{CE} = 10$  V;  $I_C = 14$  mA;  
 $T_{\text{amb}} = 25$  °C; typical values.



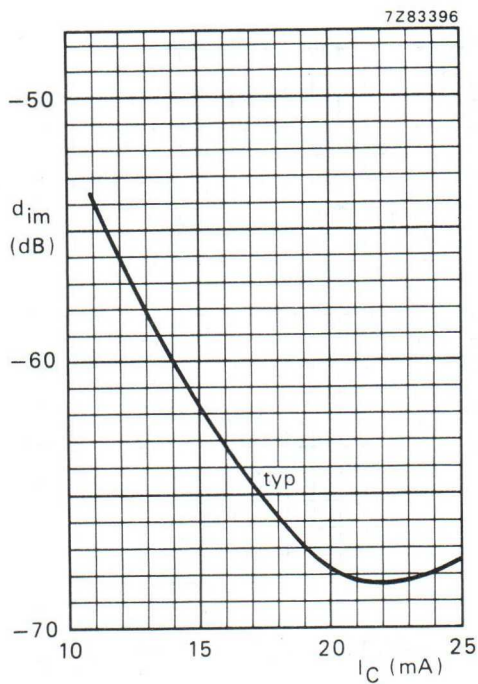


Fig. 16  $V_{CE} = 10$  V;  $V_O = 43,5$  dBmV = 150 mV;  
 $f_{(p+q-r)} = 793,25$  MHz;  $T_{amb} = 25$  °C;  
 measured in MATV test circuit (see Fig. 2);  
 typical values.

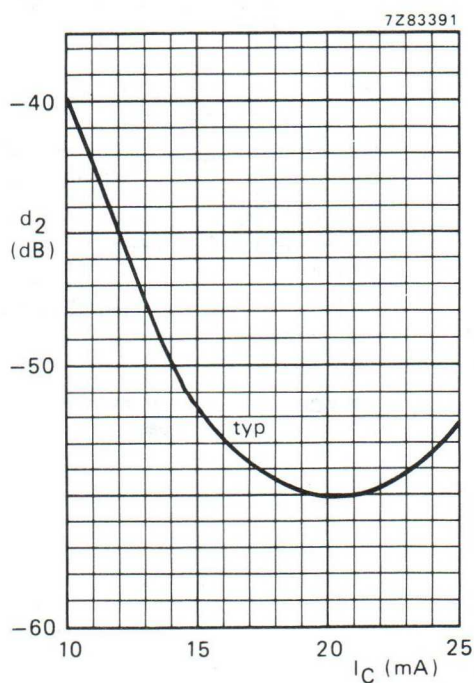


Fig. 17  $V_{CE} = 10$  V;  $V_O = 60$  mV;  
 $f_{(p+q)} = 810$  MHz;  $T_{amb} = 25$  °C; measured in  
 MATV test circuit (see Fig. 2); typical values.

## N-P-N 5 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a SOT-23 plastic envelope.\* It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers etc. The transistor features very low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

P-N-P complement is the BFT93.

### QUICK REFERENCE DATA

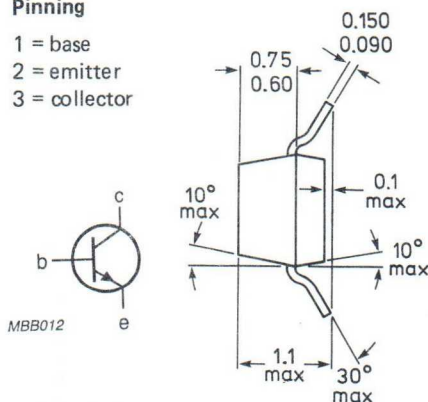
|                                                                                                                                                                                           |           |      |                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|----------------------|
| Collector-base voltage (open emitter)                                                                                                                                                     | $V_{CB0}$ | max. | 15 V                 |
| Collector-emitter voltage (open base)                                                                                                                                                     | $V_{CE0}$ | max. | 12 V                 |
| Collector current (d.c.)                                                                                                                                                                  | $I_C$     | max. | 35 mA                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$                                                                                                                                | $P_{tot}$ | max. | 300 mW               |
| Junction temperature                                                                                                                                                                      | $T_j$     | max. | 150 $^\circ\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$                                                                                              | $f_T$     | typ. | 5 GHz                |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_C = 2\text{ mA}$ ; $V_{CE} = 5\text{ V}$                                                                                                 | $C_{re}$  | typ. | 0,8 pF               |
| Noise figure at optimum source impedance<br>$I_C = 2\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$ ;                                                                          | $F$       | typ. | 1,9 dB               |
| Max. unilateral power gain<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$ ;                                                                                       | $G_{UM}$  | typ. | 16,5 dB              |
| Intermodulation distortion at $T_{amb} = 25^\circ\text{C}$<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $R_L = 75\ \Omega$ ; $V_o = 300\text{ mV}$<br>$f(p+q-r) = 493,25\text{ MHz}$ | $d_{im}$  | typ. | -60 dB               |

### MECHANICAL DATA

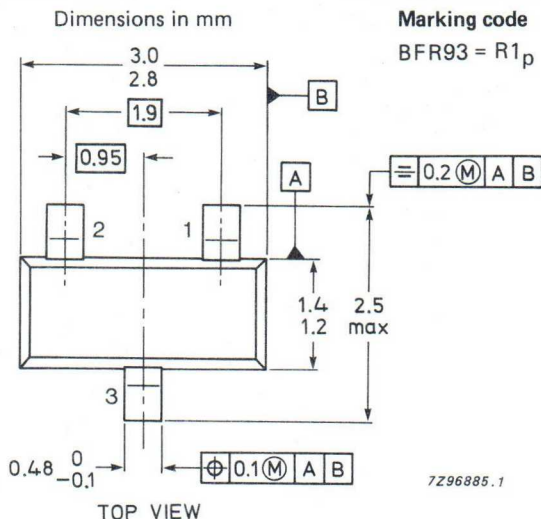
Fig. 1 SOT-23.

#### Pinning

- 1 = base
- 2 = emitter
- 3 = collector



MBB012



7Z96885.1

\* If required, the R-version (reverse pinning) is available on request.  
TO92 version is also available on request: ref. ON4186.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |           |      |                                         |
|----------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 15 V                                    |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 12 V                                    |
| Emitter-base voltage (open collector)                                | $V_{EBO}$ | max. | 2,0 V                                   |
| Collector current (d.c.)                                             | $I_C$     | max. | 35 mA                                   |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                                  |
| Storage temperature                                                  | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$                  |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 10\text{ V}$

|           |      |       |
|-----------|------|-------|
| $I_{CBO}$ | max. | 50 nA |
|-----------|------|-------|

D.C. current gain \*\*

$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 25 |
|          | typ. | 50 |

Transition frequency at  $f = 500\text{ MHz}$  \*\*

$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$

|       |      |       |
|-------|------|-------|
| $f_T$ | typ. | 5 GHz |
|-------|------|-------|

Collector capacitance at  $f = 1\text{ MHz}$ 

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

|       |      |        |
|-------|------|--------|
| $C_c$ | typ. | 0,7 pF |
|-------|------|--------|

Emitter capacitance at  $f = 1\text{ MHz}$ 

$I_C = I_c = 0; V_{EB} = 0,5\text{ V}$

|       |      |        |
|-------|------|--------|
| $C_e$ | typ. | 1,8 pF |
|-------|------|--------|

Feedback capacitance at  $f = 1\text{ MHz}$ 

$I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$

|          |      |        |
|----------|------|--------|
| $C_{re}$ | typ. | 0,8 pF |
|----------|------|--------|

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

\*\* Measured under pulse conditions.

Noise figure at optimum source impedance \*

$I_C = 2 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

F typ. 1,9 dB

Max. unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$I_C = 30 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

$G_{UM}$  typ. 16,5 dB

Intermodulation distortion at  $T_{amb} = 25 \text{ }^\circ\text{C}$  \*

$I_C = 30 \text{ mA}$ ;  $V_{CE} = 5 \text{ V}$ ;  $R_L = 75 \text{ } \Omega$ ; V.S.W.R. < 2

$V_p = V_o = 300 \text{ mV}$  at  $f_p = 495,25 \text{ MHz}$

$V_q = V_o - 6 \text{ dB}$  at  $f_q = 503,25 \text{ MHz}$

$V_r = V_o - 6 \text{ dB}$  at  $f_r = 505,25 \text{ MHz}$

Measured at  $f(p + q - r) = 493,25 \text{ MHz}$

$d_{im}$  typ. -60 dB

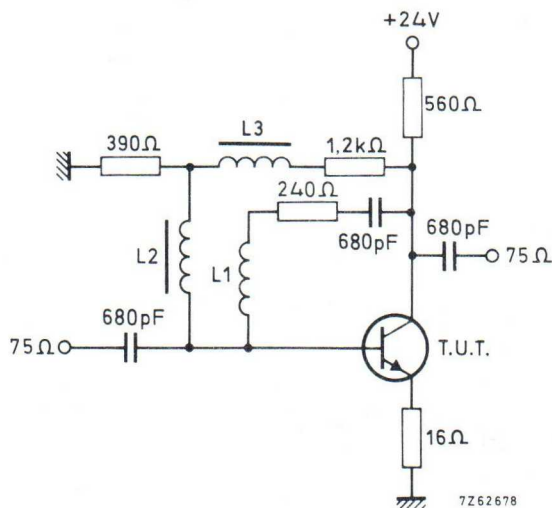


Fig. 2 Intermodulation test circuit.

$L1 = 4$  turns Cu wire (0,35); winding pitch 1 mm; int. dia. 4 mm

$L2$  and  $L3$   $5 \mu\text{H}$  (code number: 3122 108 20150)

\* Crystal mounted in a BFR91 envelope.



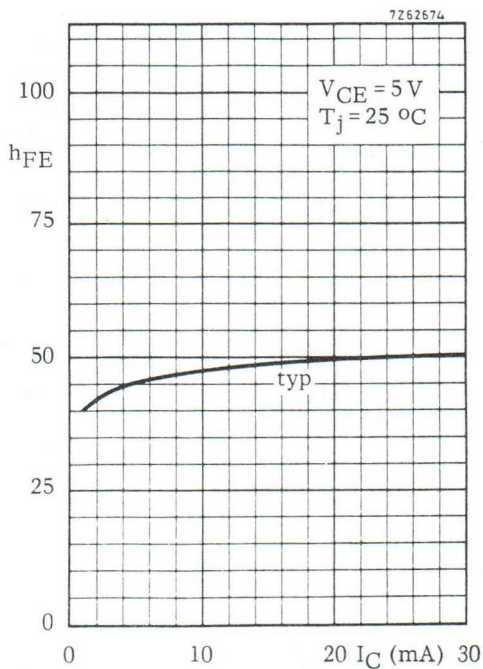


Fig. 3.

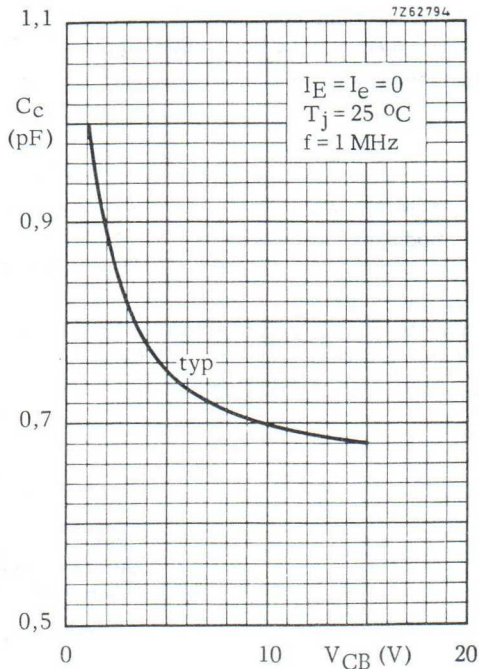


Fig. 4.

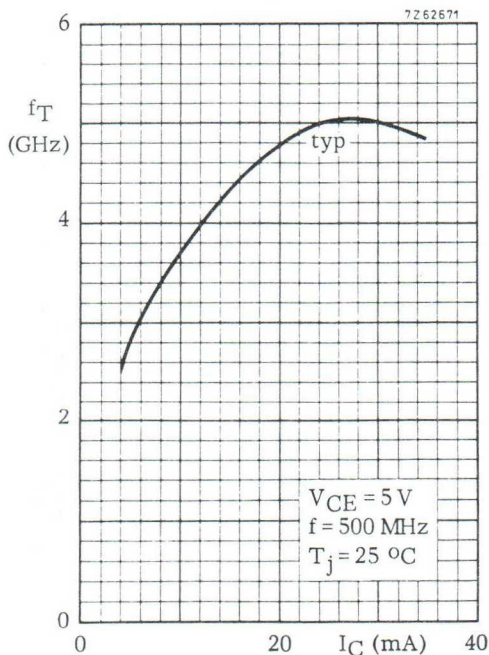


Fig. 5.

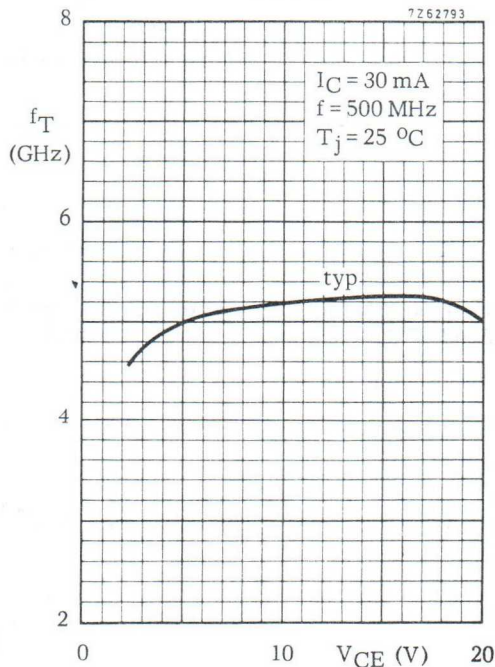


Fig. 6.



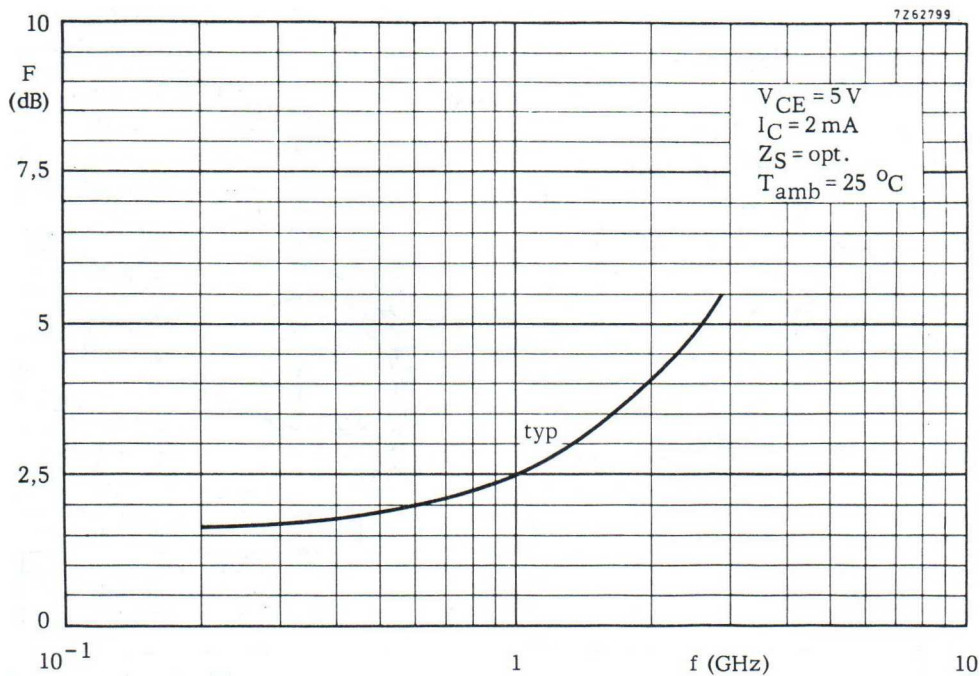


Fig. 7.

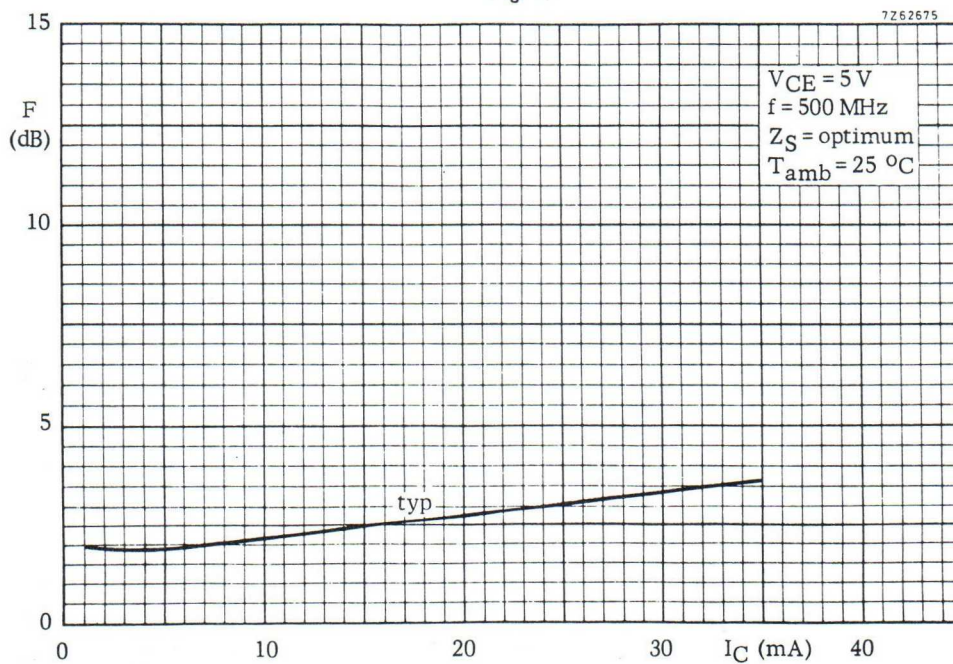


Fig. 8.

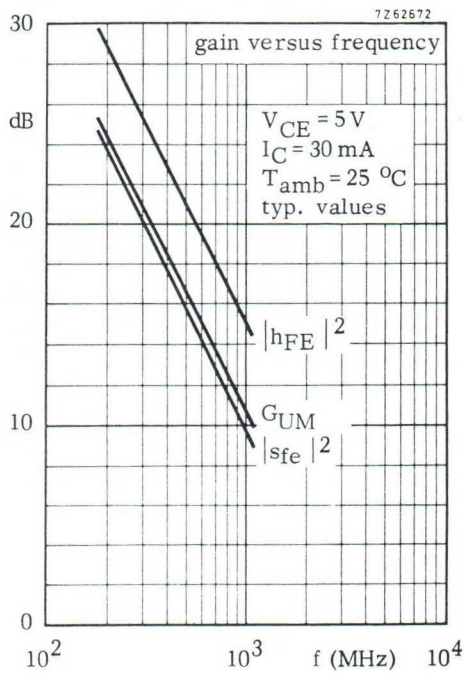


Fig. 9.

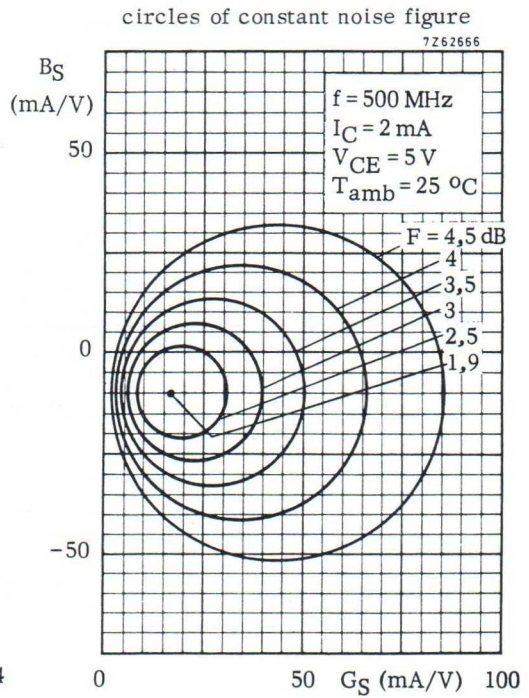
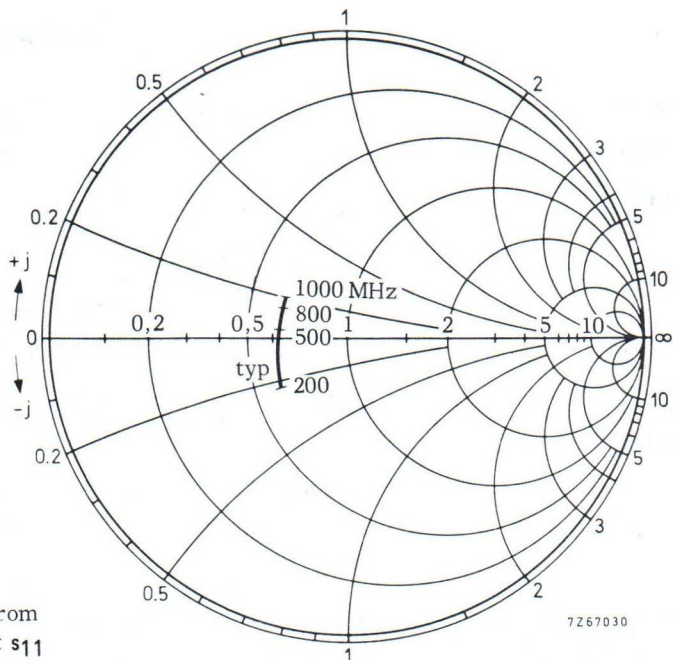


Fig. 10.

$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25^\circ\text{C}$

Fig. 11.

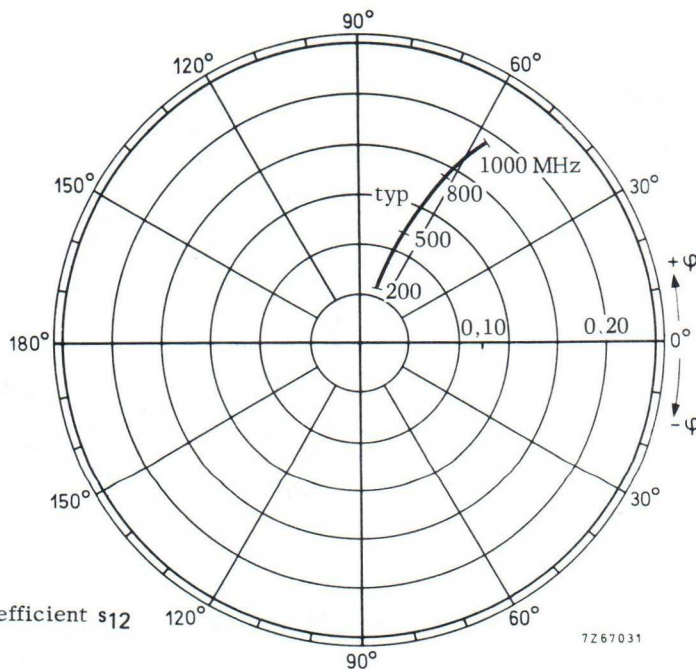
Input impedance derived from  
input reflection coefficient  $s_{11}$   
coordinates in ohm  $\times 50$



$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25^\circ\text{C}$

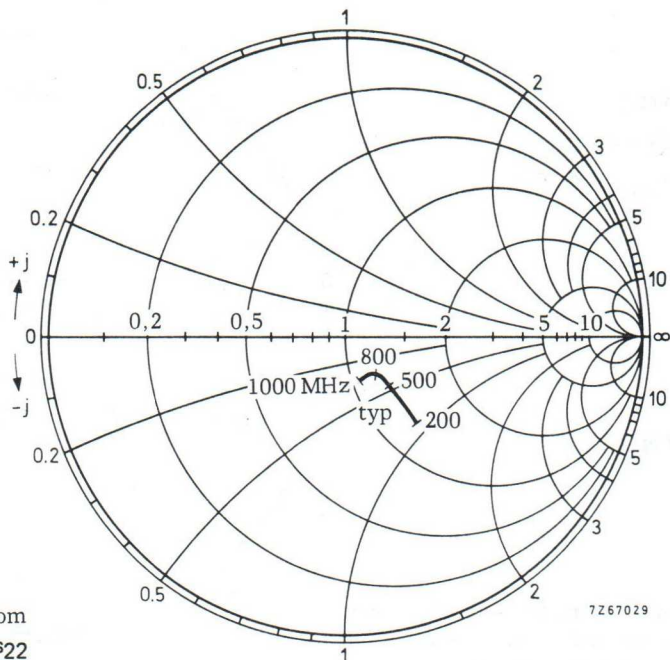
Fig. 12.

Reverse transmission coefficient  $s_{12}$



$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25^\circ \text{C}$

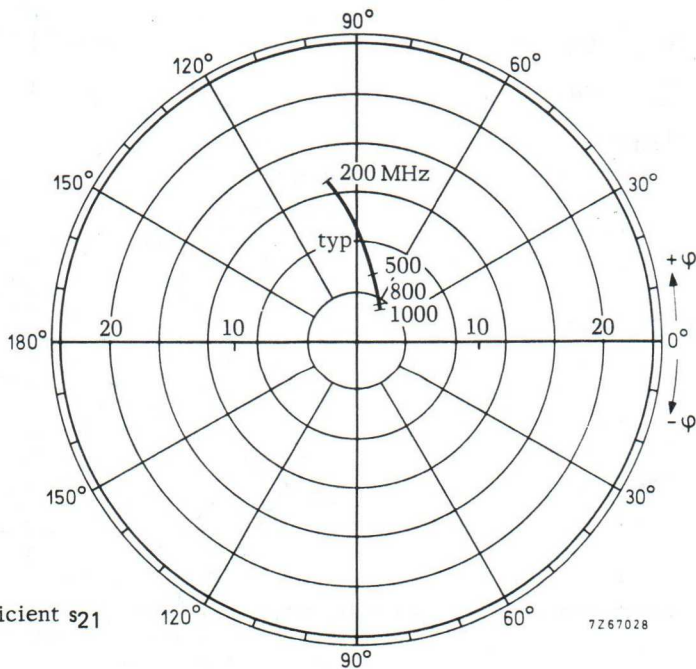
Fig. 13.



Output impedance derived from output reflection coefficient  $s_{22}$  coordinates in ohm  $\times 50$

$V_{CE} = 5 \text{ V}$   
 $I_C = 30 \text{ mA}$   
 $T_{amb} = 25^\circ \text{C}$

Fig. 14.



Forward transmission coefficient  $s_{21}$



## N-P-N 5 GHz WIDEBAND TRANSISTOR

N-P-N transistors in a SOT-23 plastic envelope.\* They are primarily intended for use in v.h.f./u.h.f. broadband amplifiers. The transistors feature:

- low noise;
- very low intermodulation distortion;
- high power gain;
- P-N-P complement is the BFT93

### QUICK REFERENCE DATA

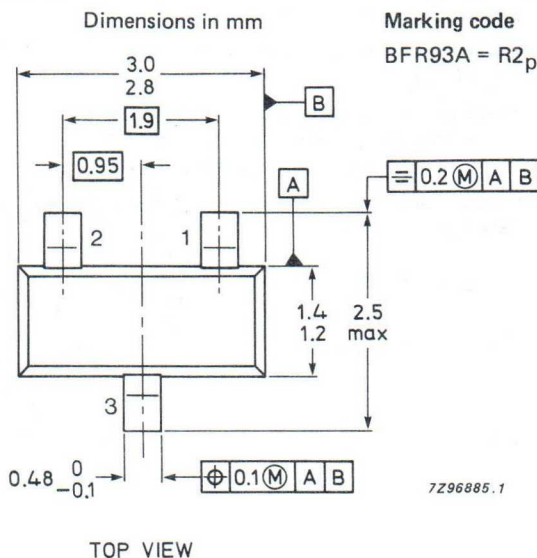
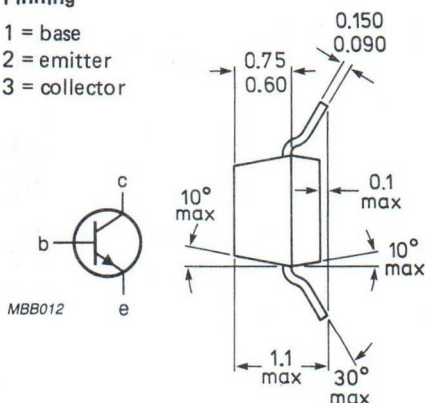
|                                                                                                                                                                                                     |           |      |                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                                                               | $V_{CBO}$ | max. | 15 V                   |
| Collector-emitter voltage (open base)                                                                                                                                                               | $V_{CEO}$ | max. | 12 V                   |
| Collector current (DC)                                                                                                                                                                              | $I_C$     | max. | 35 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                                                                | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                                                                                                                                | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$                                                                                                        | $f_T$     | typ. | 5 GHz                  |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_C = 0$ ; $V_{CE} = 5\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                            | $C_{re}$  | typ. | 0.6 pF                 |
| Noise figure at optimum source impedance<br>$I_C = 4\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 800\text{ MHz}$                                                                                      | $F$       | typ. | 1.6 dB                 |
| Output voltage at $d_{im} = -60\text{ dB}$<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>$f_{(p+q-r)} = 793.25\text{ MHz}$ | $V_o$     | typ. | 425 mV                 |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning

- 1 = base  
2 = emitter  
3 = collector



\* If required, the R-version (reverse pinning) is available on request  
TO92 version is also available on request: ref. ON 4186



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                                         |
|------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                  | $V_{CBO}$ | max. | 15 V                                    |
| Collector-emitter voltage (open base)                                  | $V_{CEO}$ | max. | 12 V                                    |
| Emitter-base voltage (open collector)                                  | $V_{EB0}$ | max. | 2.0 V                                   |
| Collector current (DC)                                                 | $I_C$     | max. | 35 mA                                   |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$ | max. | 300 mW                                  |
| Storage temperature                                                    | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

|                                |           |      |       |
|--------------------------------|-----------|------|-------|
| $I_E = 0; V_{CB} = 5\text{ V}$ | $I_{CBO}$ | max. | 50 nA |
|--------------------------------|-----------|------|-------|

DC current gain▲

|                                           |          |              |          |
|-------------------------------------------|----------|--------------|----------|
| $I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$ | $h_{FE}$ | min.<br>typ. | 40<br>90 |
|-------------------------------------------|----------|--------------|----------|

Transition frequency at  $f = 500\text{ MHz}$ ▲

|                                           |       |      |       |
|-------------------------------------------|-------|------|-------|
| $I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$ | $f_T$ | typ. | 5 GHz |
|-------------------------------------------|-------|------|-------|

Collector capacitance at  $f = 1\text{ MHz}$ 

|                                      |       |      |        |
|--------------------------------------|-------|------|--------|
| $I_E = I_e = 0; V_{CB} = 5\text{ V}$ | $C_c$ | typ. | 0.7 pF |
|--------------------------------------|-------|------|--------|

Emitter capacitance at  $f = 1\text{ MHz}$ 

|                                        |       |      |        |
|----------------------------------------|-------|------|--------|
| $I_C = I_e = 0; V_{EB} = 0.5\text{ V}$ | $C_e$ | typ. | 1.9 pF |
|----------------------------------------|-------|------|--------|

Feedback capacitance at  $f = 1\text{ MHz}$ 

|                                                                      |          |      |        |
|----------------------------------------------------------------------|----------|------|--------|
| $I_C = 0; V_{CE} = 5\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $C_{re}$ | typ. | 0.6 pF |
|----------------------------------------------------------------------|----------|------|--------|

Noise figure at optimum source impedance▲

|                                                              |     |      |        |
|--------------------------------------------------------------|-----|------|--------|
| $I_C = 4\text{ mA}; V_{CE} = 8\text{ V}; f = 800\text{ MHz}$ | $F$ | typ. | 1.6 dB |
|--------------------------------------------------------------|-----|------|--------|

|                                                               |     |      |        |
|---------------------------------------------------------------|-----|------|--------|
| $I_C = 30\text{ mA}; V_{CE} = 8\text{ V}; f = 800\text{ MHz}$ | $F$ | typ. | 2.3 dB |
|---------------------------------------------------------------|-----|------|--------|

Maximum unilateral power gain ( $s_{12}$  assumed to be zero)

See Figs 10 to 15

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

|                                                                                                     |          |      |       |
|-----------------------------------------------------------------------------------------------------|----------|------|-------|
| $I_C = 30\text{ mA}; V_{CE} = 8\text{ V}; f = 800\text{ MHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $G_{UM}$ | typ. | 14 dB |
|-----------------------------------------------------------------------------------------------------|----------|------|-------|

▲ Measured under pulse conditions.

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

Output voltage at  $d_{im} = -60$  dB (see Figs 2 and 15)\*

(DIN 45004B, par. 6.3: 3-tone)

$I_C = 30$  mA;  $V_{CE} = 8$  V;  $R_L = 75$   $\Omega$ ;  $T_{amb} = 25$   $^{\circ}$ C

$V_p = V_o$  at  $d_{im} = -60$  dB;  $f_p = 795.25$  MHz

$V_q = V_o - 6$  dB ;  $f_q = 803.25$  MHz

$V_r = V_o - 6$  dB ;  $f_r = 805.25$  MHz

Measured at  $f_{(p+q-r)} = 793.25$  MHz

$V_o$  typ. 425 mV

Second harmonic distortion (see Figs 2 and 16)\*

$I_C = 30$  mA;  $V_{CE} = 8$  V;  $R_L = 75$   $\Omega$ ;  $T_{amb} = 25$   $^{\circ}$ C

$V_p = 200$  mV at  $f_p = 250$  MHz

$V_q = 200$  mV at  $f_q = 560$  MHz

measured at  $f_{(p+q)} = 810$  MHz

$d_2$  typ.  $-50$  dB

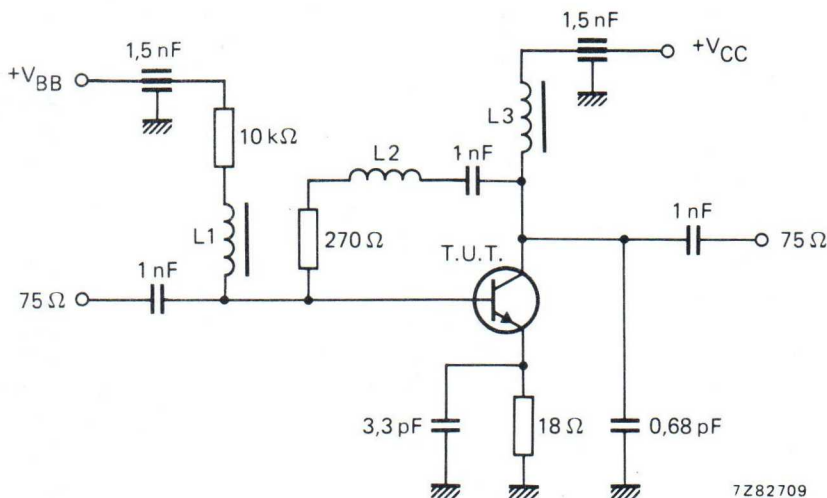


Fig. 2 Intermodulation distortion and second harmonic distortion MATV test circuit.

$L1 = L3 = 5$   $\mu$ H micro choke

$L2 = 3$  turns Cu wire (0.4 mm); internal diameter 3 mm; winding pitch 1 mm.

\* Measured on same crystal in a SOT-37 envelope (BFR91A).

## s-parameters (common emitter)

| $V_{CE}$<br>V | $I_C$<br>mA | f<br>MHz | $s_{11}$     | $s_{12}$    | $s_{21}$    | $s_{22}$    |
|---------------|-------------|----------|--------------|-------------|-------------|-------------|
| 5             | 2           | 40       | 0,89/ -12,4° | 0,016/82,3° | 7,0/171,8°  | 0,88/ -4,8° |
|               |             | 100      | 0,87/ -30,1° | 0,038/74,2° | 6,7/160,1°  | 0,96/-11,3° |
|               |             | 200      | 0,80/ -56,3° | 0,067/61,8° | 6,0/142,3°  | 0,88/-20,1° |
|               |             | 500      | 0,64/-109,5° | 0,106/44,3° | 3,8/110,6°  | 0,69/-31,9° |
|               |             | 800      | 0,57/-140,3° | 0,116/41,8° | 2,7/ 91,5°  | 0,60/-35,5° |
|               |             | 1000     | 0,54/-154,5° | 0,119/43,9° | 2,2/ 82,8°  | 0,58/-38,0° |
|               |             | 1200     | 0,53/-166,6° | 0,124/48,2° | 1,9/ 75,1°  | 0,56/-40,2° |
| 5             | 5           | 40       | 0,77/ -19,9° | 0,015/79,4° | 15,1/166,8° | 0,97/ -8,8° |
|               |             | 100      | 0,72/ -46,9° | 0,033/68,6° | 13,5/149,7° | 0,89/-19,6° |
|               |             | 200      | 0,62/ -81,4° | 0,053/57,0° | 10,5/128,5° | 0,73/-30,3° |
|               |             | 500      | 0,48/-134,4° | 0,079/52,6° | 5,5/100,5°  | 0,51/-37,3° |
|               |             | 800      | 0,45/-159,8° | 0,099/57,8° | 3,6/ 85,6°  | 0,44/-37,9° |
|               |             | 1000     | 0,44/-170,8° | 0,114/61,0° | 3,0/ 78,8°  | 0,42/-39,3° |
|               |             | 1200     | 0,43/ 179,8° | 0,131/64,2° | 2,5/ 72,9°  | 0,41/-40,9° |
| 5             | 10          | 40       | 0,63/ -29,7° | 0,013/76,5° | 24,4/161,0° | 0,95/-13,5° |
|               |             | 100      | 0,56/ -66,2° | 0,028/64,8° | 20,0/139,4° | 0,80/-17,8° |
|               |             | 200      | 0,47/-105,4° | 0,042/57,8° | 13,6/118,0° | 0,59/-37,3° |
|               |             | 500      | 0,41/-152,0° | 0,070/62,6° | 6,4/ 94,8°  | 0,39/-39,0° |
|               |             | 800      | 0,39/-171,7° | 0,099/67,6° | 4,1/ 82,7°  | 0,35/-38,2° |
|               |             | 1000     | 0,39/ 179,6° | 0,119/69,1° | 3,4/ 76,7°  | 0,34/-39,1° |
|               |             | 1200     | 0,39/ 171,6° | 0,140/70,5° | 2,8/ 71,5°  | 0,33/-40,7° |
| 5             | 20          | 40       | 0,47/ -44,2° | 0,012/73,8° | 35,2/154,0° | 0,90/-19,2° |
|               |             | 100      | 0,42/ -90,7° | 0,023/63,9° | 25,4/129,3° | 0,68/-35,0° |
|               |             | 200      | 0,39/-129,4° | 0,034/62,9° | 15,6/109,7° | 0,47/-41,0° |
|               |             | 500      | 0,37/-165,1° | 0,067/70,5° | 6,8/ 90,9°  | 0,32/-38,4° |
|               |             | 800      | 0,37/ 179,5° | 0,101/73,2° | 4,4/ 80,3°  | 0,29/-37,4° |
|               |             | 1000     | 0,36/ 173,0° | 0,124/73,4° | 3,6/ 75,4°  | 0,29/-38,3° |
|               |             | 1200     | 0,37/ 166,2° | 0,148/73,6° | 3,0/ 70,3°  | 0,28/-40,0° |
| 5             | 30          | 40       | 0,39/ -56,3° | 0,011/72,3° | 40,8/149,5° | 0,86/-22,5° |
|               |             | 100      | 0,38/-106,8° | 0,021/64,5° | 27,4/124,0° | 0,61/-37,9° |
|               |             | 200      | 0,37/-141,6° | 0,032/66,4° | 16,0/105,8° | 0,41/-41,1° |
|               |             | 500      | 0,37/-171,0° | 0,067/73,5° | 6,9/ 88,9°  | 0,29/-36,6° |
|               |             | 800      | 0,37/ 175,9° | 0,102/75,2° | 4,4/ 79,1°  | 0,27/-36,0° |
|               |             | 1000     | 0,36/ 170,0° | 0,126/74,8° | 3,6/ 74,2°  | 0,27/-37,1° |
|               |             | 1200     | 0,37/ 163,9° | 0,150/74,6° | 3,0/ 69,5°  | 0,27/-39,0° |

## s-parameters (common emitter)

| $V_{CE}$<br>V | $I_C$<br>mA | f<br>MHz | $s_{11}$     | $s_{12}$    | $s_{21}$    | $s_{22}$    |
|---------------|-------------|----------|--------------|-------------|-------------|-------------|
| 8             | 2           | 40       | 0,90/ -12,2° | 0,015/82,1° | 6,9/171,7°  | 0,99/ -4,8° |
|               |             | 100      | 0,88/ -29,2° | 0,036/74,5° | 6,6/160,4°  | 0,96/-10,8° |
|               |             | 200      | 0,81/ -54,7° | 0,064/62,4° | 5,9/143,1°  | 0,89/-19,2° |
|               |             | 500      | 0,64/-107,0° | 0,103/44,9° | 3,8/111,5°  | 0,71/-30,6° |
|               |             | 800      | 0,56/-138,1° | 0,112/42,1° | 2,7/ 92,2°  | 0,62/-34,1° |
|               |             | 1000     | 0,54/-152,6° | 0,116/44,1° | 2,3/ 83,6°  | 0,60/-36,4° |
|               |             | 1200     | 0,52/-165,2° | 0,120/48,5° | 1,9/ 75,9°  | 0,58/-38,6° |
| 8             | 5           | 40       | 0,78/ -19,2° | 0,014/79,4° | 14,8/166,9° | 0,98/ -8,6° |
|               |             | 100      | 0,73/ -44,6° | 0,032/69,0° | 13,5/150,4° | 0,90/-18,7° |
|               |             | 200      | 0,63/ -78,1° | 0,051/57,5° | 10,5/129,4° | 0,75/-28,9° |
|               |             | 500      | 0,48/-131,2° | 0,077/52,5° | 5,6/101,3°  | 0,53/-35,7° |
|               |             | 800      | 0,44/-157,3° | 0,096/57,7° | 3,7/ 86,3°  | 0,46/-36,2° |
|               |             | 1000     | 0,42/-168,3° | 0,110/61,0° | 3,0/ 79,5°  | 0,44/-37,5° |
|               |             | 1200     | 0,42/-178,3° | 0,126/64,3° | 2,6/ 73,6°  | 0,43/-39,0° |
| 8             | 10          | 40       | 0,66/ -27,7° | 0,013/76,7° | 24,0/161,5° | 0,95/-12,9° |
|               |             | 100      | 0,58/ -62,0° | 0,027/65,4° | 19,9/140,4° | 0,81/-26,3° |
|               |             | 200      | 0,48/-100,1° | 0,041/58,0° | 13,8/119,0° | 0,61/-35,5° |
|               |             | 500      | 0,40/-148,2° | 0,068/62,2° | 6,5/ 95,4°  | 0,42/-37,0° |
|               |             | 800      | 0,38/-169,1° | 0,096/67,4° | 4,2/ 83,0°  | 0,37/-36,2° |
|               |             | 1000     | 0,37/-178,3° | 0,116/69,0° | 3,4/ 77,4°  | 0,36/-37,0° |
|               |             | 1200     | 0,37/ 173,6° | 0,136/70,5° | 2,9/ 72,5°  | 0,35/-38,5° |
| 8             | 20          | 40       | 0,53/ -39,6° | 0,012/73,8° | 34,7/154,8° | 0,91/-18,1° |
|               |             | 100      | 0,45/ -83,0° | 0,023/63,9° | 25,6/130,5° | 0,70/-33,2° |
|               |             | 200      | 0,39/-122,0° | 0,034/62,2° | 15,9/110,6° | 0,49/-39,0° |
|               |             | 500      | 0,35/-161,3° | 0,066/69,7° | 7,0/ 91,4°  | 0,34/-36,2° |
|               |             | 800      | 0,35/-177,9° | 0,098/72,7° | 4,5/ 80,7°  | 0,31/-35,1° |
|               |             | 1000     | 0,34/ 175,2° | 0,121/73,1° | 3,7/ 75,8°  | 0,31/-36,0° |
|               |             | 1200     | 0,34/ 168,3° | 0,143/73,4° | 3,1/ 71,2°  | 0,30/-37,5° |
| 8             | 30          | 40       | 0,47/ -48,0° | 0,011/72,2° | 40,3/150,8° | 0,87/-20,9° |
|               |             | 100      | 0,41/ -95,5° | 0,021/63,8° | 27,5/125,4° | 0,63/-35,7° |
|               |             | 200      | 0,36/-132,8° | 0,032/64,9° | 16,4/106,8° | 0,44/-38,9° |
|               |             | 500      | 0,35/-166,6° | 0,065/72,3° | 7,1/ 89,6°  | 0,32/-34,4° |
|               |             | 800      | 0,34/ 178,8° | 0,100/74,4° | 4,5/ 79,7°  | 0,30/-33,6° |
|               |             | 1000     | 0,34/ 172,7° | 0,122/74,4° | 3,7/ 74,7°  | 0,30/-34,7° |
|               |             | 1200     | 0,34/ 166,0° | 0,145/74,3° | 3,1/ 70,3°  | 0,29/-36,5° |



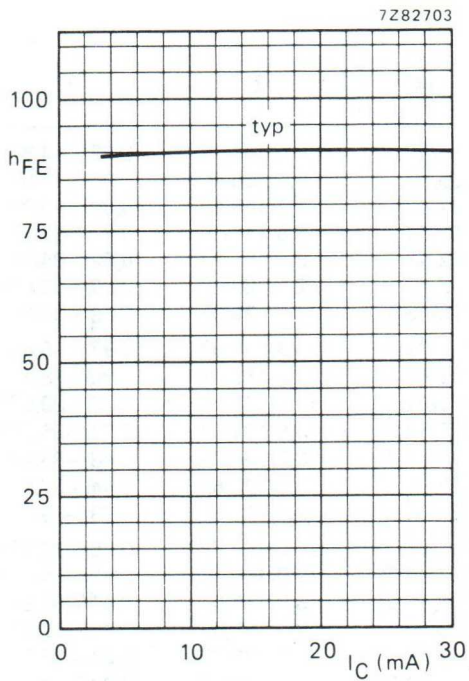


Fig. 3  $V_{CE} = 5$  V;  $T_j = 25$  °C.

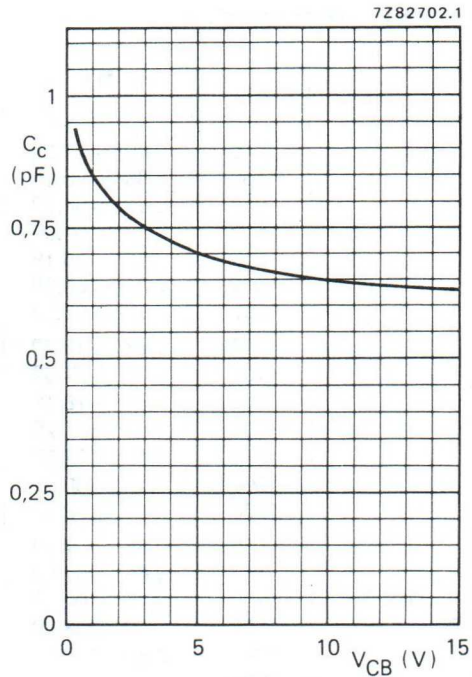


Fig. 4 Typical values collector capacitance  
 $I_E = I_e = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C.



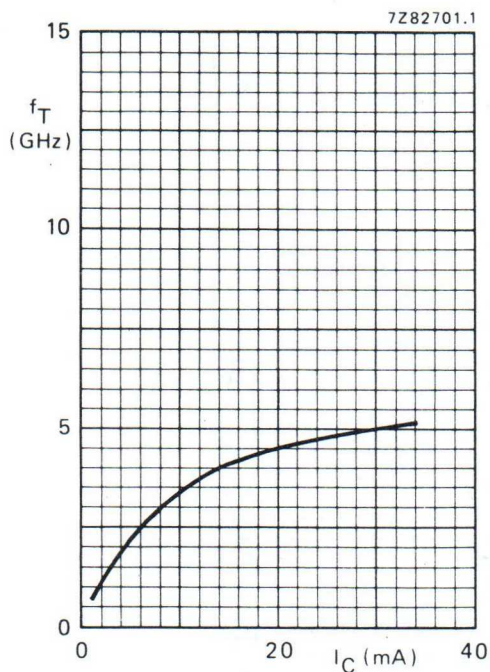


Fig. 5 Typical values transition frequency at  $V_{CE} = 5$  V;  $f = 500$  MHz;  $T_j = 25$  °C.

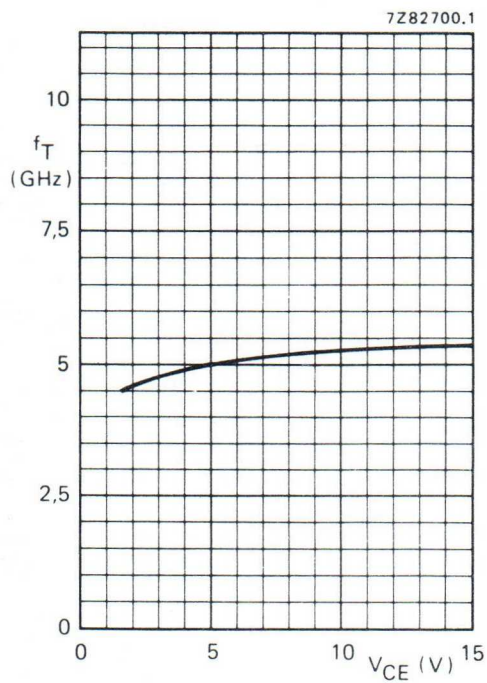


Fig. 6 Typical values transition frequency at  $I_C = 30$  mA;  $f = 500$  MHz;  $T_j = 25$  °C.

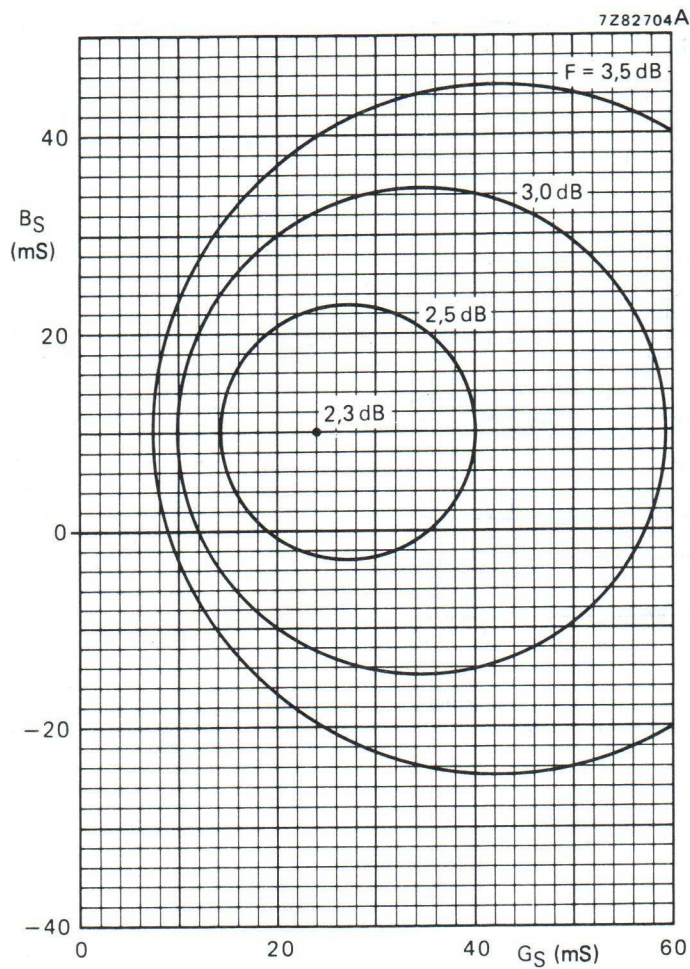


Fig. 7 Circles of constant noise figure.  
 $V_{CE} = 8$  V;  $I_C = 30$  mA;  $f = 800$  MHz;  
 $T_{amb} = 25$  °C; typical values.

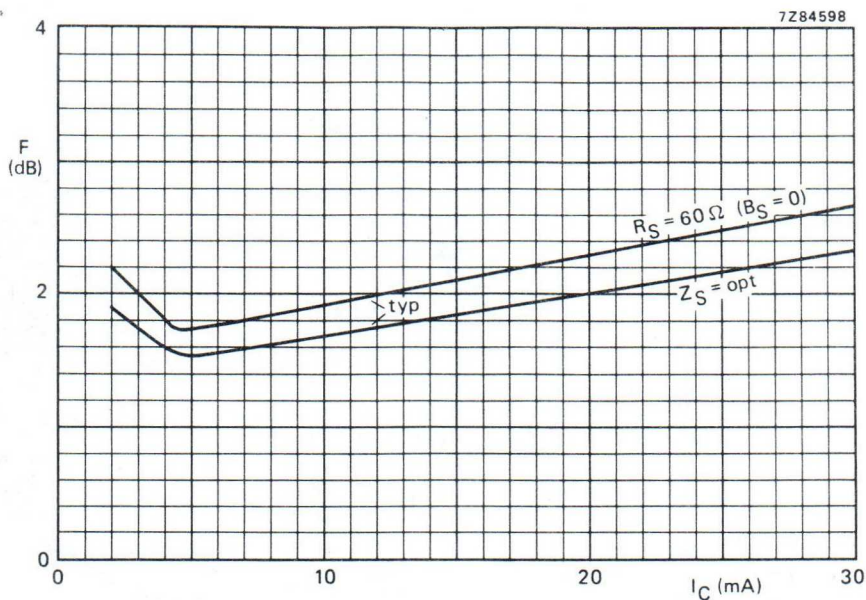


Fig. 8  $V_{CE} = 8 \text{ V}$ ;  $f = 800 \text{ MHz}$ ;  $T_{amb} = 25^\circ\text{C}$ .

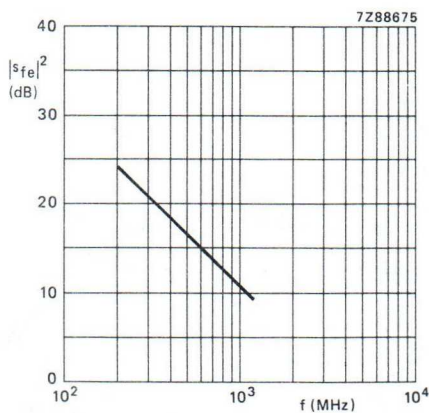


Fig. 9 Typical values forward transmission coefficient as a function of frequency.  $V_{CE} = 8 \text{ V}$ ;  $I_C = 30 \text{ mA}$ ;  $T_{amb} = 25^\circ\text{C}$ .

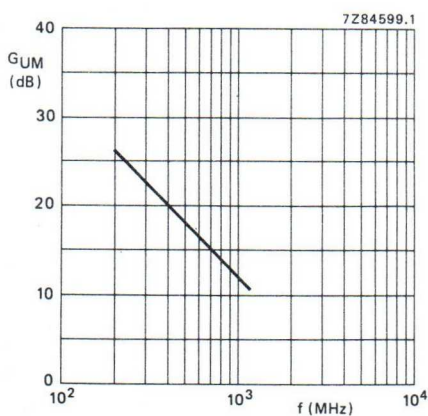


Fig. 10 Typical values unilateral power gain as a function of frequency.  $V_{CE} = 8 \text{ V}$ ;  $I_C = 30 \text{ mA}$ ;  $T_{amb} = 25^\circ\text{C}$ .

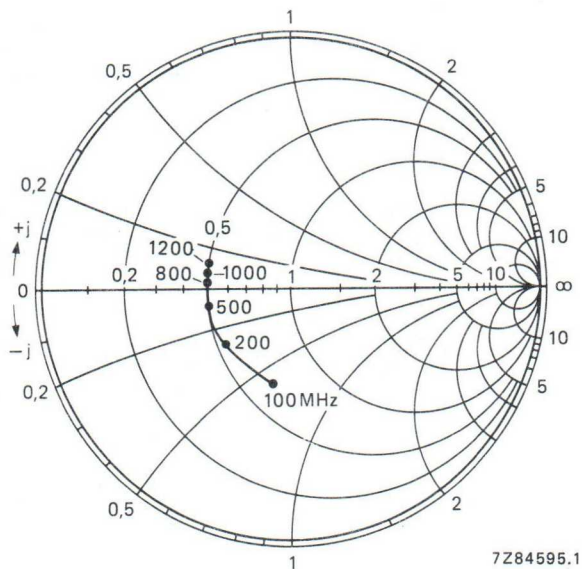


Fig. 11 Input impedance derived from input reflection coefficient  $s_{11}$  co-ordinates in ohm  $\times 50$ .  
 $V_{CE} = 8 \text{ V}$ ;  $I_C = 30 \text{ mA}$ ;  $T_{amb} = 25^\circ \text{C}$ .

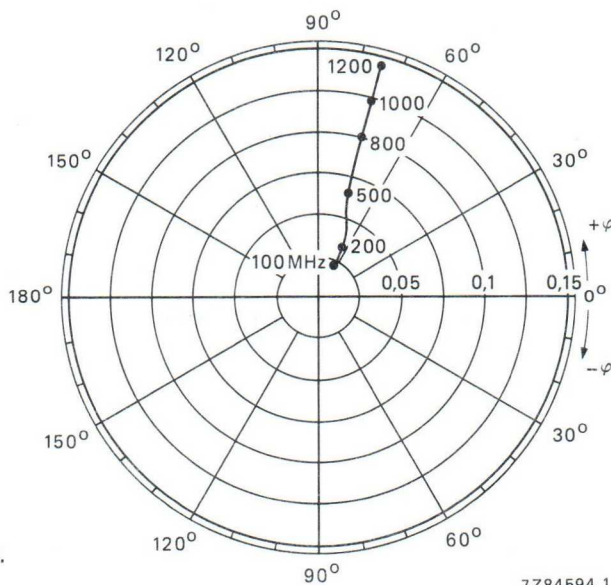
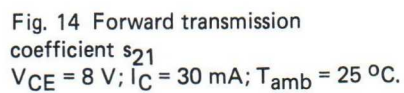
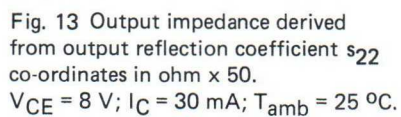


Fig. 12 Reverse transmission coefficient  $s_{12}$   
 $V_{CE} = 8 \text{ V}$ ;  $I_C = 30 \text{ mA}$ ;  $T_{amb} = 25^\circ \text{C}$ .







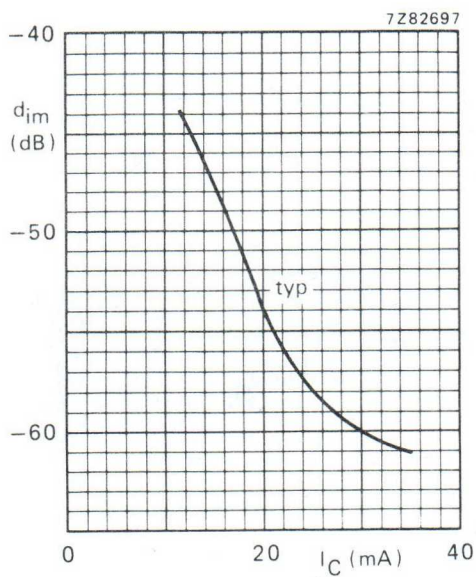


Fig. 15  $V_{CE} = 8\text{ V}$ ;  $V_o = 425\text{ mV} = 52,6\text{ dBmV}$ ;  
 $f_{(p+q-r)} = 793,25\text{ MHz}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  
 measured in MATV test circuit (see Fig. 2).

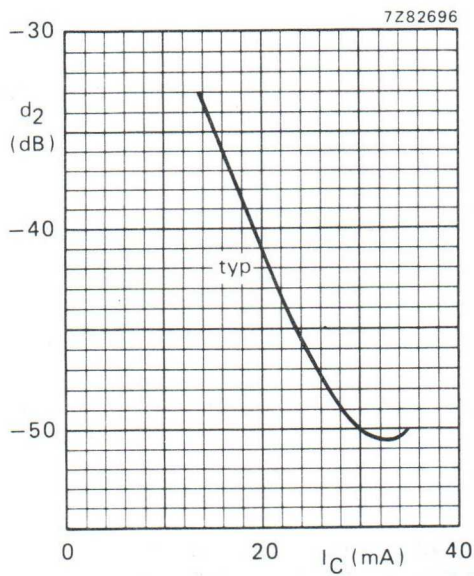


Fig. 16  $V_{CE} = 8\text{ V}$ ;  $V_o = 200\text{ mV} = 46\text{ dBmV}$ ;  
 $f_{(p+q)} = 810\text{ MHz}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; measured in  
 MATV test circuit (see Fig. 2).

## N-CHANNEL JUNCTION FIELD-EFFECT TRANSISTOR

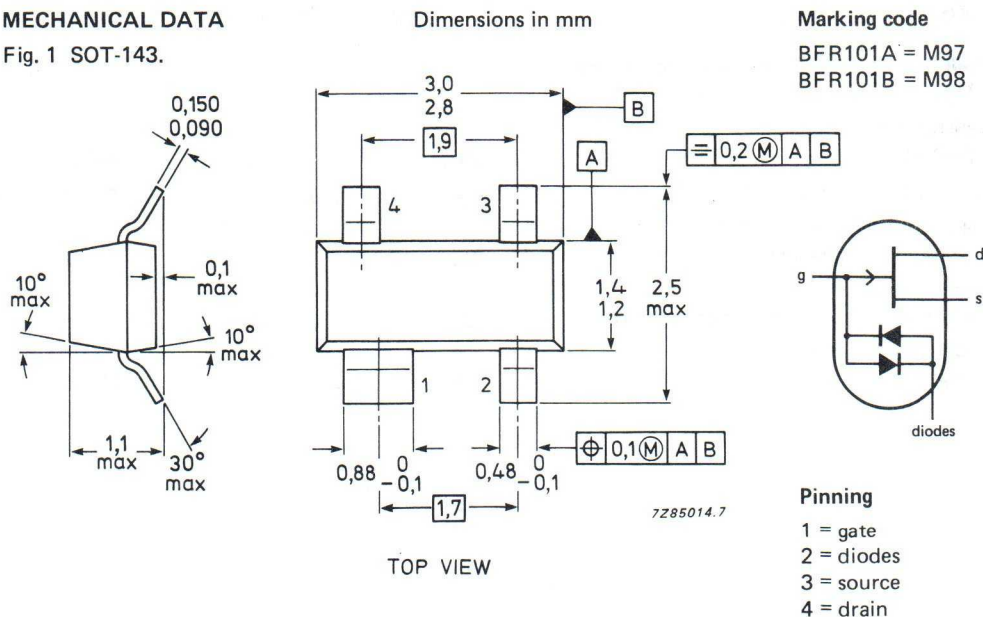
Symmetrical n-channel silicon junction field-effect transistor, designed primarily for use as a source follower with the input protected against successive voltage surges by a forward and reverse integrated diode.

### QUICK REFERENCE DATA

|                                                                      |              |            |        |
|----------------------------------------------------------------------|--------------|------------|--------|
| Drain-source voltage                                                 | $\pm V_{DS}$ | max.       | 30 V   |
| Gate-source voltage (open drain)                                     | $-V_{GS}$    | max.       | 30 V   |
| Total power dissipation up to $T_{amb} = 60\text{ }^{\circ}\text{C}$ | $P_{tot}$    | max.       | 200 mW |
| Drain current                                                        |              |            |        |
| $V_{DS} = 6\text{ V}; V_{GS} = 0$ : BFR101A                          | $I_{DSS}$    | 0,2 to 1,5 | mA     |
| $V_{DS} = 6\text{ V}; V_{GS} = 0$ : BFR101B                          | $I_{DSS}$    | 1,0 to 5,0 | mA     |
| Transfer admittance (common source)                                  |              |            |        |
| $V_{DS} = 6\text{ V}; V_{GS} = 0$ ; $f = 1\text{ kHz}$ : BFR101A     | $ y_{fs} $   | >          | 1,2 mS |
| $V_{DS} = 6\text{ V}; V_{GS} = 0$ ; $f = 1\text{ kHz}$ : BFR101B     | $ y_{fs} $   | >          | 2,5 mS |

### MECHANICAL DATA

Fig. 1 SOT-143.



Note: Drain and source are interchangeable.

See also *Soldering recommendations*.

# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |              |      |                                 |
|------------------------------------------------------------------------|--------------|------|---------------------------------|
| Drain-source voltage                                                   | $\pm V_{DS}$ | max. | 30 V                            |
| Drain-gate voltage (open source)                                       | $V_{DGO}$    | max. | 30 V                            |
| Gate-source voltage (open drain)                                       | $-V_{GSO}$   | max. | 30 V                            |
| Drain current (d.c.)                                                   | $I_D$        | max. | 20 mA                           |
| Gate current (d.c.)                                                    | $I_G$        | max. | 10 mA                           |
| Total power dissipation up to $T_{amb} = 60\text{ }^{\circ}\text{C}$ * | $P_{tot}$    | max. | 200 mW                          |
| Storage temperature                                                    | $T_{stg}$    |      | -65 to + 150 $^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$        | max. | 150 $^{\circ}\text{C}$          |

# **THERMAL RESISTANCE**

|                                       |               |   |         |
|---------------------------------------|---------------|---|---------|
| From junction to ambient in free air* | $R_{th\ j-a}$ | = | 460 K/W |
|---------------------------------------|---------------|---|---------|

# **CHARACTERISTICS** with source connected to case for all measurements

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                  |              | <b>BFR101A</b> | <b>BFR101B</b> |
|----------------------------------------------------------------------------------|--------------|----------------|----------------|
| Gate leakage current<br>$V_{DS} = 6\text{ V}; I_D = 10\text{ }\mu\text{A}$       | $-I_G$       | < 5            | 5 nA           |
| Drain current<br>$V_{DS} = 6\text{ V}; V_{GS} = 0$                               | $I_{DSS}$    | 0,2 to 1,5     | 1 to 5 mA      |
| Gate-source cut-off voltage<br>$V_{DS} = 6\text{ V}; I_D = 1\text{ }\mu\text{A}$ | $-V_{(P)GS}$ | 0,2 to 1       | 0,5 to 2,5 V   |

# **Small-signal common-source characteristics**

$V_{DS} = 6\text{ V}; V_{GS} = 0, T_{amb} = 25\text{ }^{\circ}\text{C}$

|                                                                 |            |            |              |
|-----------------------------------------------------------------|------------|------------|--------------|
| Transfer admittance<br>$f = 1\text{ kHz}$                       | $ Y_{fs} $ | > 1,2      | 2,5 mS       |
| Output admittance at $f = 1\text{ kHz}$                         | $ Y_{os} $ | typ. 10    | 50 mS        |
| Input capacitance at $f = 1\text{ MHz}$<br>diodes not connected | $C_{is}$   | < 5        | 5 pF         |
| Diode capacitance<br>$V_D = 0$ ; source and drain not connected | $C_d$      | typ. 0,7   | 0,7 pF       |
| Diode forward voltage<br>$\pm I_F = 10\text{ mA}$               | $V_F$      | 0,7 to 1,2 | 0,7 to 1,2 V |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

## NPN 3 GHz WIDEBAND TRANSISTOR

The BFR106 is a npn silicon planar epitaxial transistor in a SOT23 microminiature plastic envelope. It is primarily intended for low noise, general RF applications using SMD-technology.

### QUICK REFERENCE DATA

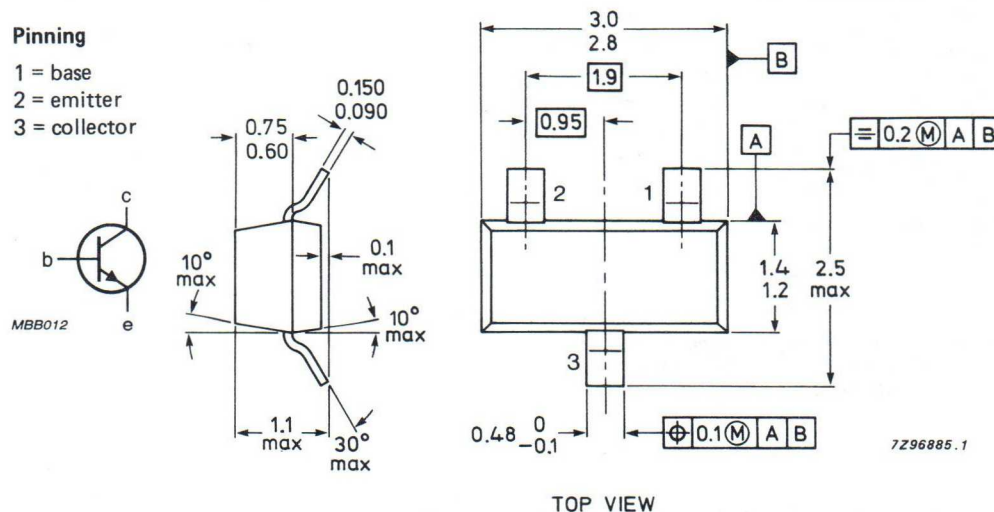
|                                                                                                                                                                                                        |           |      |                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                                                                                                                                                  | $V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage (open base)                                                                                                                                                                  | $V_{CEO}$ | max. | 15 V                   |
| Collector current (DC)                                                                                                                                                                                 | $I_C$     | max. | 100 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                                                                   | $P_{tot}$ | max. | 350 mW                 |
| Junction temperature                                                                                                                                                                                   | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| DC current gain                                                                                                                                                                                        | $h_{FE}$  | min. | 25                     |
| Transition frequency at $f = 500\text{ MHz}$                                                                                                                                                           | $f_T$     | typ. | 3.7 GHz                |
| Maximum unilateral power gain at $f = 800\text{ MHz}$                                                                                                                                                  | $G_{UM}$  | typ. | 11.5 dB                |
| Output voltage at $d_{im} = -60\text{ dB}$<br>$I_C = 30\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $R_L = 75\text{ }\Omega$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$<br>$f_{(p+q-r)} = 793.25\text{ MHz}$ | $V_O$     | typ. | 250 mV                 |

### MECHANICAL DATA

Fig.1 SOT23.

#### Pinning

- 1 = base  
2 = emitter  
3 = collector



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134).

|                                                                               |           |      |                                |
|-------------------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                                         | $V_{CB0}$ | max. | 20 V                           |
| Collector-emitter voltage (open base)                                         | $V_{CEO}$ | max. | 15 V                           |
| Emitter-base voltage (open collector)                                         | $V_{EB0}$ | max. | 3 V                            |
| Collector current (DC)                                                        | $I_C$     | max. | 100 mA                         |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$ | max. | 350 mW                         |
| Storage temperature range                                                     | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

From junction to ambient in free air mounted on a ceramic substrate of 8 x 10 x 0.7 mm

$$R_{thj-a} = 430\text{ K/W}$$

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Collector cut-off current

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$I_{CB0} \text{ max. } 100\text{ nA}$$

DC current gain

$$I_E = 30\text{ mA}; V_{CE} = 6\text{ V}$$

$$h_{FE} \text{ min. } 25$$

Transition frequency at  $f = 500\text{ MHz}$ 

$$I_E = 30\text{ mA}; V_{CE} = 6\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$$

$$f_T \text{ typ. } 3.7\text{ GHz}$$

Collector capacitance at  $f = 1\text{ MHz}$ 

$$I_E = i_e = 0; V_{CB} = 10\text{ V}$$

$$C_c \text{ typ. } 1.5\text{ pF}$$

Emitter capacitance at  $f = 1\text{ MHz}$ 

$$I_C = i_c = 0; V_{EB} = 0.5\text{ V}$$

$$C_e \text{ typ. } 4.5\text{ pF}$$

Feedback capacitance at  $f = 1\text{ MHz}$ 

$$I_C = 0; V_{CE} = 10\text{ V}$$

$$C_{re} \text{ typ. } 1.2\text{ pF}$$

Noise figure at optimum source impedance

$$I_C = 30\text{ mA}; V_{CE} = 6\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}; f = 800\text{ MHz}$$

$$F \text{ typ. } 3.5\text{ dB}$$

Maximum unilateral power gain at  $f = 800\text{ MHz}$ ;

$$I_E = 30\text{ mA}; V_{CE} = 6\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$$

$$G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

$$G_{UM} \text{ typ. } 11.5\text{ dB}$$

Output voltage at  $d_{im} = -60\text{ dB}$ 

$$T_{amb} = 25\text{ }^{\circ}\text{C}; I_C = 50\text{ mA};$$

$$V_{CE} = 7\text{ V}; R_L = 75\text{ }\Omega;$$

$$f_{(p+q-r)} = 793.25\text{ MHz}$$

$$V_O \text{ typ. } 350\text{ mV}$$

Second harmonic distortion  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

$$I_C = 30\text{ mA}; V_{CE} = 6\text{ V}; R_L = 75\text{ }\Omega;$$

$$f_{(p+q)} = 810\text{ MHz}; V_O = 100\text{ mV}$$

$$d_2 \text{ typ. } -50\text{ dB}$$

**Note**

1. Mounted on a ceramic substrate measuring 8 x 10 x 0.7 mm.



S-parameters (common emitter) at  $V_{CE} = 6\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $S_{11}$ |        | $S_{21}$    |        | $S_{12}$ |        | $S_{22}$ |        | $G_{UM}$<br>dB |
|-------------|----------|----------|--------|-------------|--------|----------|--------|----------|--------|----------------|
|             |          | M        | $\Phi$ | M           | $\Phi$ | M        | $\Phi$ | M        | $\Phi$ |                |
| 5           | 40       | 0.64/    | -34.5  | 13.18/161.8 |        | 0.03/    | 73.7   | 0.95/    | -14.3  | 35.3           |
|             | 100      | 0.64/    | -82.0  | 10.59/136.0 |        | 0.05/    | 55.7   | 0.80/    | -33.1  | 27.3           |
|             | 200      | 0.62/    | -123.3 | 6.88/114.5  |        | 0.07/    | 43.8   | 0.56/    | -45.8  | 20.5           |
|             | 500      | 0.62/    | -165.0 | 3.20/ 86.8  |        | 0.09/    | 42.0   | 0.40/    | -58.3  | 13.0           |
|             | 800      | 0.62/    | -177.7 | 2.11/ 74.0  |        | 0.11/    | 51.8   | 0.40/    | -66.7  | 9.4            |
|             | 1000     | 0.63/    | 173.8  | 1.69/ 66.5  |        | 0.12/    | 57.3   | 0.41/    | -70.5  | 7.6            |
|             | 1200     | 0.64/    | 166.0  | 1.40/ 61.9  |        | 0.13/    | 63.9   | 0.40/    | -76.7  | 6.0            |
|             | 1500     | 0.62/    | 159.5  | 1.21/ 54.1  |        | 0.17/    | 68.7   | 0.41/    | -84.0  | 4.6            |
|             | 2000     | 0.60/    | 142.6  | .97/ 46.2   |        | 0.24/    | 75.1   | 0.44/    | -97.1  | 2.6            |
| 10          | 40       | 0.50/    | -50.7  | 21.09/156.1 |        | 0.02/    | 70.8   | 0.92/    | -22.0  | 35.9           |
|             | 100      | 0.55/    | -105.9 | 14.96/128.3 |        | 0.04/    | 53.1   | 0.68/    | -46.5  | 27.7           |
|             | 200      | 0.57/    | -141.8 | 8.99/109.0  |        | 0.05/    | 47.9   | 0.43/    | -61.3  | 21.7           |
|             | 500      | 0.59/    | -173.6 | 3.94/ 85.6  |        | 0.08/    | 54.6   | 0.27/    | -77.5  | 14.1           |
|             | 800      | 0.59/    | 176.7  | 2.59/ 74.7  |        | 0.11/    | 62.5   | 0.28/    | -82.4  | 10.4           |
|             | 1000     | 0.59/    | 169.0  | 2.07/ 68.1  |        | 0.13/    | 65.5   | 0.28/    | -84.8  | 8.6            |
|             | 1200     | 0.60/    | 161.6  | 1.73/ 64.4  |        | 0.15/    | 69.1   | 0.26/    | -88.8  | 7.0            |
|             | 1500     | 0.58/    | 156.9  | 1.49/ 56.3  |        | 0.19/    | 69.6   | 0.29/    | -93.9  | 5.6            |
|             | 2000     | 0.55/    | 140.8  | 1.19/ 48.0  |        | 0.26/    | 71.4   | 0.31/    | -102.0 | 3.5            |
| 15          | 40       | 0.43/    | -64.3  | 26.39/152.1 |        | 0.02/    | 68.2   | 0.88/    | -27.6  | 35.8           |
|             | 100      | 0.52/    | -120.3 | 17.38/123.8 |        | 0.03/    | 53.9   | 0.60/    | -55.5  | 28.1           |
|             | 200      | 0.56/    | -151.1 | 10.12/106.0 |        | 0.05/    | 52.2   | 0.36/    | -72.4  | 22.3           |
|             | 500      | 0.58/    | -177.5 | 4.29/ 85.1  |        | 0.08/    | 61.3   | 0.23/    | -93.2  | 14.6           |
|             | 800      | 0.57/    | 174.0  | 2.82/ 75.0  |        | 0.12/    | 66.9   | 0.23/    | -95.8  | 10.9           |
|             | 1000     | 0.58/    | 166.8  | 2.25/ 69.0  |        | 0.14/    | 68.3   | 0.23/    | -97.8  | 9.0            |
|             | 1200     | 0.59/    | 159.5  | 1.89/ 65.4  |        | 0.16/    | 71.0   | 0.21/    | -100.0 | 7.5            |
|             | 1500     | 0.56/    | 155.6  | 1.63/ 57.5  |        | 0.21/    | 69.9   | 0.24/    | -103.1 | 6.1            |
|             | 2000     | 0.52/    | 139.7  | 1.30/ 49.1  |        | 0.28/    | 70.1   | 0.26/    | -107.7 | 4.0            |
| 20          | 40       | 0.40/    | -76.0  | 30.55/148.9 |        | 0.02/    | 64.9   | 0.85/    | -32.1  | 36.1           |
|             | 100      | 0.51/    | -129.8 | 19.05/120.7 |        | 0.03/    | 54.2   | 0.55/    | -62.2  | 28.5           |
|             | 200      | 0.55/    | -156.8 | 10.72/104.0 |        | 0.04/    | 55.8   | 0.33/    | -80.9  | 22.7           |
|             | 500      | 0.57/    | -179.9 | 4.49/ 84.6  |        | 0.08/    | 65.1   | 0.21/    | -105.3 | 15.0           |
|             | 800      | 0.56/    | 172.5  | 2.95/ 75.0  |        | 0.12/    | 69.1   | 0.21/    | -106.4 | 11.2           |
|             | 1000     | 0.57/    | 165.5  | 2.36/ 69.3  |        | 0.14/    | 69.9   | 0.20/    | -107.7 | 9.3            |
|             | 1200     | 0.58/    | 158.1  | 1.98/ 66.1  |        | 0.17/    | 71.8   | 0.18/    | -110.9 | 7.8            |
|             | 1500     | 0.54/    | 154.7  | 1.71/ 58.0  |        | 0.21/    | 69.9   | 0.21/    | -111.3 | 6.4            |
|             | 2000     | 0.51/    | 138.9  | 1.37/ 49.8  |        | 0.29/    | 69.2   | 0.22/    | -113.1 | 4.3            |
| 30          | 40       | 0.37/    | -92.2  | 36.02/144.4 |        | 0.02/    | 63.6   | 0.80/    | -38.5  | 36.3           |
|             | 100      | 0.51/    | -140.5 | 20.70/116.7 |        | 0.03/    | 55.5   | 0.49/    | -71.4  | 28.8           |
|             | 200      | 0.54/    | -161.9 | 11.40/101.8 |        | 0.04/    | 60.71  | 0.29/    | -92.7  | 23.0           |
|             | 500      | 0.56/    | 177.6  | 4.70/ 84.1  |        | 0.08/    | 69.0   | 0.20/    | -120.5 | 15.3           |
|             | 800      | 0.55/    | 170.8  | 3.09/ 75.0  |        | 0.12/    | 71.6   | 0.20/    | 161.4  | 11.5           |
|             | 1000     | 0.56/    | 164.1  | 2.46/ 69.5  |        | 0.15/    | 71.2   | 0.19/    | -122.1 | 9.6            |
|             | 1200     | 0.57/    | 156.8  | 2.07/ 66.6  |        | 0.17/    | 73.0   | 0.16/    | -126.6 | 8.1            |
|             | 1500     | 0.53/    | 153.9  | 1.79/ 58.5  |        | 0.22/    | 70.1   | 0.19/    | -122.2 | 6.7            |
|             | 2000     | 0.49/    | 138.0  | 1.44/ 50.5  |        | 0.29/    | 68.6   | 0.19/    | -121.1 | 4.5            |

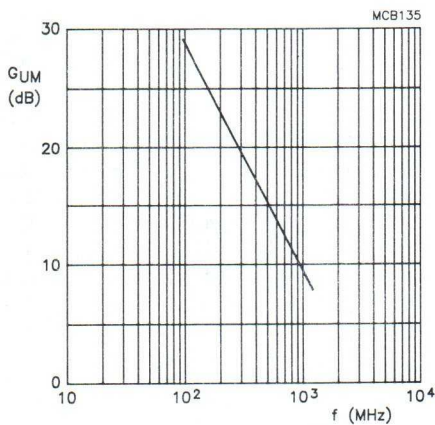


Fig. 2 Maximum power gain as a function of frequency;  $V_{CE} = 6\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

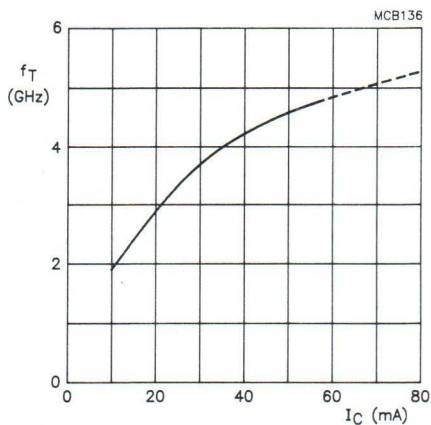


Fig. 3 Transition frequency as a function of collector current;  $V_{CE} = 6\text{ V}$ ;  $f = 500\text{ MHz}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ .

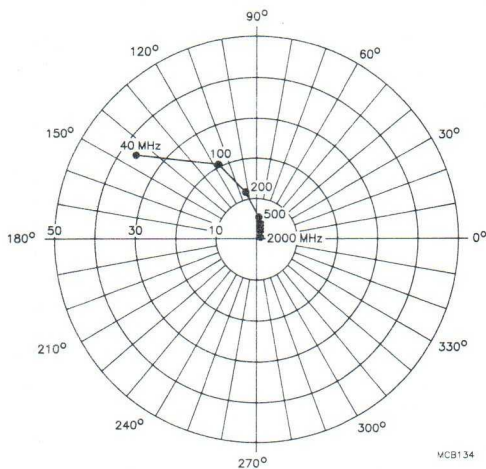


Fig. 4 Forward transmission coefficient  $S_{21}$ ;  $V_{CE} = 6\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

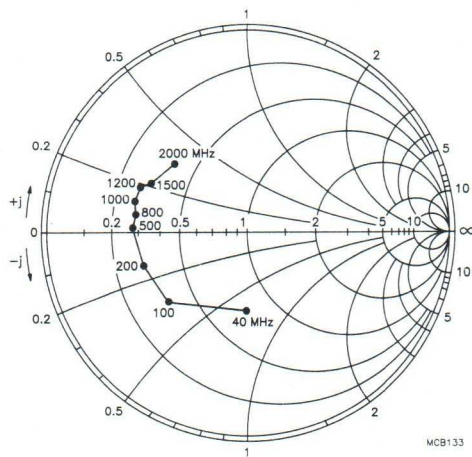


Fig. 5 Input impedance derived from  $S_{11}$  (in  $\text{Ohm} \times 50$ );  $V_{CE} = 6\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

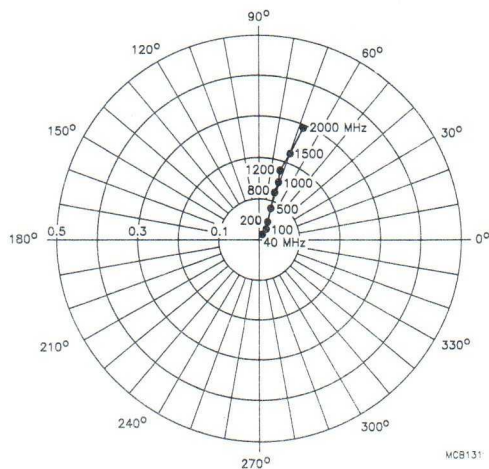


Fig.6 Reverse transmission coefficient  $S_{12}$ ;  
 $V_{CE} = 6\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

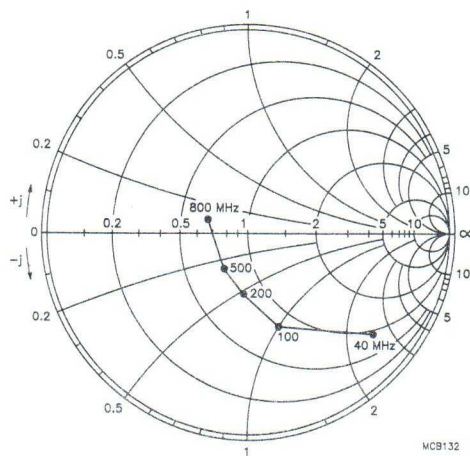


Fig.7 Output impedance derived from  $S_{22}$   
(in Ohm  $\times 50$ );  $V_{CE} = 6\text{ V}$ ;  $I_C = 30\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ .



## Philips Components

| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# BFR200

## N-channel junction field-effect transistor

### FEATURES

- Ultra-low leakage performance ( $-I_{GSS}$  max. 3 pA); important for use in highly sensitive equipment, such as burglar alarms, infrared sensors, etc.
- Insensitive to radio frequency interference (RFI), owing to an integrated low pass filter.
- Input protected against successive voltage surges by a forward and reverse integrated diode.
- Low LF noise performance (20 nV/ $\sqrt{\text{Hz}}$ ).

### DESCRIPTION

Silicon asymmetrical n-channel junction FET in a surface mount SOT143 envelope, with an integrated RC low pass filter and two anti-parallel diodes connected to the gate. It is designed primarily for use as a source follower in infrared detectors, burglar alarms, electret microphones, smoke alarms and radiation detectors.

### QUICK REFERENCE DATA

| SYMBOL         | PARAMETER                   | MIN. | MAX. | UNIT |
|----------------|-----------------------------|------|------|------|
| $V_{DS}$       | drain-source voltage        | -    | 30   | V    |
| $I_{DSS}$      | drain current               | 0.2  | 3.5  | mA   |
| $-V_{GS(off)}$ | gate-source cut-off voltage | 0.5  | 2    | V    |



**N-channel junction field-effect transistor****BFR200****MECHANICAL DATA**

Dimensions in mm

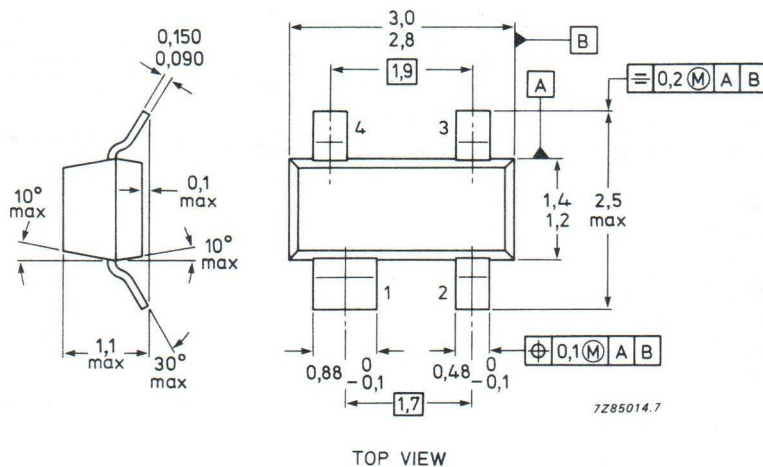


Fig.1 SOT143.

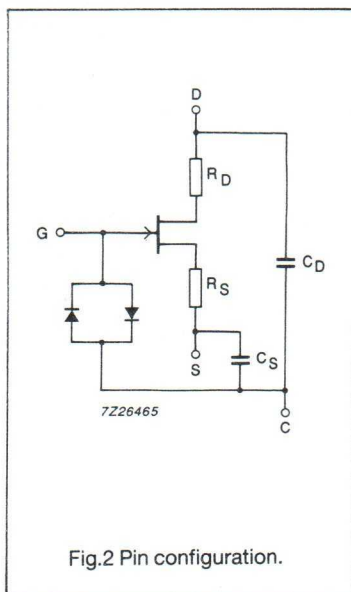
**PIN CONFIGURATION**

Fig.2 Pin configuration.

**PINNING**

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | common      |
| 3   | source      |
| 4   | drain       |

**Marking:** BFR200 = M20

**N-channel junction field-effect transistor****BFR200****LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL       | PARAMETER                      | CONDITIONS                                   | MIN. | MAX. | UNIT               |
|--------------|--------------------------------|----------------------------------------------|------|------|--------------------|
| $\pm V_{DS}$ | drain-source voltage           |                                              | -    | 30   | V                  |
| $-V_{GS0}$   | gate-source voltage            |                                              | -    | 30   | V                  |
| $-V_{GDO}$   | gate-drain voltage             |                                              | -    | 30   | V                  |
| $I_D$        | drain current                  | DC                                           | -    | 20   | mA                 |
| $I_G$        | forward gate current           | DC                                           | -    | 10   | mA                 |
| $P_{tot}$    | total power dissipation        | up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | -    | 250  | mW                 |
| $T_{stg}$    | storage temperature range      |                                              | -65  | 150  | $^{\circ}\text{C}$ |
| $T_j$        | operating junction temperature |                                              | -    | 150  | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                         | VALUE | UNIT |
|---------------|-----------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient (note 1) | 500   | K/W  |

**Notes**

1. Mounted on FR4 printboard.

# N-channel junction field-effect transistor

**BFR200**

## STATIC CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL         | PARAMETER                            | CONDITIONS                                              | MIN. | TYP. | MAX. | UNIT     |
|----------------|--------------------------------------|---------------------------------------------------------|------|------|------|----------|
| $-V_{(BR)GSS}$ | gate-source breakdown voltage        | $V_{DS} = 0$<br>$-I_G = 1\text{ }\mu\text{A}$           | 30   | -    | -    | V        |
| $I_{DSS}$      | drain current                        | $V_{DS} = 6\text{ V}$<br>$V_{GS} = 0$                   | 0.2  | -    | 3.5  | mA       |
| $-I_{GSS}$     | gate-source leakage current (note 1) | $-V_{GS} = 6\text{ V}$<br>$V_{DS} = 0$<br>$V_{GC} = 0$  | -    | -    | 3    | pA       |
| $-V_{GS(off)}$ | gate-source cut-off voltage          | $I_D = 0.1\text{ }\mu\text{A}$<br>$V_{DS} = 6\text{ V}$ | 0.5  | -    | 2    | V        |
| $V_F$          | diode forward voltage                | $\pm I_F = 10\text{ mA}$                                | 0.7  | -    | 1.2  | V        |
| $R_D$          | drain resistance                     |                                                         | -    | 800  | -    | $\Omega$ |
| $R_S$          | source resistance                    |                                                         | -    | 180  | -    | $\Omega$ |

## Notes

- Based on level I, AQL 1.5%.

## DYNAMIC CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL     | PARAMETER                     | CONDITIONS                                                                  | MIN. | TYP. | MAX. | UNIT          |
|------------|-------------------------------|-----------------------------------------------------------------------------|------|------|------|---------------|
| $ Y_{fs} $ | transfer admittance           | $V_{DS} = 6\text{ V}$<br>$V_{GS} = 0$                                       | 1.3  | -    | -    | mS            |
| $ Y_{os} $ | output admittance             | $V_{DS} = 6\text{ V}$<br>$V_{GS} = 0$                                       | -    | 40   | -    | $\mu\text{S}$ |
| $C_{iss}$  | input capacitance (note 1)    | $V_{DS} = 6\text{ V}$<br>$V_{GS} = 0$<br>$V_{GC} = 0$<br>$f = 1\text{ MHz}$ | -    | -    | 6    | pF            |
| $C_{GC}$   | diode capacitance             | $V_{GC} = 0$<br>drain and source grounded                                   | -    | 3    | -    | pF            |
| $C_D$      | drain decoupling capacitance  | $V_{DC} = 0$<br>gate and source grounded                                    | -    | 8    | -    | pF            |
| $C_S$      | source decoupling capacitance | $V_{SC} = 0$<br>gate and drain grounded                                     | -    | 8    | -    | pF            |

## Notes

- Value is inclusive of the capacitance of the diodes.

## N-P-N 4 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope. It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

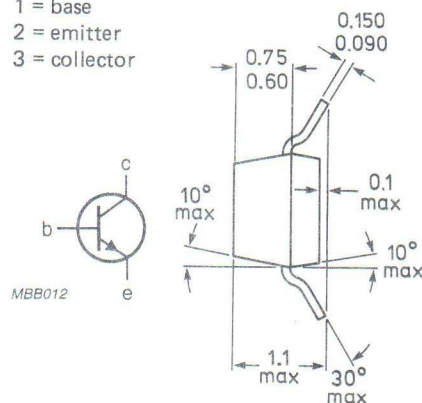
|                                                                                      |            |      |                        |
|--------------------------------------------------------------------------------------|------------|------|------------------------|
| Collector-base voltage (open emitter; peak value)                                    | $V_{CBOM}$ | max. | 25 V                   |
| Collector-emitter voltage (open base)                                                | $V_{CEO}$  | max. | 15 V                   |
| Collector current (peak value)                                                       | $I_{CM}$   | max. | 50 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                 | $P_{tot}$  | max. | 300 mW                 |
| Junction temperature                                                                 | $T_j$      | max. | 150 $^{\circ}\text{C}$ |
| DC current gain                                                                      |            |      |                        |
| $I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$                                             | $h_{FE}$   |      | 20 to 150              |
| Transition frequency                                                                 |            |      |                        |
| $I_C = 25\text{ mA}; V_{CE} = 5\text{ V}; f = 500\text{ MHz}$                        | $f_T$      | typ. | 1.3 GHz                |
| Noise figure                                                                         |            |      |                        |
| $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; R_S = 50\text{ }\Omega; f = 500\text{ MHz}$ | $F$        | typ. | 4.5 dB                 |

## MECHANICAL DATA

Fig. 1 SOT-23.

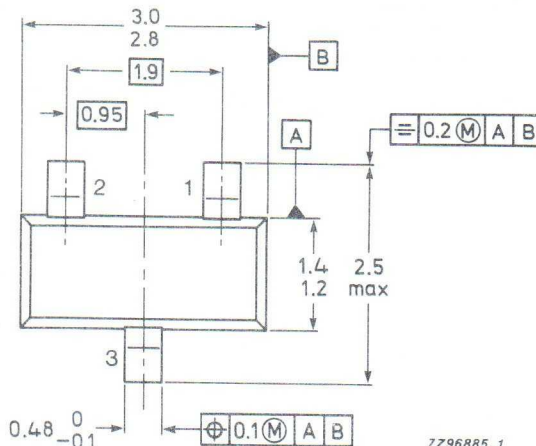
## Pinning

- 1 = base  
2 = emitter  
3 = collector



Dimensions in mm

Marking code

$$\text{BFS17} = \text{E1}_p$$


TOP VIEW

If required, the R-version (reverse pinning) is available on request.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |            |      |                                               |
|---------------------------------------------------------------------|------------|------|-----------------------------------------------|
| Collector-base voltage (open emitter; peak value)                   | $V_{CBOM}$ | max. | 25 V                                          |
| Collector-emitter voltage (open base)<br>$I_C = 10 \text{ mA}$      | $V_{CEO}$  | max. | 15 V                                          |
| Emitter-base voltage (open collector)                               | $V_{EBO}$  | max. | 2.5 V                                         |
| Collector current (DC)                                              | $I_C$      | max. | 25 mA                                         |
| Collector current (peak value)                                      | $I_{CM}$   | max. | 50 mA                                         |
| Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ | $P_{tot}$  | max. | 300 mW                                        |
| Storage temperature                                                 | $T_{stg}$  |      | $-65 \text{ to } +150 \text{ }^\circ\text{C}$ |
| Junction temperature                                                | $T_j$      | max. | 150 $^\circ\text{C}$                          |

**THERMAL RESISTANCE**

|                                   |                      |   |         |
|-----------------------------------|----------------------|---|---------|
| From junction to ambient (note 1) | $R_{th \text{ j-a}}$ | = | 430 K/W |
|-----------------------------------|----------------------|---|---------|

**CHARACTERISTICS** $T_j = 25 \text{ }^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 10 \text{ V}$

$I_{CBO}$  max. 10 nA

$I_E = 0; V_{CB} = 10 \text{ V}; T_j = 100 \text{ }^\circ\text{C}$

$I_{CBO}$  max. 10  $\mu\text{A}$

DC current gain

$I_C = 2 \text{ mA}; V_{CE} = 1 \text{ V}$

$h_{FE}$  20 to 150

$I_C = 25 \text{ mA}; V_{CE} = 1 \text{ V}$

$h_{FE}$  min. 20

Transition frequency

$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V}; f = 500 \text{ MHz}$

$f_T$  typ. 1.0 GHz

$I_C = 25 \text{ mA}; V_{CE} = 5 \text{ V}; f = 500 \text{ MHz}$

$f_T$  typ. 1.3 GHz

Collector capacitance at  $f = 1 \text{ MHz}$ 

$I_E = I_e = 0; V_{CB} = 10 \text{ V}$

$C_C$  max. 1.5 pF

**Notes**

1. Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.
2. Crystal mounted in a BFY90 envelope.



Emitter capacitance at  $f = 1$  MHz

$$I_C = I_{C0} = 0; V_{EB} = 0.5 \text{ V}$$

$C_e$  max. 2.0 pF

Feedback capacitance at  $f = 1$  MHz

$$I_C = 1 \text{ mA}; V_{CE} = 5 \text{ V}$$

$C_{re}$  typ. 0.65 pF

Noise figure (note 2)

$$I_C = 2 \text{ mA}; V_{CE} = 5 \text{ V};$$

$$f = 500 \text{ MHz}; R_S = 50 \Omega$$

F typ. 4.5 dB

Intermodulation distortion

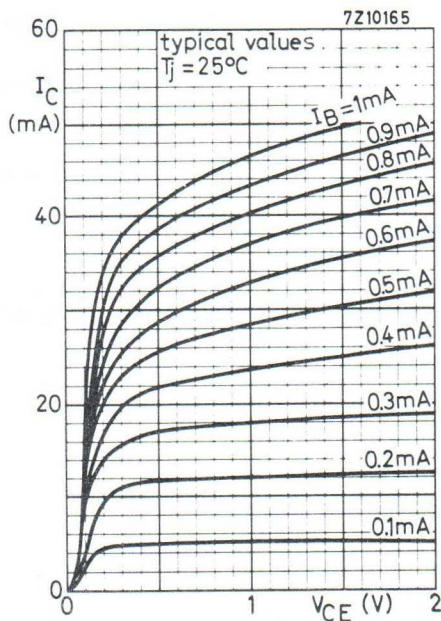
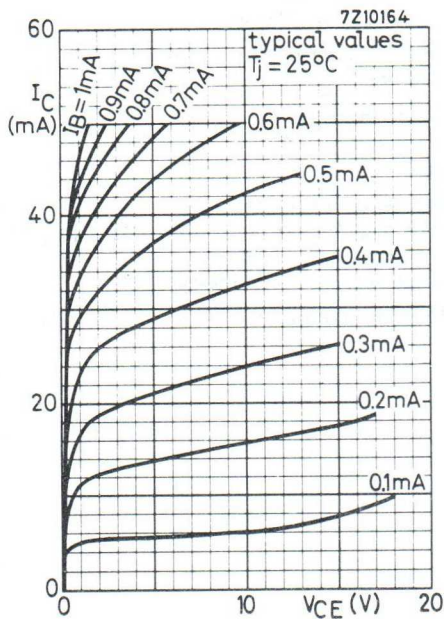
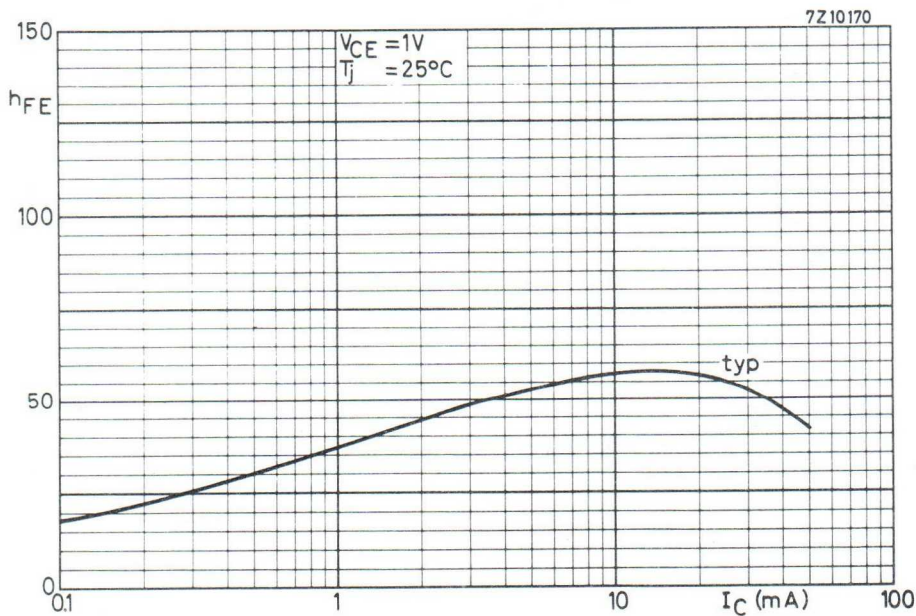
$$I_C = 10 \text{ mA}; V_{CE} = 6 \text{ V}; R_L = 37.5 \Omega; T_{amb} = 25^\circ \text{C}$$

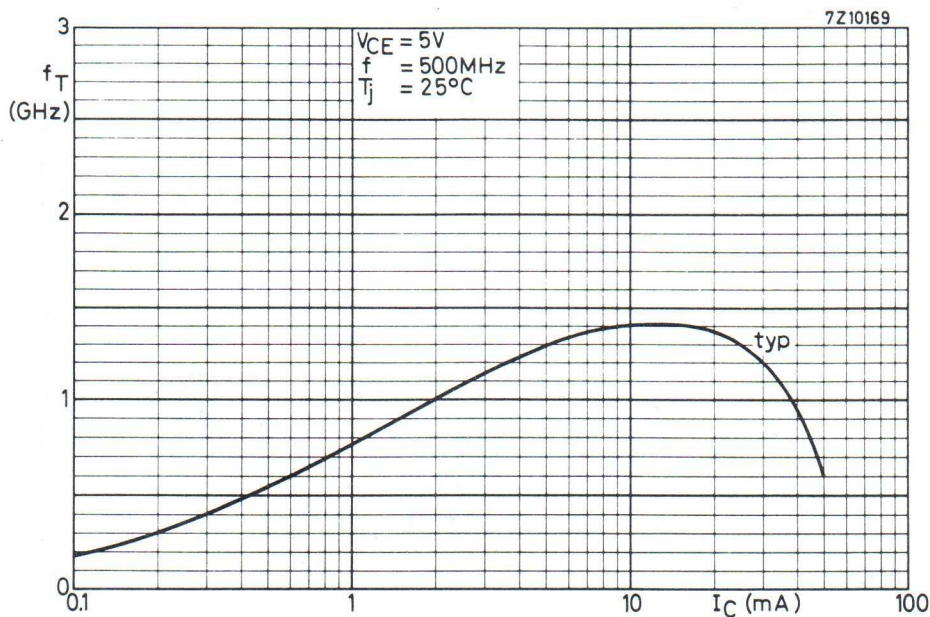
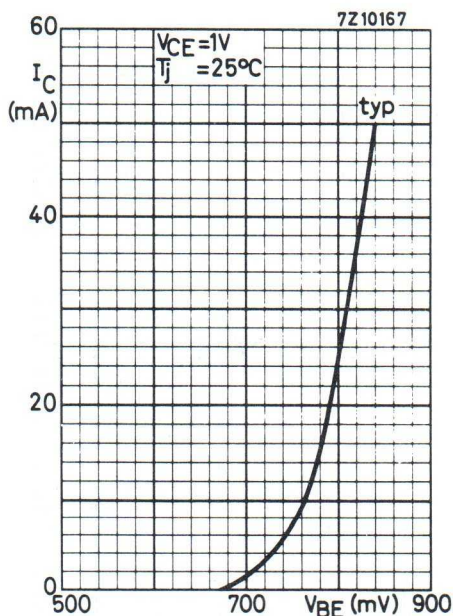
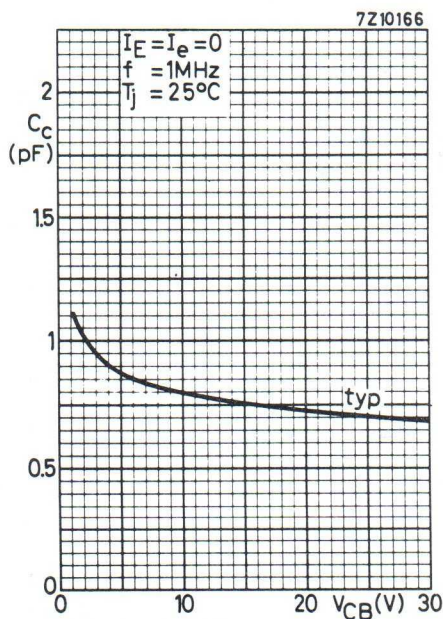
$$V_o = 100 \text{ mV at } f_p = 183 \text{ MHz}$$

$$V_o = 100 \text{ mV at } f_q = 200 \text{ MHz}$$

$$\text{measured at } f_{(2q-p)} = 217 \text{ MHz}$$

$d_{im}$  typ. -45 dB

Fig. 2  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 3  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 4  $V_{CE} = 1\text{V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.

Fig. 5  $V_{CE} = 5V$ ;  $f = 500MHz$ ;  $T_j = 25^{\circ}C$ ; typical values.Fig. 6  $V_{CE} = 1V$ ;  $T_j = 25^{\circ}C$ ; typical values.Fig. 7  $I_E = I_e = 0$ ;  $f = 1MHz$ ;  $T_j = 25^{\circ}C$ ; typical values.



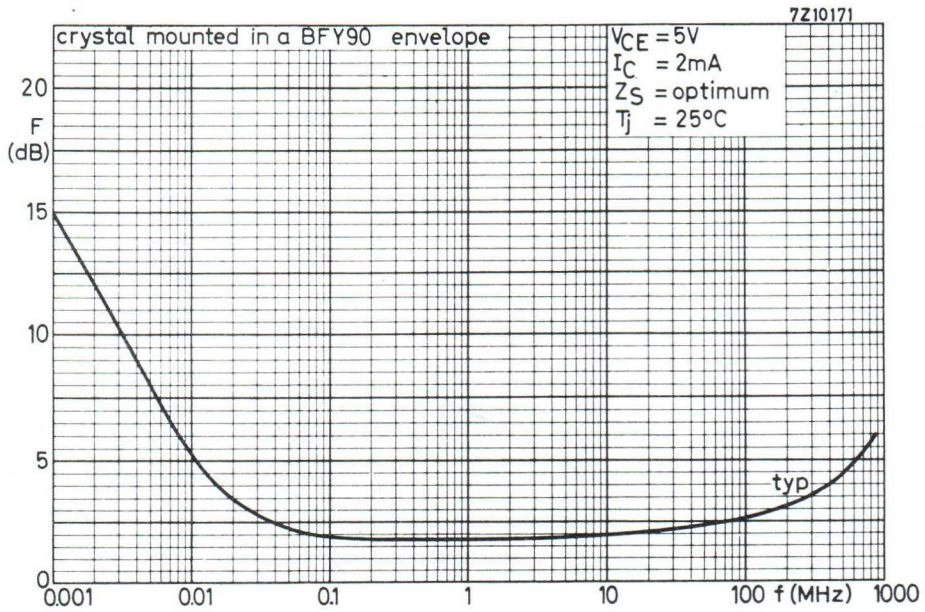


Fig. 8  $V_{CE} = 5V$ ;  $I_C = 2mA$ ;  $Z_S = \text{optimum}$ ;  $T_j = 25^\circ C$ ; typical values.

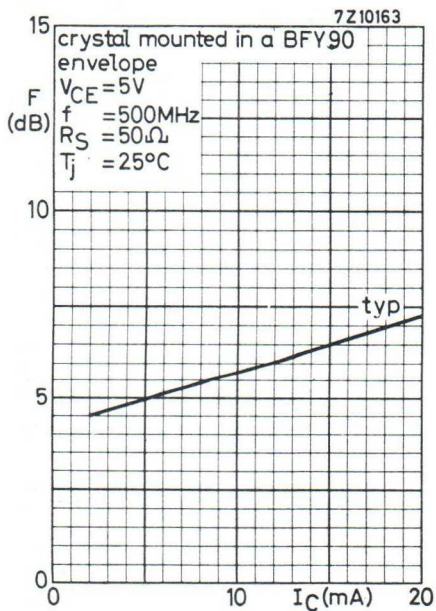


Fig. 9  $V_{CE} = 5V$ ;  $f = 500MHz$ ;  $R_S = 50\Omega$ ;  $T_j = 25^\circ C$ ; typical values.

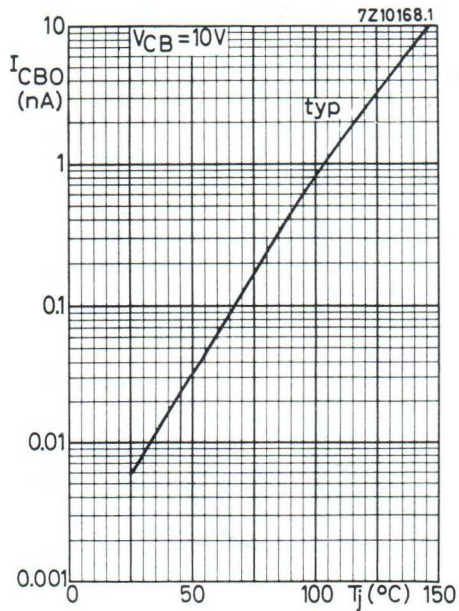


Fig. 10  $V_{CB} = 10V$ ; typical values.

## N-P-N 2 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope. It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin-film circuits.

The BFS17A is the successor to the BFS17 and offers a higher power gain and an improved noise behaviour.

### QUICK REFERENCE DATA

|                                                                      |           |      |                        |
|----------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 25 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 15 V                   |
| Collector current (DC)                                               | $I_C$     | max. | 25 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                    | $h_{FE}$  | min. | 20                     |
| $I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$                             |           | max. | 150                    |
| Transition frequency at $f = 500\text{ MHz}$                         | $f_T$     | typ. | 2.8 GHz                |
| $I_C = 25\text{ mA}; V_{CE} = 5\text{ V}$                            |           |      |                        |
| Noise figure                                                         | $F$       | typ. | 2.5 dB                 |
| $I_C = 2\text{ mA}; V_{CE} = 5\text{ V}; f = 800\text{ MHz}$         |           |      |                        |
| Output voltage at $d_{im} = -60\text{ dB}$                           | $V_o$     | typ. | 150 mV                 |
| $V_{CE} = 10\text{ V}; I_C = 14\text{ mA}; Z_L = 75\text{ }\Omega$   |           |      |                        |
| $f_{(p+q-r)} = 793.25\text{ MHz}$                                    |           |      |                        |
| Maximum unilateral power gain at $f = 800\text{ MHz}$                | $G_{UM}$  | typ. | 13.5 dB                |
| $V_{CE} = 10\text{ V}; I_C = 14\text{ mA}$                           |           |      |                        |

### MECHANICAL DATA (see Fig. 1).

If required, the R-version (reverse pinning) is available on request.



## MECHANICAL DATA

Dimensions in mm

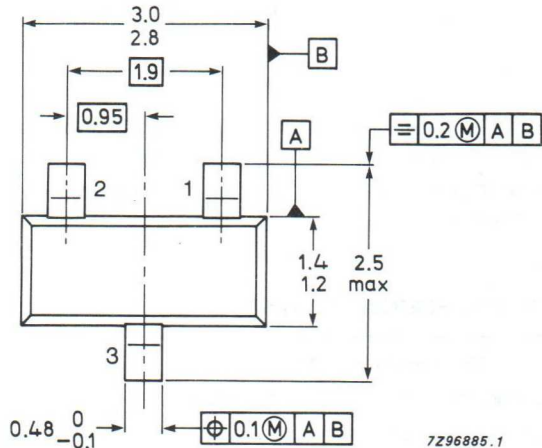
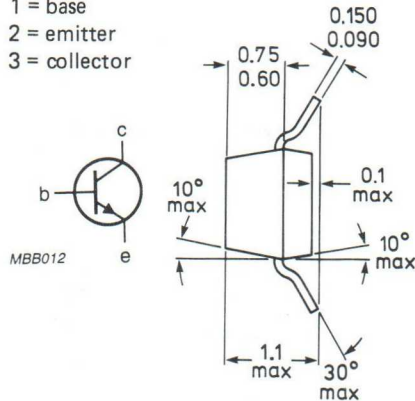
Marking code

Fig. 1 SOT-23.

BFS17A = E2

## Pinning

- 1 = base  
2 = emitter  
3 = collector



TOP VIEW

7296885.1

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                                              |
|------------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Collector-base voltage (open emitter)                                  | $V_{CB0}$ | max. | 25 V                                         |
| Collector-emitter voltage (open base)                                  | $V_{CEO}$ | max. | 15 V                                         |
| Emitter-base voltage (open collector)                                  | $V_{EBO}$ | max. | 2.5 V                                        |
| Collector current (DC)                                                 | $I_C$     | max. | 25 mA                                        |
| Collector current (peak value)                                         | $I_{CM}$  | max. | 50 mA                                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 300 mW                                       |
| Storage temperature                                                    | $T_{stg}$ |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | 150 $^{\circ}\text{C}$                       |

## THERMAL RESISTANCE

From junction to ambient\*

$$R_{th\ j-a} = 430\text{ K/W}$$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

## CHARACTERISTICS

$T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$I_{CBO} \quad \text{max.} \quad 50\text{ nA}$$

DC current gain

$$I_C = 2\text{ mA}; V_{CE} = 1\text{ V}$$

$$h_{FE} \quad \begin{array}{l} 20 \text{ to } 150 \\ \text{min.} \quad 20 \end{array}$$

$$I_C = 25\text{ mA}; V_{CE} = 1\text{ V}$$

Transition frequency at  $f = 500\text{ MHz}$

$$I_C = 25\text{ mA}; V_{CE} = 5\text{ V}$$

$$f_T \quad \text{typ.} \quad 2.8\text{ GHz}$$

Collector capacitance at  $f = 1\text{ MHz}$

$$I_E = 0; V_{CB} = 10\text{ V}$$

$$C_c \quad \text{typ.} \quad 0.7\text{ pF}$$

Emitter capacitance at  $f = 1\text{ MHz}$

$$I_C = 0; V_{EB} = 0.5\text{ V}$$

$$C_e \quad \text{typ.} \quad 1.25\text{ pF}$$

Feedback capacitance at  $f = 1\text{ MHz}$

$$I_C = 0; V_{CE} = 5\text{ V}$$

$$C_{re} \quad \text{typ.} \quad 0.6\text{ pF}$$

Maximum unilateral power gain

( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$$I_C = 14\text{ mA}; V_{CE} = 10\text{ V}; f = 800\text{ MHz}$$

$$G_{UM} \quad \text{typ.} \quad 13.5\text{ dB}$$

Noise figure at  $f = 800\text{ MHz}$

$$I_C = 2\text{ mA}; V_{CE} = 5\text{ V};$$

$$Z_S = 60\ \Omega; T_{amb} = 25^\circ\text{C}$$

$$F \quad \text{typ.} \quad 2.5\text{ dB}$$

Output voltage at  $d_{im} = -60\text{ dB}$

(DIN 45004B, par. 6.3: 3-tone)

$$I_C = 14\text{ mA}; V_{CE} = 10\text{ V}; Z_L = 75\ \Omega$$

$$V_p = V_o; f_p = 795.25\text{ MHz}$$

$$V_q = V_o - 6\text{ dB}; f_q = 803.25\text{ MHz}$$

$$V_r = V_o - 6\text{ dB}; f_r = 805.25\text{ MHz}$$

$$\text{Measured at } f_{(p+q-r)} = 793.25\text{ MHz}$$

$$V_o \quad \text{typ.} \quad 150\text{ mV}$$

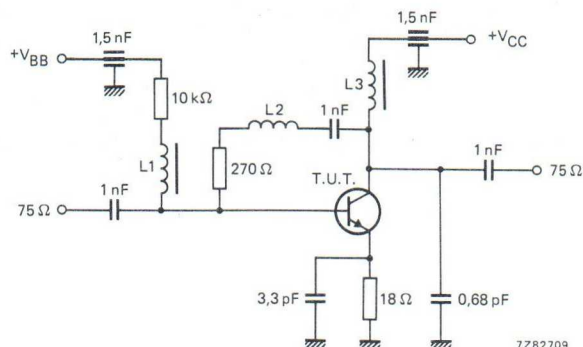


Fig. 2 Intermodulation distortion and second harmonic distortion MATV test circuit.

$L1 = L3 = 5\ \mu\text{H}$  Ferroxcube choke.

$L2 = 3$  turns Cu wire (0.4 mm), internal diameter 3 mm, winding pitch 1 mm.

s-parameters (common emitter) at  $V_{CE} = 5\text{ V}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $s_{11}$      | $s_{21}$     | $s_{12}$   | $s_{22}$     | $G_{UM}$<br>dB |
|-------------|----------|---------------|--------------|------------|--------------|----------------|
| 2           | 40       | 0,94/ -11,1°  | 6,50/173,0°  | 0,01/83,1° | 1,00/ -4,1°  | 45,7           |
|             | 100      | 0,89/ -27,6°  | 6,22/158,7°  | 0,03/74,1° | 0,96/ -9,8°  | 34,0           |
|             | 200      | 0,79/ -50,3°  | 5,38/143,2°  | 0,06/63,8° | 0,89/ -16,0° | 25,7           |
|             | 500      | 0,50/ -103,1° | 3,37/107,0°  | 0,09/47,1° | 0,68/ -24,3° | 14,5           |
|             | 800      | 0,43/ -130,7° | 2,43/ 93,1°  | 0,11/47,9° | 0,64/ -28,0° | 10,9           |
|             | 1000     | 0,43/ -148,2° | 2,08/ 84,5°  | 0,12/50,1° | 0,62/ -32,6° | 9,3            |
|             | 1200     | 0,41/ -172,5° | 1,73/ 75,8°  | 0,13/51,6° | 0,54/ -31,6° | 7,1            |
| 5           | 40       | 0,84/ -19,0°  | 14,43/167,4° | 0,01/80,2° | 0,98/ -7,6°  | 42,5           |
|             | 100      | 0,74/ -45,0°  | 12,92/147,3° | 0,03/67,8° | 0,89/ -16,9° | 32,5           |
|             | 200      | 0,60/ -75,6°  | 9,60/128,6°  | 0,05/58,6° | 0,75/ -23,1° | 25,3           |
|             | 500      | 0,38/ -133,5° | 4,94/ 98,3°  | 0,07/54,6° | 0,52/ -23,7° | 15,9           |
|             | 800      | 0,35/ -158,6° | 3,25/ 86,5°  | 0,09/60,3° | 0,52/ -25,6° | 12,2           |
|             | 1000     | 0,37/ -171,2° | 2,71/ 79,9°  | 0,11/62,7° | 0,50/ -30,1° | 10,5           |
|             | 1200     | 0,41/ +166,1° | 2,31/ 73,4°  | 0,12/64,3° | 0,43/ -24,8° | 8,9            |
| 10          | 40       | 0,73/ -28,7°  | 23,50/160,9° | 0,01/76,3° | 0,95/ -11,7° | 41,0           |
|             | 100      | 0,59/ -64,1°  | 18,60/136,3° | 0,02/63,7° | 0,79/ -22,4° | 31,6           |
|             | 200      | 0,46/ -99,8°  | 12,38/117,6° | 0,04/58,6° | 0,62/ -26,1° | 25,0           |
|             | 500      | 0,35/ -156,4° | 5,64/ 92,5°  | 0,06/62,4° | 0,44/ -20,2° | 16,5           |
|             | 800      | 0,34/ -175,1° | 3,67/ 82,7°  | 0,09/67,9° | 0,46/ -22,2° | 12,8           |
|             | 1000     | 0,36/ +175,8° | 3,00/ 76,7°  | 0,11/69,3° | 0,44/ -26,6° | 11,1           |
|             | 1200     | 0,43/ +158,2° | 2,56/ 71,6°  | 0,13/70,6° | 0,38/ -19,1° | 9,7            |
| 14          | 40       | 0,65/ -35,6°  | 28,67/156,8° | 0,01/74,8° | 0,93/ -13,7° | 40,5           |
|             | 100      | 0,52/ -75,9°  | 20,73/131,2° | 0,02/62,5° | 0,74/ -24,3° | 31,2           |
|             | 200      | 0,41/ -113,1° | 13,17/113,0° | 0,03/60,3° | 0,57/ -25,8° | 24,9           |
|             | 500      | 0,35/ -164,2° | 5,85/ 90,3°  | 0,06/65,2° | 0,42/ -17,6° | 16,8           |
|             | 800      | 0,34/ -179,4° | 3,76/ 81,3°  | 0,09/70,6° | 0,44/ -20,1° | 13,0           |
|             | 1000     | 0,37/ +173,9° | 3,04/ 75,8°  | 0,11/71,7° | 0,43/ -24,8° | 11,2           |
|             | 1200     | 0,44/ +154,6° | 2,63/ 69,7°  | 0,13/72,4° | 0,38/ -17,0° | 10,0           |
| 20          | 40       | 0,58/ -44,3°  | 33,42/152,4° | 0,01/72,4° | 0,90/ -15,8° | 39,6           |
|             | 100      | 0,45/ -89,5°  | 22,57/125,6° | 0,02/61,8° | 0,69/ -25,0° | 30,9           |
|             | 200      | 0,38/ -125,9° | 13,53/108,7° | 0,03/62,5° | 0,53/ -24,2° | 24,8           |
|             | 500      | 0,35/ -171,5° | 5,80/ 87,8°  | 0,06/68,0° | 0,42/ -15,0° | 16,7           |
|             | 800      | 0,35/ +176,2° | 3,68/ 79,4°  | 0,09/72,5° | 0,44/ -18,4° | 12,8           |
|             | 1000     | 0,38/ +170,1° | 3,01/ 74,2°  | 0,11/73,5° | 0,43/ -23,1° | 11,1           |
|             | 1200     | 0,46/ +153,2° | 2,63/ 69,3°  | 0,12/74,1° | 0,38/ -15,8° | 10,1           |

s-parameters (common emitter) at  $V_{CE} = 10\text{ V}$ ; typical values.

| $I_C$<br>mA | f<br>MHz | $s_{11}$      | $s_{21}$     | $s_{12}$   | $s_{22}$     | $G_{UM}$<br>dB |
|-------------|----------|---------------|--------------|------------|--------------|----------------|
| 2           | 40       | 0,94/ -10,5°  | 6,35/173,2°  | 0,01/83,2° | 1,00/ -3,5°  | 45,5           |
|             | 100      | 0,89/ -26,1°  | 6,15/159,7°  | 0,03/74,7° | 0,97/ -8,7°  | 34,6           |
|             | 200      | 0,80/ -47,7°  | 5,37/144,2°  | 0,05/64,9° | 0,91/ -13,8° | 26,5           |
|             | 500      | 0,51/ -98,2°  | 3,40/108,9°  | 0,08/48,8° | 0,72/ -21,3° | 15,1           |
|             | 800      | 0,42/ -126,1° | 2,45/ 94,6°  | 0,10/50,0° | 0,69/ -25,0° | 11,4           |
|             | 1000     | 0,41/ -144,2° | 2,09/ 85,6°  | 0,11/52,1° | 0,66/ -29,0° | 9,7            |
|             | 1200     | 0,39/ -170,5° | 1,76/ 77,1°  | 0,12/53,1° | 0,59/ -28,1° | 7,5            |
| 5           | 40       | 0,85/ -18,0°  | 14,09/168,2° | 0,01/81,0° | 0,99/ -6,3°  | 44,0           |
|             | 100      | 0,76/ -41,4°  | 12,61/149,1° | 0,03/69,2° | 0,91/ -14,4° | 33,3           |
|             | 200      | 0,61/ -70,9°  | 9,69/130,0°  | 0,04/60,1° | 0,79/ -19,9° | 26,0           |
|             | 500      | 0,38/ -126,8° | 5,04/ 99,2°  | 0,07/54,9° | 0,57/ -20,6° | 16,5           |
|             | 800      | 0,33/ -152,2° | 3,35/ 87,9°  | 0,08/61,2° | 0,57/ -22,7° | 12,7           |
|             | 1000     | 0,35/ -165,9° | 2,75/ 81,0°  | 0,10/64,0° | 0,55/ -26,4° | 10,9           |
|             | 1200     | 0,39/ +168,5° | 2,35/ 74,1°  | 0,11/65,4° | 0,49/ -22,3° | 9,3            |
| 10          | 40       | 0,76/ -25,9°  | 22,67/161,9° | 0,01/76,6° | 0,96/ -9,8°  | 42,1           |
|             | 100      | 0,63/ -57,9°  | 18,55/138,5° | 0,02/65,1° | 0,83/ -19,2° | 32,5           |
|             | 200      | 0,47/ -91,5°  | 12,47/119,0° | 0,03/59,8° | 0,67/ -22,4° | 25,6           |
|             | 500      | 0,33/ -151,1° | 5,82/ 93,0°  | 0,06/62,2° | 0,50/ -17,7° | 17,1           |
|             | 800      | 0,31/ -169,4° | 3,78/ 83,6°  | 0,08/68,4° | 0,51/ -19,6° | 13,3           |
|             | 1000     | 0,33/ -178,6° | 3,10/ 77,9°  | 0,10/70,0° | 0,50/ -23,5° | 11,6           |
|             | 1200     | 0,39/ +158,8° | 2,65/ 71,9°  | 0,12/70,8° | 0,45/ -17,8° | 10,1           |
| 14          | 40       | 0,70/ -30,8°  | 27,63/158,1° | 0,01/74,7° | 0,95/ -11,6° | 41,5           |
|             | 100      | 0,55/ -67,6°  | 20,66/133,4° | 0,02/63,8° | 0,78/ -20,9° | 32,0           |
|             | 200      | 0,42/ -102,5° | 13,42/115,4° | 0,03/60,9° | 0,62/ -22,4° | 25,5           |
|             | 500      | 0,32/ -158,3° | 5,97/ 91,4°  | 0,06/65,1° | 0,48/ -15,7° | 17,1           |
|             | 800      | 0,31/ -174,4° | 3,88/ 81,8°  | 0,08/70,5° | 0,50/ -18,3° | 13,5           |
|             | 1000     | 0,34/ +177,7° | 3,14/ 76,7°  | 0,10/71,9° | 0,49/ -22,2° | 11,6           |
|             | 1200     | 0,40/ +156,0° | 2,71/ 70,2°  | 0,12/72,3° | 0,44/ -15,9° | 10,3           |
| 20          | 40       | 0,65/ -37,4°  | 32,19/154,4° | 0,01/73,2° | 0,92/ -13,4° | 40,8           |
|             | 100      | 0,49/ -76,7°  | 22,74/127,9° | 0,02/62,7° | 0,73/ -21,8° | 31,7           |
|             | 200      | 0,38/ -112,6° | 13,78/110,5° | 0,03/62,3° | 0,59/ -21,1° | 25,3           |
|             | 500      | 0,32/ -164,7° | 6,05/ 88,6°  | 0,06/67,4° | 0,47/ -13,6° | 17,2           |
|             | 800      | 0,31/ -179,0° | 3,84/ 80,1°  | 0,08/72,4° | 0,50/ -16,8° | 13,4           |
|             | 1000     | 0,34/ +173,5° | 3,14/ 75,1°  | 0,10/73,1° | 0,49/ -21,0° | 11,6           |
|             | 1200     | 0,40/ +155,0° | 2,69/ 69,8°  | 0,12/73,6° | 0,44/ -14,7° | 10,3           |



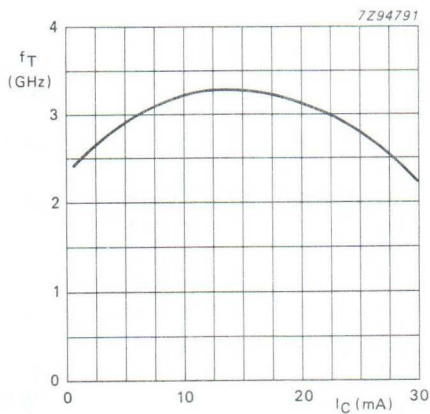


Fig. 3  $V_{CE} = 5$  V;  $f = 500$  MHz;  
 $T_{amb} = 25$  °C; typical values.

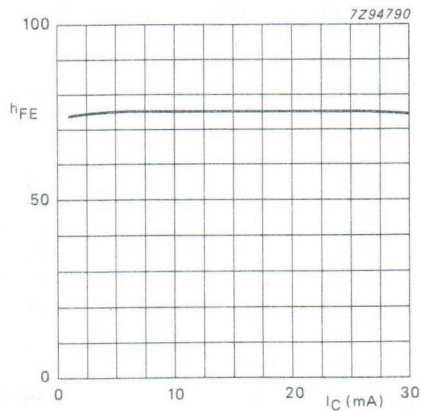


Fig. 4  $V_{CE} = 1$  V;  $T_{amb} = 25$  °C;  
typical values.

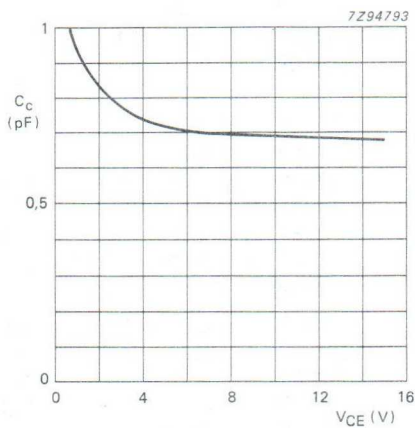


Fig. 5  $I_E = 0$ ;  $f = 1$  MHz;  
 $T_{amb} = 25$  °C; typical values.

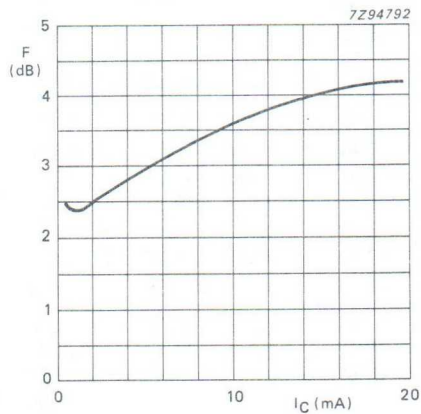


Fig. 6  $V_{CE} = 5$  V;  $T_{amb} = 25$  °C;  
 $f = 800$  MHz;  $Z_S = 60$   $\Omega$ ; typical values.



## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature plastic envelope. They are intended for general purpose and h.f. applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                                      |           |      |     |                    |
|----------------------------------------------------------------------|-----------|------|-----|--------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 30  | V                  |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 20  | V                  |
| Collector current (d.c.)                                             | $I_C$     | max. | 30  | mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 | mW                 |
| Junction temperature                                                 | $T_j$     | max. | 150 | $^{\circ}\text{C}$ |

## D.C. current gain

$$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$$

Transition frequency at  $f = 100\text{ MHz}$ 

$$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$$

Noise figure at  $f = 100\text{ MHz}$ 

$$I_C = 1\text{ mA}; V_{CE} = 10\text{ V}; G_S = 10\text{ mS}$$

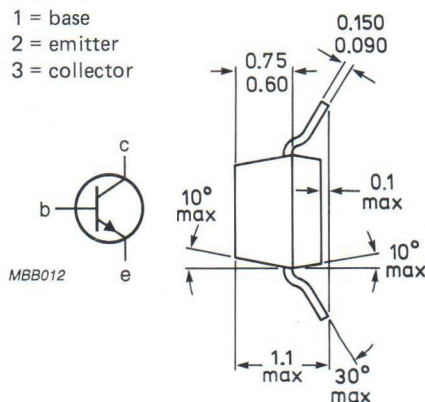
|          |      | BFS18     | BFS19     |     |
|----------|------|-----------|-----------|-----|
| $h_{FE}$ |      | 35 to 125 | 65 to 225 |     |
| $f_T$    | typ. | 200       | 260       | MHz |
| F        | typ. | 4         |           | dB  |

## MECHANICAL DATA

Fig. 1 SOT-23.

## Pinning:

- 1 = base  
2 = emitter  
3 = collector

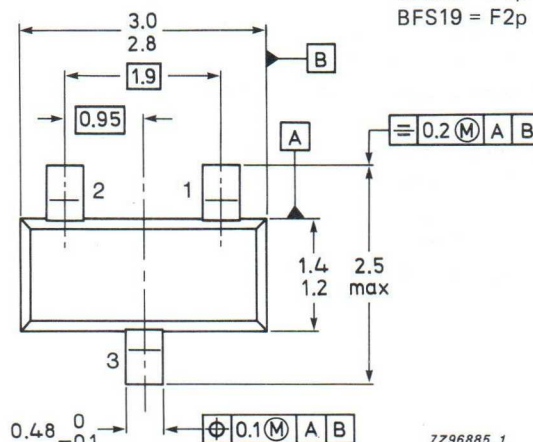


## Dimensions in mm

## Marking code

BFS18 = F1p

BFS19 = F2p



TOP VIEW

Reverse pinning types are available on request.  
See also *Soldering recommendations*.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                       |           |      |              |                    |
|-----------------------------------------------------------------------|-----------|------|--------------|--------------------|
| Collector-base voltage (open emitter)                                 | $V_{CBO}$ | max. | 30           | V                  |
| Collector-emitter voltage (open base)<br>$I_C = 2 \text{ mA}$         | $V_{CEO}$ | max. | 20           | V                  |
| Emitter-base voltage (open collector)                                 | $V_{EBO}$ | max. | 5            | V                  |
| Collector current (d.c.)                                              | $I_C$     | max. | 30           | mA                 |
| Collector current (peak value)                                        | $I_{CM}$  | max. | 30           | mA                 |
| Total power dissipation up to $T_{amb} = 25 \text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250          | mW                 |
| Storage temperature                                                   | $T_{stg}$ |      | -65 to + 150 | $^{\circ}\text{C}$ |
| Junction temperature                                                  | $T_j$     | max. | 150          | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                           |                      |   |     |     |
|---------------------------|----------------------|---|-----|-----|
| From junction to ambient* | $R_{th \text{ j-a}}$ | = | 500 | K/W |
|---------------------------|----------------------|---|-----|-----|

# CHARACTERISTICS

$T_j = 25 \text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                              |           |      |              |               |
|--------------------------------------------------------------------------------------------------------------|-----------|------|--------------|---------------|
| Collector cut-off current<br>$I_E = 0; V_{CB} = 20 \text{ V}$                                                | $I_{CBO}$ | <    | 100          | nA            |
| $I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100 \text{ }^{\circ}\text{C}$                                         | $I_{CBO}$ | <    | 10           | $\mu\text{A}$ |
| Base-emitter voltage<br>$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                                          | $V_{BE}$  |      | 0,65 to 0,74 | V             |
| D.C. current gain<br>$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                                             | $h_{FE}$  |      | 35 to 125    | 65 to 225     |
| Transition frequency at $f = 100 \text{ MHz}$<br>$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                 | $f_T$     | typ. | 200          | 260 MHz       |
| Collector capacitance at $f = 1 \text{ MHz}$<br>$I_E = I_C = 0; V_{CB} = 10 \text{ V}$                       | $C_c$     | typ. | 1            | pF            |
| Feedback capacitance at $f = 1 \text{ MHz}$<br>$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                   | $-C_{re}$ | typ. | 0,85         | pF            |
| Noise figure**<br>$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V};$<br>$G_S = 10 \text{ mS}; f = 100 \text{ MHz}$ | F         | typ. | 4            | dB            |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

\*\* Crystal mounted in a BF115 envelope.

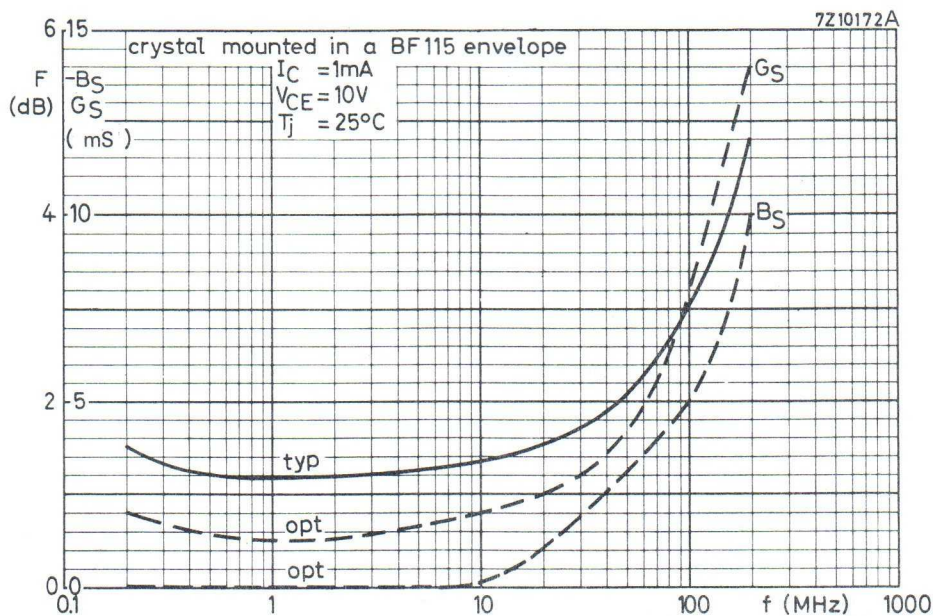


Fig. 2.

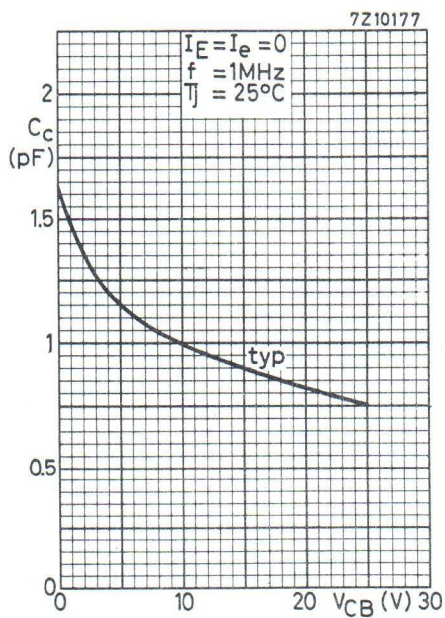


Fig. 3.

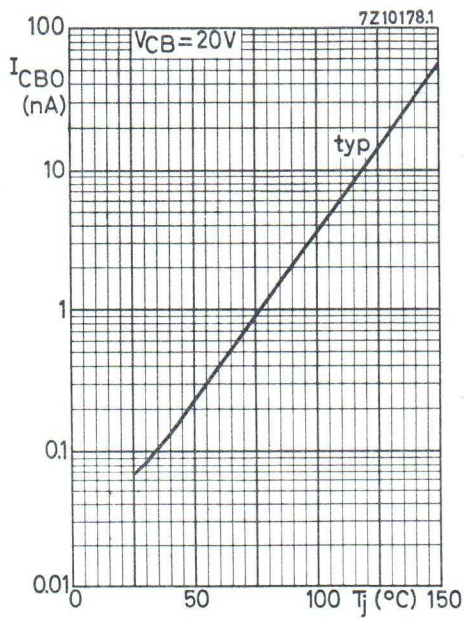


Fig. 4.



Typical behaviour of collector current versus collector-emitter voltage

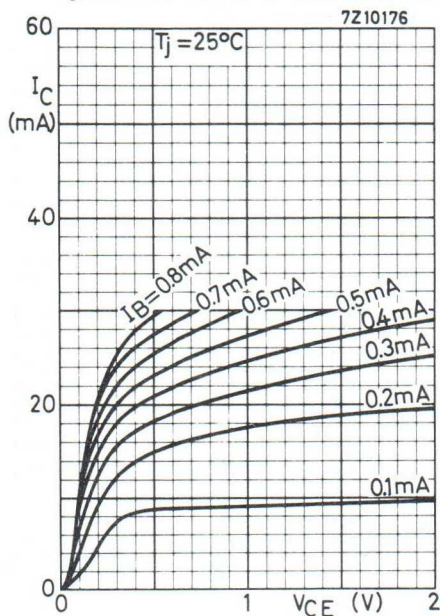


Fig. 5.

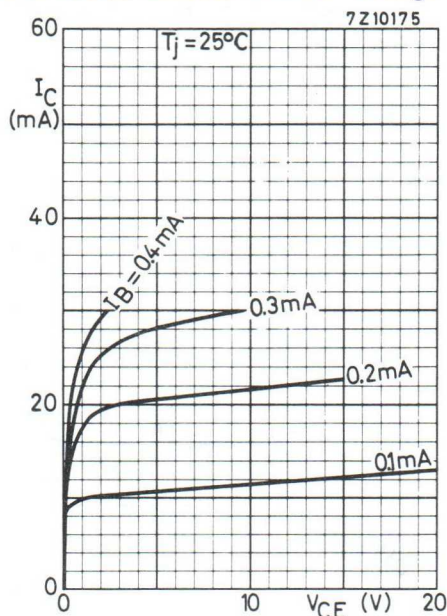


Fig. 6.

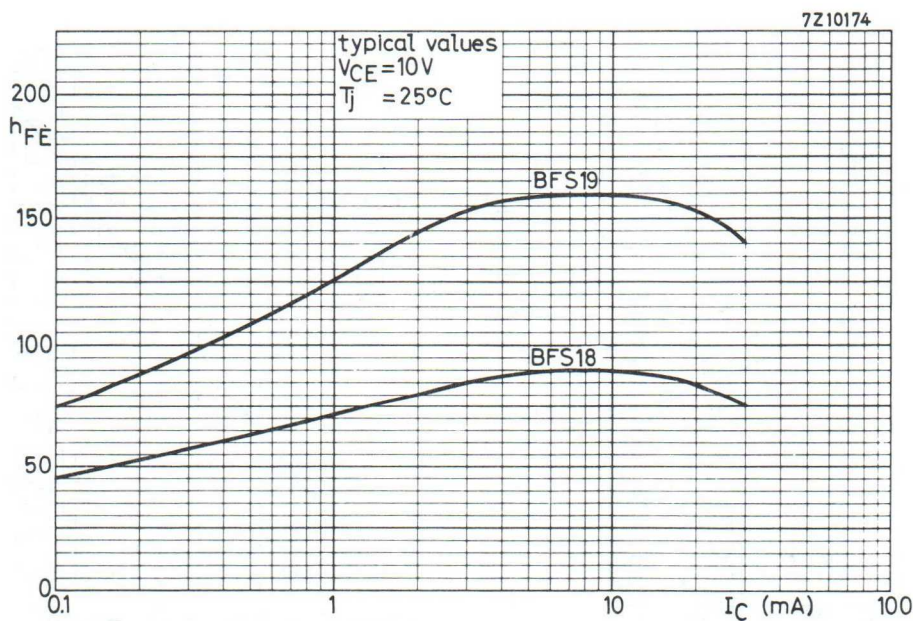


Fig. 7.

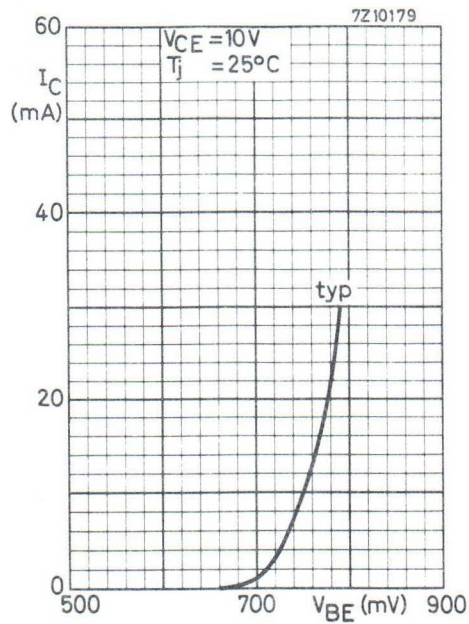


Fig. 8.

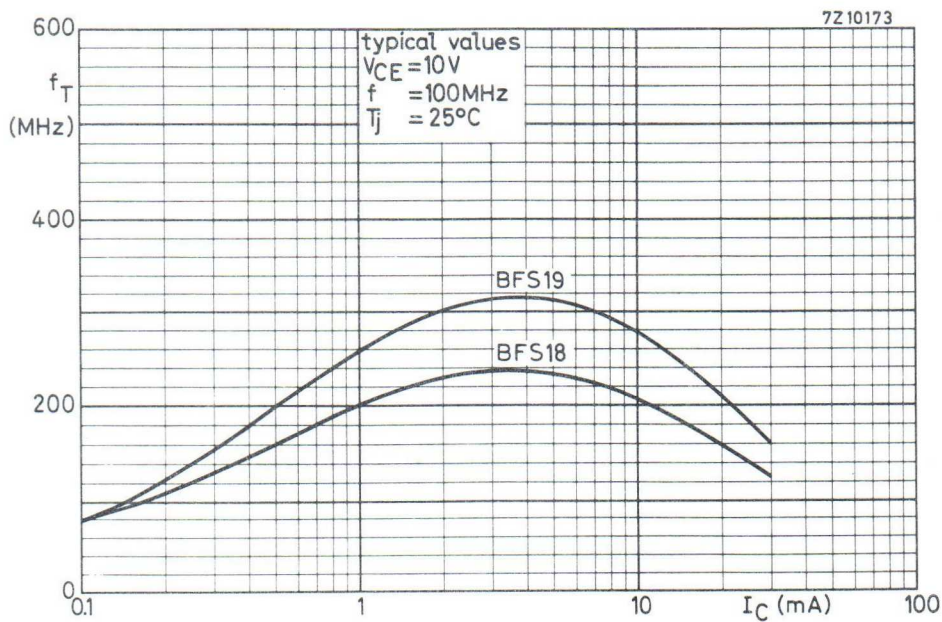


Fig. 9.





## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistor in a microminiature plastic envelope. It has a very low feedback capacitance and is intended for i.f. and v.h.f. applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

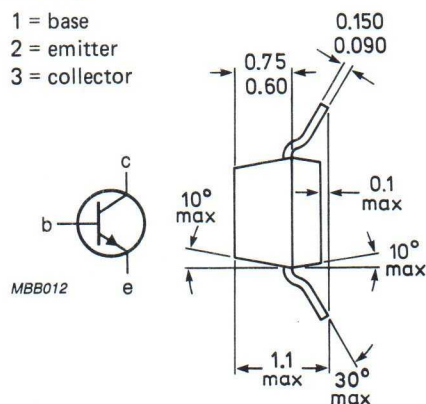
|                                                                      |           |      |                        |
|----------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 30 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 20 V                   |
| Collector current (d.c.)                                             | $I_C$     | max. | 25 mA                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW                 |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                    |           |      |                        |
| $I_C = 7\text{ mA}; V_{CE} = 10\text{ V}$                            | $h_{FE}$  | >    | 40                     |
| Transition frequency at $f = 100\text{ MHz}$                         | $f_T$     | typ. | 450 MHz                |
| Feedback capacitance at $f = 1\text{ MHz}$                           | $C_{re}$  | typ. | 350 fF                 |
| $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$                            |           |      |                        |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector

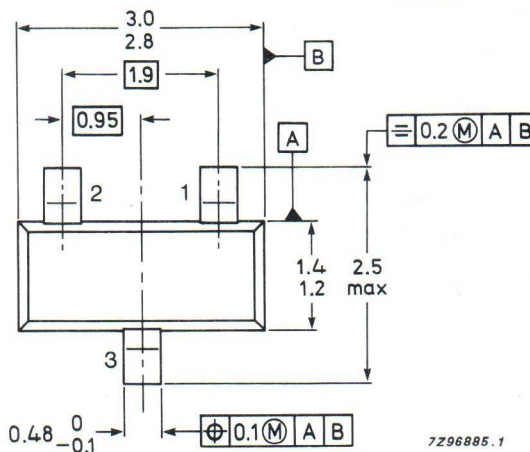


MBB012

Dimensions in mm

Marking code

BFS20 = G1p



TOP VIEW

Reverse pinning types are available on request.

See also *Soldering recommendations*.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |           |             |                      |
|--------------------------------------------------------------------------|-----------|-------------|----------------------|
| Collector-base voltage (open emitter) see Fig. 2                         | $V_{CBO}$ | max.        | 30 V                 |
| Collector-emitter voltage (open base) see Fig. 2<br>$I_C = 2 \text{ mA}$ | $V_{CEO}$ | max.        | 20 V                 |
| Emitter-base voltage (open collector) see Fig. 2                         | $V_{EBO}$ | max.        | 4 V                  |
| Collector current (d.c.)                                                 | $I_C$     | max.        | 25 mA                |
| Collector current (peak value)                                           | $I_{CM}$  | max.        | 25 mA                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$               | $P_{tot}$ | max.        | 250 mW               |
| Storage temperature                                                      | $T_{stg}$ | -65 to +150 | $^\circ\text{C}$     |
| Junction temperature                                                     | $T_j$     | max.        | 150 $^\circ\text{C}$ |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 20 \text{ V}$

$I_{CBO} < 100 \text{ nA}$

$I_E = 0; V_{CB} = 20 \text{ V}; T_j = 100^\circ\text{C}$

$I_{CBO} < 10 \text{ }\mu\text{A}$

Base-emitter voltage

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$

$$V_{BE} \begin{matrix} \text{typ.} & 740 \text{ mV} \\ < & 900 \text{ mV} \end{matrix}$$

D.C. current gain

$I_C = 7 \text{ mA}; V_{CE} = 10 \text{ V}$

$$h_{FE} \begin{matrix} > & 40 \\ \text{typ.} & 85 \end{matrix}$$

Transition frequency at  $f = 100 \text{ MHz}$ 

$I_C = 5 \text{ mA}; V_{CE} = 10 \text{ V}$

$$f_T \begin{matrix} > & 275 \text{ MHz} \\ \text{typ.} & 450 \text{ MHz} \end{matrix}$$

Collector capacitance at  $f = 1 \text{ MHz}$ 

$I_E = I_C = 0; V_{CB} = 10 \text{ V}$

$C_c \text{ typ. } 0,8 \text{ pF}$

Feedback capacitance at  $f = 1 \text{ MHz}$ 

$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$

$-C_{re} \text{ typ. } 350 \text{ fF}$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

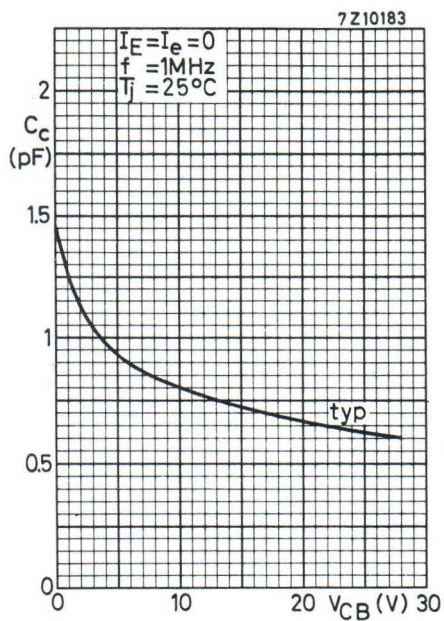


Fig. 2.

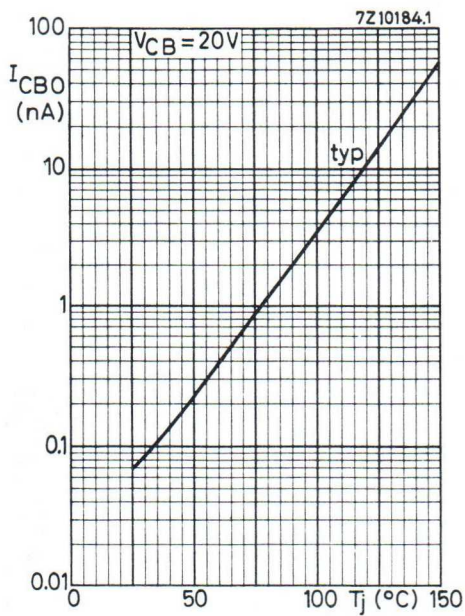


Fig. 3.



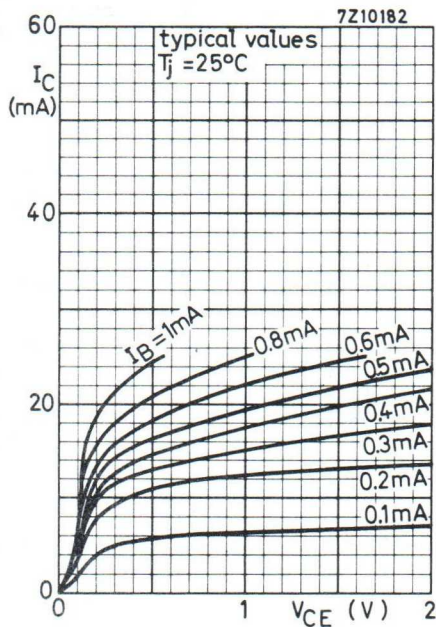


Fig. 4.

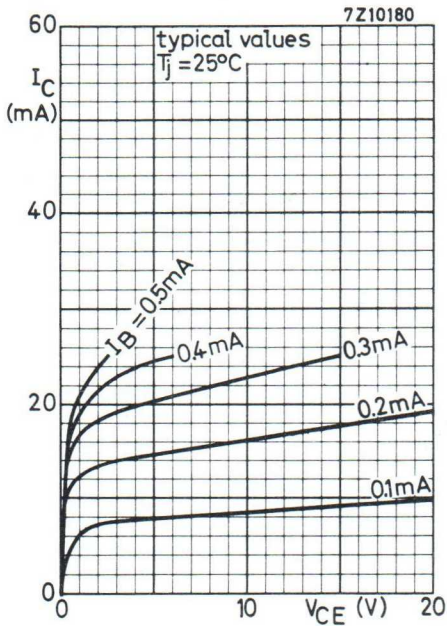


Fig. 5.

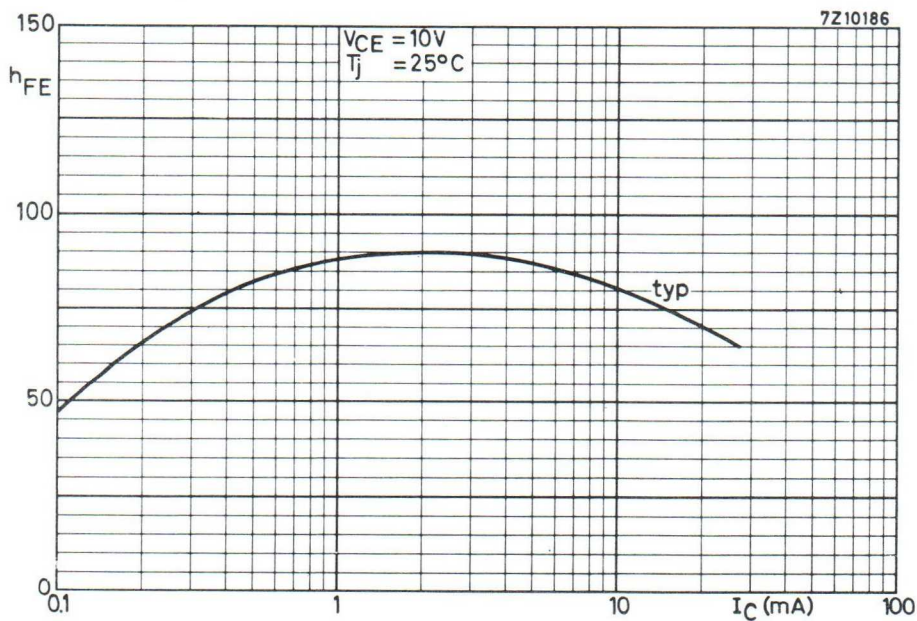


Fig. 6.

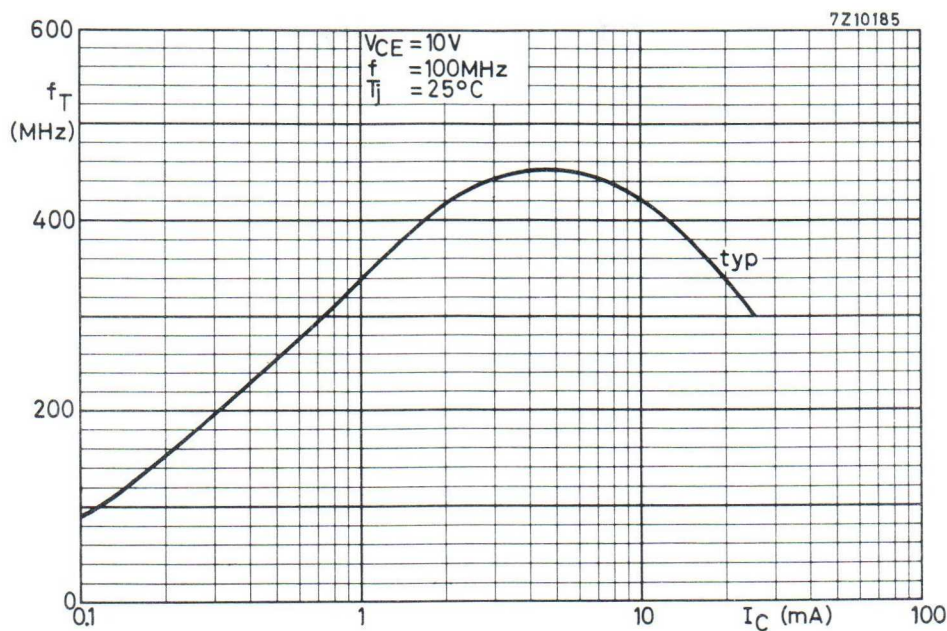


Fig. 7.

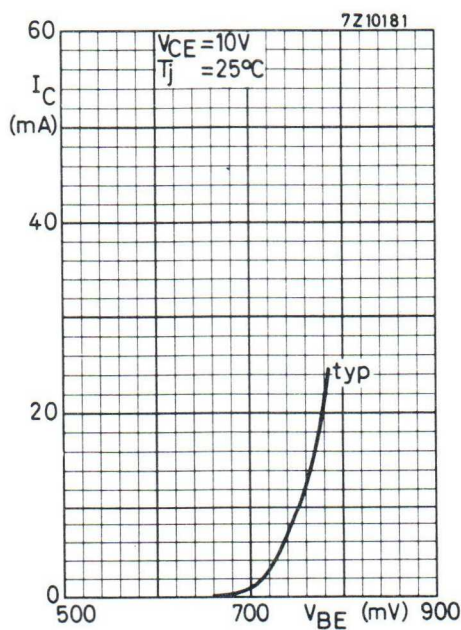
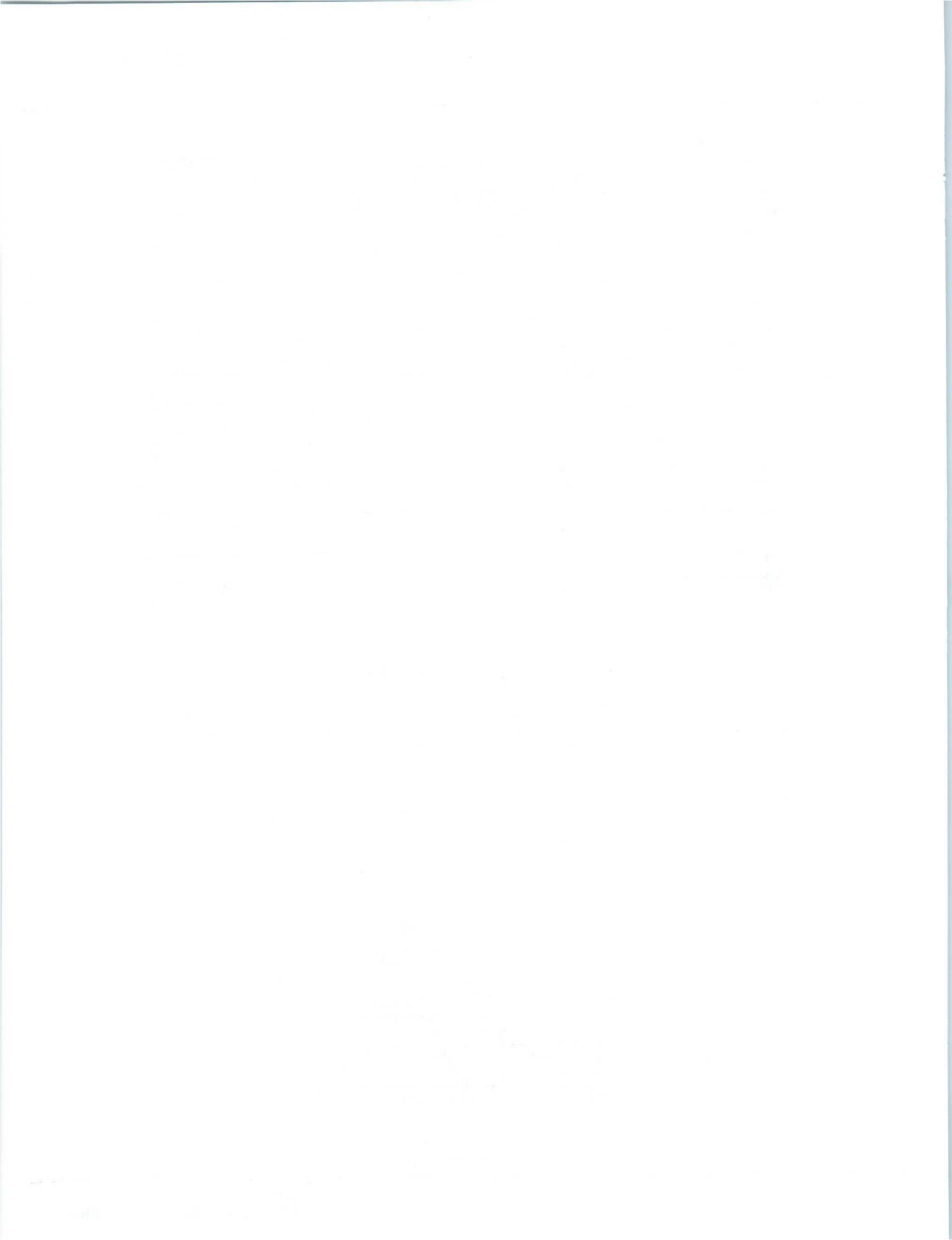


Fig. 8.



## N-P-N 2 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope, primarily intended for use in u.h.f. low power amplifiers in thick and thin-film circuits, such as in pocket phones, paging systems, etc. The transistor features low current consumption ( $100\ \mu\text{A} - 1\ \text{mA}$ ); thanks to its high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

### QUICK REFERENCE DATA

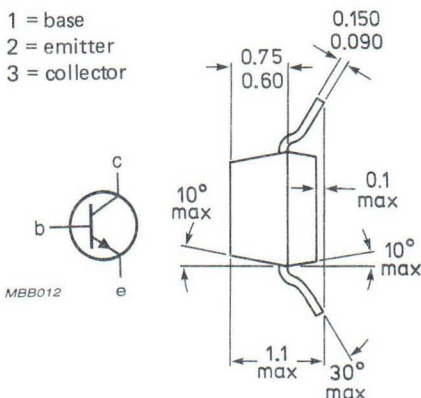
|                                                                                                                             |                  |      |                      |
|-----------------------------------------------------------------------------------------------------------------------------|------------------|------|----------------------|
| Collector-base voltage (open emitter)                                                                                       | $V_{\text{CBO}}$ | max. | 8 V                  |
| Collector-emitter voltage (open base)                                                                                       | $V_{\text{CEO}}$ | max. | 5 V                  |
| Collector current (DC)                                                                                                      | $I_{\text{C}}$   | max. | 6.5 mA               |
| Total power dissipation up to $T_{\text{amb}} = 25\ ^\circ\text{C}$                                                         | $P_{\text{tot}}$ | max. | 300 mW               |
| Junction temperature                                                                                                        | $T_{\text{j}}$   | max. | 150 $^\circ\text{C}$ |
| Transition frequency at $f = 500\ \text{MHz}$<br>$I_{\text{C}} = 1\ \text{mA}; V_{\text{CE}} = 1\ \text{V}$                 | $f_{\text{T}}$   | typ. | 2.3 GHz              |
| Feedback capacitance at $f = 1\ \text{MHz}$<br>$I_{\text{C}} = 1\ \text{mA}; V_{\text{CE}} = 1\ \text{V}$                   | $C_{\text{re}}$  | max. | 0.45 pF              |
| Noise figure at optimum source impedance<br>$I_{\text{C}} = 1\ \text{mA}; V_{\text{CE}} = 1\ \text{V}; f = 500\ \text{MHz}$ | $F$              | typ. | 3.8 dB               |
| Max. unilateral power gain<br>$I_{\text{C}} = 1\ \text{mA}; V_{\text{CE}} = 1\ \text{V}; f = 500\ \text{MHz}$               | $G_{\text{UM}}$  | typ. | 18 dB                |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning

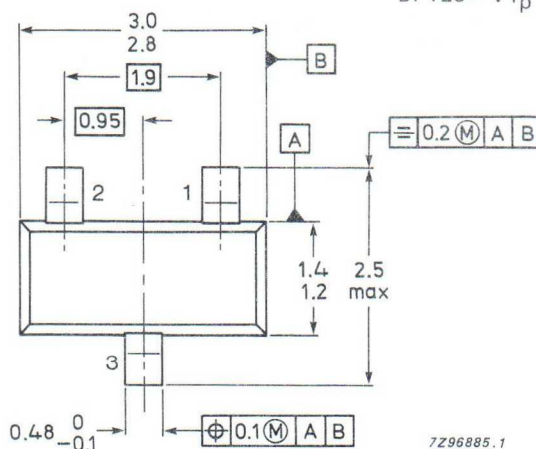
- 1 = base  
2 = emitter  
3 = collector



Dimensions in mm

Marking code

BFT25 = V1<sub>p</sub>



TOP VIEW

If required, the R-version (reverse pinning) is available on request.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                            |           |      |                               |
|------------------------------------------------------------|-----------|------|-------------------------------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ | max. | 8 V                           |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. | 5 V                           |
| Emitter-base voltage (open collector)                      | $V_{EBO}$ | max. | 2 V                           |
| Collector current (DC)                                     | $I_C$     | max. | 6.5 mA                        |
| Collector current (peak value; $f > 1$ MHz)                | $I_{CM}$  | max. | 10 mA                         |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. | 300 mW                        |
| Storage temperature                                        | $T_{stg}$ |      | $-65$ to $+150^\circ\text{C}$ |
| Junction temperature                                       | $T_j$     | max. | $150^\circ\text{C}$           |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 5\text{ V}$

|           |      |       |
|-----------|------|-------|
| $I_{CBO}$ | max. | 50 nA |
|-----------|------|-------|

D.C. current gain

$I_C = 10\ \mu\text{A}; V_{CE} = 1\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 20 |
|          | typ. | 30 |

$I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 20 |
|          | typ. | 40 |

Saturation voltages

$I_C = 10\ \mu\text{A}; I_B = 1\ \mu\text{A}$

|             |      |        |
|-------------|------|--------|
| $V_{CEsat}$ | max. | 200 mV |
| $V_{BEsat}$ | max. | 750 mV |

$I_C = 1\text{ mA}; I_B = 0.1\text{ mA}$

|             |      |        |
|-------------|------|--------|
| $V_{CEsat}$ | max. | 175 mV |
| $V_{BEsat}$ | max. | 900 mV |

Transition frequency at  $f = 500\text{ MHz}$ 

$I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$

|       |      |         |
|-------|------|---------|
| $f_T$ | min. | 1.2 GHz |
|       | typ. | 2.3 GHz |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



Collector capacitance at  $f = 1$  MHz

$$I_E = I_C = 0; V_{CB} = 0.5 \text{ V}$$

|       |      |        |
|-------|------|--------|
| $C_C$ | max. | 0.6 pF |
|-------|------|--------|

Emitter capacitance at  $f = 1$  MHz

$$I_C = I_E = 0; V_{EB} = 0$$

|       |      |        |
|-------|------|--------|
| $C_e$ | max. | 0.5 pF |
|-------|------|--------|

Feedback capacitance at  $f = 1$  MHz

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; T_{amb} = 25^\circ \text{C}$$

|          |      |         |
|----------|------|---------|
| $C_{re}$ | max. | 0.45 pF |
|----------|------|---------|

Noise figure at optimum source impedance

$$I_C = 0.1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25^\circ \text{C}$$

|   |      |        |
|---|------|--------|
| F | typ. | 5.5 dB |
|---|------|--------|

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25^\circ \text{C}$$

|   |      |        |
|---|------|--------|
| F | typ. | 3.8 dB |
|---|------|--------|

Maximum unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} \text{ (in dB)} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 200 \text{ MHz}; T_{amb} = 25^\circ \text{C}$$

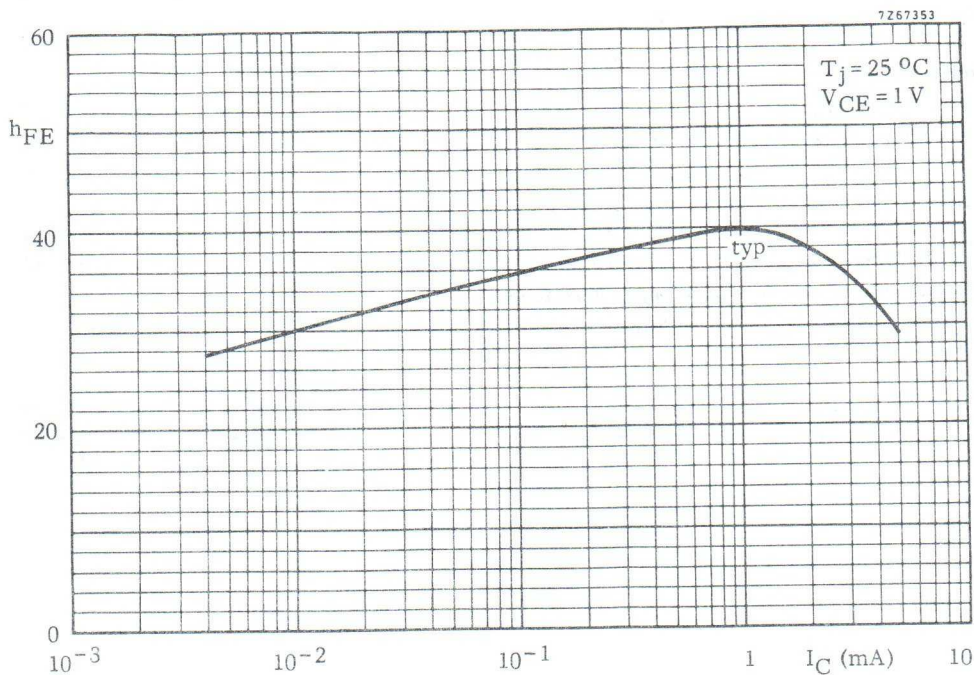
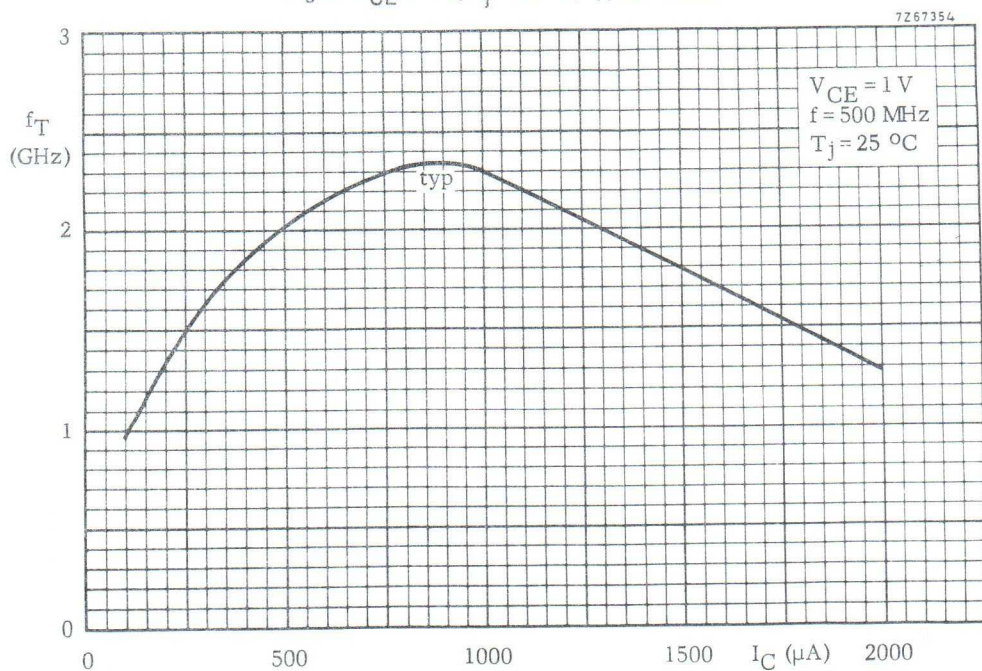
|          |      |         |
|----------|------|---------|
| $G_{UM}$ | typ. | 25.0 dB |
|----------|------|---------|

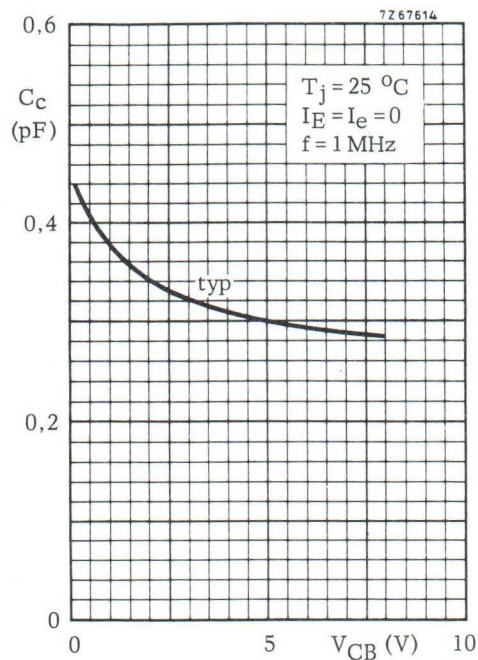
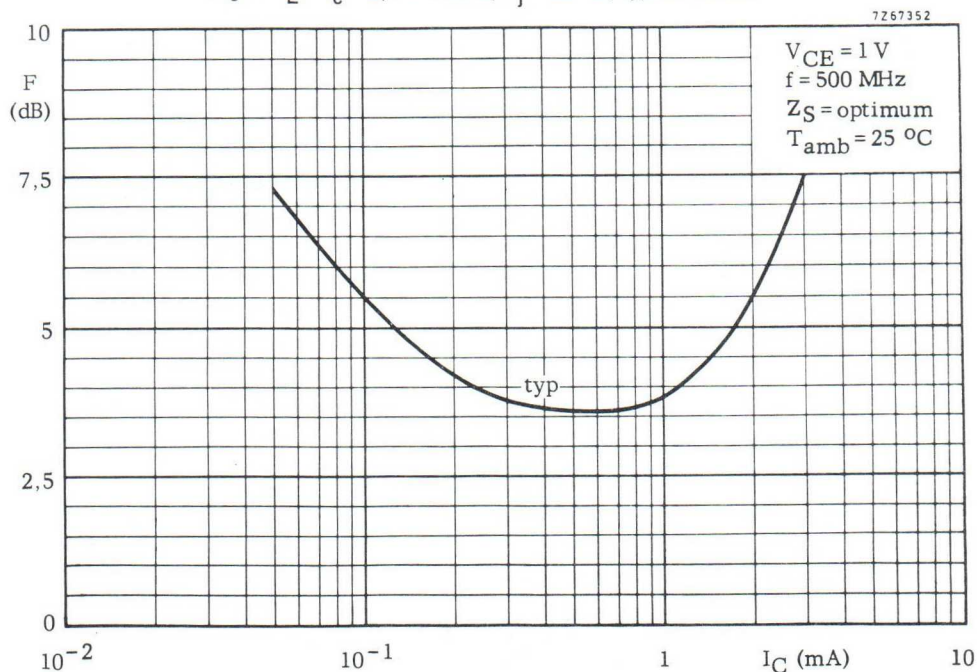
$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 500 \text{ MHz}; T_{amb} = 25^\circ \text{C}$$

|          |      |         |
|----------|------|---------|
| $G_{UM}$ | typ. | 18.0 dB |
|----------|------|---------|

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}; f = 800 \text{ MHz}; T_{amb} = 25^\circ \text{C}$$

|          |      |         |
|----------|------|---------|
| $G_{UM}$ | typ. | 12.0 dB |
|----------|------|---------|

Fig. 2  $V_{CE} = 1\text{ V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 3  $V_{CE} = 1\text{ V}$ ;  $f = 500\text{ MHz}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.

Fig. 4  $I_E = I_e = 0$ ;  $f = 1\text{ MHz}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.Fig. 5  $V_{CE} = 1\text{ V}$ ;  $f = 500\text{ MHz}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ ; typical values.

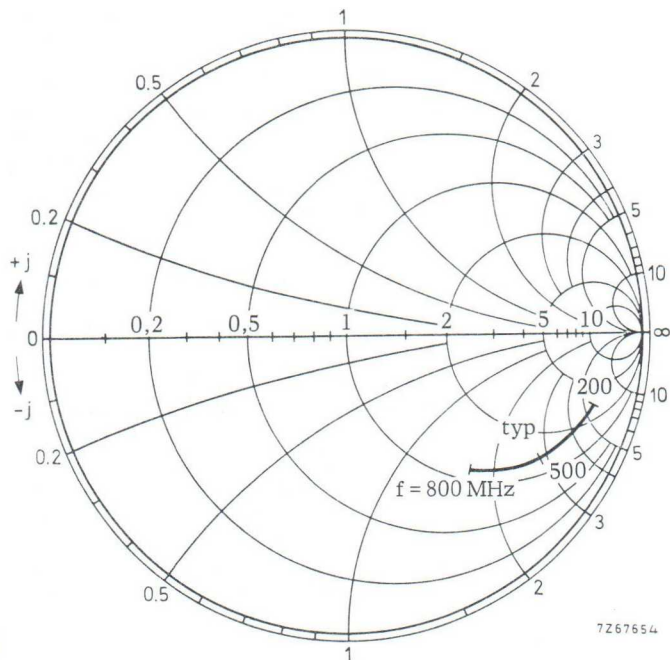


Fig. 6  $V_{CE} = 1\text{ V}$ ;  $I_C = 1\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Input impedance derived from  
 input reflection coefficient  $s_{11}$   
 coordinates in ohm  $\times 50$

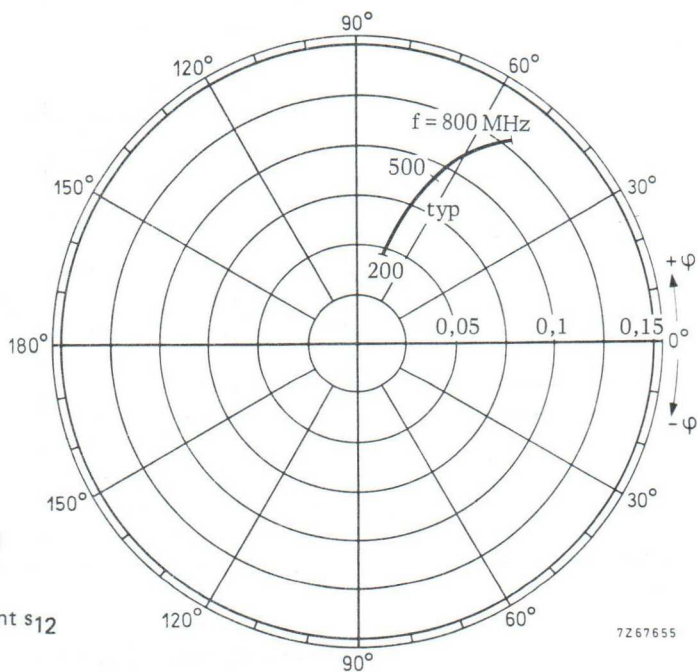


Fig. 7  $V_{CE} = 1\text{ V}$ ;  $I_C = 1\text{ mA}$ ;  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

Reverse transmission coefficient  $s_{12}$



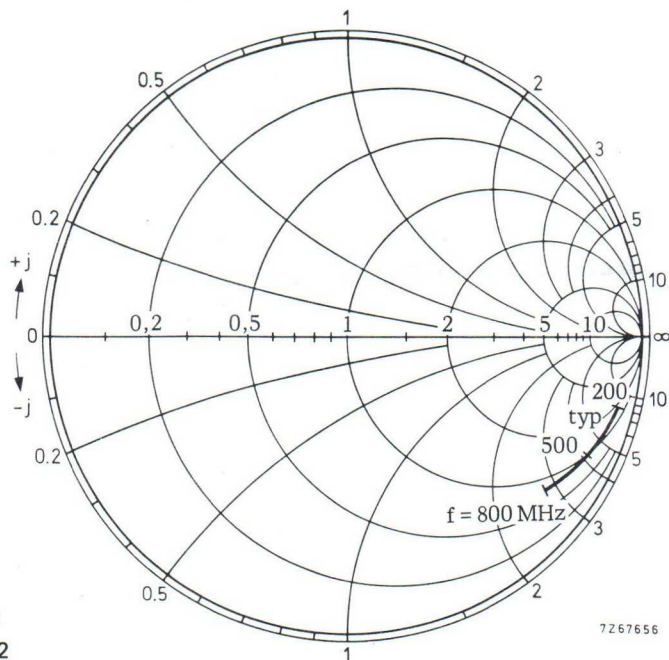


Fig. 8  $V_{CE} = 1\text{ V}$ ;  $I_C = 1\text{ mA}$ ;  
 $T_{amb} = 25^\circ\text{C}$ ; typical values.

Output impedance derived from  
 output reflection coefficient  $s_{22}$   
 coordinates in ohm  $\times 50$

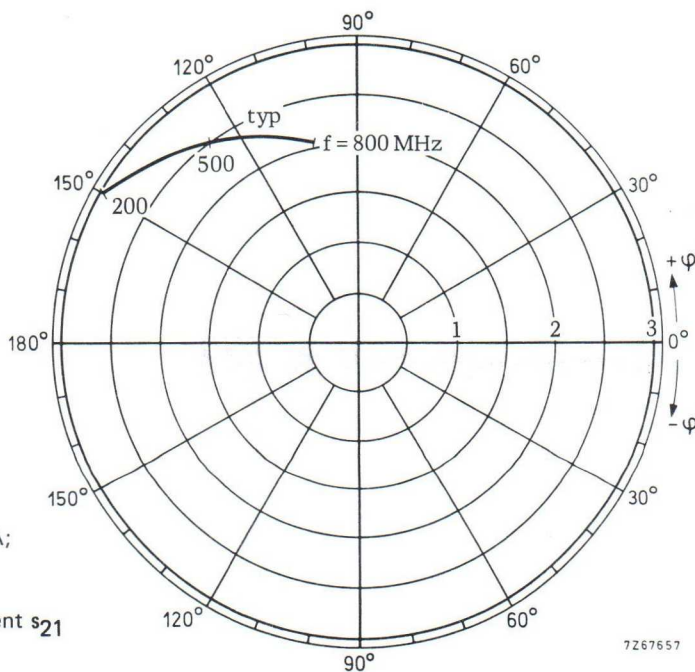
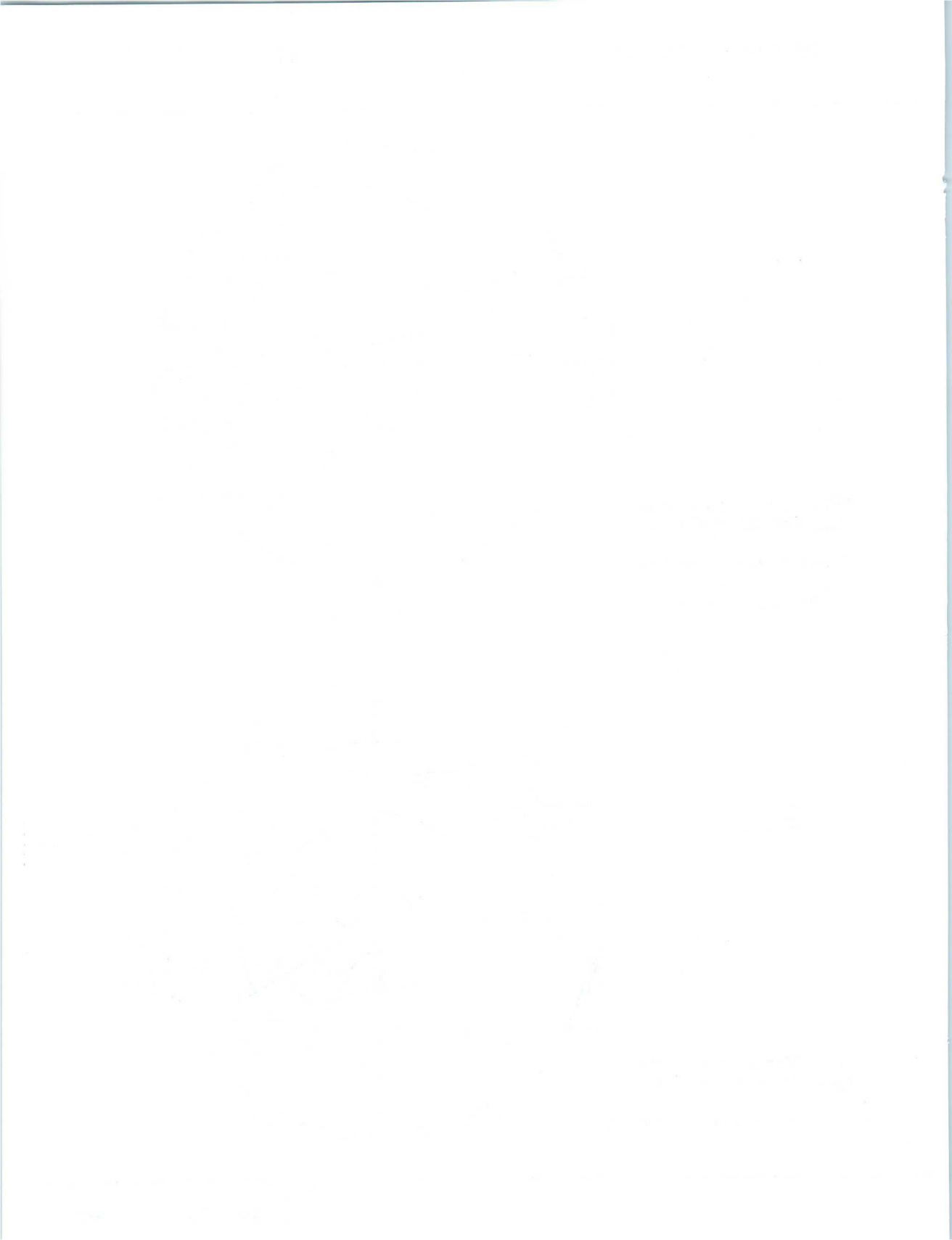


Fig. 9  $V_{CE} = 1\text{ V}$ ;  $I_C = 1\text{ mA}$ ;  
 $T_{amb} = 25^\circ\text{C}$ ; typical values.

Forward transmission coefficient  $s_{21}$





| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# BFT25A

## NPN HF wideband transistor

### DESCRIPTION

NPN transistor in a plastic SOT23 envelope, primarily for use on low power amplifiers. Ideal for pagers and other battery operated systems where low power consumption is critical.

### PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | emitter     |
| 3   | collector   |

### MECHANICAL DATA

SOT23.

Marking code: V10

### QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                    | CONDITIONS                                                      | MIN. | TYP. | MAX. | UNIT |
|-----------|------------------------------|-----------------------------------------------------------------|------|------|------|------|
| $V_{CBO}$ | collector-base voltage       | open emitter                                                    | -    | -    | 8    | V    |
| $V_{CEO}$ | collector-emitter voltage    | open base                                                       | -    | -    | 5    | V    |
| $I_C$     | collector current            |                                                                 | -    | -    | 6.5  | mA   |
| $P_{tot}$ | total power dissipation (DC) |                                                                 | -    | -    | 50   | mW   |
| $T_j$     | junction temperature         |                                                                 | -    | -    | 150  | °C   |
| $h_{FE}$  | DC current gain              | $I_C = 0.1 \text{ mA};$<br>$V_{CE} = V$                         | -    | 80   | -    |      |
| $f_T$     | transition frequency         | $f = 500 \text{ MHz};$<br>$I_C = 1 \text{ mA};$<br>$V_{CE} = V$ | 3.5  | 5    | -    | GHz  |

### LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134)

| SYMBOL    | PARAMETER                    | MIN. | MAX. | UNIT |
|-----------|------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage       | -    | 8    | V    |
| $V_{CEO}$ | collector-emitter voltage    | -    | 5    | V    |
| $V_{EBO}$ | emitter-base voltage         | -    | 2    | V    |
| $I_C$     | collector current            | -    | 6.5  | mA   |
| $P_{tot}$ | total power dissipation (DC) | -    | 50   | mW   |
| $T_{stg}$ | storage temperature range    | -65  | +150 | °C   |
| $T_j$     | junction temperature         | -    | 150  | °C   |

**NPN HF wideband transistor****BFT25A****THERMAL RESISTANCE**

| SYMBOL        | PARAMETER             | MAX. | UNIT |
|---------------|-----------------------|------|------|
| $R_{th\ j-c}$ | from junction to case | 320  | K/W  |

**CHARACTERISTICS**

$T_j = 25\ ^\circ\text{C}$  unless otherwise specified

| SYMBOL          | PARAMETER                           | CONDITIONS                                                                    | MIN. | TYP. | MAX. | UNIT |
|-----------------|-------------------------------------|-------------------------------------------------------------------------------|------|------|------|------|
| $V_{(BR)\ CBO}$ | collector-base breakdown voltage    | open emitter<br>$I_C = 10\ \mu\text{A}$                                       | 8    | -    | -    | V    |
| $V_{(BR)\ CEO}$ | collector-emitter breakdown voltage | open base<br>$I_C = 100\ \mu\text{A}$                                         | 5    | -    | -    | V    |
| $V_{(BR)\ EBO}$ | emitter-base breakdown voltage      | open collector<br>$I_E = 10\ \mu\text{A}$                                     | 2    | -    | -    | V    |
| $h_{FE}$        | DC current gain                     | $I_C = 0.5\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$                            | -    | 80   | -    |      |
| $C_{re}$        | feedback capacitance                | $f = 1\ \text{MHz}$ ;<br>$I_C = 0$ ;<br>$V_{CE} = 1\ \text{V}$                | -    | 0.22 | -    | pF   |
| $G_{UM}$        | maximum unilateral gain             | $f = 500\ \text{MHz}$ ;<br>$I_C = 0.5\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$ | -    | 24   | -    | dB   |
| $G_{UM}$        | maximum unilateral gain             | $f = 1\ \text{GHz}$ ;<br>$I_C = 0.5\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$   | -    | 15   | -    | dB   |
| F               | noise figure                        | $f = 500\ \text{MHz}$ ;<br>$I_C = 0.5\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$ | -    | 1.7  | 2    | dB   |
| F               | noise figure                        | $f = 1\ \text{GHz}$ ;<br>$I_C = 0.5\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$   | -    | 2    | 2.5  | dB   |
| $f_T$           | transition frequency                | $f = 500\ \text{MHz}$ ;<br>$I_C = 1\ \text{mA}$ ;<br>$V_{CE} = 1\ \text{V}$   | 3.5  | 5    | -    | GHz  |

## N-CHANNEL SILICON FET

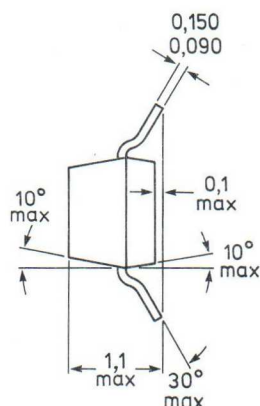
Symmetrical n-channel silicon epitaxial planar junction field-effect transistor in a microminiature plastic envelope. The transistor is intended for low level general purpose amplifiers in thick and thin-film circuits.

## QUICK REFERENCE DATA

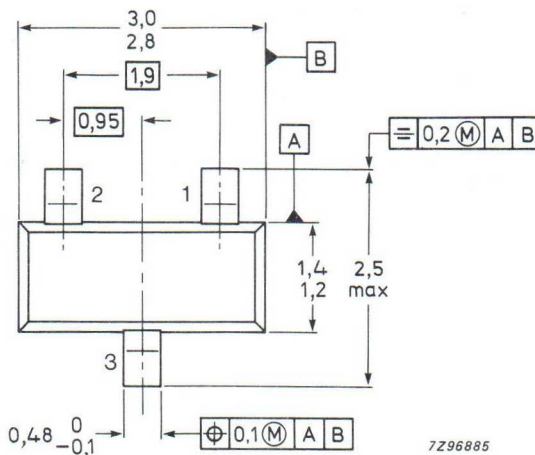
|                                                                                       |              |      |                   |
|---------------------------------------------------------------------------------------|--------------|------|-------------------|
| Drain-source voltage                                                                  | $\pm V_{DS}$ | max. | 25 V              |
| Gate-source voltage (open drain)                                                      | $-V_{GSO}$   | max. | 25 V              |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}$                  | $P_{tot}$    | max. | 250 mW            |
| Drain current                                                                         |              |      |                   |
| $V_{DS} = 10\text{ V}; V_{GS} = 0$                                                    | $I_{DSS}$    | $>$  | 0,2 mA            |
|                                                                                       |              | $<$  | 1,5 mA            |
| Transfer admittance (common source)                                                   |              |      |                   |
| $I_D = 0,2\text{ mA}; V_{DS} = 10\text{ V}; f = 1\text{ kHz}$                         | $ y_{fs} $   | $>$  | 0,5 mS            |
| Equivalent noise voltage                                                              |              |      |                   |
| $V_{DS} = 10\text{ V}; I_D = 200\text{ }\mu\text{A}; B = 0,6\text{ to }100\text{ Hz}$ | $V_n$        | $<$  | 0,5 $\mu\text{V}$ |

## MECHANICAL DATA

Fig. 1 SOT-23.



Dimensions in mm



TOP VIEW

## Marking code

BFT46 = M3

## Pinning

- 1 = drain
- 2 = source
- 3 = gate



**Note :** Drain and source are interchangeable.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |              |      |                                |
|------------------------------------------------------------------------|--------------|------|--------------------------------|
| Drain-source voltage                                                   | $\pm V_{DS}$ | max. | 25 V                           |
| Drain-gate voltage (open source)                                       | $V_{DGO}$    | max. | 25 V                           |
| Gate-source voltage (open drain)                                       | $-V_{GSO}$   | max. | 25 V                           |
| Drain current                                                          | $I_D$        | max. | 10 mA                          |
| Gate current                                                           | $I_G$        | max. | 5 mA                           |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}^*$ | $P_{tot}$    | max. | 250 mW                         |
| Storage temperature range                                              | $T_{stg}$    |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$        | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                 |              |        |                  |
|-----------------------------------------------------------------------------------------------------------------|--------------|--------|------------------|
| Gate cut-off current<br>$-V_{GS} = 10\text{ V}; V_{DS} = 0$                                                     | $-I_{GSS}$   | <      | 0,2 nA           |
| Drain current<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                                             | $I_{DSS}$    | ><br>< | 0,2 mA<br>1,5 mA |
| Gate-source voltage<br>$I_D = 50\text{ }\mu\text{A}; V_{DS} = 10\text{ V}$                                      | $-V_{GS}$    | ><br>< | 0,1 V<br>1,0 V   |
| Gate-source cut-off voltage<br>$I_D = 0,5\text{ nA}; V_{DS} = 10\text{ V}$                                      | $-V_{(P)GS}$ | <      | 1,2 V            |
| y-parameters at $f = 1\text{ kHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0; T_{amb} = 25\text{ }^{\circ}\text{C}$ |              |        |                  |
| Transfer admittance                                                                                             | $ y_{fs} $   | >      | 1,0 mS           |
| Output admittance                                                                                               | $ y_{os} $   | <      | 10 $\mu\text{S}$ |
| $V_{DS} = 10\text{ V}; I_D = 200\text{ }\mu\text{A}; T_{amb} = 25\text{ }^{\circ}\text{C}$                      |              |        |                  |
| Transfer admittance                                                                                             | $ y_{fs} $   | >      | 0,5 mS           |
| Output admittance                                                                                               | $ y_{os} $   | <      | 5 $\mu\text{S}$  |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



Input capacitance at  $f = 1 \text{ MHz}$ ;

$V_{DS} = 10 \text{ V}$ ;  $V_{GS} = 0$ ;  $T_{amb} = 25^\circ\text{C}$

$C_{is} < 5 \text{ pF}$

Feedback capacitance at  $f = 1 \text{ MHz}$ ;

$V_{DS} = 10 \text{ V}$ ;  $V_{GS} = 0$ ;  $T_{amb} = 25^\circ\text{C}$

$C_{rs} < 1,5 \text{ pF}$

Equivalent noise voltage

$V_{DS} = 10 \text{ V}$ ;  $I_D = 200 \mu\text{A}$ ;  $T_{amb} = 25^\circ\text{C}$

$B = 0,6 \text{ to } 100 \text{ Hz}$

$V_n < 0,5 \mu\text{V}$

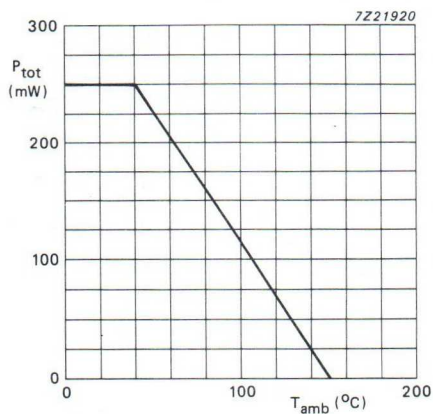
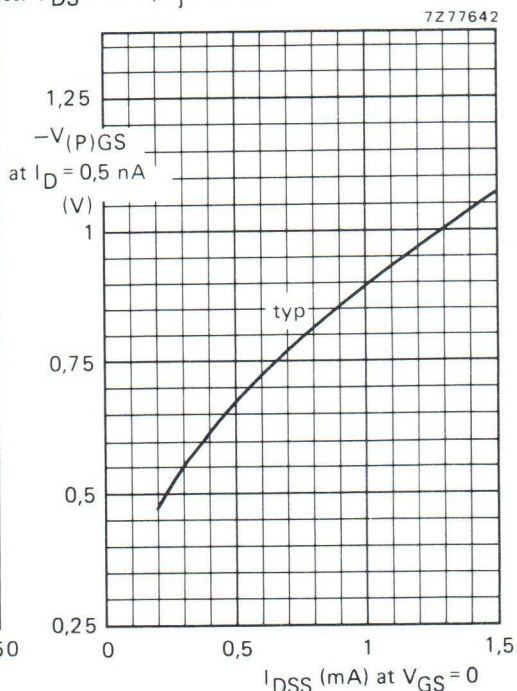
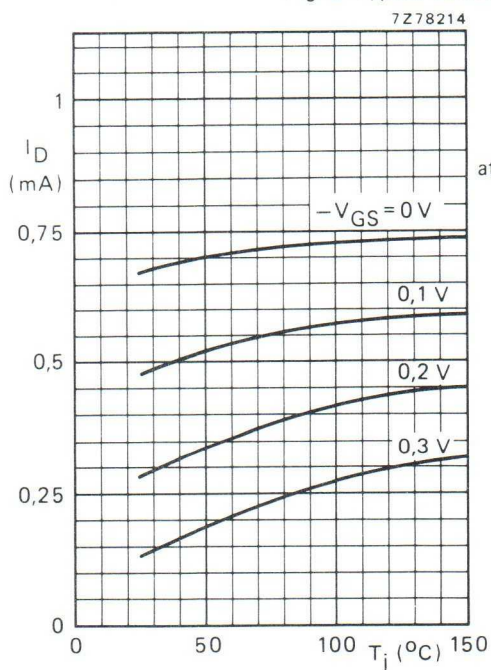
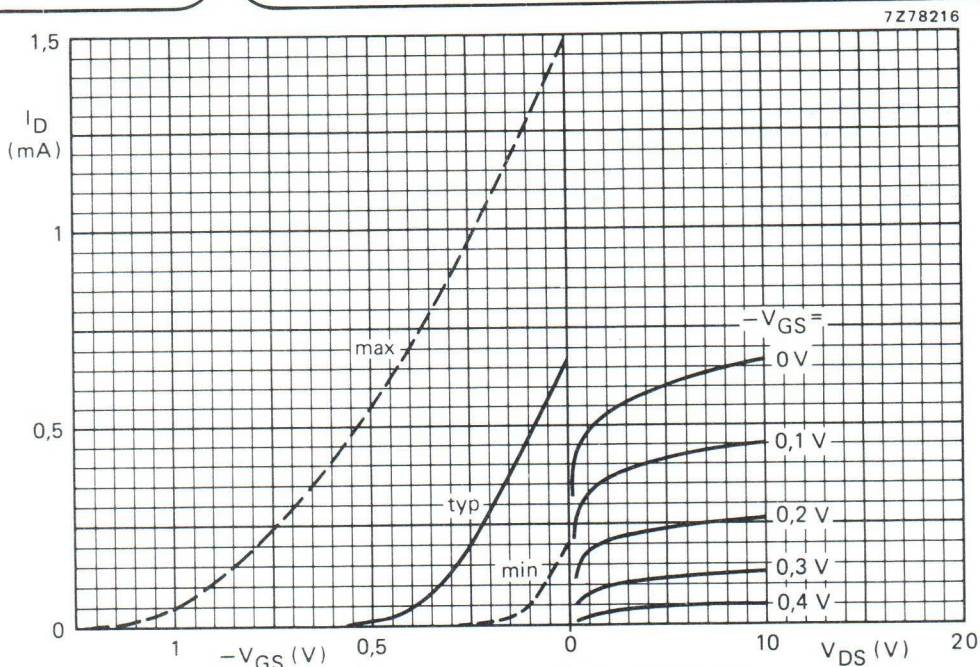


Fig.2 Power derating curve.



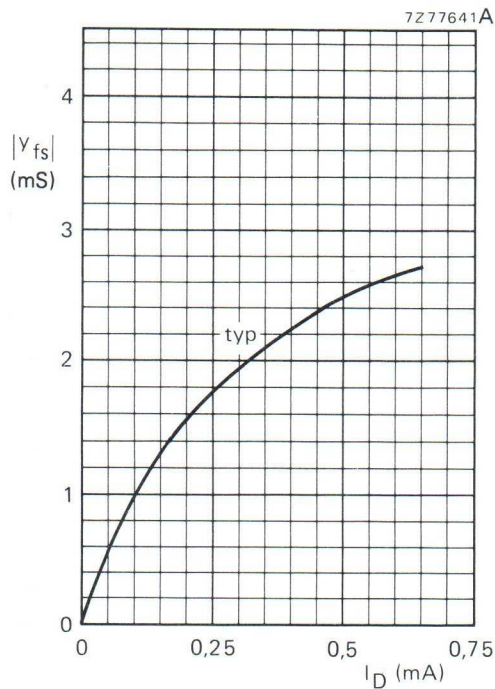


Fig. 6

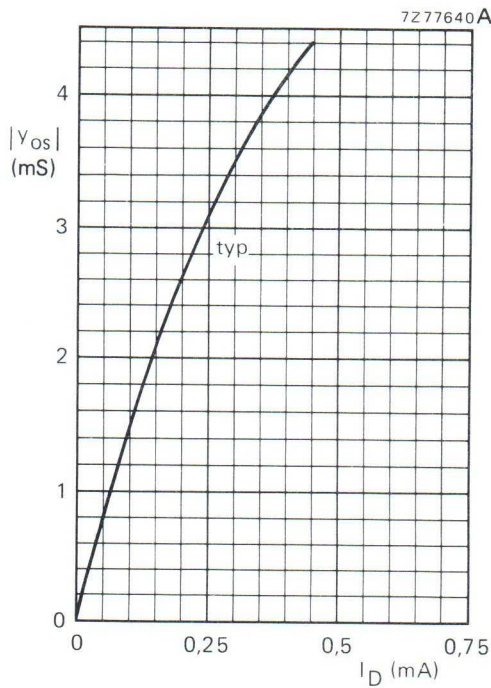


Fig. 7

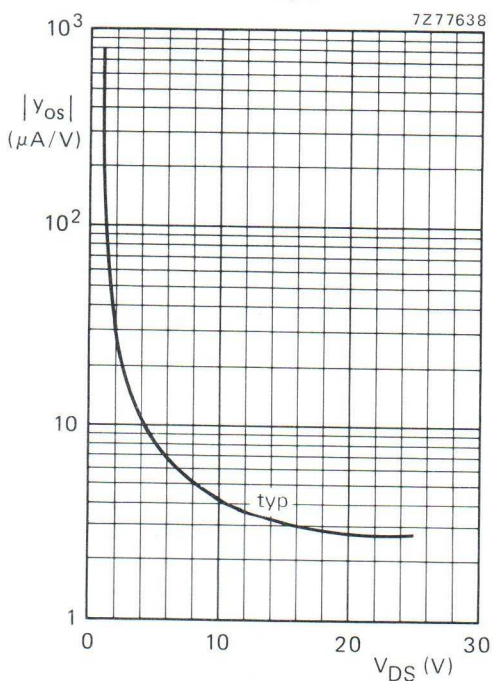


Fig. 8

Fig. 6  $|y_{fs}|$  versus  $I_D$ .  
 $V_{DS} = 10 \text{ V}$ ;  $f = 1 \text{ kHz}$ ;  $T_{amb} = 25^\circ \text{C}$ .

Fig. 7  $|y_{os}|$  versus  $I_D$ .  
 $V_{DS} = 10 \text{ V}$ ;  $f = 1 \text{ kHz}$ ;  $T_{amb} = 25^\circ \text{C}$ .

Fig. 8  $|y_{os}|$  versus  $V_{DS}$ .  
 $I_D = 0,4 \text{ mA}$ ;  $f = 1 \text{ kHz}$ ;  $T_{amb} = 25^\circ \text{C}$ .

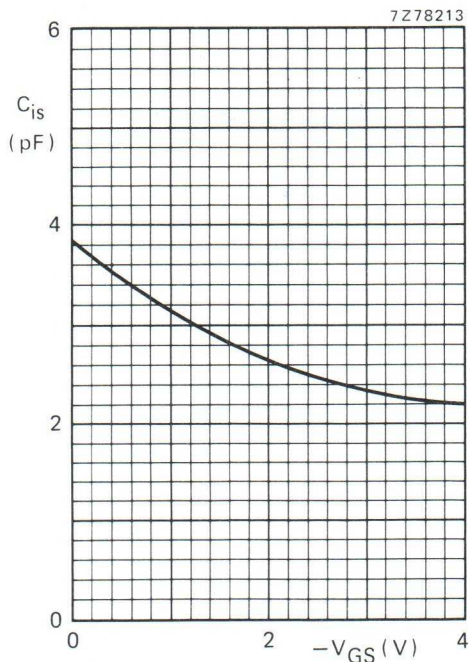


Fig. 9

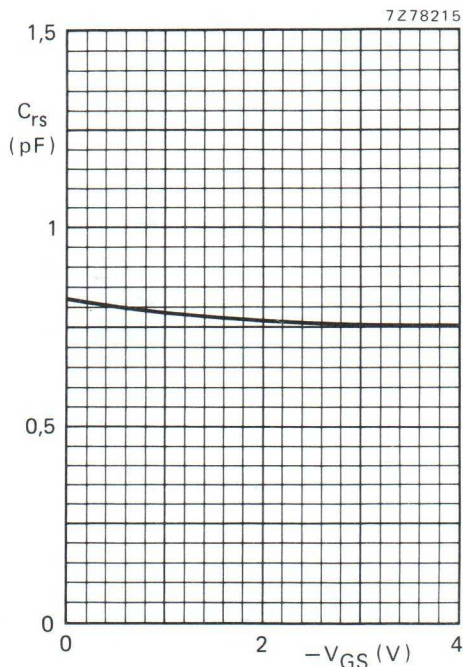


Fig. 10

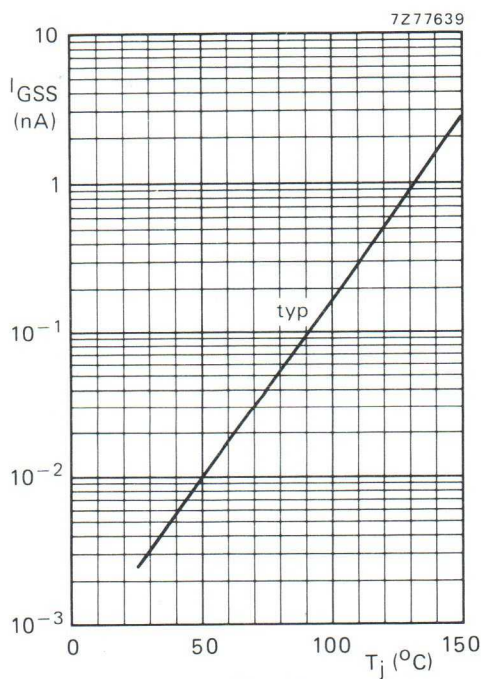


Fig. 11

Fig. 9 Typical values.  
 $V_{DS} = 10 \text{ V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ .

Fig. 10 Typical values.  
 $V_{DS} = 10 \text{ V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ .

Fig. 11  $I_{GSS}$  versus  $T_j$ .  
 $-V_{GSS} = 10 \text{ V}$ ;  $V_{DS} = 0$ .



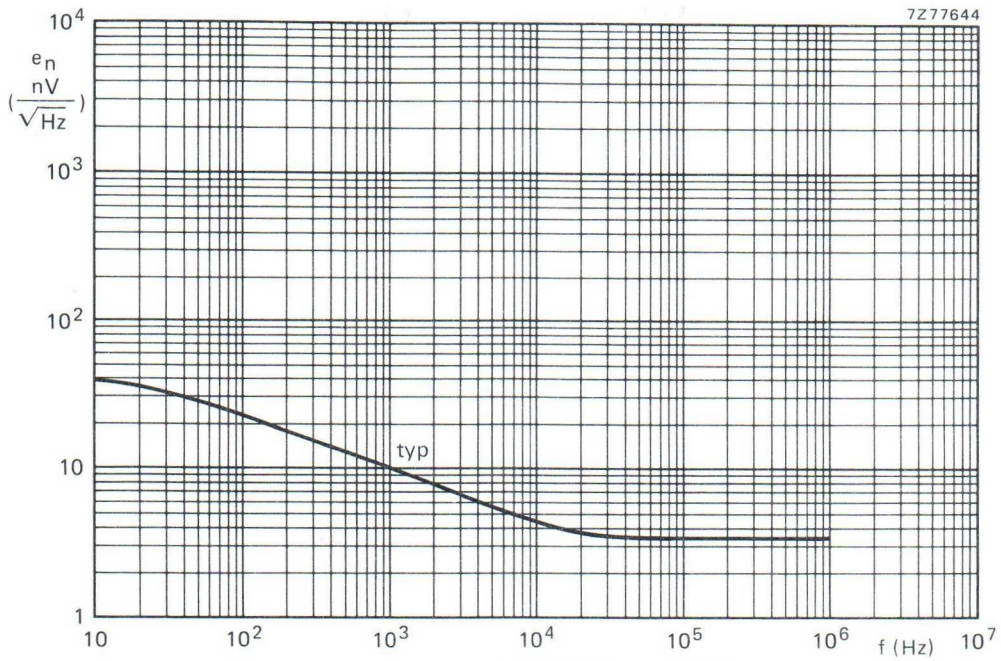


Fig. 12  $V_{DS} = 10\text{ V}$ ;  $I_D = 0,2\text{ mA}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

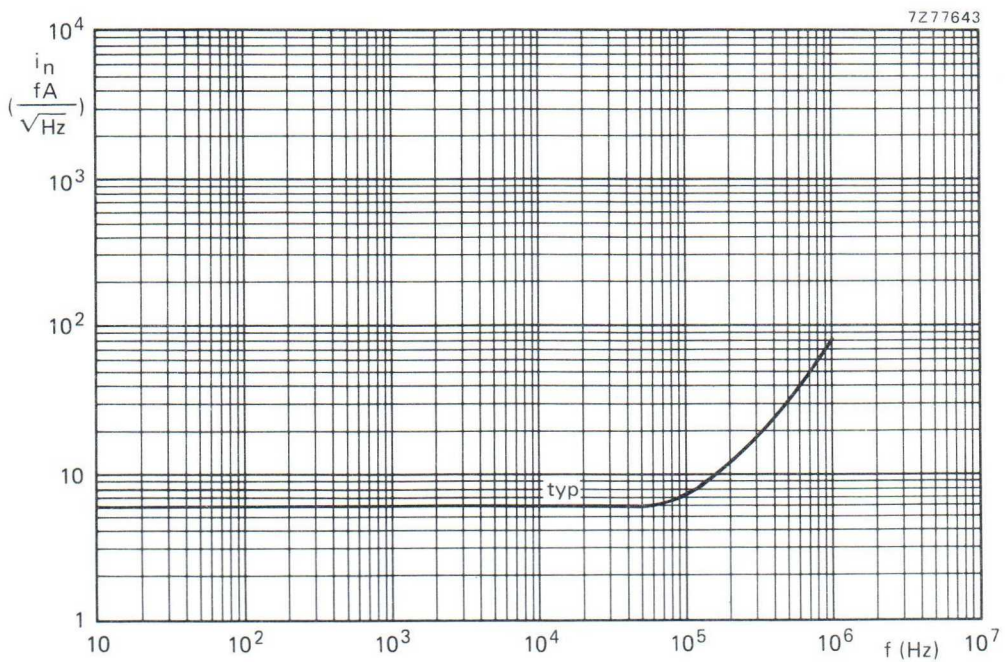


Fig. 13  $V_{DS} = 10\text{ V}$ ;  $I_D = 0,2\text{ mA}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .





## PNP 5 GHz WIDEBAND TRANSISTOR

P-N-P transistor in a microminiature plastic envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analysers, etc.

The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

N-P-N complements are BFR92 and BFR92A.

### QUICK REFERENCE DATA

|                                                                                                                                                                                        |            |      |                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|----------------------|
| Collector-base voltage (open emitter)                                                                                                                                                  | $-V_{CBO}$ | max. | 20 V                 |
| Collector-emitter voltage (open base)                                                                                                                                                  | $-V_{CEO}$ | max. | 15 V                 |
| Collector current (DC)                                                                                                                                                                 | $-I_C$     | max. | 25 mA                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$                                                                                                                             | $P_{tot}$  | max. | 300 mW               |
| Junction temperature                                                                                                                                                                   | $T_j$      | max. | 150 $^\circ\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}$                                                                                           | $f_T$      | typ. | 5 GHz                |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}; T_{amb} = 25^\circ\text{C}$                                                                  | $C_{re}$   | typ. | 0.7 pF               |
| Noise figure at optimum source impedance<br>$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}; T_{amb} = 25^\circ\text{C}$                                                | $F$        | typ. | 2.7 dB               |
| Max. unilateral power gain<br>$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}; T_{amb} = 25^\circ\text{C}$                                                             | $G_{UM}$   | typ. | 18 dB                |
| Intermodulation distortion at $T_{amb} = 25^\circ\text{C}$<br>$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; R_L = 75\ \Omega; V_o = 150\text{ mV}$<br>$f_{(p+q-r)} = 493.25\text{ MHz}$ | $dim$      | typ. | -60 dB               |

### MECHANICAL DATA

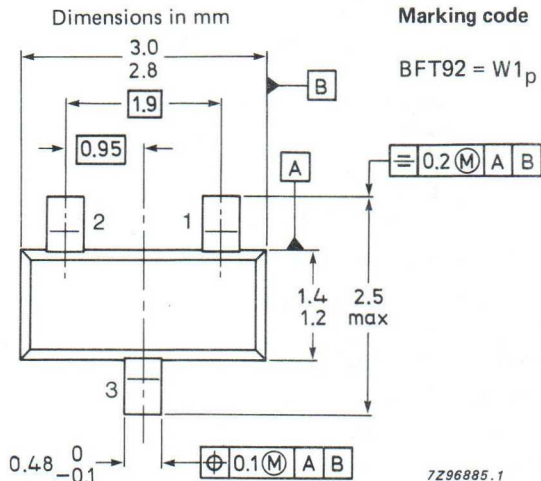
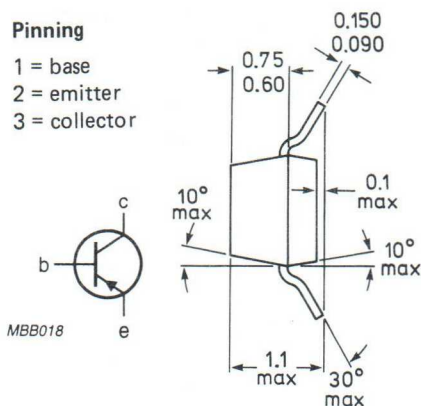
(See next page).

## MECHANICAL DATA

Fig. 1 SOT-23.

## Pinning

- 1 = base  
2 = emitter  
3 = collector



## TOP VIEW

If required, the R-version (reverse pinning) is available on request.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                 |            |                 |        |
|-------------------------------------------------|------------|-----------------|--------|
| Collector-base voltage (open emitter)           | $-V_{CBO}$ | max.            | 20 V   |
| Collector-emitter voltage (open base)           | $-V_{CEO}$ | max.            | 15 V   |
| Emitter-base voltage (open collector)           | $-V_{EB0}$ | max.            | 2 V    |
| Collector current (DC)                          | $-I_C$     | max.            | 25 mA  |
| Collector current (peak value; $f > 1$ MHz)     | $-I_{CM}$  | max.            | 35 mA  |
| Total power dissipation up to $T_{amb} = 25$ °C | $P_{tot}$  | max.            | 300 mW |
| Storage temperature                             | $T_{stg}$  | -65 to + 150 °C |        |
| Junction temperature                            | $T_j$      | max.            | 150 °C |

## THERMAL RESISTANCE

From junction to ambient\*

$$R_{th\ j-a} = 430\ K/W$$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 10\text{ V}$$

$$-I_{CBO} \quad \text{max.} \quad 50\text{ nA}$$

DC current gain

$$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}$$

$$h_{FE} \quad \begin{array}{l} \text{min.} \quad 20 \\ \text{typ.} \quad 50 \end{array}$$

Transition frequency at  $f = 500\text{ MHz}$

$$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}$$

$$f_T \quad \text{typ.} \quad 5.0\text{ GHz}$$

Collector capacitance at  $f = 1\text{ MHz}$

$$I_E = I_C = 0; -V_{CB} = 10\text{ V}$$

$$C_C \quad \text{typ.} \quad 0.75\text{ pF}$$

Emitter capacitance at  $f = 1\text{ MHz}$

$$I_C = I_E = 0; -V_{EB} = 0.5\text{ V}$$

$$C_e \quad \text{typ.} \quad 0.8\text{ pF}$$

$T_{amb} = 25\text{ }^{\circ}\text{C}$

Feedback capacitance at  $f = 1\text{ MHz}$

$$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}$$

$$C_{re} \quad \text{typ.} \quad 0.7\text{ pF}$$

Noise figure at optimum source impedance \*

$$-I_C = 2\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}$$

$$F \quad \text{typ.} \quad 2.7\text{ dB}$$

Max. unilateral power gain ( $s_{re}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; f = 500\text{ MHz}$$

$$G_{UM} \quad \text{typ.} \quad 18.0\text{ dB}$$

Output voltage at  $d_{im} = -60\text{ dB}$  (see Fig. 2)

(DIN 45004B, par. 6.3.: 3-tone)

$$-I_C = 14\text{ mA}; -V_{CE} = 10\text{ V}; R_L = 75\text{ }\Omega$$

$$V_p = V_o \text{ at } d_{im} = -60\text{ dB}; f_p = 495.25\text{ MHz}$$

$$V_q = V_o - 6\text{ dB}; f_q = 503.25\text{ MHz}$$

$$R_r = V_o - 6\text{ dB}; f_r = 505.25\text{ MHz}$$

$$\text{measured at } f_{(p+q-r)} = 493.25\text{ MHz}$$

$$V_o \quad \text{typ.} \quad 150\text{ mV}$$

\* Crystal mounted in SOT-37 envelope.

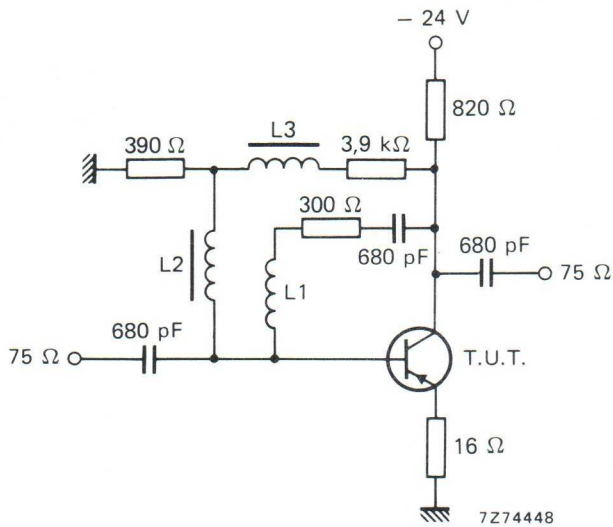


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0,35 mm); winding pitch 1 mm; int. dia. 4 mm.  
 L2 = L3 = 5  $\mu$ H (catalogue number: 3122 108 20150).



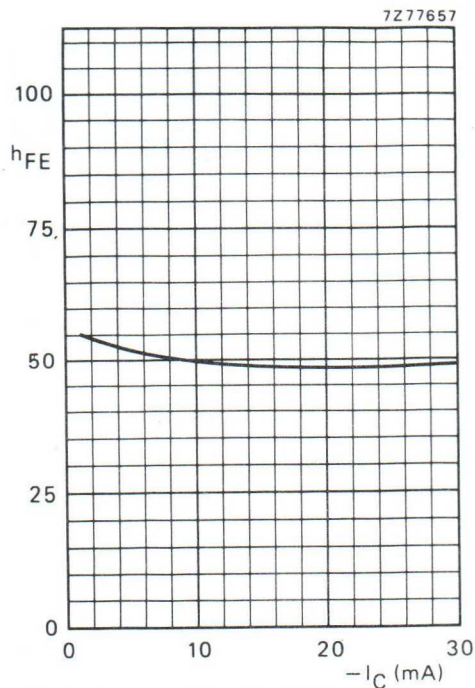


Fig. 3  $-V_{CE} = 10$  V;  $T_j = 25$  °C; typical values.

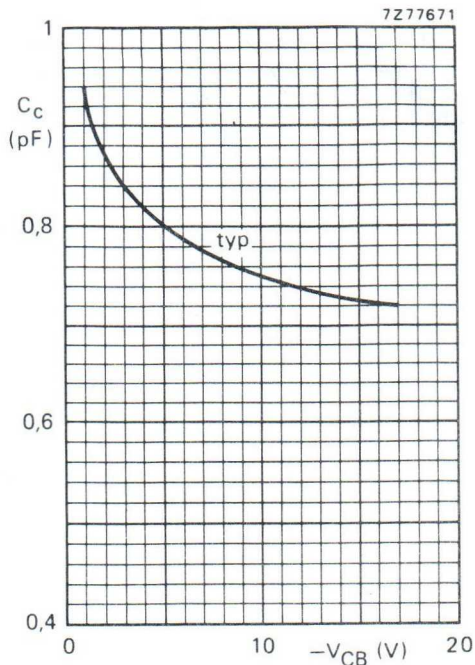


Fig. 4  $I_E = I_c = 0$ ;  $T_j = 25$  °C;  $f = 1$  MHz; typical values.

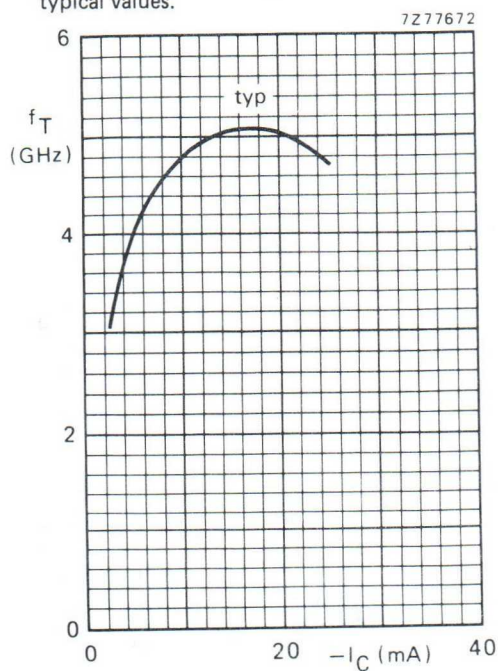


Fig. 5  $-V_{CE} = 10$  V;  $f = 500$  MHz;  $T_j = 25$  °C; typical values.

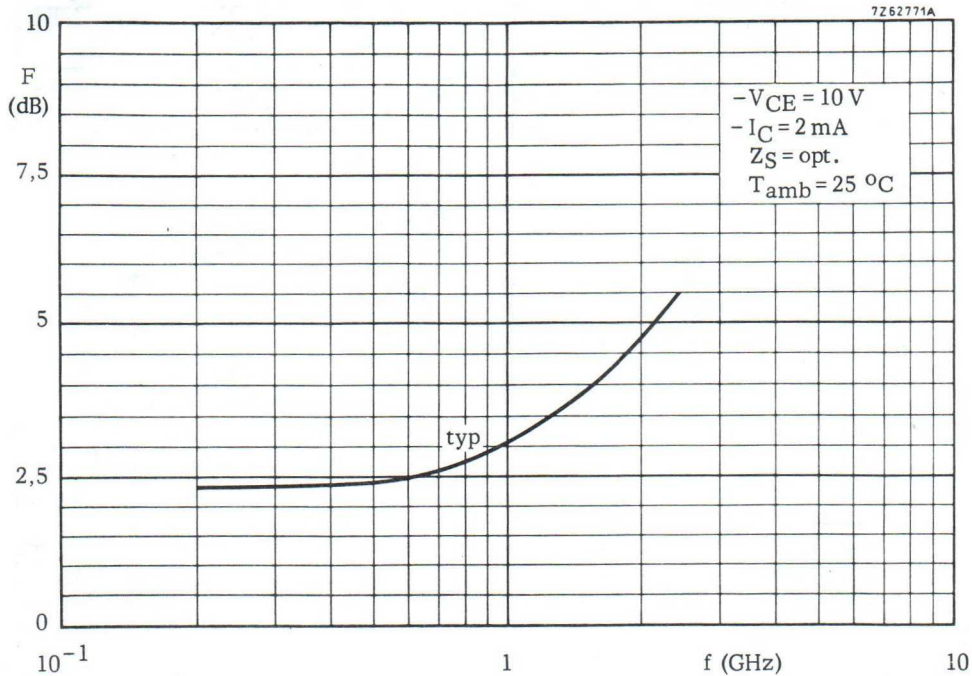


Fig. 6  $-V_{CE} = 10 \text{ V}$ ;  $-I_C = 2 \text{ mA}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

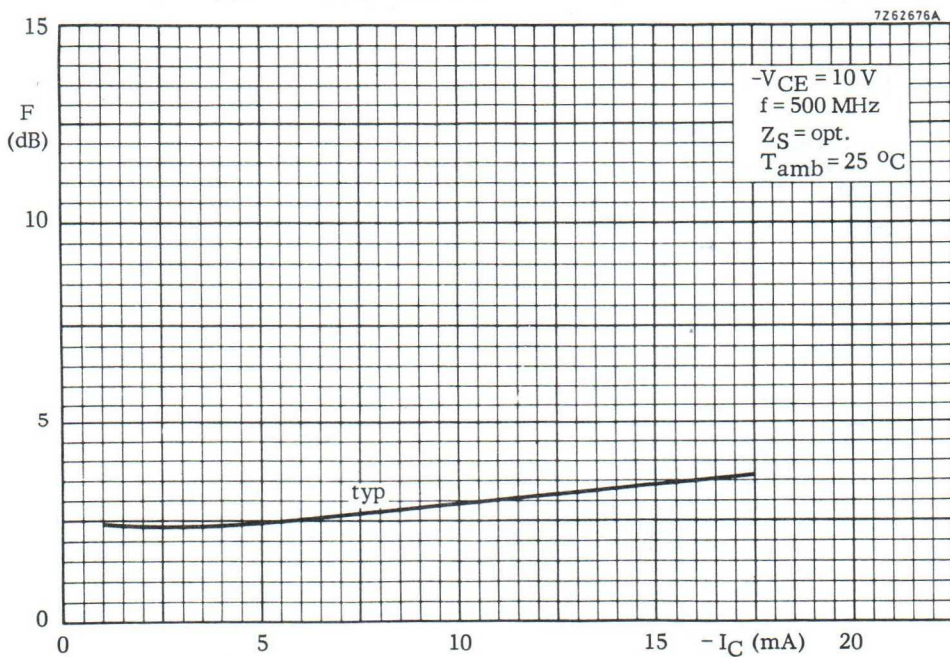


Fig. 7  $-V_{CE} = 10 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

## P-N-P 5 GHz WIDEBAND TRANSISTOR

P-N-P transistor in a plastic SOT-23 envelope. It is primarily intended for use in u.h.f. and microwave amplifiers in thick and thin-film circuits, such as in aerial amplifiers, radar systems, oscilloscopes, spectrum analyses, etc.

The transistor features low intermodulation distortion and high power gain; thanks to its very high transition frequency, it also has excellent wideband properties and low noise up to high frequencies.

N-P-N complements are BFR93 and BFR93A.

### QUICK REFERENCE DATA

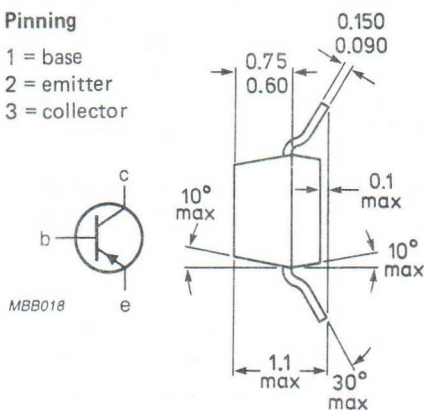
|                                                                                                                                                  |            |      |                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|----------------------|
| Collector-base voltage (open emitter)                                                                                                            | $-V_{CBO}$ | max. | 15 V                 |
| Collector-emitter voltage (open base)                                                                                                            | $-V_{CEO}$ | max. | 12 V                 |
| Collector current (DC)                                                                                                                           | $-I_C$     | max. | 35 mA                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$                                                                                       | $P_{tot}$  | max. | 300 mW               |
| Junction temperature                                                                                                                             | $T_j$      | max. | 150 $^\circ\text{C}$ |
| Transition frequency at $f = 500\text{ MHz}$<br>$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}$                                                      | $f_T$      | typ. | 5.0 GHz              |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$                                                         | $C_{re}$   | typ. | 1.0 pF               |
| Noise figure at optimum source impedance<br>$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}$                                       | $F$        | typ. | 2.4 dB               |
| Max. unilateral power gain<br>$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}$                                                    | $G_{UM}$   | typ. | 16.5 dB              |
| Output voltage at $d_{im} = -60\text{ dB}$<br>$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; R_L = 75\ \Omega$<br>$f_{(p+q-r)} = 493.25\text{ MHz}$ | $V_o$      | typ. | 300 mV               |

## MECHANICAL DATA

Fig. 1 SOT-23.

## Pinning

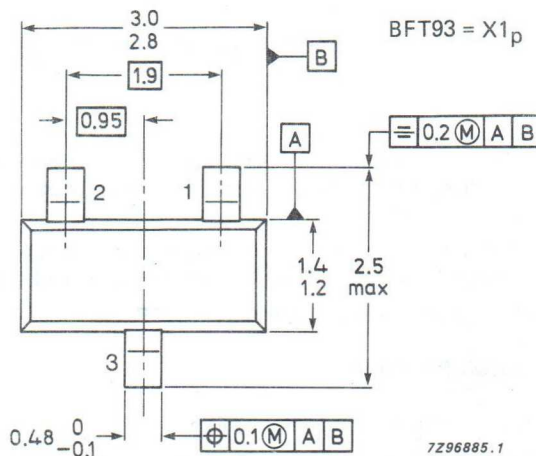
- 1 = base  
2 = emitter  
3 = collector



MBB018

## Dimensions in mm

## Marking code

BFT93 = X1<sub>p</sub>

## TOP VIEW

If required, the R-version (reverse pinning) is available on request.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                 |            |      |                 |
|-------------------------------------------------|------------|------|-----------------|
| Collector-base voltage (open emitter)           | $-V_{CBO}$ | max. | 15 V            |
| Collector-emitter voltage (open base)           | $-V_{CEO}$ | max. | 12 V            |
| Emitter-base voltage (open collector)           | $-V_{EB0}$ | max. | 2 V             |
| Collector current (DC)                          | $-I_C$     | max. | 35 mA           |
| Collector current (peak value; $f > 1$ MHz)     | $-I_{CM}$  | max. | 50 mA           |
| Total power dissipation up to $T_{amb} = 25$ °C | $P_{tot}$  | max. | 300 mW          |
| Storage temperature                             | $T_{stg}$  |      | -65 to + 150 °C |
| Junction temperature                            | $T_j$      | max. | 150 °C          |

## THERMAL RESISTANCE

From junction to ambient\*

$$R_{th\ j-a} = 430\ K/W$$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



## CHARACTERISTICS

$T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$$I_E = 0; -V_{CB} = 5\text{ V}$$

DC current gain

$$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}$$

Transition frequency at  $f = 500\text{ MHz}$

$$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}$$

Collector capacitance at  $f = 1\text{ MHz}$

$$I_E = I_c = 0; -V_{CB} = 10\text{ V}$$

Emitter capacitance at  $f = 1\text{ MHz}$

$$I_C = I_c = 0; -V_{EB} = 0.5\text{ V}$$

$T_{\text{amb}} = 25^\circ\text{C}$

Feedback capacitance at  $f = 1\text{ MHz}$

$$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}$$

Noise figure at optimum source impedance \*

$$-I_C = 2\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}$$

Max. unilateral power gain ( $s_{12}$  assumed to be zero)

$$G_{UM} = 10 \log \frac{|s_{21}|^2}{[1 - |s_{11}|^2][1 - |s_{22}|^2]}$$

$$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; f = 500\text{ MHz}$$

Output voltage at  $d_{im} = -60\text{ dB}$  (see Fig. 2)

$$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}; R_L = 75\ \Omega$$

$$V_p = V_o \text{ at } d_{im} = -60\text{ dB}; f_p = 495.25\text{ MHz}$$

$$V_q = V_o - 6\text{ dB}; f_q = 503.25\text{ MHz}$$

$$V_r = V_o - 6\text{ dB}; f_r = 505.25\text{ MHz}$$

$$\text{measured at } f_{(p+q-r)} = 443.25\text{ MHz}$$

|            |      |       |
|------------|------|-------|
| $-I_{CBO}$ | max. | 50 nA |
| $h_{FE}$   | min. | 20    |
|            | typ. | 50    |

|       |      |         |
|-------|------|---------|
| $f_T$ | typ. | 5.0 GHz |
|-------|------|---------|

|       |      |         |
|-------|------|---------|
| $C_C$ | typ. | 0.95 pF |
|-------|------|---------|

|       |      |        |
|-------|------|--------|
| $C_e$ | typ. | 1.8 pF |
|-------|------|--------|

|          |      |        |
|----------|------|--------|
| $C_{re}$ | typ. | 1.0 pF |
|----------|------|--------|

|   |      |        |
|---|------|--------|
| F | typ. | 2.4 dB |
|---|------|--------|

|          |      |         |
|----------|------|---------|
| $G_{UM}$ | typ. | 16.5 dB |
|----------|------|---------|

|       |      |        |
|-------|------|--------|
| $V_o$ | typ. | 300 mV |
|-------|------|--------|

\* Crystal mounted in SOT-37 envelope.



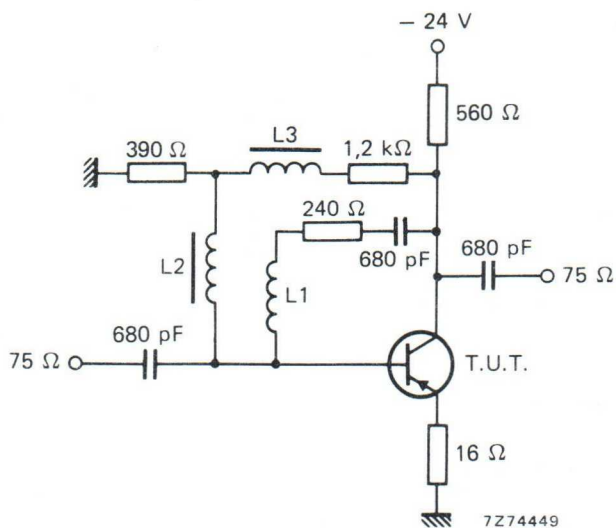


Fig. 2 Intermodulation test circuit.

L1 = 4 turns Cu wire (0.35); winding pitch 1 mm; int. dia. 4 mm.  
 L2 and L3 = 5  $\mu$ H (catalogue number: 3122 108 20150).

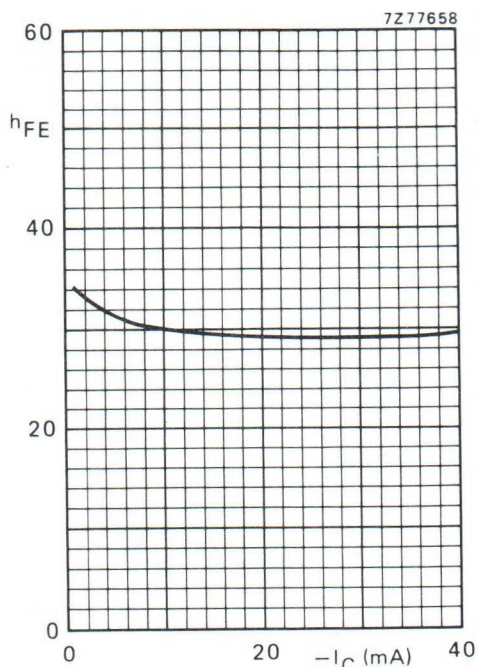


Fig. 3  $-V_{CE} = 5$  V;  $T_j = 25$  °C; typical values.

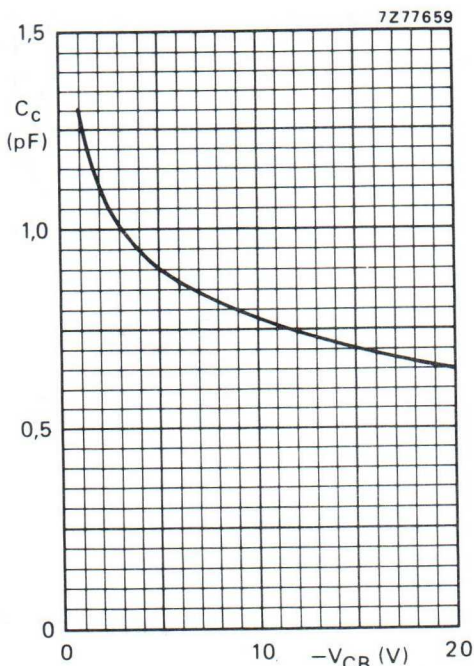


Fig. 4  $I_E = I_e = 0$ ;  $T_j = 25$  °C;  $f = 1$  MHz; typical values.

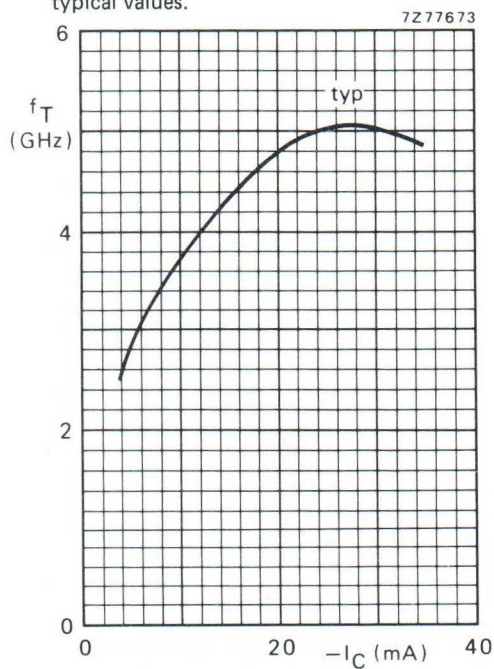


Fig. 5  $-V_{CE} = 5$  V;  $T_j = 25$  °C;  $f = 500$  MHz; typical values.

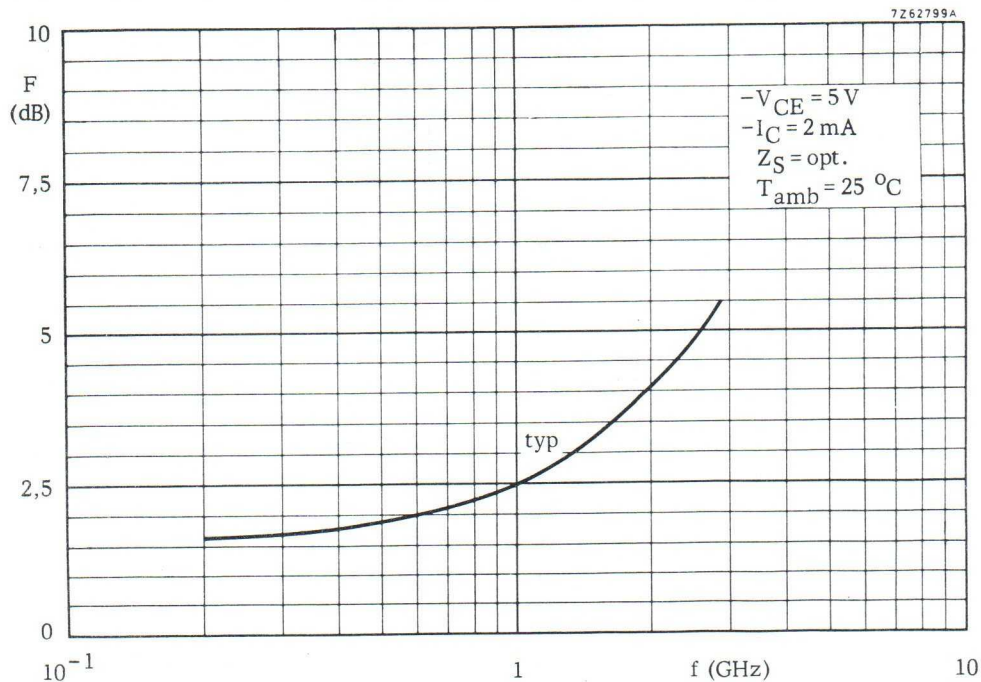


Fig. 6  $-V_{CE} = 5 \text{ V}$ ;  $-I_C = 2 \text{ mA}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

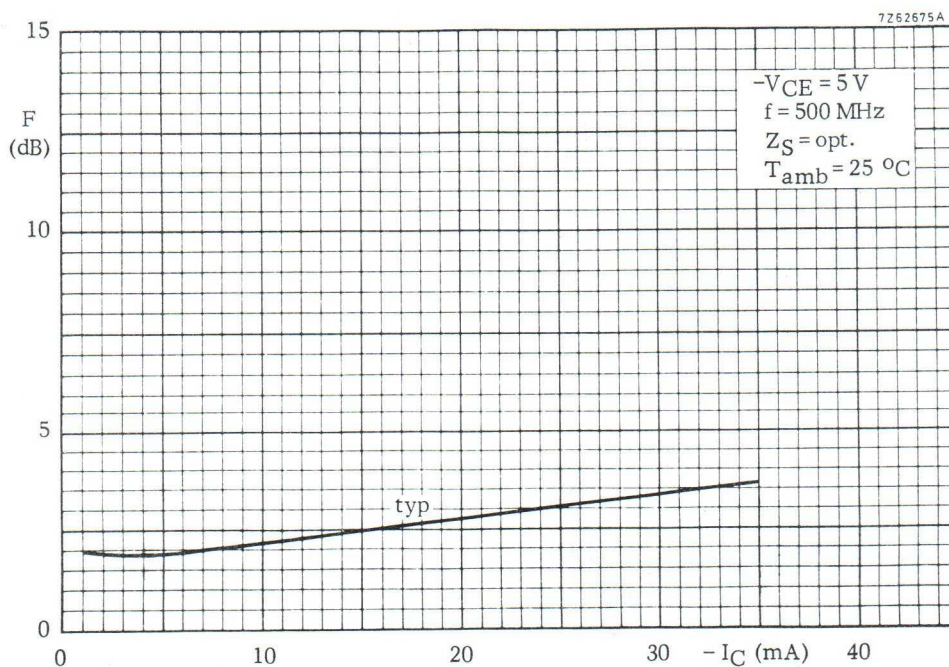


Fig. 7  $-V_{CE} = 5 \text{ V}$ ;  $f = 500 \text{ MHz}$ ;  $Z_S = \text{opt.}$ ;  $T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$ ; typical values.

## PROGRAMMABLE UNIJUNCTION TRANSISTOR

Planar p-n-p-n trigger device in a microminiature plastic envelope intended for applications in thick and thin-film circuits. It is intended for use in switching applications such as motor control, oscillators, relay replacement, timers, pulse shaper, trigger device etc.

### QUICK REFERENCE DATA

|                                                                      |          |      |                        |
|----------------------------------------------------------------------|----------|------|------------------------|
| Gate-anode voltage                                                   | $V_{GA}$ | max. | 70 V                   |
| Anode current (d.c.) up to $T_{amb} = 25\text{ }^{\circ}\text{C}$    | $I_A$    | max. | 175 mA                 |
| Junction temperature                                                 | $T_j$    | max. | 150 $^{\circ}\text{C}$ |
| Peak point current<br>$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$   | $I_P$    | <    | 5 $\mu\text{A}$        |
| Valley point current<br>$V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$ | $I_V$    | >    | 30 $\mu\text{A}$       |

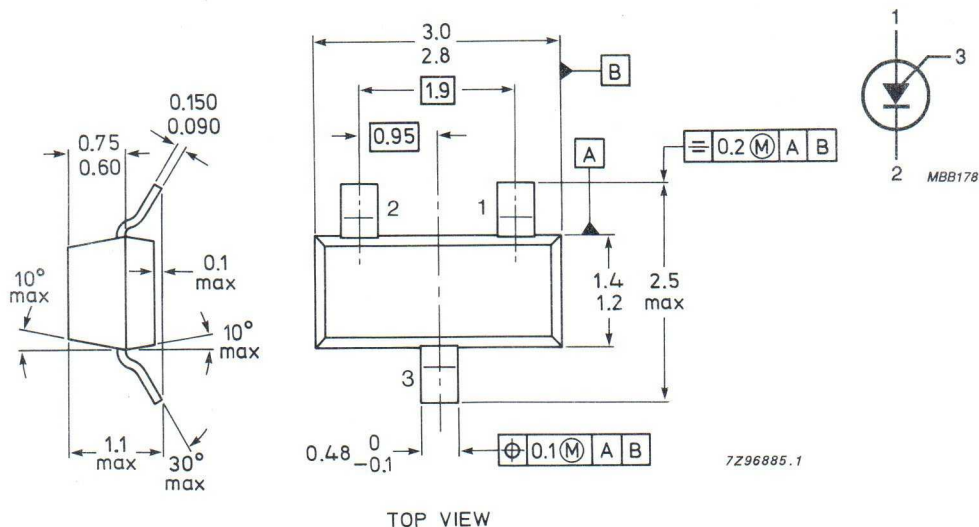
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-23.

BRY61 = A5p



See also *Soldering Recommendations*.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                     |                   |                                              |                        |
|-----------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------|------------------------|
| Gate-anode voltage                                                                                  | $V_{GA}$          | max.                                         | 70 V                   |
| Anode current (d.c.) up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                   | $I_A$             | max.                                         | 175 mA                 |
| Repetitive peak anode current<br>$t = 10\text{ }\mu\text{s}; \delta = 0,01$                         | $I_{ARM}$         | max.                                         | 2,5 A                  |
| Non-repetitive peak anode current<br>$t = 10\text{ }\mu\text{s}; T_j = 150\text{ }^{\circ}\text{C}$ | $I_{ASM}$         | max.                                         | 3 A                    |
| Rate of rise of anode current<br>up to $I_A = 2,5\text{ A}$                                         | $\frac{dI_A}{dt}$ | max.                                         | 20 A/ $\mu\text{s}$    |
| Storage temperature                                                                                 | $T_{stg}$         | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |                        |
| Junction temperature                                                                                | $T_j$             | max.                                         | 150 $^{\circ}\text{C}$ |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                | $P_{tot}$         | max.                                         | 250 mW                 |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Peak point current (see Figs 2, 3 and 4)

 $V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$  $V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$ 

|       |   |                 |
|-------|---|-----------------|
| $I_p$ | < | 5 $\mu\text{A}$ |
| $I_p$ | < | 1 $\mu\text{A}$ |

Valley point current (see also Figs 2, 3 and 4)

 $V_S = 10\text{ V}; R_G = 10\text{ k}\Omega$  $V_S = 10\text{ V}; R_G = 1\text{ M}\Omega$ 

|       |   |                  |
|-------|---|------------------|
| $I_V$ | > | 30 $\mu\text{A}$ |
| $I_V$ | < | 50 $\mu\text{A}$ |

Offset voltage (see Fig. 12)

 $I_A = 0$  (for  $V_P$  see Fig. 2; for  $V_S$  see Fig. 4)

$$V_{offset} = V_P - V_S\text{ V}$$

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



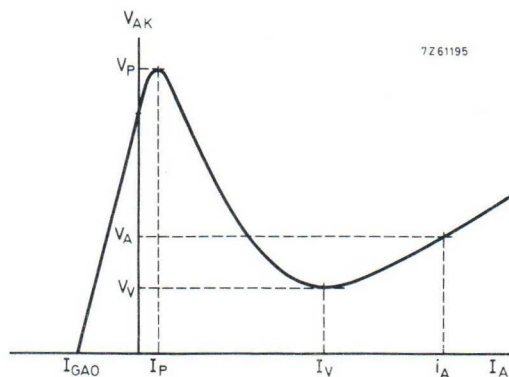


Fig. 2 See also Fig. 11.

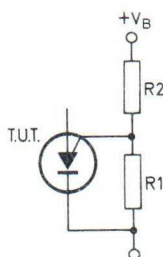


Fig. 3 BRY61 with "program" resistors R1 and R2.

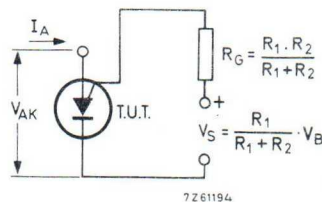


Fig. 4 Equivalent test circuit for characteristics testing.

Gate-anode leakage current (Fig. 5a)

$$I_K = 0; V_{GA} = 70 \text{ V}$$

Gate-cathode leakage current (Fig. 5b)

$$V_{AK} = 0; V_{GK} = 70 \text{ V}$$

$$I_{GAO} < 10 \text{ nA}$$

$$I_{GKS} < 100 \text{ nA}$$

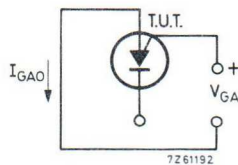


Fig. 5a.

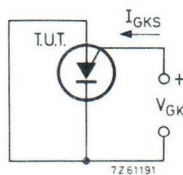


Fig. 5b.

Anode voltage

$$I_A = 100 \text{ mA}$$

$$I_A = 180 \text{ mA}$$

Peak output voltage

$$V_{AA} = 20 \text{ V}; C = 200 \text{ nF (see Fig. 12)}$$

Rise time

$$V_{AA} = 20 \text{ V}; C = 10 \text{ nF (see Fig. 12)}$$

$$V_A < 1,4 \text{ V}$$

$$V_A < 1,6 \text{ V}$$

$$V_{OM} > 6 \text{ V}$$

$$t_r < 80 \text{ ns}$$

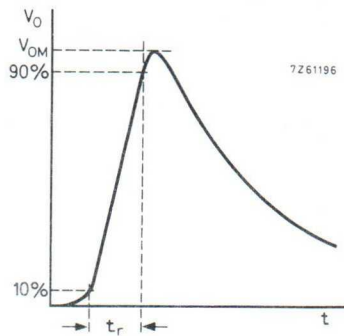


Fig. 6 Output voltage waveform.

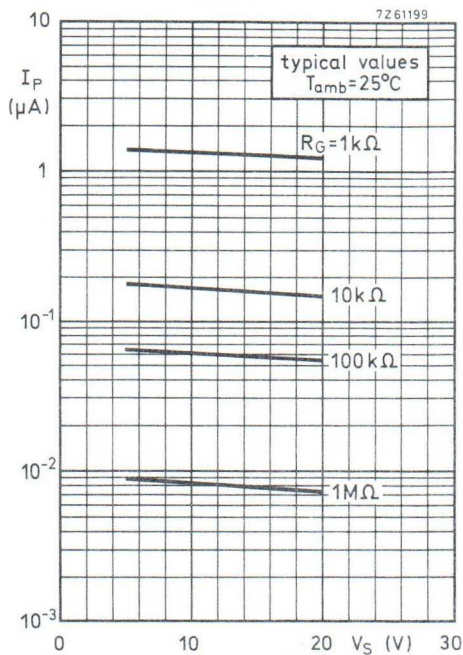


Fig. 7.

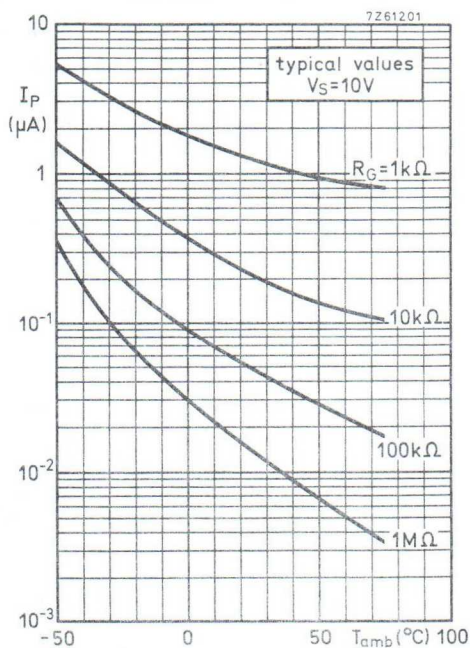


Fig. 8.

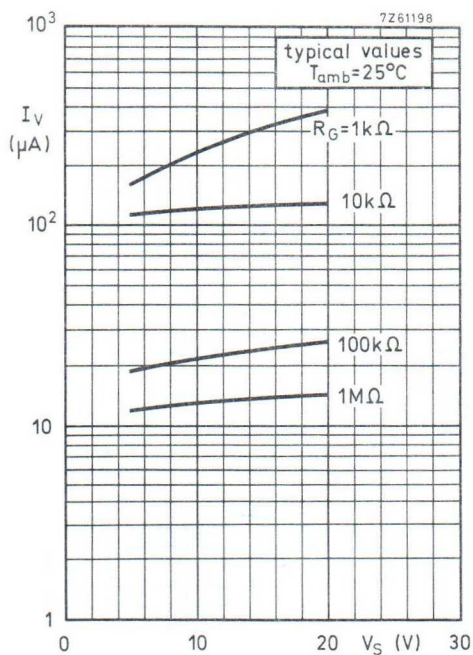


Fig. 9.

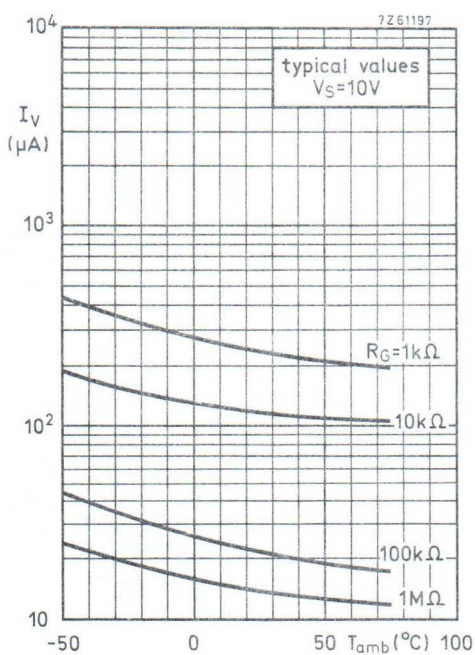


Fig. 10.

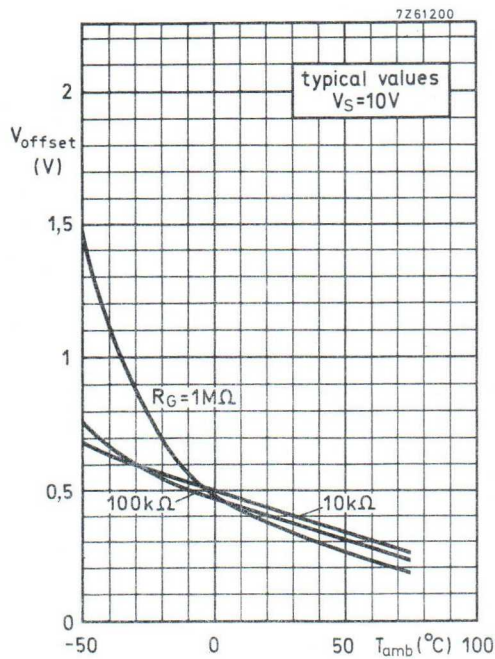


Fig. 11.

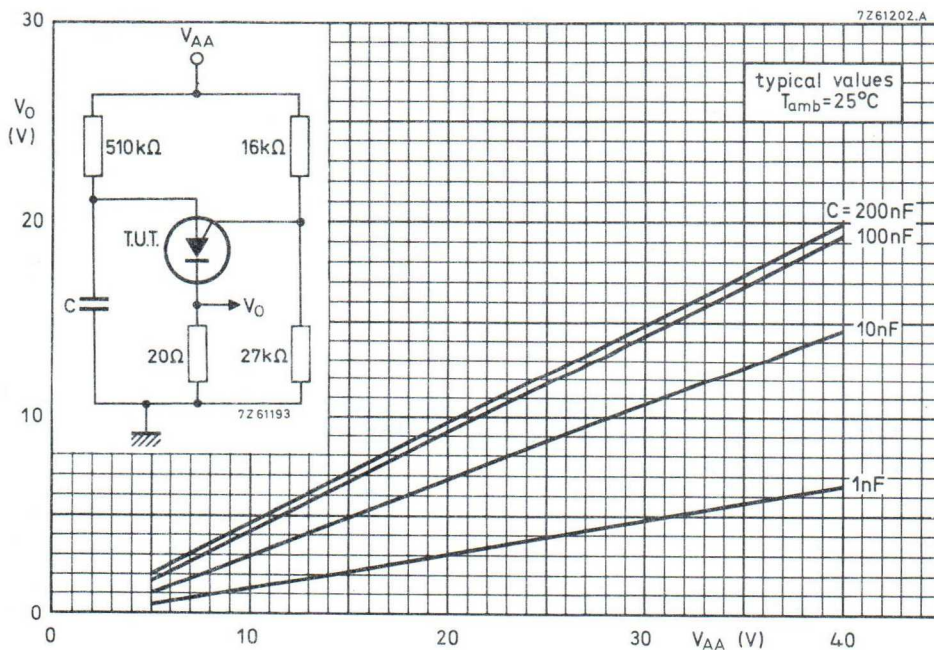


Fig. 12.

## SILICON P-N-P-N PLANAR TETRODE THYRISTOR

Planar p-n-p-n trigger device in a microminiature plastic envelope. It is intended for use as a programmable trigger device (SCS = silicon controlled switch).

### QUICK REFERENCE DATA

|                                                                   |             |      |                        |
|-------------------------------------------------------------------|-------------|------|------------------------|
| Anode gate — cathode voltage                                      | $V_{ga-kR}$ | max. | 70 V                   |
| Anode gate — anode voltage (open cathode)                         | $V_{ga-aO}$ | max. | 70 V                   |
| Average anode current                                             | $I_A(AV)$   | max. | 175 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$   | max. | 250 mW                 |
| Junction temperature                                              | $T_j$       | max. | 150 $^{\circ}\text{C}$ |
| Gate-controlled turn-on time<br>$R_{gk-k} = 1\text{ k}\Omega$     | $t_{gt}$    | <    | 0,25 $\mu\text{s}$     |
| Circuit-commutated turn-off time<br>$R_{gk-k} = 1\text{ k}\Omega$ | $t_q$       | <    | 5 $\mu\text{s}$        |

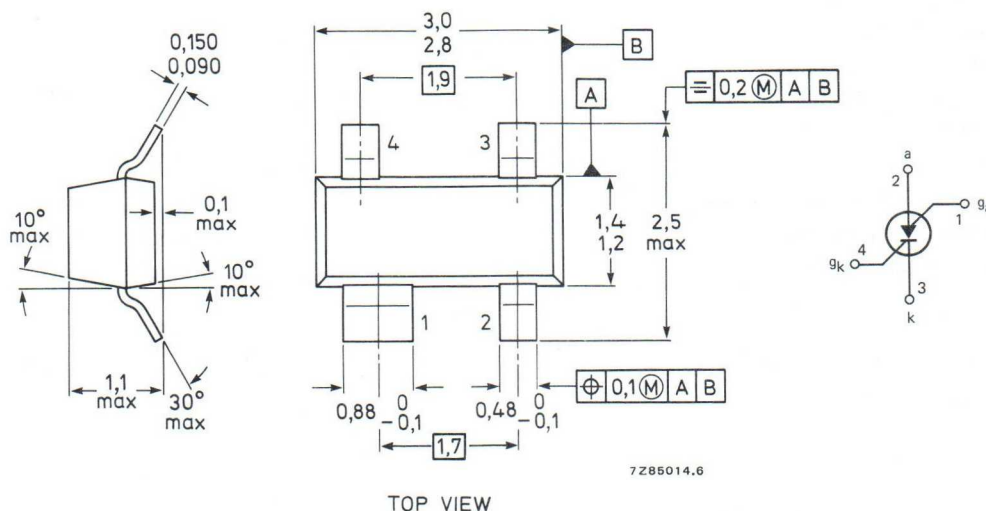
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-143.

BRY62 = A51



See also *Soldering recommendations*.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

## Transistor 1 (T1)

|                                                            |             |      |           |
|------------------------------------------------------------|-------------|------|-----------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$   | max. | 70 V      |
| Collector-emitter voltage ( $R_{BE} = 10\text{ k}\Omega$ ) | $V_{CEO}$   | max. | 70 V      |
| Emitter-collector voltage ( $I_{C1} = 0$ )                 | $V_{EBO}$   | max. | 5 V       |
| Average collector current                                  | $I_{C(AV)}$ | max. | 175 mA ▲  |
| Collector current (peak value)                             | $I_{CM}$    | max. | 175 mA ** |
| Average emitter current                                    | $I_{E(AV)}$ | max. | 175 mA    |
| Emitter current (peak value)                               |             |      |           |
| $t_p = 10\text{ }\mu\text{s}; \delta = 1\%$                | $I_{EM}$    | max. | 2,5 A     |

## Transistor 2 (T2)

|                                                                     |              |      |                                 |
|---------------------------------------------------------------------|--------------|------|---------------------------------|
| Collector-base voltage ( $I_{E2} = 0$ )                             | $-V_{CBO}$   | max. | 70 V                            |
| Collector-emitter voltage ( $I_{B2} = 0$ )                          | $-V_{CEO}$   | max. | 70 V                            |
| Emitter-base voltage ( $I_{C2} = 0$ )                               | $-V_{EBO}$   | max. | 70 V                            |
| Emitter current (average)                                           | $I_{E(AV)}$  | max. | 175 mA                          |
| Emitter current (peak value)                                        |              |      |                                 |
| $t_p = 10\text{ }\mu\text{s}; \delta = 1\%$                         | $I_{EM}$     | max. | 2,5 A                           |
| Reverse gate to cathode voltage                                     | $V_{ga-kR}$  | max. | 70 V                            |
| Gate to anode voltage (open cathode)                                | $V_{ga-aO}$  | max. | 70 V                            |
| Gate to cathode voltage (open anode)                                | $V_{gk-kO}$  | max. | 5 V                             |
| Average anode current                                               | $I_{A(AV)}$  | max. | 175 mA                          |
| Anode current (peak value)                                          |              |      |                                 |
| $t_p = 10\text{ }\mu\text{s}; \delta = 1\%$                         | $I_{AM}$     | max. | 2,5 A                           |
| Anode gate current (average)                                        | $I_{GA(AV)}$ | max. | 175 mA                          |
| Anode gate current (peak value)                                     | $I_{GAM}$    | max. | **                              |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$    | max. | 250 mW                          |
| Junction temperature                                                | $T_j$        | max. | 150 $^{\circ}\text{C}$          |
| Storage temperature                                                 | $T_{stg}$    |      | -65 to + 150 $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                           |                     |   |         |
|---------------------------|---------------------|---|---------|
| From junction to ambient* | $R_{th\text{ }j-a}$ | = | 500 K/W |
|---------------------------|---------------------|---|---------|

\* Device mounted on a ceramic substrate of 15 mm x 15 mm x 0,5 mm.

\*\* During switching on, the device can withstand the discharge of a capacitor of maximum value of 500 pF. This capacitor is charged when the transistor is in cut-off condition, with a collector supply voltage of 160 V and a series resistance of 100 k $\Omega$ .▲ Provided the  $I_E$  rating is not exceeded.

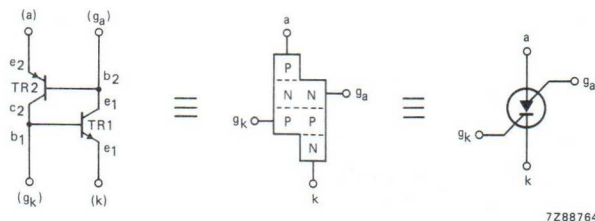


Fig. 2 Circuit diagram.

**CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

**Transistor 1 (TR1)**

Collector-emitter cut-off current

$$V_{CE} = 60\text{ V}; R_{BE} = 10\text{ k}\Omega$$

$$V_{CE} = 70\text{ V}; R_{BE} = 10\text{ k}\Omega; T_j = 150\text{ }^{\circ}\text{C}$$

Emitter cut-off current

$$V_{EB} = 5\text{ V}; I_C = 0; T_j = 150\text{ }^{\circ}\text{C}$$

Saturation voltages

$$I_C = 10\text{ mA}; I_B = 1\text{ mA}$$

D.C. current gain

$$V_{CE} = 2\text{ V}; I_C = 10\text{ mA}$$

Collector capacitance

$$V_{CB} = 20\text{ V}; I_E = I_C = 0$$

Emitter capacitance

$$V_{EB} = 1\text{ V}; I_C = I_C = 0$$

Transition frequency at  $f = 100\text{ MHz}$

$$V_{CE} = 2\text{ V}; I_C = 10\text{ mA}$$

**Transistor 2 (TR2)**

Collector-emitter cut-off current

$$-V_{CE} = 70\text{ V}; I_B = 0; T_j = 150\text{ }^{\circ}\text{C}$$

Emitter cut-off current

$$-V_{EB} = 70\text{ V}; I_C = I_C = 0; T_j = 150\text{ }^{\circ}\text{C}$$

D.C. current gain

$$V_{CB} = 0\text{ V}; I_E = 1\text{ mA}$$

$$I_{CER} < 100\text{ nA}$$

$$I_{CER} < 10\text{ }\mu\text{A}$$

$$I_{EBO} < 10\text{ }\mu\text{A}$$

$$V_{CEsat} < 0,5\text{ V}$$

$$V_{BEsat} < 0,9\text{ V}$$

$$h_{FE} > 50$$

$$C_c < 5\text{ pF}$$

$$C_e < 25\text{ pF}$$

$$f_T = 300\text{ MHz}$$

$$-I_{CEO} < 10\text{ }\mu\text{A}$$

$$-I_{EBO} < 10\text{ }\mu\text{A}$$

$$h_{FE} \text{ 0,25 to 2,5}$$

**THYRISTOR**

Anode to cathode

On-state voltage

$$I_A = 50 \text{ mA}; I_{ga} = 0; R_{gk-k} = 10 \text{ k}\Omega$$

$$I_A = 1 \text{ mA}; I_{ga} = 10 \text{ mA}; R_{gk-k} = 10 \text{ k}\Omega$$

Holding current

$$I_{ga} = 10 \text{ mA}; -V_{gk} = 2 \text{ V}; R_{gk-k} = 10 \text{ k}\Omega$$

$$V_T < 1,4 \text{ V}$$

$$V_T < 1,2 \text{ V}$$

$$I_H < 1 \text{ mA}$$

**Switching characteristics**Gate-controlled turn-on time ( $t_{gt} = t_d + t_r$ )when switched from  $V_{gk} = -0,5 \text{ V}$  to  $4,5 \text{ V}$ at  $R_{gk-k} = 1 \text{ k}\Omega$ at  $R_{gk-k} = 10 \text{ k}\Omega$ 

$$t_{gt} < 0,25 \text{ } \mu\text{s}$$

$$t_{gt} < 1,5 \text{ } \mu\text{s}$$

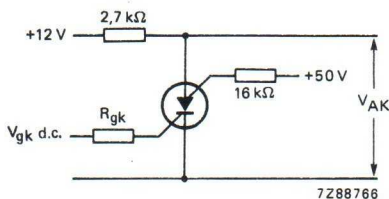


Fig. 3 Switching times test circuit.

The pulse time of  $V_{gk}$  can be adjusted in such a way that the broken line in Fig. 4 disappears, which means that the thyristor starts triggering.

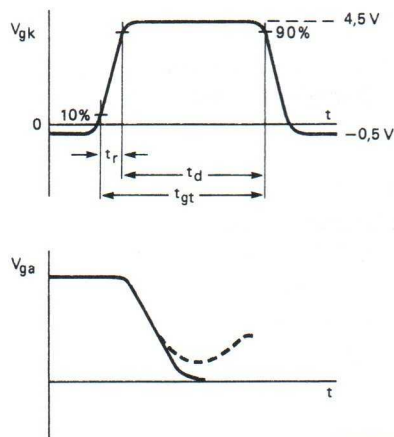


Fig. 4 Switching times waveforms.

Turn-off time (Figs 5 and 6)

$$R_{gk} = 1 \text{ k}\Omega$$

$$R_{gk} = 10 \text{ k}\Omega$$

$$R_{gk} = 10 \text{ k}\Omega; T_j = 125 \text{ }^\circ\text{C}$$

$$t_q < 5 \text{ } \mu\text{s}$$

$$t_q < 8 \text{ } \mu\text{s}$$

$$t_q < 15 \text{ } \mu\text{s}$$

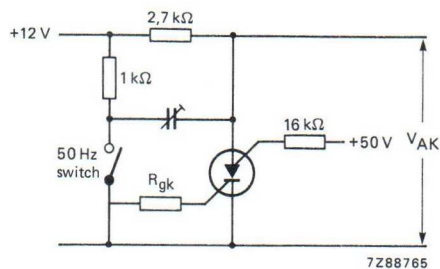


Fig. 5 Switching times test circuit.

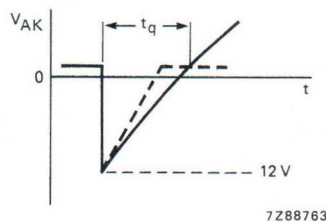


Fig. 6 Switching times waveforms.

The capacitor can be adjusted in such a way that the broken line disappears, which means that the thyristor will not trigger any more.





# MOSFET N-CHANNEL DEPLETION SWITCHING TRANSISTOR

Symmetrical insulated-gate silicon MOS field-effect transistor of the n-channel depletion mode type. The transistor is sealed in a SOT-143 envelope and features a low ON-resistance and low capacitances. The transistor is protected against excessive input voltages by integrated back-to-back diodes between gate and substrate.

## Applications:

- analog and/or digital switch
- switch driver
- convertor
- chopper

## QUICK REFERENCE DATA

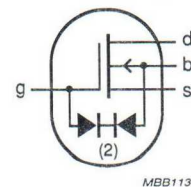
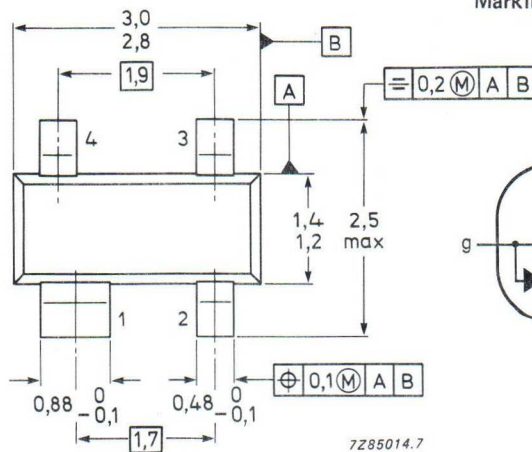
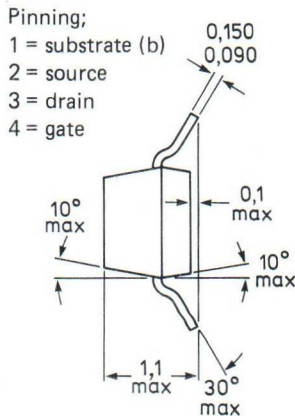
|                                                                                                  |            |      |              |                    |
|--------------------------------------------------------------------------------------------------|------------|------|--------------|--------------------|
| Drain-source voltage                                                                             | $V_{DS}$   | max. | 20           | V                  |
| Gate-source voltage                                                                              | $V_{GS}$   | max. | + 15<br>- 40 | V                  |
| Drain current (DC)                                                                               | $I_D$      | max. | 50           | mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                             | $P_{tot}$  | max. | 230          | mW                 |
| Junction temperature                                                                             | $T_j$      | max. | 125          | $^{\circ}\text{C}$ |
| Drain-source ON-resistance<br>$V_{GS} = 10\text{ V}; V_{SB} = 0; I_D = 1\text{ mA}$              | $R_{DSon}$ | max. | 30           | $\Omega$           |
| Feed-back capacitance<br>$V_{GS} = V_{BS} = -5\text{ V}; V_{DS} = 10\text{ V}; f = 1\text{ MHz}$ | $C_{rss}$  | typ. | 0.6          | pF                 |

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-143.

Marking code: M32



TOP VIEW

Note: Drain and source are interchangeable

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                  |                    |
|------------------------------------------------------------------------|-----------|------|------------------|--------------------|
| Drain-source voltage                                                   | $V_{DS}$  | max. | 20               | V                  |
| Source-drain voltage                                                   | $V_{SD}$  | max. | 20               | V                  |
| Drain-substrate voltage                                                | $V_{DB}$  | max. | 25               | V                  |
| Source-substrate voltage                                               | $V_{SB}$  | max. | 25               | V                  |
| Gate-substrate voltage                                                 | $V_{GB}$  | max. | $\pm 25$         | V                  |
| Gate-source voltage                                                    | $V_{GS}$  | max. | $+ 15$<br>$- 40$ | V                  |
| Drain current (DC)                                                     | $I_D$     | max. | 50               | mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 230              | mW                 |
| Storage temperature range                                              | $T_{stg}$ |      | $-65$ to $+ 150$ | $^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | 125              | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                                       |               |   |     |     |
|---------------------------------------|---------------|---|-----|-----|
| From junction to ambient in free air* | $R_{th\ j-a}$ | = | 430 | K/W |
|---------------------------------------|---------------|---|-----|-----|

# CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                          |               |      |     |    |
|------------------------------------------------------------------------------------------|---------------|------|-----|----|
| Drain-source breakdown voltage<br>$V_{GS} = V_{BS} = -5\text{ V}$ ; $I_S = 10\text{ nA}$ | $V_{(BR)DSX}$ | min. | 20  | V  |
| Source-drain breakdown voltage<br>$V_{GD} = V_{BD} = -5\text{ V}$ ; $I_D = 10\text{ nA}$ | $V_{(BR)SDX}$ | min. | 20  | V  |
| Drain-substrate breakdown voltage<br>$V_{GB} = 0$ ; $I_D = 10\text{ nA}$ ; open source   | $V_{(BR)DBO}$ | min. | 25  | V  |
| Source-substrate breakdown voltage<br>$V_{GB} = 0$ ; $I_S = 10\text{ nA}$ ; open drain   | $V_{(BR)SBO}$ | min. | 25  | V  |
| Drain-source leakage current<br>$V_{GS} = V_{BS} = -5\text{ V}$ ; $V_{DS} = 10\text{ V}$ | $I_{DSoff}$   | typ. | 1.0 | nA |
| Source-drain leakage current<br>$V_{GD} = V_{BD} = 5\text{ V}$ ; $V_{SD} = 10\text{ V}$  | $I_{SDoff}$   | typ. | 1.0 | nA |
| Gate-substrate leakage current<br>$V_{DB} = V_{SB} = 0$ ; $V_{GB} = \pm 15\text{ V}$     | $I_{GBS}$     | max. | 10  | nA |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

Forward transconductance at  $f = 1 \text{ kHz}$ 

$$V_{DS} = 10 \text{ V}; V_{SB} = 0; I_D = 20 \text{ mA}$$

|          |      |       |
|----------|------|-------|
| $g_{fs}$ | min. | 10 mS |
|          | typ. | 15 mS |

Gate-source cut-off voltage

$$V_{DS} = 10 \text{ V}; V_{SB} = 0; I_D = 10 \mu\text{A}$$

$$I_D = 10 \mu\text{A}$$

|              |      |       |
|--------------|------|-------|
| $-V_{(P)GS}$ | max. | 2.0 V |
|--------------|------|-------|

Drain-source ON-resistance

$$I_D = 1 \text{ mA}; V_{SB} = 0;$$

$$V_{GS} = 5 \text{ V}$$

|            |      |             |
|------------|------|-------------|
| $R_{DSon}$ | typ. | 25 $\Omega$ |
|            | max. | 50 $\Omega$ |

$$V_{GS} = 10 \text{ V}$$

|            |      |             |
|------------|------|-------------|
| $R_{DSon}$ | typ. | 15 $\Omega$ |
|            | max. | 30 $\Omega$ |

Capacitances at  $f = 1 \text{ MHz}$ 

$$V_{GS} = V_{BS} = -5 \text{ V}; V_{DS} = 10 \text{ V}$$

Feed-back capacitance

|           |      |        |
|-----------|------|--------|
| $C_{rss}$ | typ. | 0.6 pF |
|-----------|------|--------|

Input capacitance

|           |      |        |
|-----------|------|--------|
| $C_{iss}$ | typ. | 1.5 pF |
|-----------|------|--------|

Output capacitance

|           |      |        |
|-----------|------|--------|
| $C_{oss}$ | typ. | 1.0 pF |
|-----------|------|--------|

Switching times (see Fig. 3)

$$V_{DD} = 10 \text{ V}; V_i = -5 \text{ V to } +5 \text{ V}$$

|           |      |        |
|-----------|------|--------|
| $t_{on}$  | typ. | 1.0 ns |
| $t_{off}$ | typ. | 5.0 ns |

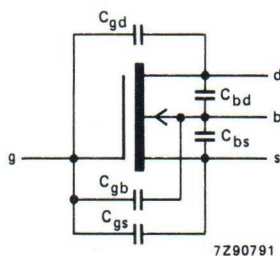


Fig. 2 Capacitances model.

$$C_{iss} = C_{gs} + C_{gd} + C_{gb}$$

$$C_{oss} = C_{gd} + C_{bd}$$

$$C_{rss} = C_{gd}$$

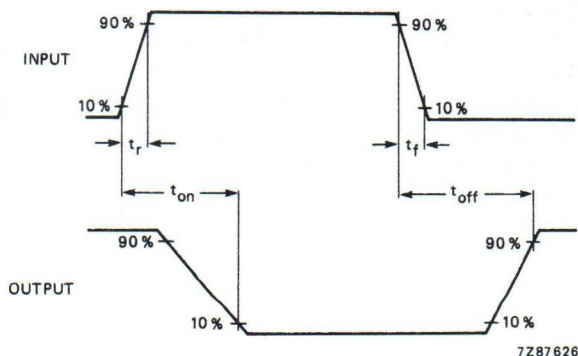
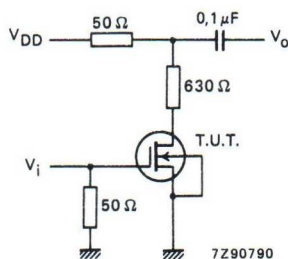
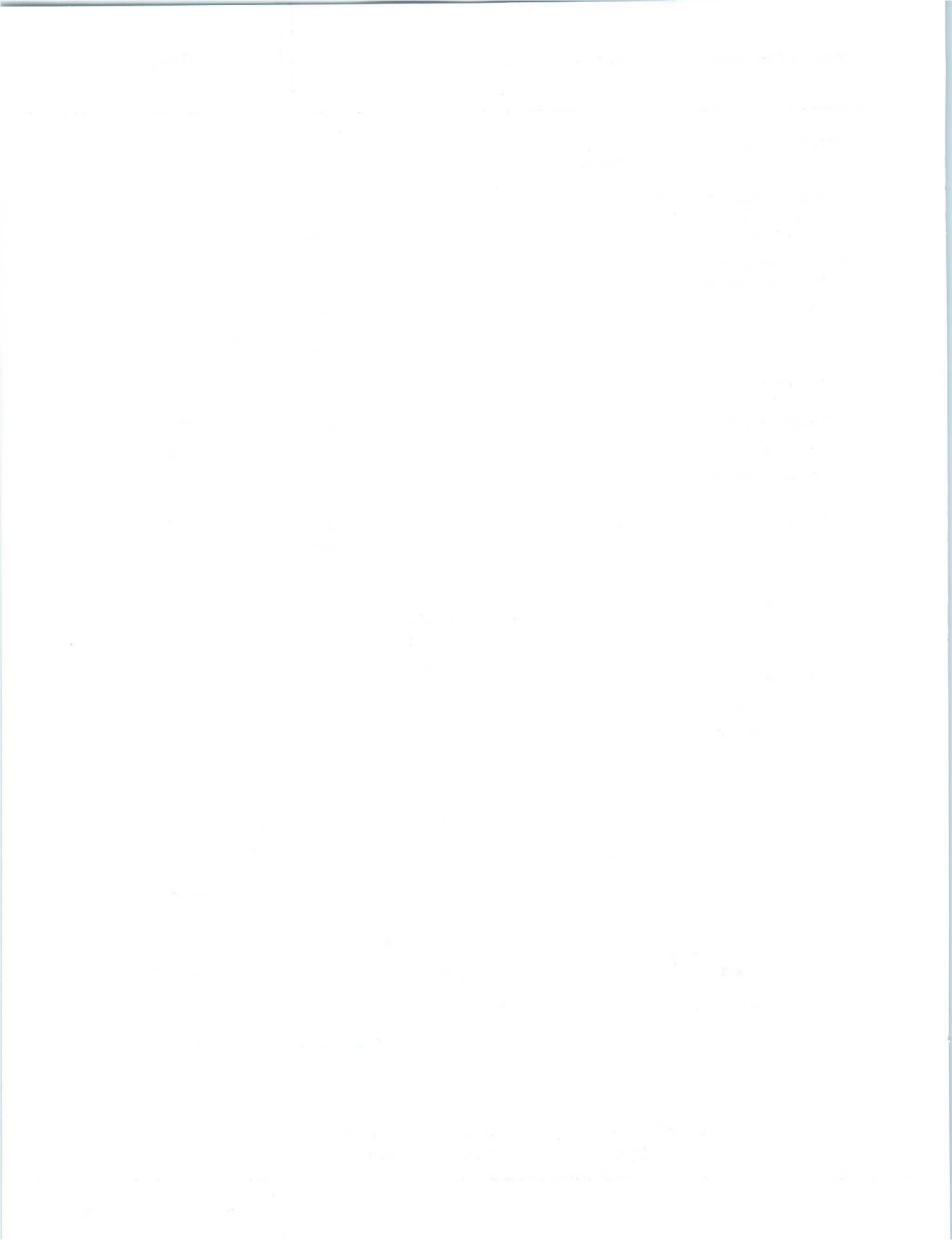


Fig. 3 Switching times and input and output waveforms;

$$R_i = 50 \Omega; t_r < 0.5 \text{ ns}; t_f < 1.0 \text{ ns}; t_p = 20 \text{ ns}; \delta < 0.01.$$







## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |            | BSP15                         | BSP16              |
|------------------------------------------------------------------------|------------|-------------------------------|--------------------|
| Collector-base voltage (open emitter)                                  | $-V_{CBO}$ | max. 200                      | 350 V              |
| Collector-emitter voltage (open base)                                  | $-V_{CEO}$ | max. 200                      | 300 V              |
| Emitter-base voltage (open collector)                                  | $-V_{EBO}$ | max. 4                        | 6 V                |
| Collector current (DC)                                                 | $-I_C$     | max. 1                        | A                  |
| Base current                                                           | $-I_B$     | max. 0,5                      | A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. 1,5                      | W                  |
| Junction temperature                                                   | $T_j$      | max. 150                      | $^{\circ}\text{C}$ |
| Storage temperature range                                              | $T_{stg}$  | -65 to 150 $^{\circ}\text{C}$ |                    |

## THERMAL RESISTANCE

|                           |                |   |      |     |
|---------------------------|----------------|---|------|-----|
| from junction to ambient* | $R_{th\ j-mb}$ | = | 83,3 | K/W |
|---------------------------|----------------|---|------|-----|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                  |                | BSP15     | BSP16            |
|--------------------------------------------------|----------------|-----------|------------------|
| Collector cut-off current                        |                |           |                  |
| $I_E = 0; -V_{CB} = 175\text{ V}$                | $-I_{CBO}$     | < 1       | — $\mu\text{A}$  |
| $I_E = 0; -V_{CB} = 280\text{ V}$                | $-I_{CBO}$     | < —       | 1 $\mu\text{A}$  |
| $I_B = 0; -V_{CE} = 150\text{ V}$                | $-I_{CEO}$     | < 50      | — $\mu\text{A}$  |
| $I_B = 0; -V_{CE} = 250\text{ V}$                | $-I_{CEO}$     | < —       | 50 $\mu\text{A}$ |
| Emitter cut-off current                          |                |           |                  |
| $I_C = 0; -V_{EB} = 4\text{ V}$                  | $-I_{EBO}$     | < 20      | — $\mu\text{A}$  |
| $I_C = 0; -V_{EB} = 6\text{ V}$                  | $-I_{EBO}$     | < —       | 20 $\mu\text{A}$ |
| Collector-emitter breakdown voltage              |                |           |                  |
| $I_B = 0; -I_C = 50\text{ mA}; L = 25\text{ mH}$ | $-V_{(BR)CEO}$ | > 200     | 300 V            |
| Collector-emitter saturation voltage             |                |           |                  |
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$        | $-V_{CEsat}$   | < 2,5     | 2,0 V            |
| DC current gain                                  |                |           |                  |
| $-V_{CE} = 10\text{ V}; -I_C = 50\text{ mA}$     | $h_{FE}$       | 30 to 150 | 30 to 120        |
| Transition frequency at $f = 30\text{ MHz}$      |                |           |                  |
| $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$     | $f_T$          | > 15      | MHz              |
| Collector capacitance at $f = 1\text{ MHz}$      |                |           |                  |
| $I_E = I_e = 0; -V_{CB} = 10\text{ V}$           | $C_c$          | < 15      | pF               |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

# SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in miniature plastic envelopes intended for use in amplifier and switching applications. Complementary pnp types are BSP15/16.

## QUICK REFERENCE DATA

|                                                            |           |      | BSP19 | BSP20 |                  |
|------------------------------------------------------------|-----------|------|-------|-------|------------------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ | max. | 400   | 300   | V                |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. | 350   | 250   | V                |
| Collector current (DC)                                     | $I_C$     | max. |       | 1     | A                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. |       | 1,5   | W                |
| Junction temperature                                       | $T_j$     | max. |       | 150   | $^\circ\text{C}$ |
| DC current gain                                            |           |      |       |       |                  |
| $V_{CE} = 10\text{ V}; I_C = 20\text{ mA}$                 | $h_{FE}$  | min. |       | 40    |                  |
| Transition frequency at $f = 5\text{ MHz}$                 |           |      |       |       |                  |
| $V_{CE} = 10\text{ V}; I_C = 10\text{ mA}$                 | $f_T$     | min. |       | 70    | MHz              |

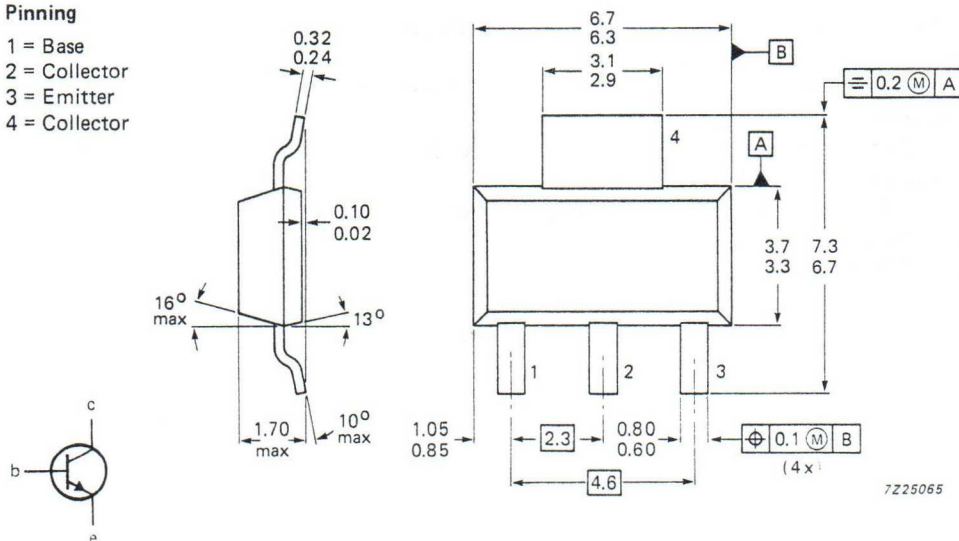
## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223

### Pinning

- 1 = Base
- 2 = Collector
- 3 = Emitter
- 4 = Collector



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      | BSP19      | BSP20 |                    |
|------------------------------------------------------------------------|-----------|------|------------|-------|--------------------|
| Collector-base voltage (open emitter)                                  | $V_{CBO}$ | max. | 400        | 300   | V                  |
| Collector-emitter voltage (open base)                                  | $V_{CEO}$ | max. | 350        | 250   | V                  |
| Emitter-base voltage (open collector)                                  | $V_{EBO}$ | max. | 5          |       | V                  |
| Collector current (DC)                                                 | $I_C$     | max. | 1          |       | A                  |
| Base current                                                           | $I_B$     | max. | 0,5        |       | A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 1,5        |       | W                  |
| Junction temperature                                                   | $T_j$     | max. | 150        |       | $^{\circ}\text{C}$ |
| Storage temperature range                                              | $T_{stg}$ |      | -65 to 150 |       | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                           |               |   |      |     |
|---------------------------|---------------|---|------|-----|
| from junction to ambient* | $R_{th\ j-a}$ | = | 83,3 | K/W |
|---------------------------|---------------|---|------|-----|

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                          |             |        |     |               |
|------------------------------------------------------------------------------------------|-------------|--------|-----|---------------|
| Collector cut-off current<br>$I_B = 0; V_{CE} = 300\text{ V}$                            | $I_{CBO}$   | $\leq$ | 20  | nA            |
| Emitter cut-off current<br>$I_C = 0; V_{EB} = 5\text{ V}$                                | $I_{EBO}$   | $\leq$ | 10  | $\mu\text{A}$ |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}; I_B = 4\text{ mA}$          | $V_{CEsat}$ | $\leq$ | 0,5 | V             |
| Base-emitter saturation voltage<br>$I_C = 50\text{ mA}; I_B = 4\text{ mA}$               | $V_{BEsat}$ | $\leq$ | 1,3 | V             |
| DC current gain<br>$V_{CE} = 10\text{ V}; I_C = 20\text{ mA}$                            | $h_{FE}$    | $\leq$ | 40  |               |
| Collector capacitance at $f = 1\text{ MHz}$<br>$I_E = I_C = 0; V_{CB} = 10\text{ V}$     | $C_c$       | $\leq$ | 2   | pF            |
| Emitter capacitance at $f = 1\text{ MHz}$<br>$I_C = I_E = 0; V_{EB} = 5\text{ V}$        | $C_e$       | $\leq$ | 20  | pF            |
| Transition frequency at $f = 5\text{ MHz}$<br>$V_{CE} = 10\text{ V}; I_C = 10\text{ mA}$ | $f_T$       | $\geq$ | 70  | MHz           |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## SILICON PLANAR EPITAXIAL TRANSISTORS

PNP transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

## QUICK REFERENCE DATA

|                                                            |                 | BSP30 | BSP31 | BSP32 | BSP33                |
|------------------------------------------------------------|-----------------|-------|-------|-------|----------------------|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ max. | 70    | 70    | 90    | 90 V                 |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ max. | 60    | 60    | 80    | 80 V                 |
| Collector current (DC)                                     | $-I_C$ max.     | 1     | 1     | 1     | 1 A                  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ max.  | 1,5   | 1,5   | 1,5   | 1,5 W                |
| Junction temperature                                       | $T_j$ max.      | 150   | 150   | 150   | 150 $^\circ\text{C}$ |
| DC current gain                                            | $h_{FE}$        | > 40  | 100   | 40    | 100                  |
| $-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$               |                 | < 120 | 300   | 120   | 300                  |
| Transition frequency at $f = 35\text{ MHz}$                | $f_T$           | > 100 | 100   | 100   | 100 MHz              |
| $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$               |                 |       |       |       |                      |

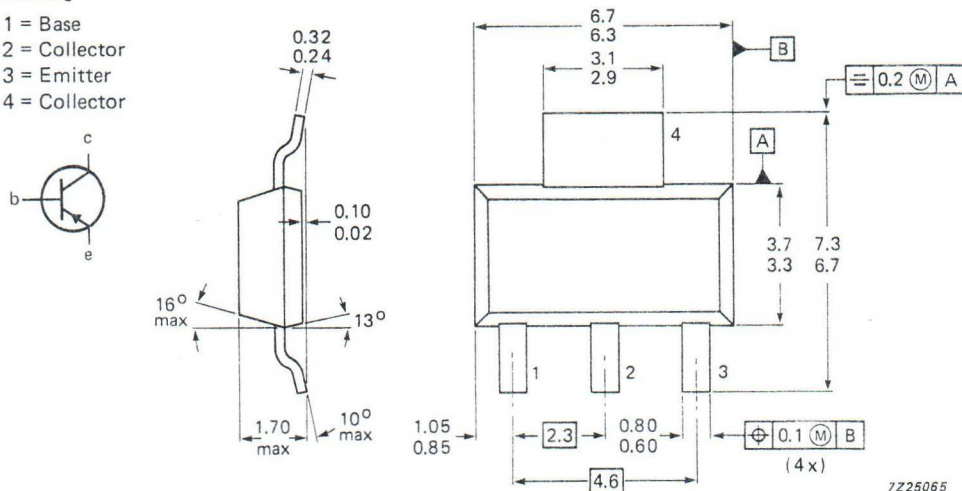
## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223

## Pinning

- 1 = Base  
2 = Collector  
3 = Emitter  
4 = Collector



7225065

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                   |            |      | BSP30 | BSP31 | BSP32       | BSP33              |
|-------------------------------------------------------------------|------------|------|-------|-------|-------------|--------------------|
| Collector-base voltage (open emitter)                             | $-V_{CBO}$ | max. | 70    | 70    | 90          | 90 V               |
| Collector-emitter voltage (open base)                             | $-V_{CEO}$ | max. | 60    | 60    | 80          | 80 V               |
| Emitter-base voltage (open collector)                             | $-V_{EBO}$ | max. | 5     | 5     | 5           | 5 V                |
| Collector current (DC)                                            | $-I_C$     | max. |       |       | 1           | A                  |
| Base current (DC)                                                 | $-I_B$     | max. |       |       | 0,1         | A                  |
| Total power dissipation up to<br>$T_{amb} = 25^{\circ}\text{C}^*$ | $P_{tot}$  | max. |       |       | 1,5         | W                  |
| Storage temperature range                                         | $T_{stg}$  |      |       |       | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                              | $T_j$      | max. |       |       | 150         | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                                |                 |   |  |      |     |
|--------------------------------|-----------------|---|--|------|-----|
| From junction to collector tab | $R_{th\ j-tab}$ | = |  | 10   | K/W |
| From junction to ambient*      | $R_{th\ j-a}$   | = |  | 83,3 | K/W |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.



**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified**Collector cut-off current**

|                                                                     |            |   |     |               |
|---------------------------------------------------------------------|------------|---|-----|---------------|
| $I_E = 0; -V_{CB} = 60\text{ V}$                                    | $-I_{CBO}$ | < | 100 | nA            |
| $I_E = 0; -V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $-I_{CBO}$ | < | 50  | $\mu\text{A}$ |

**Breakdown voltages**

|                                            |                |   | BSP30 | BSP31 | BSP32 | BSP33 |   |
|--------------------------------------------|----------------|---|-------|-------|-------|-------|---|
| $I_B = 0; -I_C = 10\text{ mA}$             | $-V_{(BR)CEO}$ | > | 60    | 60    | 80    | 80    | V |
| $V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$ | $-V_{(BR)CES}$ | > | 70    | 70    | 90    | 90    | V |
| $I_C = 0; -I_E = 10\text{ }\mu\text{A}$    | $-V_{(BR)EBO}$ | > | 5     | 5     | 5     | 5     | V |

**Saturation voltages \***

|                                             |              |   |      |      |      |      |   |
|---------------------------------------------|--------------|---|------|------|------|------|---|
| $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$ | $-V_{CEsat}$ | < | 0,25 | 0,25 | 0,25 | 0,25 | V |
|                                             | $-V_{BEsat}$ | < | 1,0  | 1,0  | 1,0  | 1,0  | V |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$ | $-V_{CEsat}$ | < | 0,5  | 0,5  | 0,5  | 0,5  | V |
|                                             | $-V_{BEsat}$ | < | 1,2  | 1,2  | 1,2  | 1,2  | V |

**DC current gain\***

|                                                      |          |   |     |     |     |     |
|------------------------------------------------------|----------|---|-----|-----|-----|-----|
| $-I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ | $h_{FE}$ | > | 10  | 30  | 10  | 30  |
| $-I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 40  | 100 | 40  | 100 |
|                                                      |          | < | 120 | 300 | 120 | 300 |
| $-I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 30  | 50  | 30  | 50  |

**Transition frequency at  $f = 35\text{ MHz}$** 

|                                              |       |   |     |     |
|----------------------------------------------|-------|---|-----|-----|
| $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$ | $f_T$ | > | 100 | MHz |
|----------------------------------------------|-------|---|-----|-----|

**Collector capacitance at  $f = 1\text{ MHz}$** 

|                                        |       |   |    |    |
|----------------------------------------|-------|---|----|----|
| $I_E = I_e = 0; -V_{CB} = 10\text{ V}$ | $C_c$ | < | 20 | pF |
|----------------------------------------|-------|---|----|----|

**Emitter capacitance at  $f = 1\text{ MHz}$** 

|                                         |       |   |     |    |
|-----------------------------------------|-------|---|-----|----|
| $I_C = I_c = 0; -V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 120 | pF |
|-----------------------------------------|-------|---|-----|----|

Switching times see next page.

\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta < 0,01$ .

CHARACTERISTICS (continued)

$T_{amb} = 25^{\circ}\text{C}$

Switching times

$-I_{Con} = 100\text{ mA}; -I_{Bon} = +I_{Boff} = 5\text{ mA}$

Turn-on time

$t_{on} < 500\text{ ns}$

Turn-off time

$t_{off} < 650\text{ ns}$

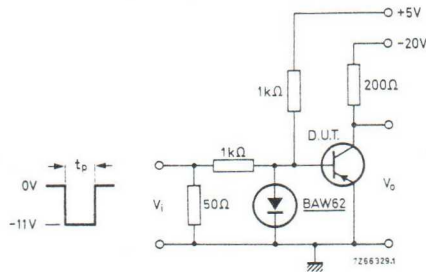


Fig. 2 Switching times test circuit.

Pulse generator:

Pulse duration  $t_p = 10\text{ }\mu\text{s}$

Rise time  $t_r \leq 15\text{ ns}$

Fall time  $t_f \leq 15\text{ ns}$

Source impedance  $Z_S = 50\text{ }\Omega$

Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$

Input impedance  $Z_I \geq 100\text{ k}\Omega$

## SILICON PLANAR EPITAXIAL TRANSISTORS

NPN transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

## QUICK REFERENCE DATA

|                                                            |                | BSP40 | BSP41 | BSP42 | BSP43                |
|------------------------------------------------------------|----------------|-------|-------|-------|----------------------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ max. | 70    | 70    | 90    | 90 V                 |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ max. | 60    | 60    | 80    | 80 V                 |
| Collector current (DC)                                     | $I_C$ max.     | 1     | 1     | 1     | 1 A                  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ max. | 1,5   | 1,5   | 1,5   | 1,5 W                |
| Junction temperature                                       | $T_j$ max.     | 150   | 150   | 150   | 150 $^\circ\text{C}$ |
| DC current gain                                            | $h_{FE}$       | > 40  | 100   | 40    | 100                  |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                 |                | < 120 | 300   | 120   | 300                  |
| Transition frequency at $f = 35\text{ MHz}$                | $f_T$          | > 100 | 100   | 100   | 100 MHz              |
| $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$                 |                |       |       |       |                      |

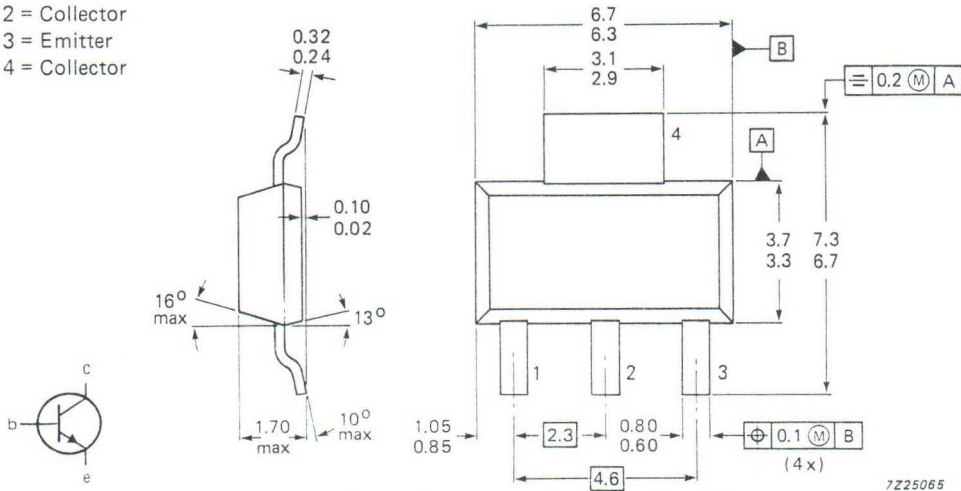
## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223

## Pinning

- 1 = Base
- 2 = Collector
- 3 = Emitter
- 4 = Collector



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |               |      | BSP40 | BSP41 | BSP42       | BSP43              |
|----------------------------------------------------------------|---------------|------|-------|-------|-------------|--------------------|
| Collector-base voltage (open emitter)                          | $V_{CBO}$     | max. | 70    | 70    | 90          | 90 V               |
| Collector-emitter voltage (open base)                          | $V_{CEO}$     | max. | 60    | 60    | 80          | 80 V               |
| Emitter-base voltage (open collector)                          | $V_{EBO}$     | max. | 5     | 5     | 5           | 5 V                |
| Collector current (DC)                                         | $I_C$         | max. |       |       | 1           | A                  |
| Base current (DC)                                              | $I_B$         | max. |       |       | 0,1         | A                  |
| Total power dissipation up to $T_{amb} = 25^{\circ}\text{C}^*$ | $P_{tot}$     | max. |       |       | 1,5         | W                  |
| Storage temperature range                                      | $T_{stg}$     |      |       |       | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                           | $T_j$         | max. |       |       | 150         | $^{\circ}\text{C}$ |
| <b>THERMAL RESISTANCE</b>                                      |               |      |       |       |             |                    |
| From junction to ambient*                                      | $R_{th\ j-a}$ | =    |       |       | 83,3        | K/W                |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

## Collector cut-off current

|                                                                    |           |   |     |               |
|--------------------------------------------------------------------|-----------|---|-----|---------------|
| $I_E = 0; V_{CB} = 60\text{ V}$                                    | $I_{CBO}$ | < | 100 | nA            |
| $I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $I_{CBO}$ | < | 50  | $\mu\text{A}$ |

## Breakdown voltages

|                                           |               |   | BSP40 | BSP41 | BSP42 | BSP43 |   |
|-------------------------------------------|---------------|---|-------|-------|-------|-------|---|
| $I_B = 0; I_C = 10\text{ mA}$             | $V_{(BR)CEO}$ | > | 60    | 60    | 80    | 80    | V |
| $V_{BE} = 0; I_C = 10\text{ }\mu\text{A}$ | $V_{(BR)CES}$ | > | 70    | 70    | 90    | 90    | V |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$    | $V_{(BR)EBO}$ | > | 5     | 5     | 5     | 5     | V |

## Saturation voltages \*

|                                           |             |   |      |      |      |      |   |
|-------------------------------------------|-------------|---|------|------|------|------|---|
| $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ | $V_{CEsat}$ | < | 0,25 | 0,25 | 0,25 | 0,25 | V |
|                                           | $V_{BEsat}$ | < | 1,0  | 1,0  | 1,0  | 1,0  | V |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$ | $V_{CEsat}$ | < | 0,5  | 0,5  | 0,5  | 0,5  | V |
|                                           | $V_{BEsat}$ | < | 1,2  | 1,2  | 1,2  | 1,2  | V |

## DC current gain\*

|                                                     |          |   |     |     |     |     |
|-----------------------------------------------------|----------|---|-----|-----|-----|-----|
| $I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ | $h_{FE}$ | > | 10  | 30  | 10  | 30  |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 40  | 100 | 40  | 100 |
|                                                     |          | < | 120 | 300 | 120 | 300 |
| $I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 30  | 50  | 30  | 50  |

Transition frequency at  $f = 35\text{ MHz}$ 

|                                            |       |   |     |     |
|--------------------------------------------|-------|---|-----|-----|
| $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$ | $f_T$ | > | 100 | MHz |
|--------------------------------------------|-------|---|-----|-----|

Collector capacitance at  $f = 1\text{ MHz}$ 

|                                       |       |   |    |    |
|---------------------------------------|-------|---|----|----|
| $I_E = I_c = 0; V_{CB} = 10\text{ V}$ | $C_C$ | < | 12 | pF |
|---------------------------------------|-------|---|----|----|

Emitter capacitance at  $f = 1\text{ MHz}$ 

|                                        |       |   |    |    |
|----------------------------------------|-------|---|----|----|
| $I_C = I_c = 0; V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 90 | pF |
|----------------------------------------|-------|---|----|----|

Switching times see next page.

\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta < 0,01$ .



## CHARACTERISTICS (continued)

 $T_{amb} = 25^{\circ}\text{C}$ 

## Switching times

 $I_{Con} = 100\text{ mA}; I_{Bon} = -I_{Boff} = 5\text{ mA}$ 

Turn-on time

 $t_{on} < 250\text{ ns}$ 

Turn-off time

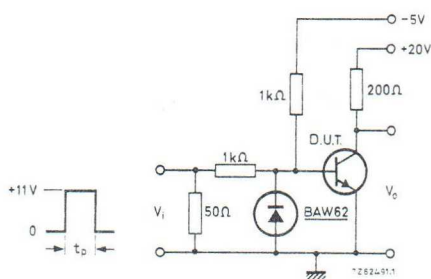
 $t_{off} < 1000\text{ ns}$ 

Fig. 2 Switching times test circuit.

Pulse generator:

Pulse duration  $t_p = 10\text{ }\mu\text{s}$ Rise time  $t_r \leq 15\text{ ns}$ Fall time  $t_f \leq 15\text{ ns}$ Source impedance  $Z_S = 50\text{ }\Omega$ 

Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$ Input impedance  $Z_I \geq 100\text{ k}\Omega$



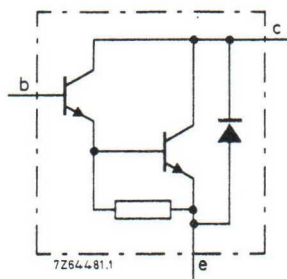


Fig. 2 Circuit diagram.

### RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |           |      | BSP50       | BSP51 | BSP52              |
|--------------------------------------------------------------------------|-----------|------|-------------|-------|--------------------|
| Collector-base voltage (open emitter)                                    | $V_{CBO}$ | max. | 60          | 80    | 90 V               |
| Collector-emitter voltage*                                               | $V_{CER}$ | max. | 45          | 60    | 80 V               |
| Emitter-base voltage (open collector)                                    | $V_{EBO}$ | max. | 5           |       | V                  |
| Collector current (DC)                                                   | $I_C$     | max. | 0,5         |       | A                  |
| Collector current (peak)                                                 | $I_{CM}$  | max. | 1,5         |       | A                  |
| Base current (DC)                                                        | $I_B$     | max. | 0,1         |       | A                  |
| Total power dissipation▲<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 1,5         |       | W                  |
| Storage temperature range                                                | $T_{stg}$ |      | -65 to +150 |       | $^{\circ}\text{C}$ |
| Junction temperature**                                                   | $T_j$     | max. | 150         |       | $^{\circ}\text{C}$ |

### THERMAL RESISTANCE\*\*

|                           |               |   |      |     |
|---------------------------|---------------|---|------|-----|
| From junction to ambient▲ | $R_{th\ j-a}$ | = | 83,3 | K/W |
|---------------------------|---------------|---|------|-----|

\* External  $R_{BE}$  not to exceed value shown in Fig. 5.

\*\* Based on maximum average junction temperature in line with common industrial practice.

The resulting higher junction temperature of the output transistor part is taken into account.

▲ Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CErmax}$

$I_{CES} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

$I_{EBO} < 10\text{ }\mu\text{A}$

DC current gain\*

$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 1000$

$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 2000$

Collector-emitter saturation voltage

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

$V_{CEsat} < 1,3\text{ V}$

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}; T_j = 150\text{ }^{\circ}\text{C}$

$V_{CEsat} < 1,3\text{ V}$

Base-emitter saturation voltage

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

$V_{BEsat} < 1,9\text{ V}$

Switching times (see also Fig. 3 and Fig. 4)

$I_C = 500\text{ mA}; I_{B(on)} = -I_{B(off)} = 0,5\text{ mA}$

Turn-on time

$t_{on}$  typ. 400 ns

Turn-off time

$t_{off}$  typ. 1500 ns

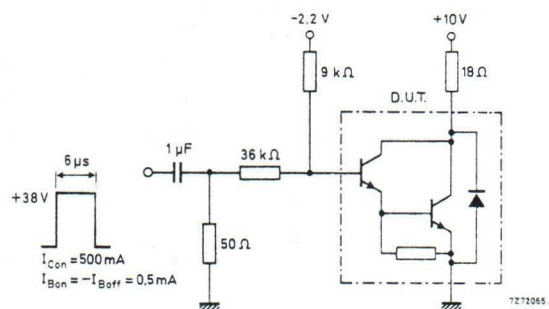


Fig. 3 Switching times test circuit.

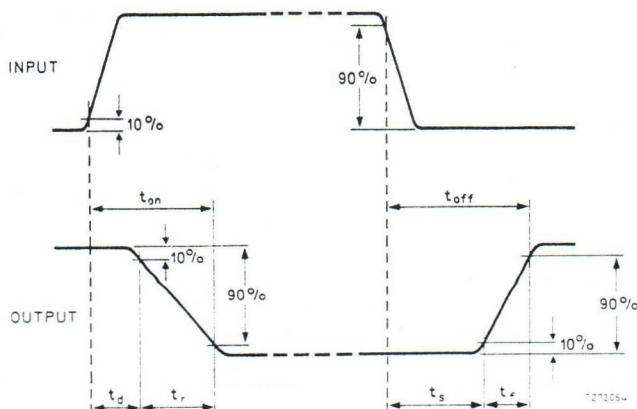


Fig. 4 Switching times waveform.

\* Measured under pulsed conditions.

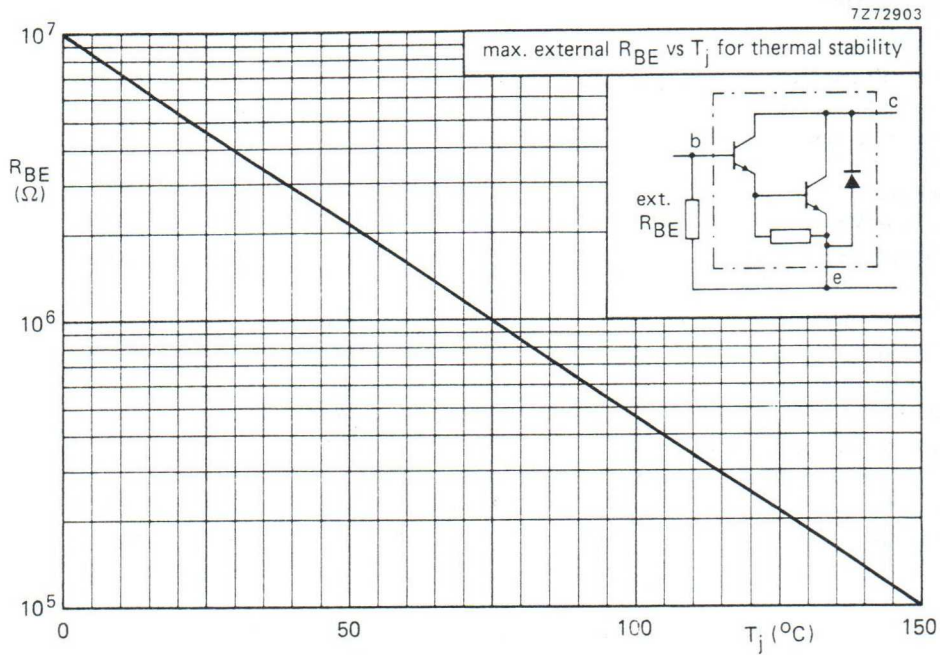


Fig. 5 Maximum values external  $R_{BE}$  as a function of junction temperature.

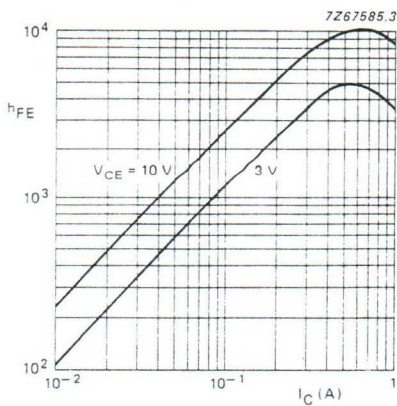


Fig. 6  $T_j = 25^{\circ}\text{C}$ .

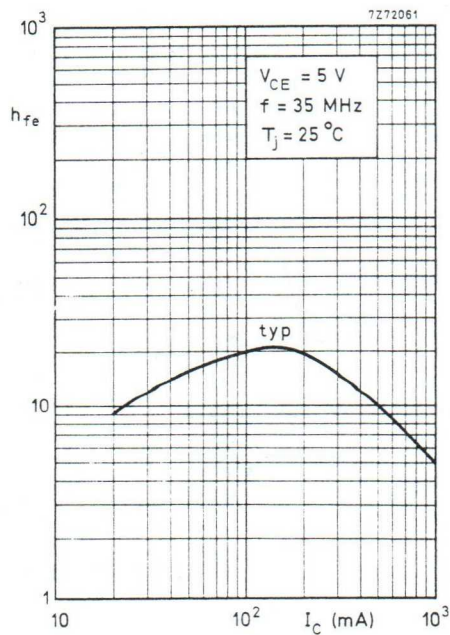


Fig. 7.



## SILICON PLANAR DARLINGTON TRANSISTORS

Silicon pnp planar Darlington transistors for industrial switching applications such as print hammer, solenoid, relay and lamp driving. They are encapsulated in a microminiature plastic SOT-223 envelope.

NPN complements are BSP50, BSP51 and BSP52 respectively.

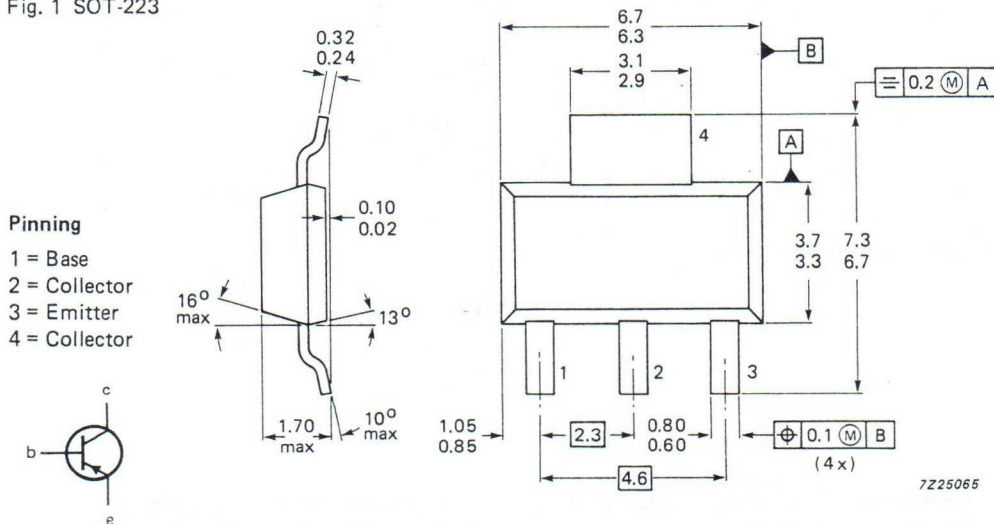
### QUICK REFERENCE DATA

|                                                                                     |              |      | BSP60 | BSP61 | BSP62 |
|-------------------------------------------------------------------------------------|--------------|------|-------|-------|-------|
| Collector-base voltage (open emitter)                                               | $-V_{CBO}$   | max. | 60    | 80    | 90 V  |
| Collector-emitter voltage                                                           | $-V_{CER}$   | max. | 45    | 60    | 80 V  |
| Collector current                                                                   | $-I_C$       | max. | 0,5   | 0,5   | 0,5 A |
| Total power dissipation<br>up to $T_{amb} = 25^\circ\text{C}$                       | $P_{tot}$    | max. | 1,5   |       | W     |
| DC current gain<br>$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$                    | $h_{FE}$     | >    | 2000  |       |       |
| Collector-emitter saturation voltage<br>$-I_C = 0,5\text{ A}; -I_B = 0,5\text{ mA}$ | $-V_{CEsat}$ | <    | 1,3   |       | V     |
| Turn-off time<br>$-I_C = 500\text{ mA}; -I_{Bon} = I_{Boff} = 0,5\text{ mA}$        | $t_{off}$    | typ. | 1500  |       | ns    |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



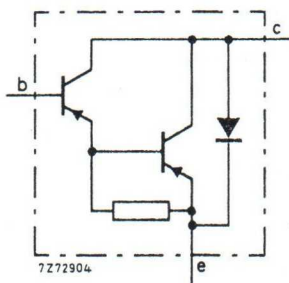


Fig. 2 Circuit diagram.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |               |      | BSP60        | BSP61 | BSP62 |                    |
|--------------------------------------------------------------------------|---------------|------|--------------|-------|-------|--------------------|
| Collector-base voltage (open emitter)                                    | $-V_{CBO}$    | max. | 60           | 80    | 90    | V                  |
| Collector-emitter voltage*                                               | $-V_{CER}$    | max. | 45           | 60    | 80    | V                  |
| Emitter-base voltage (open collector)                                    | $-V_{EBO}$    | max. | 5            |       |       | V                  |
| Collector current (DC)                                                   | $-I_C$        | max. | 0,5          |       |       | A                  |
| Collector current (peak)                                                 | $-I_{CM}$     | max. | 1,5          |       |       | A                  |
| Base current (DC)                                                        | $-I_B$        | max. | 0,1          |       |       | A                  |
| Total power dissipation▲<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$     | max. | 1,5          |       |       | W                  |
| Storage temperature range                                                | $T_{stg}$     |      | -65 to + 150 |       |       | $^{\circ}\text{C}$ |
| Junction temperature**                                                   | $T_j$         | max. | 150          |       |       | $^{\circ}\text{C}$ |
| <b>THERMAL RESISTANCE**</b>                                              |               |      |              |       |       |                    |
| From junction to ambient▲                                                | $R_{th\ j-a}$ | =    | 83,3         |       |       | K/W                |

\* External  $R_{BE}$  not to exceed value shown in Fig. 5.

\*\* Based on maximum average junction temperature in line with common industrial practice.  
The resulting higher junction temperature of the output transistor part is taken into account.

▲ Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$V_{BE} = 0; -V_{CE} = -V_{CERmax}$

$-I_{CES} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

$-I_{EBO} < 10\text{ }\mu\text{A}$

DC current gain\*

$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$

$h_{FE} > 1000$

$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$

$h_{FE} > 2000$

Collector-emitter saturation voltage

$-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}$

$-V_{CEsat} < 1,3\text{ V}$

$-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}; T_j = 150\text{ }^{\circ}\text{C}$

$-V_{CEsat} < 1,3\text{ V}$

Base-emitter saturation voltage

$-I_C = 500\text{ mA}; -I_B = 0,5\text{ mA}$

$-V_{BEsat} < 1,9\text{ V}$

Switching times (see also Fig. 3 and Fig. 4)

$-I_C = 500\text{ mA}; -I_{Bon} = -I_{Boff} = 0,5\text{ mA}$

Turn-on time

$t_{on} \text{ typ. } 400\text{ ns}$

Turn-off time

$t_{off} \text{ typ. } 1500\text{ ns}$

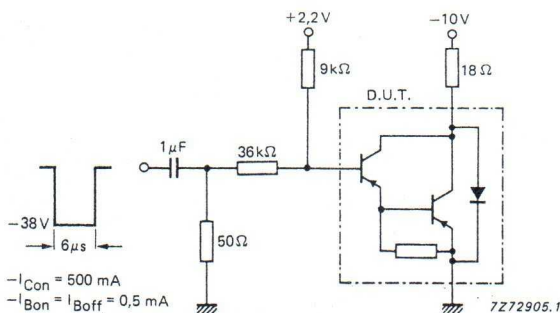


Fig. 3 Switching times test circuit.

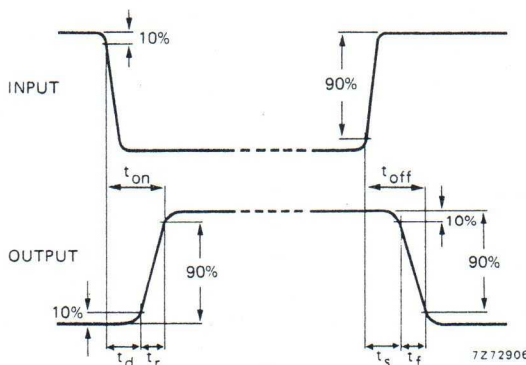


Fig. 4 Switching times waveform.

\* Measured under pulsed conditions.

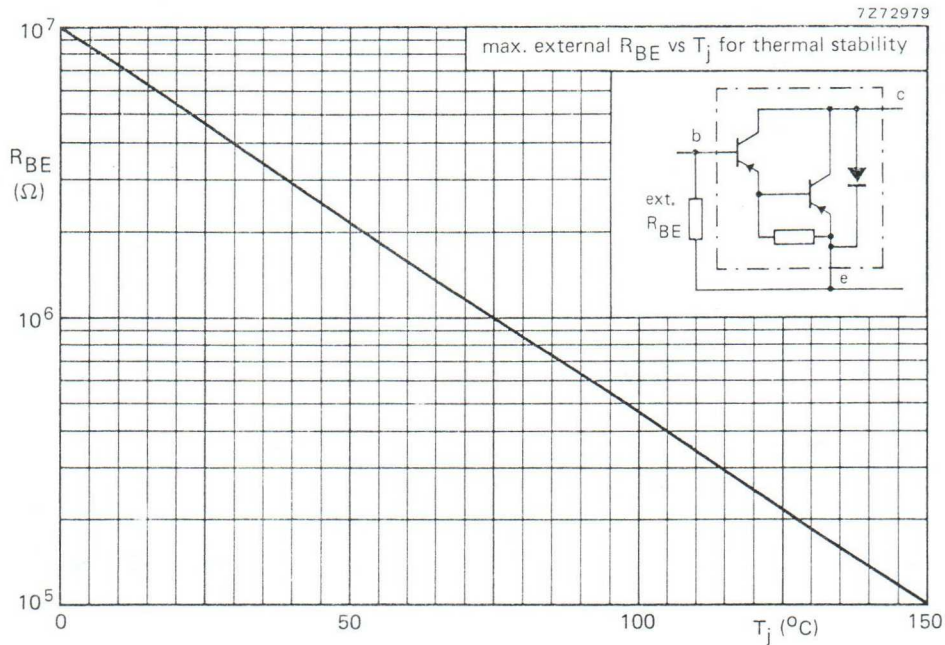


Fig. 5 Maximum values external  $R_{BE}$  as a function of junction temperature.

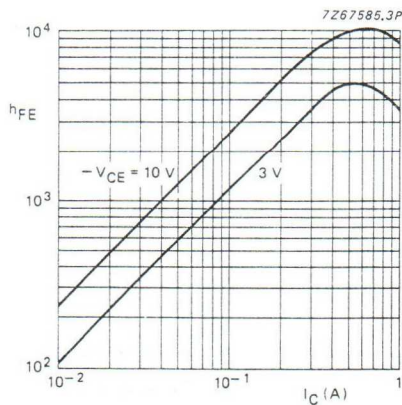


Fig. 6  $T_j = 25^{\circ}\text{C}$ .

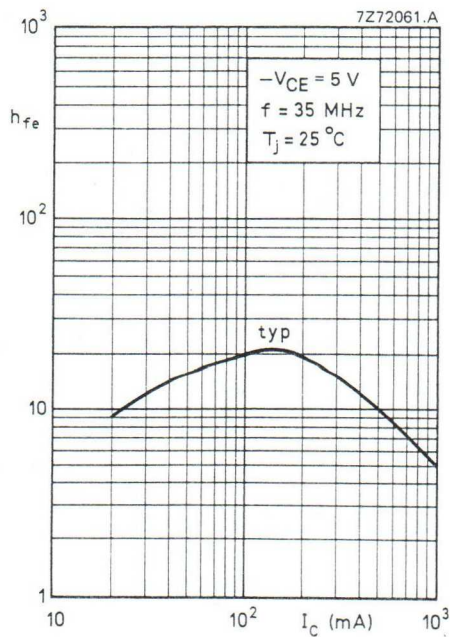


Fig. 7.

| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# BSP103/BSP105/BSP109

## N-channel enhancement mode vertical D-MOS transistors

### FEATURES

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown
- Low  $R_{DS(on)}$

### DESCRIPTION

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope, designed for application as low power, high frequency inverters and line drivers.

### PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | drain       |
| 3   | source      |
| 4   | drain       |

### MARKING CODES

BSP103: BSP103

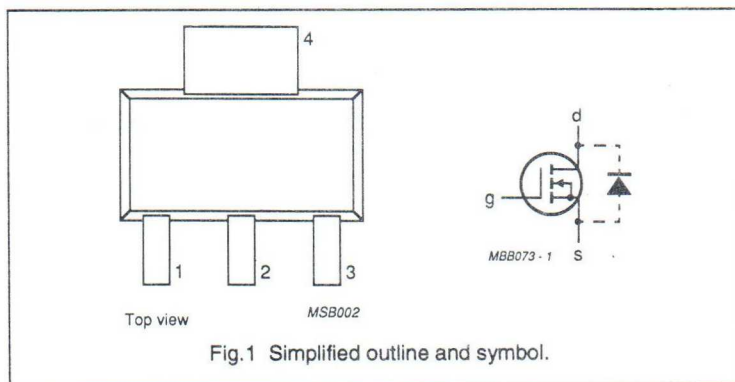
BSP105: BSP105

BSP109: BSP109

### QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                                                    | CONDITIONS                                   | MAX.              | UNIT                             |
|--------------|--------------------------------------------------------------|----------------------------------------------|-------------------|----------------------------------|
| $V_{DS}$     | drain-source voltage<br>BSP103<br>BSP105<br>BSP109           |                                              | 35<br>60<br>90    | V<br>V<br>V                      |
| $I_D$        | drain current<br>BSP103<br>BSP105<br>BSP109                  | DC value                                     | 700<br>500<br>450 | mA<br>mA<br>mA                   |
| $R_{DS(on)}$ | drain-source on-resistance<br><br>BSP103<br>BSP105<br>BSP109 | $I_D = 1\text{ A}$<br>$V_{GS} = 10\text{ V}$ | 1.8<br>3<br>4     | $\Omega$<br>$\Omega$<br>$\Omega$ |
| $V_{GS(th)}$ | gate-source threshold voltage                                | $I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$     | 2                 | V                                |

### PIN CONFIGURATION





# N-channel enhancement mode vertical D-MOS transistors

**BSP103/BSP105/BSP109**
**LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                   | MIN. | MAX. | UNIT               |
|---------------|---------------------------|----------------------------------------------|------|------|--------------------|
| $V_{DS}$      | drain-source voltage      |                                              |      |      |                    |
|               | BSP103                    |                                              | —    | 35   | V                  |
|               | BSP105                    |                                              | —    | 60   | V                  |
|               | BSP109                    |                                              | —    | 90   | V                  |
| $\pm V_{GSO}$ | gate-source voltage       | open drain                                   | —    | 30   | V                  |
| $I_D$         | drain current             | DC value                                     |      |      |                    |
|               | BSP103                    |                                              | —    | 700  | mA                 |
|               | BSP105                    |                                              | —    | 500  | mA                 |
|               | BSP109                    |                                              | —    | 450  | mA                 |
| $I_{DM}$      | drain current             | peak value                                   | —    | 1    | A                  |
| $P_{tot}$     | total power dissipation   | up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | —    | 1.5  | W                  |
| $T_{stg}$     | storage temperature range |                                              | —65  | 150  | $^{\circ}\text{C}$ |
| $T_j$         | junction temperature      |                                              | —    | 150  | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                            | VALUE | UNIT |
|---------------|--------------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient<br>(note 1) | 83.3  | K/W  |

**Note**

1. Device mounted on an epoxy printed-circuit board,  
40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead minimum  
6 mm<sup>2</sup>.

# N-channel enhancement mode vertical D-MOS transistors

## BSP103/BSP105/BSP109

### CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                            | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$                             | drain-source breakdown voltage | $I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                         |      |      |      |               |
|                                           | BSP103                         |                                                                                       | 35   | —    | —    | V             |
|                                           | BSP105                         |                                                                                       | 60   | —    | —    | V             |
|                                           | BSP109                         |                                                                                       | 90   | —    | —    | V             |
| $I_{DSS}$                                 | drain-source leakage current   | $V_{DS} = V_{DS\text{ max.}}$<br>$V_{GS} = 0$                                         | —    | —    | 10   | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $\pm V_{GS} = 15\text{ V}$<br>$V_{DS} = 0$                                            | —    | —    | 100  | nA            |
| $V_{GS(th)}$                              | gate-source threshold voltage  | $I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                              | 0.8  | —    | 2    | V             |
| $I_{D(on)}$                               | on-state drain current         | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 10\text{ V}$                                      | 1    | 2    | —    | A             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $I_D = 300\text{ mA}$<br>$V_{GS} = 5\text{ V}$                                        |      |      |      |               |
|                                           | BSP103                         |                                                                                       | —    | 1.5  | 5    | $\Omega$      |
|                                           | BSP105                         |                                                                                       | —    | 1.8  | 5    | $\Omega$      |
|                                           | BSP109                         |                                                                                       | —    | 2.4  | 5.3  | $\Omega$      |
|                                           |                                | $I_D = 1\text{ A}$<br>$V_{GS} = 10\text{ V}$                                          |      |      |      |               |
|                                           | BSP103                         |                                                                                       | —    | 0.9  | 1.8  | $\Omega$      |
|                                           | BSP105                         |                                                                                       | —    | 1.4  | 3    | $\Omega$      |
|                                           | BSP109                         |                                                                                       | —    | 1.9  | 4    | $\Omega$      |
| $ y_{fs} $                                | transfer admittance            | $I_D = 500\text{ mA}$<br>$V_{DS} = 25\text{ V}$                                       | 170  | —    | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | —    | 60   | pF            |
| $C_{oss}$                                 | output capacitance             | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          |      |      |      |               |
|                                           | BSP103                         |                                                                                       | —    | —    | 50   | pF            |
|                                           | BSP105                         |                                                                                       | —    | —    | 40   | pF            |
|                                           | BSP109                         |                                                                                       | —    | —    | 40   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | —    | 15   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                       |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $I_D = 500\text{ mA}$<br>$V_{DD} = 25\text{ V}$<br>$V_{GS} = 0\text{ to }10\text{ V}$ | —    | —    | 10   | ns            |

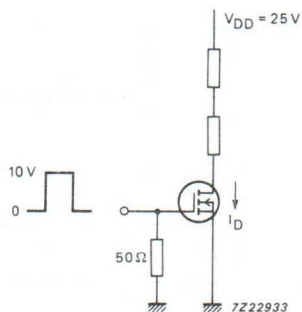
**N-channel enhancement mode  
vertical D-MOS transistors****BSP103/BSP105/BSP109**

Fig.2 Switching time test circuit.

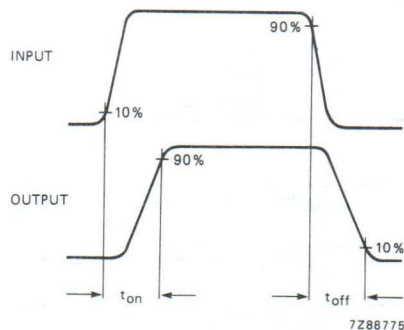


Fig.3 Input and output waveforms.

| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# BSP106

## N-channel enhancement mode vertical D-MOS transistor

### FEATURES

- Very low  $R_{DS(on)}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.

### DESCRIPTION

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use in relay, high-speed and line transformer drivers.

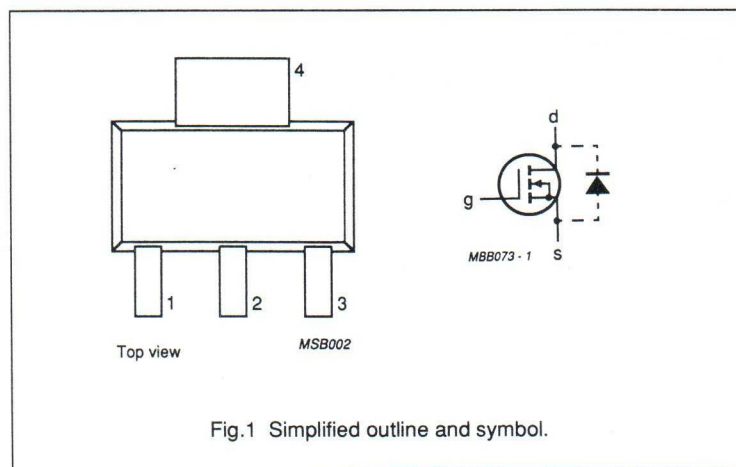
### PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | drain       |
| 3   | source      |
| 4   | drain       |

### QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                     | CONDITIONS                                        | MAX. | UNIT     |
|--------------|-------------------------------|---------------------------------------------------|------|----------|
| $V_{DS}$     | drain-source voltage          | —                                                 | 60   | V        |
| $I_D$        | drain current                 | DC value                                          | 425  | mA       |
| $R_{DS(on)}$ | drain-source on-resistance    | $I_D = 200 \text{ mA}$<br>$V_{GS} = 10 \text{ V}$ | 4    | $\Omega$ |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1 \text{ mA}$<br>$V_{GS} = V_{DS}$         | 3    | V        |

### PIN CONFIGURATION



# N-channel enhancement mode vertical D-MOS transistor

**BSP106**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                 | MIN. | MAX. | UNIT |
|---------------|---------------------------|--------------------------------------------|------|------|------|
| $V_{DS}$      | drain-source voltage      |                                            | —    | 60   | V    |
| $V_{DG}$      | drain-gate voltage        |                                            | —    | 60   | V    |
| $\pm V_{GSO}$ | gate-source voltage       |                                            | —    | 20   | V    |
| $I_D$         | drain current             | DC value                                   | —    | 425  | mA   |
| $I_{DM}$      | drain current             | peak value                                 | —    | 850  | mA   |
| $P_{tot}$     | total power dissipation   | up to $T_{amb} = 25\text{ °C}$<br>(note 1) | —    | 1.5  | W    |
| $T_{stg}$     | storage temperature range |                                            | −55  | 150  | °C   |
| $T_j$         | junction temperature      |                                            | —    | 150  | °C   |

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                            | VALUE | UNIT |
|---------------|--------------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient<br>(note 1) | 83.3  | K/W  |

## Note

1. Device mounted on an epoxy printed-circuit board 40 x 40 x 1.5 mm;  
mounting pad for the drain lead minimum 6 cm<sup>2</sup>.



# N-channel enhancement mode vertical D-MOS transistor

**BSP106**
**CHARACTERISTICS**
 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                            | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$                             | drain-source breakdown voltage | $I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                         | 60   | 90   | —    | V             |
| $I_{DSS}$                                 | drain-source leakage current   | $V_{DS} = 48\text{ V}$<br>$V_{GS} = 0$                                                | —    | —    | 1    | $\mu\text{A}$ |
|                                           |                                | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$                                                | —    | —    | 0.5  | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $V_{DS} = 0$<br>$\pm V_{GS} = 15\text{ V}$                                            | —    | —    | 10   | nA            |
| $V_{GS(th)}$                              | gate-source threshold voltage  | $I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                              | 0.8  | —    | 3    | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $I_D = 200\text{ mA}$<br>$V_{GS} = 10\text{ V}$                                       | —    | 2.5  | 4    | $\Omega$      |
| $ Y_{fs} $                                | transfer admittance            | $I_D = 200\text{ mA}$<br>$V_{DS} = 10\text{ V}$                                       | 100  | 200  | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 25   | 40   | pF            |
| $C_{oss}$                                 | output capacitance             | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 22   | 30   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 6    | 10   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                       |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $I_D = 200\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0\text{ to }10\text{ V}$ | —    | 2    | 5    | ns            |
| $t_{off}$                                 | turn-off time                  | $I_D = 200\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0\text{ to }10\text{ V}$ | —    | 10   | 15   | ns            |

# N-channel enhancement mode vertical D-MOS transistor

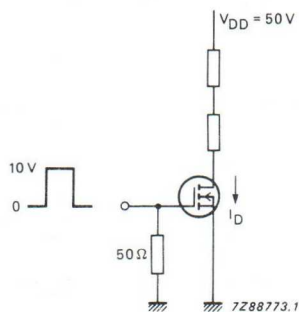
**BSP106**


Fig.2 Switching time test circuit.

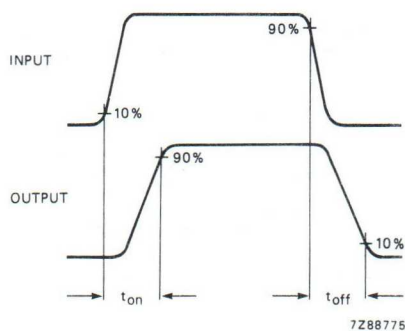


Fig.3 Input and output waveforms.

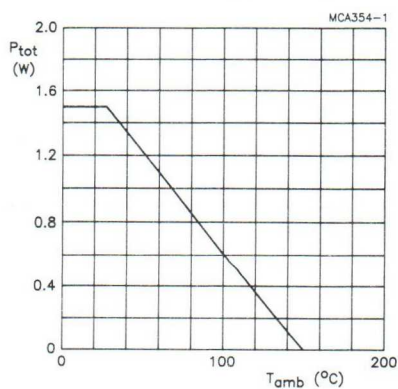
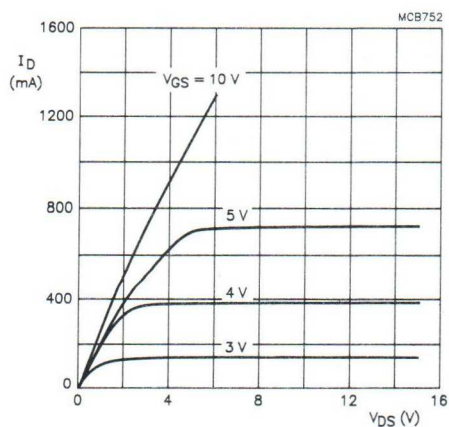


Fig.4 Power derating curve.


 Fig.5 Typical output characteristics;  $T_j = 25\text{ }^{\circ}\text{C}$ .

# N-channel enhancement mode vertical D-MOS transistor

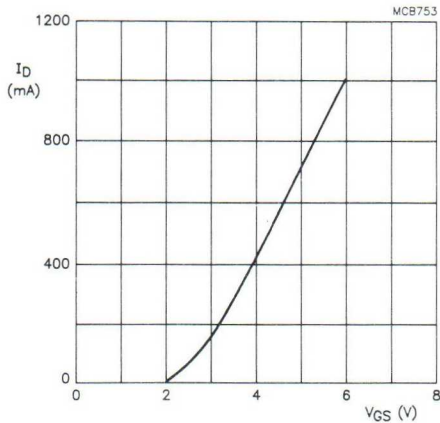
**BSP106**


Fig.6 Typical transfer characteristic;  $V_{DS} = 10$  V;  
 $T_J = 25$  °C.

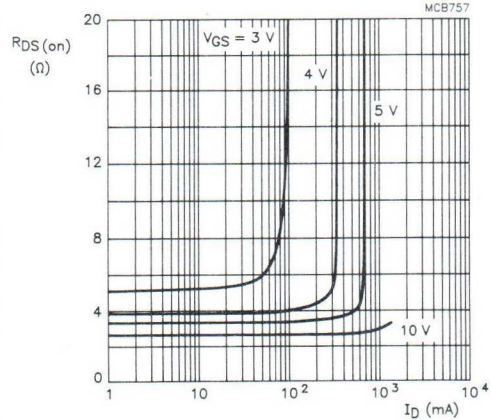


Fig.7 Typical on-resistance as a function of  
drain current;  $T_J = 25$  °C.

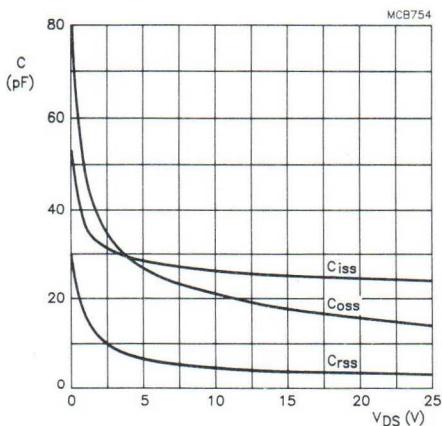


Fig.8 Typical capacitances as a function of  
drain-source voltage;  $V_{GS} = 0$ ;  $f = 1$  MHz;  
 $T_J = 25$  °C.

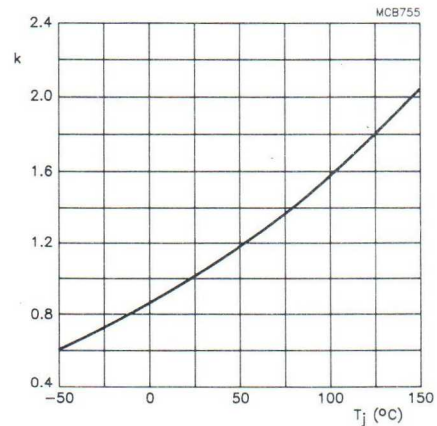


Fig.9 Temperature coefficient of drain-source  
on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_J}{R_{DS(on)} \text{ at } 25 \text{ °C}}$ ; typical  $R_{DS(on)}$   
at 200 mA/10 V.

# N-channel enhancement mode vertical D-MOS transistor

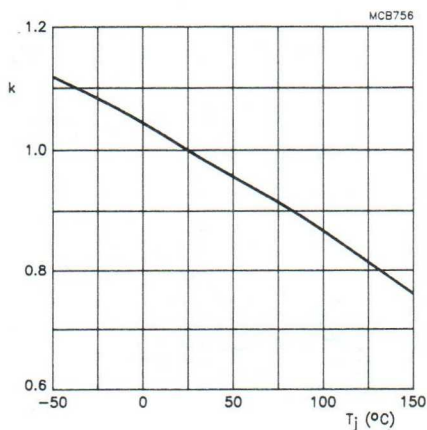
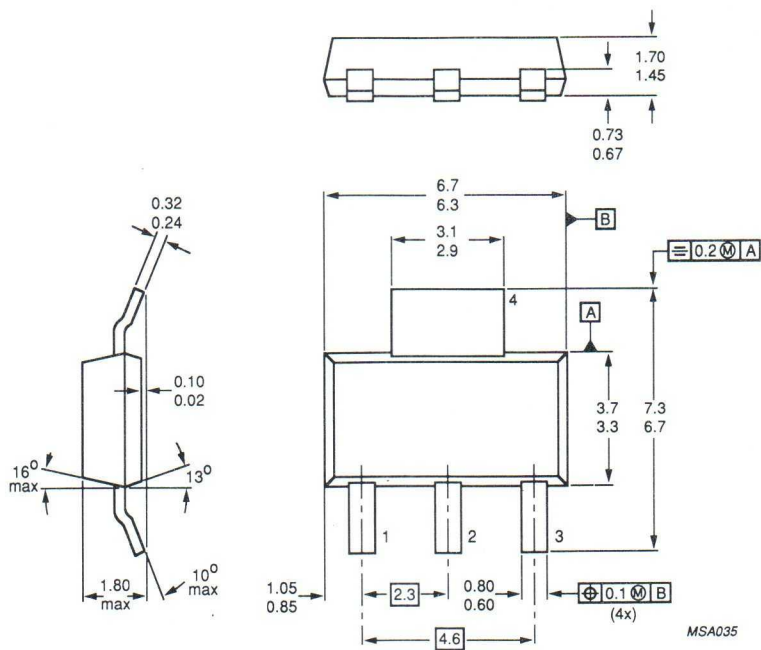
**BSP106**


Fig.10 Temperature coefficient of gate-source threshold voltage;  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ; typical  $V_{GS(th)}$  at 1 mA.

# N-channel enhancement mode vertical D-MOS transistor

**BSP106**

## PACKAGE OUTLINE

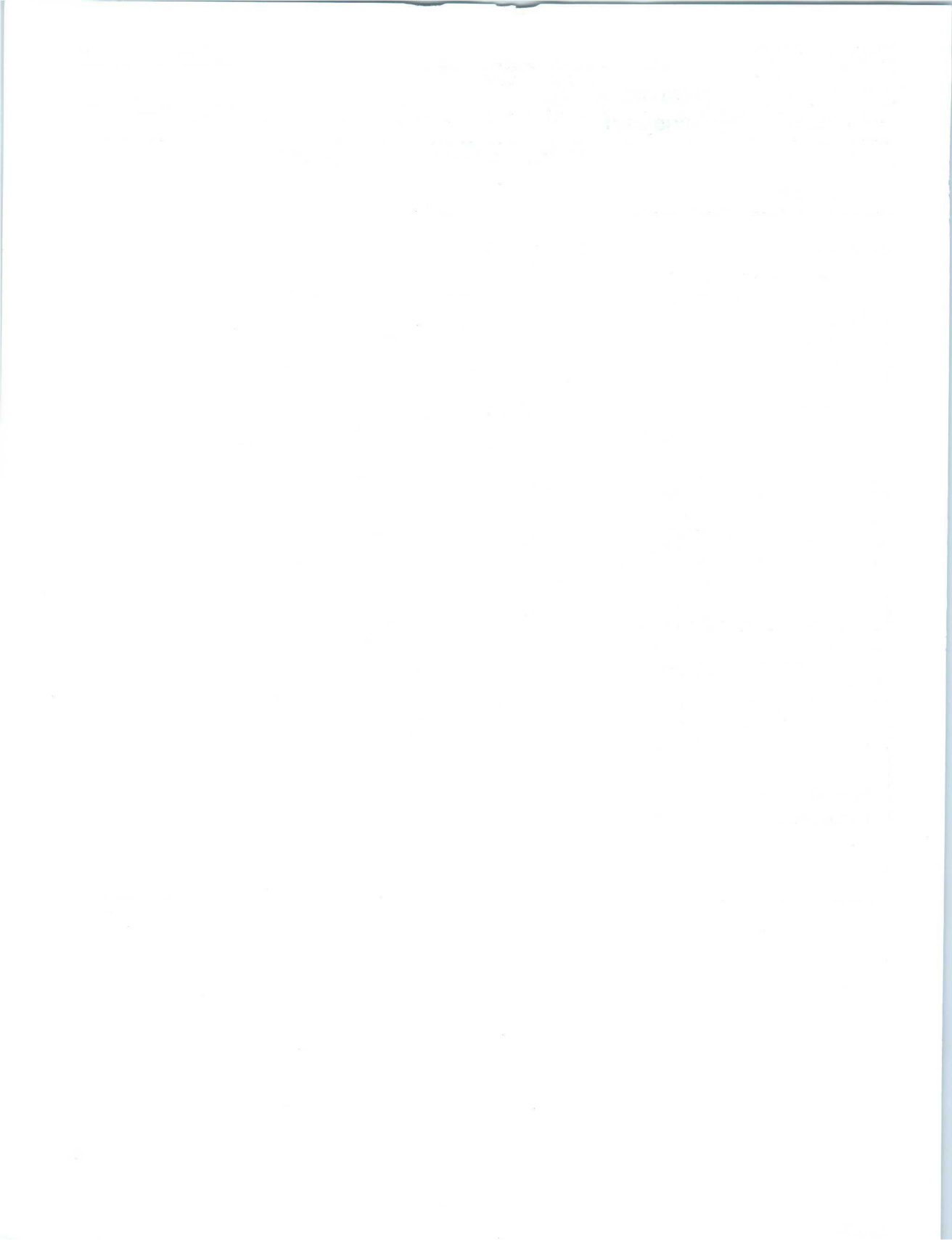


Dimensions in mm.

**Marking code:** BSP106.

Fig.11 SOT223.





| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# BSP107

## N-channel enhancement mode vertical D-MOS transistor

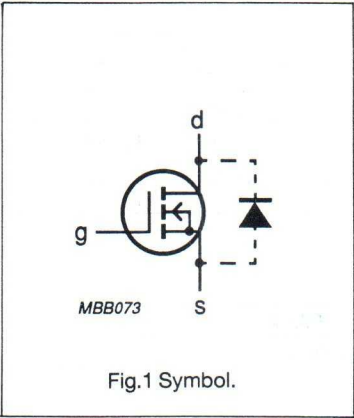
FEATURES

- Direct interface to C-MOS, TTL, etc., due to low threshold voltage
- High speed switching
- No secondary breakdown

DESCRIPTION

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use as a line current interruptor in telephone sets and for applications in relay, high speed and line transformer driver switching.

PIN CONFIGURATION



PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | drain       |
| 3   | source      |
| 4   | drain       |

QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                  | MAX. | UNIT     |
|--------------|----------------------------|------|----------|
| $V_{DS}$     | drain-source voltage       | 200  | V        |
| $I_D$        | drain current              | 200  | mA       |
| $R_{DS(on)}$ | drain-source on-resistance | 28   | $\Omega$ |
| $V_{GS(th)}$ | gate threshold voltage     | 2.4  | V        |

# N-channel enhancement mode vertical D-MOS transistor

**BSP107****LIMITING VALUES**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

| SYMBOL        | PARAMETER                      | CONDITIONS                                   | MIN. | MAX. | UNIT               |
|---------------|--------------------------------|----------------------------------------------|------|------|--------------------|
| $V_{DS}$      | drain-source voltage           |                                              | -    | 200  | V                  |
| $\pm V_{GSO}$ | gate-source voltage            | open drain                                   | -    | 20   | V                  |
| $I_D$         | drain current                  | DC                                           | -    | 200  | mA                 |
| $I_{DM}$      | drain current                  | peak                                         | -    | 350  | mA                 |
| $P_{tot}$     | total power dissipation        | up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | -    | 1.5  | W                  |
| $T_{stg}$     | storage temperature range      |                                              | -65  | 150  | $^{\circ}\text{C}$ |
| $T_j$         | operating junction temperature |                                              | -    | 150  | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                         | VALUE | UNIT |
|---------------|-----------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient (note 1) | 83.3  | K/W  |

**Notes**

1. Device mounted on an epoxy printed circuit board, 40 mm x 40 mm x 1.5 mm. Mounting pad for the drain lead minimum 6 cm<sup>2</sup>.

# N-channel enhancement mode vertical D-MOS transistor

**BSP107****CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                    | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|-------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$                             | drain-source breakdown voltage | $V_{GS} = 0$<br>$I_D = 10\text{ }\mu\text{A}$                                 | 200  | -    | -    | V             |
| $I_{DSS}$                                 | drain-source leakage current   | $V_{DS} = 130\text{ V}$<br>$V_{GS} = 0$                                       | -    | -    | 30   | nA            |
| $I_{DSX}$                                 | drain-source leakage current   | $V_{DS} = 70\text{ V}$<br>$V_{GS} = 0.2\text{ V}$                             | -    | -    | 1    | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $\pm V_{GS} = 15\text{ V}$<br>$V_{DS} = 0$                                    | -    | -    | 10   | nA            |
| $V_{GS(th)}$                              | gate threshold voltage         | $I_D = 1\text{ mA}$<br>$V_{DS} = V_{GS}$                                      | 0.8  | -    | 2.4  | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $I_D = 20\text{ mA}$<br>$V_{GS} = 2.6\text{ V}$                               | -    | 20   | 28   | $\Omega$      |
| $R_{DS(on)}$                              | drain-source on-resistance     | $I_D = 150\text{ mA}$<br>$V_{GS} = 10\text{ V}$                               | -    | 14   | -    | $\Omega$      |
| $ Y_{fs} $                                | transfer admittance            | $I_D = 250\text{ mA}$<br>$V_{DS} = 15\text{ V}$                               | 90   | 180  | -    | mS            |
| $C_{iss}$                                 | input capacitance              | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 50   | 65   | pF            |
| $C_{oss}$                                 | output capacitance             | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 16   | 25   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 4    | 10   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                               |      |      |      |               |
| $t_{on}$                                  | switching-on time              | $I_D = 250\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0 - 10\text{ V}$ | -    | 2    | 10   | ns            |
| $t_{off}$                                 | switching-off time             | $I_D = 250\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0 - 10\text{ V}$ | -    | 5    | 20   | ns            |

# N-channel enhancement mode vertical D-MOS transistor

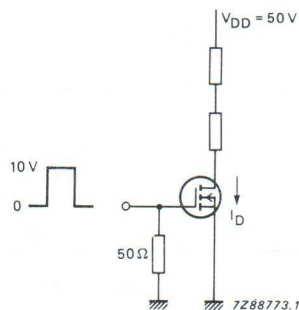
**BSP107**


Fig.2 Switching time test circuit.

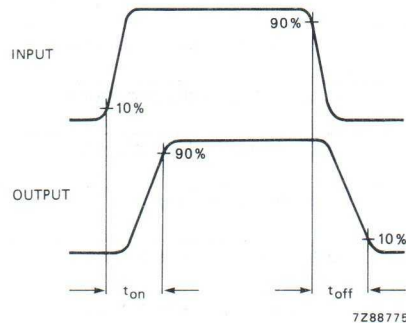
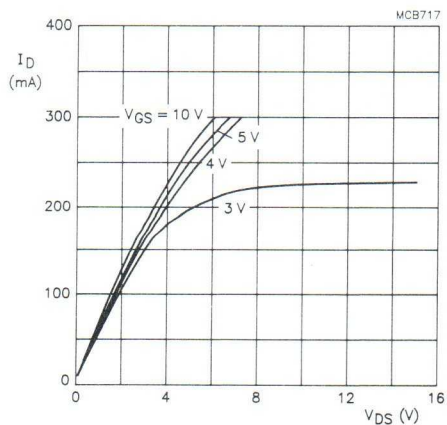
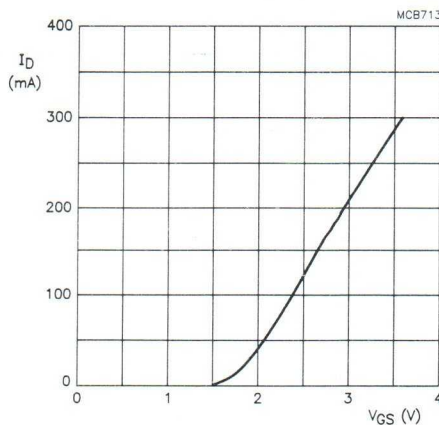


Fig.3 Input and output waveforms.


 Fig.4 Typical output characteristics;  $T_j = 25^\circ\text{C}$ .

 Fig.5 Typical transfer characteristics;  $V_{DS} = 10\text{V}$ ;  $T_j = 25^\circ\text{C}$ .



# N-channel enhancement mode vertical D-MOS transistor

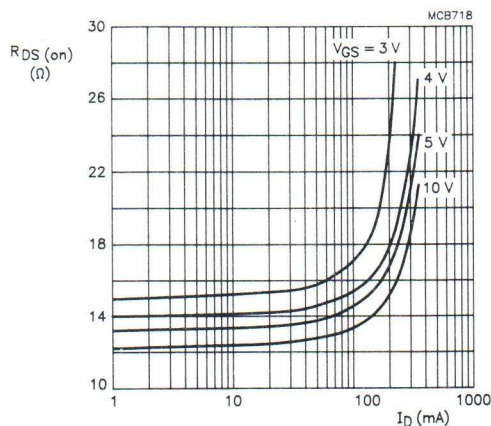
**BSP107**


Fig.6 Typical on-resistance as a function of drain current;  $T_j = 25^\circ\text{C}$ .

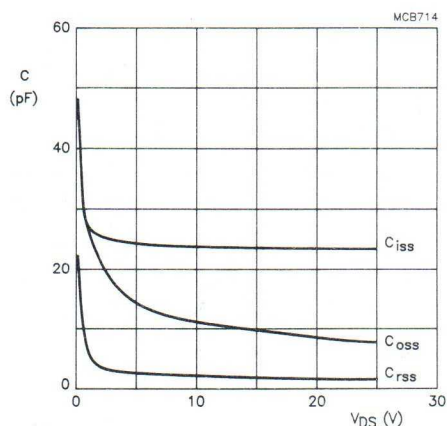


Fig.7 Typical capacitances as a function of drain-source voltage;  $V_{GS} = 0$ ;  $f = 1\text{ MHz}$ ;  $T_j = 25^\circ\text{C}$

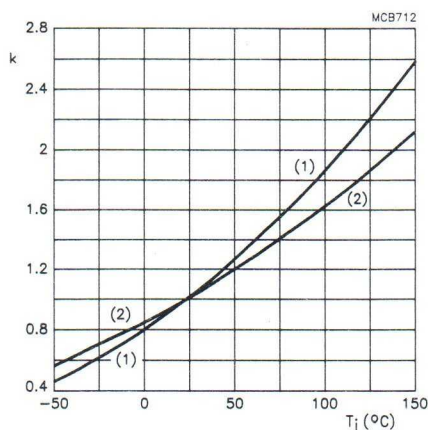


Fig.8 Temperature coefficient of drain-source on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_j}{R_{DS(on)} \text{ at } 25^\circ\text{C}}$ ; typical  $R_{DS(on)}$  at 150 mA/10 V;  
(1)  $I_D = 150\text{ mA}$ ;  $V_{GS} = 10\text{ V}$ ;  
(2)  $I_D = 20\text{ mA}$ ;  $V_{GS} = 2.6\text{ V}$ ;

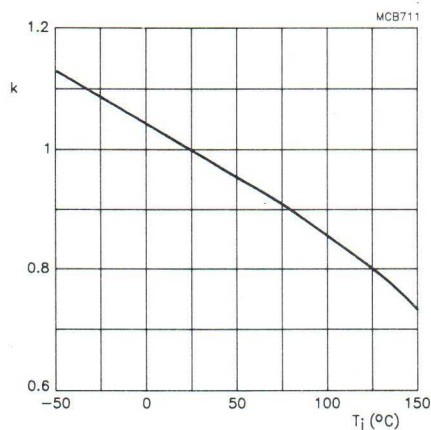


Fig.9 Temperature coefficient of gate-source threshold voltage;  
 $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ; typical  $V_{GS(th)}$  at 1 mA.

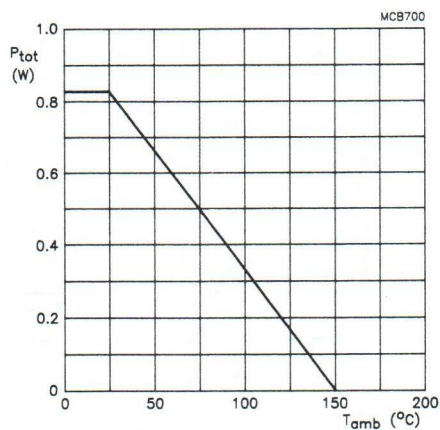
**N-channel enhancement mode vertical  
D-MOS transistor****BSP107**

Fig.10 Power derating curve.

**BSP107**

Dimensions in mm

BSP107 = BSP107

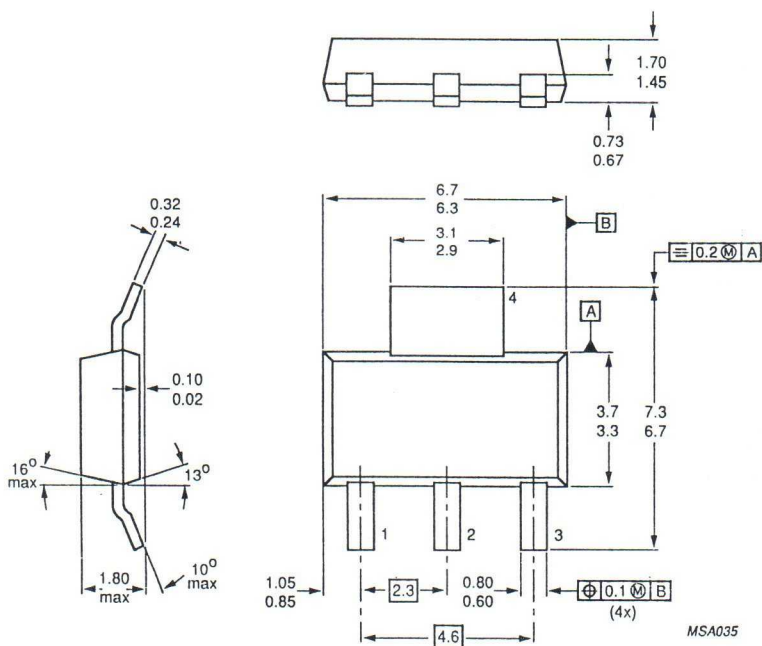


Fig.11 SOT223



# N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use in relay, high-speed and line-transformer drivers.

## Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

|                                                                           |                    |              |                              |
|---------------------------------------------------------------------------|--------------------|--------------|------------------------------|
| Drain-source voltage                                                      | $V_{DS}$           | max.         | 80 V                         |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$      | max.         | 20 V                         |
| Drain current (DC)                                                        | $I_D$              | max.         | 500 mA                       |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$      | $P_{tot}$          | max.         | 1.5 W                        |
| Drain-source ON-resistance<br>$I_D = 500\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DS\text{ on}}$ | typ.<br>max. | 2.0 $\Omega$<br>3.0 $\Omega$ |
| Transfer admittance<br>$I_D = 500\text{ mA}; V_{DS} = 15\text{ V}$        | $ y_{fs} $         | min.<br>typ. | 150 mS<br>300 mS             |

## MECHANICAL DATA

Dimensions in mm

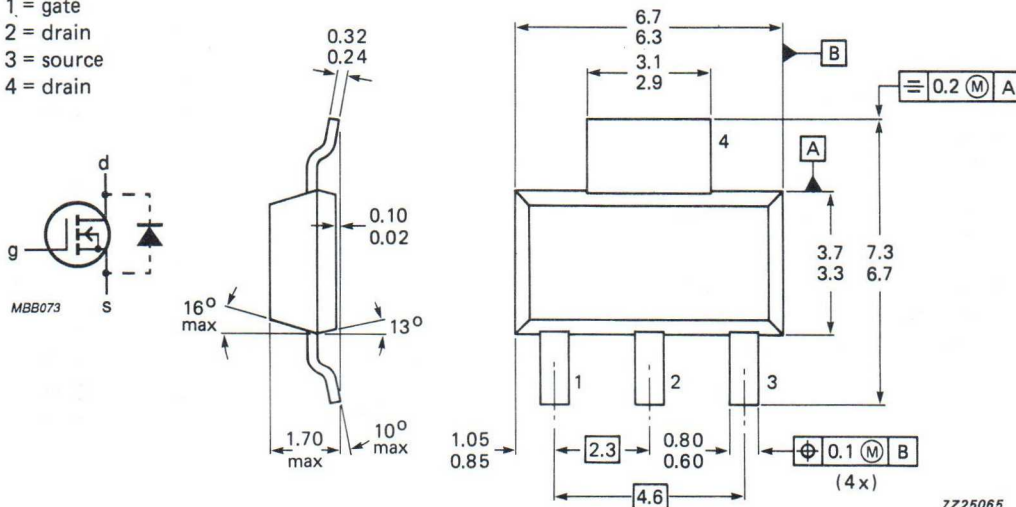
Marking code

Fig.1 SOT223.

BSP108

## Pinning

- 1 = gate  
2 = drain  
3 = source  
4 = drain





**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |              |                        |
|-------------------------------------------------------------------------------|---------------|--------------|------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max.         | 80 V                   |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max.         | 20 V                   |
| Drain current (DC)                                                            | $I_D$         | max.         | 500 mA                 |
| Drain current (peak)                                                          | $I_{DM}$      | max.         | 1.0 A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max.         | 1.5 W                  |
| Storage temperature range                                                     | $T_{stg}$     | —65 to + 150 | $^{\circ}\text{C}$     |
| Junction temperature                                                          | $T_j$         | max.         | 150 $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                                   |               |   |          |
|-----------------------------------|---------------|---|----------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 83.3 K/W |
|-----------------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                           |                           |                                  |                                    |
|-----------------------------------------------------------------------------------------------------------|---------------------------|----------------------------------|------------------------------------|
| Drain-source breakdown voltage<br>$I_D = 10\text{ }\mu\text{A}; V_{GS} = 0$                               | $V_{(BR)DSS}$             | min.                             | 80 V                               |
| Gate threshold voltage<br>$I_D = 1\text{ mA}; V_{GS} = V_{DS}$                                            | $V_{GS(th)}$              | min.<br>max.                     | 1.5 V<br>3.5 V                     |
| Gate-source leakage current<br>$\pm V_{GS} = 20\text{ V}; V_{DS} = 0$                                     | $I_{GSS}$                 | max.                             | 100 nA                             |
| Drain-source leakage current<br>$V_{DS} = 60\text{ V}; V_{GS} = 0$                                        | $I_{DSS}$                 | max.                             | 1.0 $\mu\text{A}$                  |
| Drain-source ON-resistance<br>$I_D = 500\text{ mA}; V_{GS} = 10\text{ V}$                                 | $R_{DS\ on}$              | typ.<br>max.                     | 2.0 $\Omega$<br>3.0 $\Omega$       |
| Transfer admittance<br>$I_D = 500\text{ mA}; V_{DS} = 15\text{ V}$                                        | $ y_{fs} $                | min.<br>typ.                     | 150 mS<br>300 mS                   |
| Input capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                            | $C_{iss}$                 | typ.<br>max.                     | 45 pF<br>60 pF                     |
| Output capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                           | $C_{oss}$                 | typ.<br>max.                     | 30 pF<br>45 pF                     |
| Feedback capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                         | $C_{rss}$                 | typ.<br>max.                     | 8 pF<br>12 pF                      |
| Switching times (see Figs 2 and 3)<br>$I_D = 500\text{ mA}; V_{DD} = 50\text{ V}$<br>$V_{GS} = 0$ to 10 V | $t_{on}$<br><br>$t_{off}$ | typ.<br>max.<br><br>typ.<br>max. | 4 ns<br>8 ns<br><br>10 ns<br>15 ns |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the collector lead min. 6 cm<sup>2</sup>.

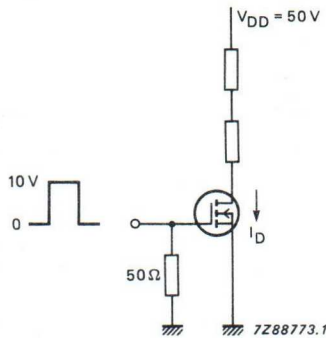


Fig.2 Switching times test circuit.

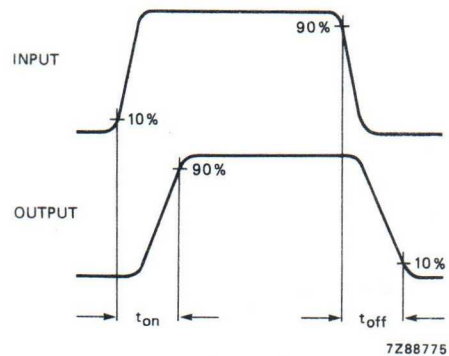


Fig.3 Input and output waveforms.

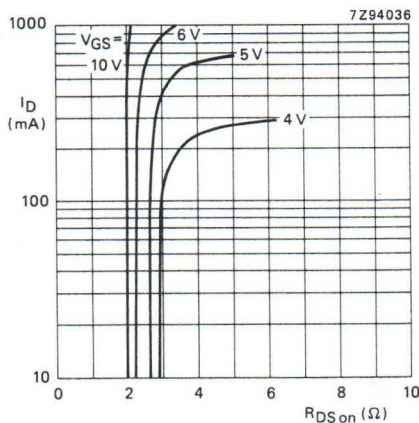
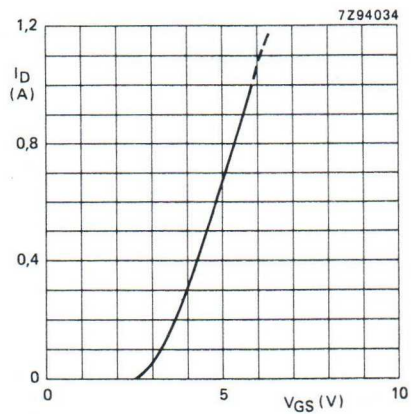
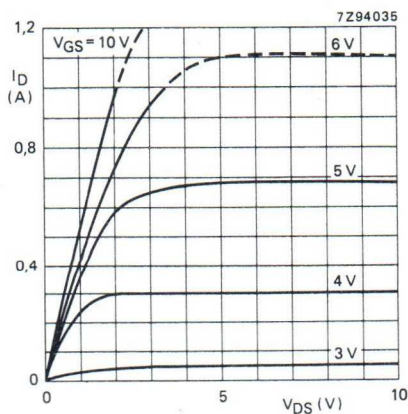
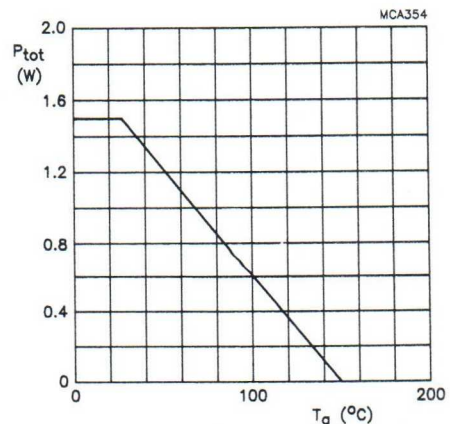
Fig.4  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.Fig.5  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values at  $V_{DS} = 10\text{ V}$ .Fig.6  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

Fig.7 Power derating curve.

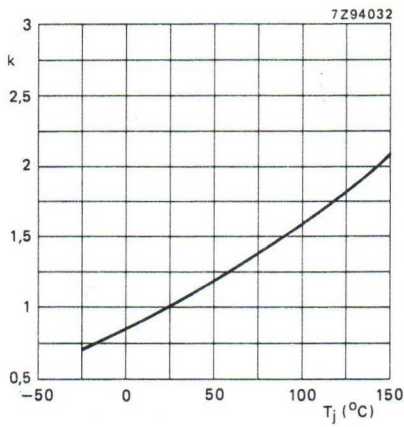


Fig. 8  $k = \frac{R_{DS\text{ on at } T_j}}{R_{DS\text{ on at } 25^\circ\text{C}}}$ ; typ. values at 500 mA/10 V.

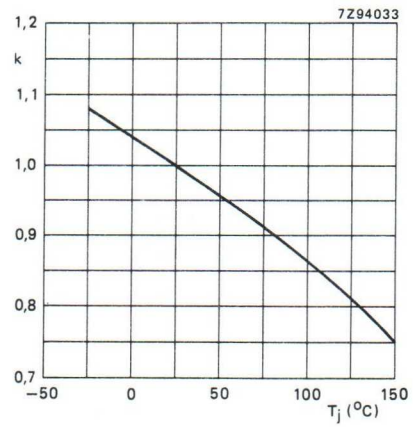


Fig. 9  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ;  $V_{GS(th)}$  at 1 mA; typical values.

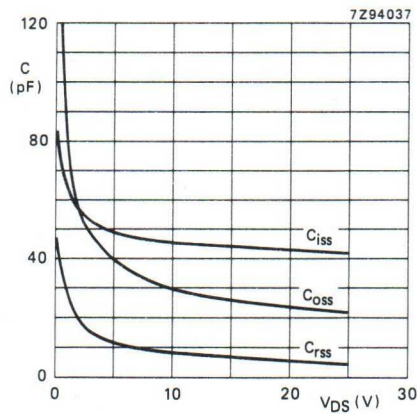


Fig. 10  $T_j = 25^\circ\text{C}$ ;  $V_{GS} = 0$ ;  $f = 1\text{ MHz}$ ; typical values.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and designed for use in telephone ringer circuits and for application with relay, high-speed and line transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

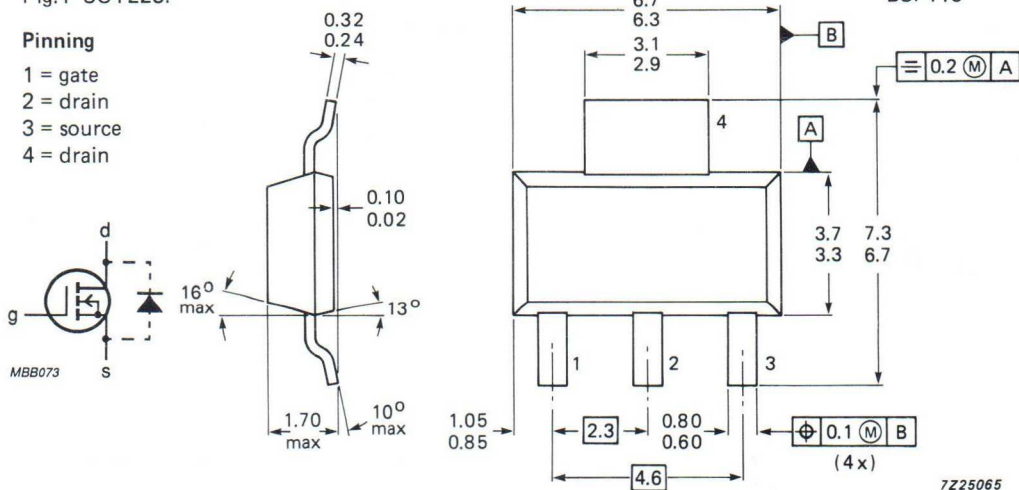
|                                                                |               |              |                            |
|----------------------------------------------------------------|---------------|--------------|----------------------------|
| Drain-source voltage                                           | $V_{DS}$      | max.         | 80 V                       |
| Drain-source voltage<br>(non-repetitive peak; $t_p \leq 2$ ms) | $V_{DS(SM)}$  | max.         | 100 V                      |
| Gate-source voltage (open drain)                               | $\pm V_{GSO}$ | max.         | 20 V                       |
| Drain current (DC)                                             | $I_D$         | max.         | 325 mA                     |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$     | $P_{tot}$     | max.         | 1.5 W                      |
| Drain-source ON-resistance<br>$I_D = 200$ mA; $V_{GS} = 10$ V  | $R_{DS(on)}$  | typ.<br>max. | 4.5 $\Omega$<br>7 $\Omega$ |
| Transfer admittance<br>$I_D = 200$ mA; $V_{DS} = 15$ V         | $ Y_{fs} $    | min.<br>typ. | 75 mS<br>150 mS            |

### MECHANICAL DATA

Fig.1 SOT223.

#### Pinning

- 1 = gate  
2 = drain  
3 = source  
4 = drain



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |               |      |                 |
|----------------------------------------------------------------|---------------|------|-----------------|
| Drain-source voltage                                           | $V_{DS}$      | max. | 80 V            |
| Drain-source voltage<br>(non-repetitive peak; $t_p \leq 2$ ms) | $V_{DS(SM)}$  | max. | 100 V           |
| Gate-source voltage (open drain)                               | $\pm V_{GSO}$ | max. | 20 V            |
| Drain current (DC)                                             | $I_D$         | max. | 325 mA          |
| Drain current (peak)                                           | $I_{DM}$      | max. | 650 mA          |
| Total power dissipation up to $T_{amb} = 25$ °C (note 1)       | $P_{tot}$     | max. | 1.5 W           |
| Storage temperature range                                      | $T_{stg}$     | max. | -65 to + 150 °C |
| Junction temperature                                           | $T_j$         | max. | 150 °C          |

**THERMAL RESISTANCE**

|                                   |               |   |          |
|-----------------------------------|---------------|---|----------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 83.3 K/W |
|-----------------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25$  °C unless otherwise specified

|                                                                          |               |              |                            |
|--------------------------------------------------------------------------|---------------|--------------|----------------------------|
| Drain-source breakdown voltage<br>$I_D = 10$ $\mu$ A; $V_{GS} = 0$       | $V_{(BR)DSS}$ | min.         | 80 V                       |
| Drain-source leakage current<br>$V_{DS} = 60$ V; $V_{GS} = 0$            | $I_{DSS}$     | max.         | 1.0 $\mu$ A                |
| Gate-source leakage current<br>$V_{GS} = 20$ V; $V_{DS} = 0$             | $I_{GSS}$     | max.         | 100 nA                     |
| Gate threshold voltage<br>$I_D = 1$ mA; $V_{DS} = V_{GS}$                | $I_{GS(th)}$  | min.<br>max. | 0.8 V<br>2.8 V             |
| Drain-source ON-resistance (see Fig.4)<br>$I_D = 150$ mA; $V_{GS} = 5$ V | $R_{DSon}$    | typ.<br>max. | 7 $\Omega$<br>10 $\Omega$  |
| $I_D = 200$ mA; $V_{GS} = 10$ V                                          | $R_{DSon}$    | typ.<br>max. | 4.5 $\Omega$<br>7 $\Omega$ |
| Transfer admittance<br>$I_D = 200$ mA; $V_{DS} = 5$ V                    | $ Y_{fs} $    | min.<br>typ. | 75 mS<br>150 mS            |
| Input capacitance at $f = 1$ MHz;<br>$V_{DS} = 10$ V; $V_{GS} = 0$       | $C_{iss}$     | typ.<br>max. | 15 pF<br>30 pF             |
| Output capacitance at $f = 1$ MHz;<br>$V_{DS} = 10$ V; $V_{GS} = 0$      | $C_{oss}$     | typ.<br>max. | 13 pF<br>20 pF             |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min. 6 cm<sup>2</sup>.



Feedback capacitance at  $f = 1 \text{ MHz}$ ;

$$V_{DS} = 10 \text{ V}; V_{GS} = 0$$

Switching times (see Figs 2 and 3)

$$I_D = 200 \text{ mA}; V_{DD} = 50 \text{ V};$$

$$V_{GS} = 0 \text{ to } 10 \text{ V}$$

|           |      |      |
|-----------|------|------|
| $C_{rss}$ | typ. | 3 pF |
|           | max. | 6 pF |

|          |      |      |
|----------|------|------|
| $t_{on}$ | typ. | 2 ns |
|          | max. | 5 ns |

|           |      |       |
|-----------|------|-------|
| $t_{off}$ | typ. | 5 ns  |
|           | max. | 10 ns |

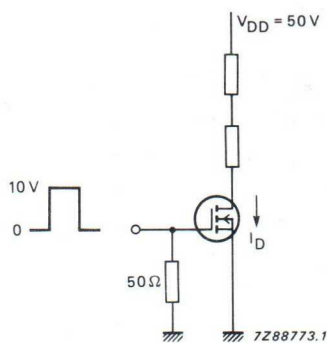


Fig.2 Switching time test circuit.

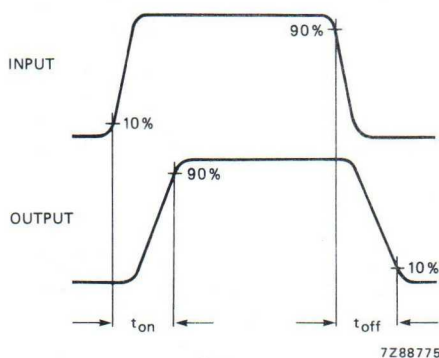


Fig.3 Input and output waveforms.

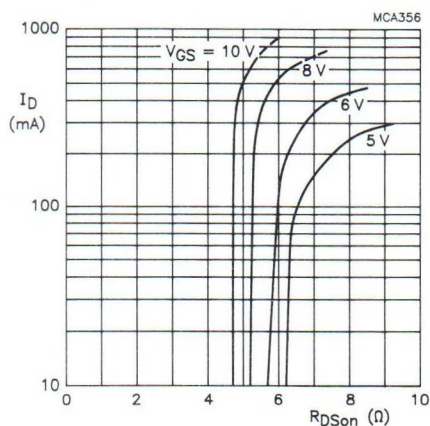


Fig.4  $T_j = 25^\circ\text{C}$ ; typical values.

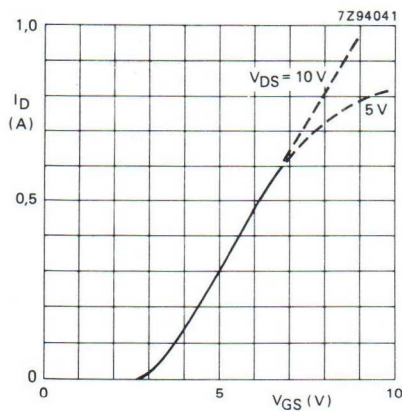


Fig.5  $T_j = 25^\circ\text{C}$ ; typical values.

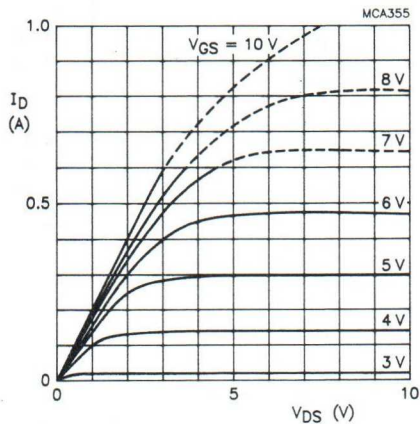
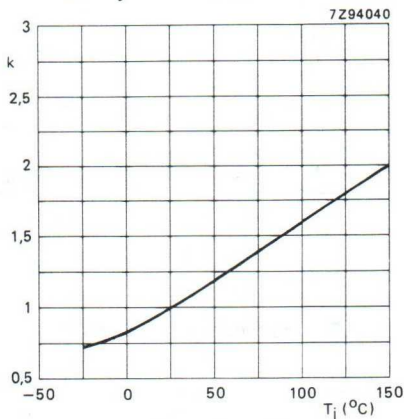
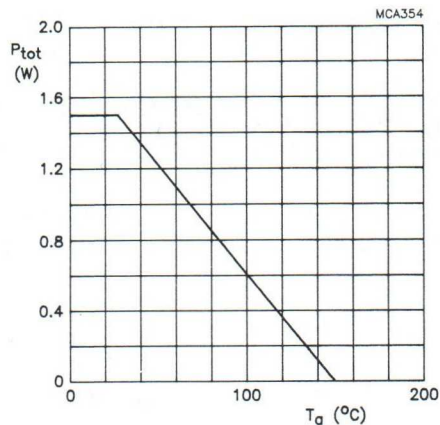
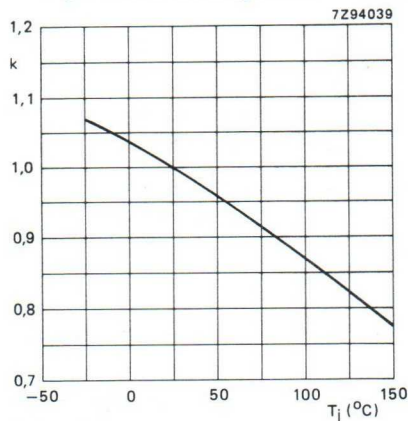
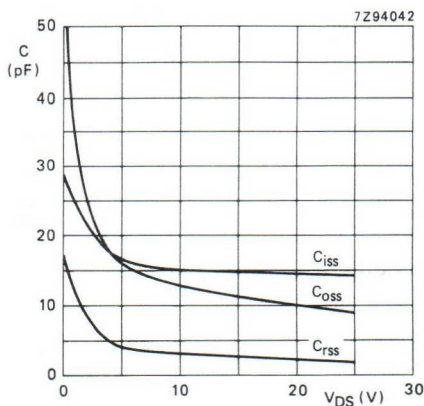
Fig.6  $T_j = 25^\circ\text{C}$ ; typical values.Fig.8  $k = \frac{R_{DSon} \text{ at } T_j}{R_{DSon} \text{ at } 25^\circ\text{C}}$ ;  
typical values at 150 mA/5 V.

Fig.7 Power derating curve.

Fig.9  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ;  
 $V_{GS(th)}$  at 1 mA; typical values.Fig.10  $T_j = 25^\circ\text{C}$ ;  $V_{GS} = 0$ ;  
 $f = 1\text{ MHz}$ ; typical values.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and designed for use as a line current interrupter in telephone sets and for application in relay, high-speed and line-transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

|                                                                             |              |              |                           |
|-----------------------------------------------------------------------------|--------------|--------------|---------------------------|
| Drain-source voltage                                                        | $V_{DS}$     | max.         | 200 V                     |
| Drain-current (DC)                                                          | $I_D$        | max.         | 250 mA                    |
| Drain-source ON-resistance<br>$I_D = 250 \text{ mA}; V_{GS} = 10 \text{ V}$ | $R_{DS(on)}$ | typ.<br>max. | 7 $\Omega$<br>12 $\Omega$ |
| Gate threshold voltage                                                      | $V_{GS(th)}$ | max.         | 2.8 V                     |

### MECHANICAL DATA

Dimensions in mm

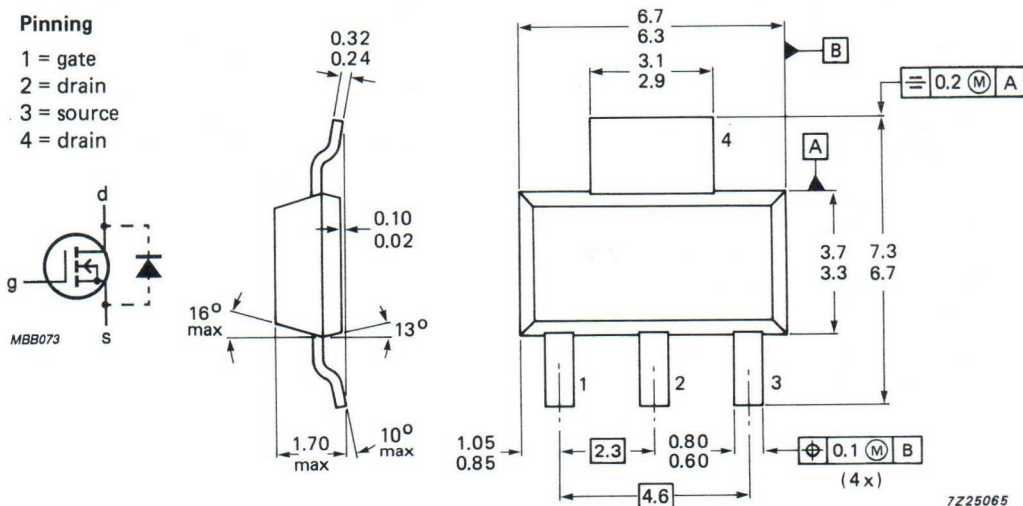
Marking code

Fig.1 SOT223.

BSP120

### Pinning

- 1 = gate  
2 = drain  
3 = source  
4 = drain



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                 |
|-------------------------------------------------------------------------------|---------------|------|---------------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max. | 200 V                           |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max. | 20 V                            |
| Drain current (DC)                                                            | $I_D$         | max. | 250 mA                          |
| Drain current (peak)                                                          | $I_{DM}$      | max. | 800 mA                          |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1.5 W                           |
| Storage temperature range                                                     | $T_{stg}$     |      | -65 to + 150 $^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | 150 $^{\circ}\text{C}$          |

**THERMAL RESISTANCE**

|                                   |               |   |          |
|-----------------------------------|---------------|---|----------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 83.3 K/W |
|-----------------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                       |               |              |                           |
|---------------------------------------------------------------------------------------|---------------|--------------|---------------------------|
| Drain-source breakdown voltage<br>$I_D = 10\text{ }\mu\text{A}; V_{GS} = 0$           | $V_{(BR)DSS}$ | min.         | 200 V                     |
| Drain-source leakage current<br>$V_{DS} = 160\text{ V}; V_{GS} = 0$                   | $I_{DSS}$     | max.         | 1.0 $\mu\text{A}$         |
| Gate-source leakage current<br>$V_{GS} = 20\text{ V}; V_{DS} = 0$                     | $I_{GSS}$     | max.         | 100 nA                    |
| Drain-source ON-resistance (see Fig.4)<br>$I_D = 250\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DSon}$    | typ.<br>max. | 7 $\Omega$<br>12 $\Omega$ |
| Gate threshold voltage<br>$I_D = 1\text{ mA}; V_{GS} = V_{DS}$                        | $V_{GS(th)}$  | min.<br>max. | 0.8 V<br>2.8 V            |
| Transfer admittance<br>$I_D = 250\text{ mA}; V_{DS} = 15\text{ V}$                    | $ Y_{fs} $    | min.<br>typ. | 125 mS<br>250 mS          |
| Input capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$        | $C_{iss}$     | typ.<br>max. | 45 pF<br>65 pF            |
| Output capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$       | $C_{oss}$     | typ.<br>max. | 20 pF<br>30 pF            |
| Feedback capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$     | $C_{rss}$     | typ.<br>max. | 5 pF<br>10 pF             |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min. 6 cm<sup>2</sup>.

Switching times (see Figs 2 and 3)

$I_D = 250 \text{ mA}$ ;  $V_{DD} = 50 \text{ V}$ ;

$V_{GS} = 0 \text{ to } 10 \text{ V}$

|           |      |       |
|-----------|------|-------|
| $t_{on}$  | typ. | 3 ns  |
|           | max. | 6 ns  |
| $t_{off}$ | typ. | 15 ns |
|           | max. | 20 ns |

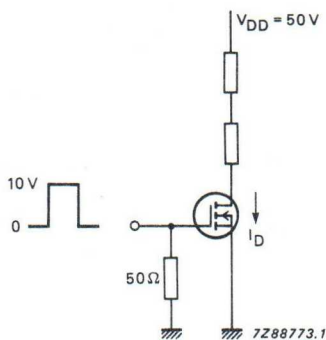


Fig.2 Switching time test circuit.

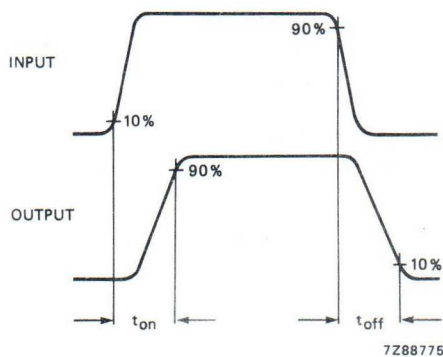


Fig.3 Input and output waveforms.

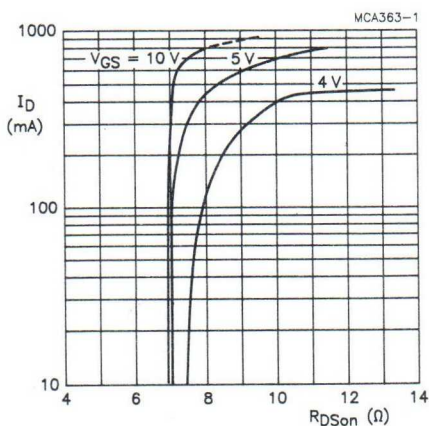


Fig.4  $T_j = 25^\circ\text{C}$ ; typical values.

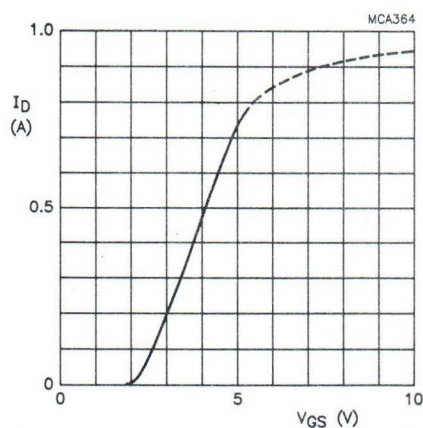
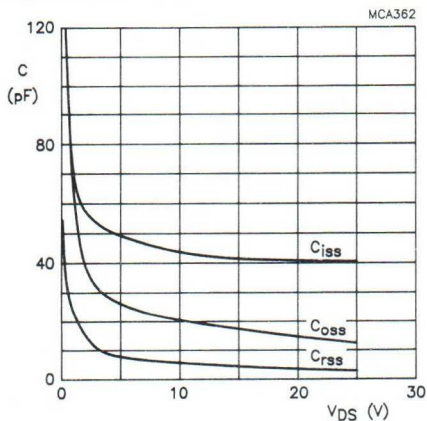
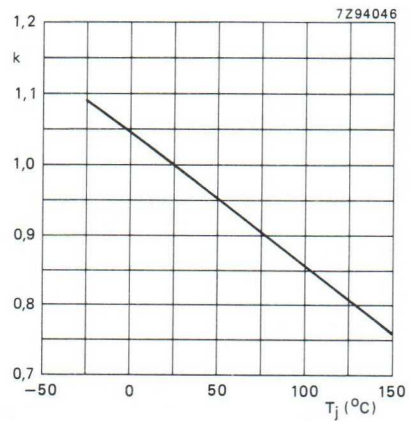
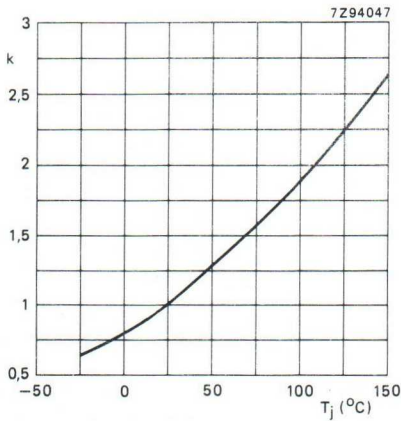
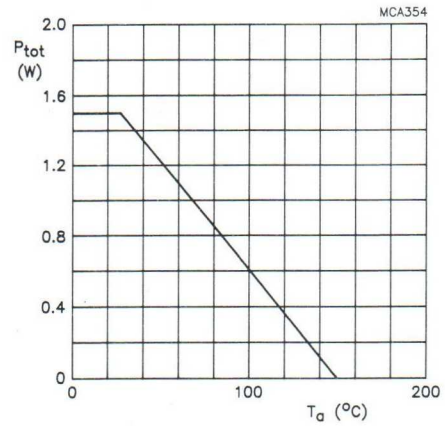
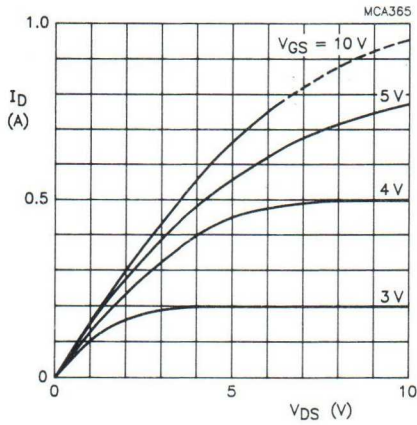


Fig.5  $T_j = 25^\circ\text{C}$ ;  $V_{DS} = 10 \text{ V}$ ; typical values.





## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and designed for use as a line current interrupter in telephone sets and for application in relay, high-speed and line-transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

|                                                                           |               |              |                              |
|---------------------------------------------------------------------------|---------------|--------------|------------------------------|
| Drain source voltage                                                      | $V_{DS}$      | max.         | 200 V                        |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$ | max.         | 20 V                         |
| Drain current (DC)                                                        | $I_D$         | max.         | 350 mA                       |
| Total power dissipation up to<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$   | $P_{tot}$     | max.         | 1.5 W                        |
| Drain-source on-resistance<br>$I_D = 400\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DS(on)}$  | typ.<br>max. | 4.5 $\Omega$<br>6.0 $\Omega$ |
| Transfer admittance<br>$I_D = 400\text{ mA}; V_{DS} = 25\text{ V}$        | $ Y_{fs} $    | min.<br>typ. | 200 mS<br>350 mS             |

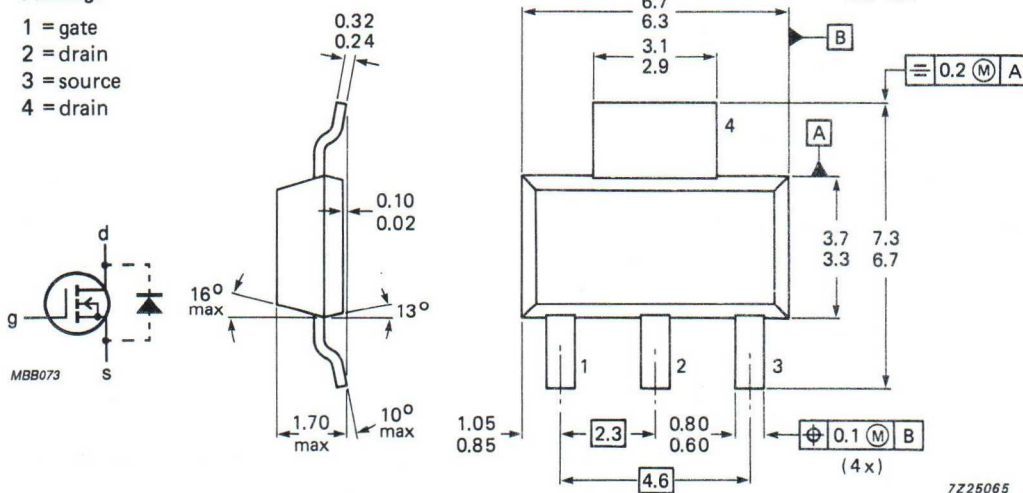
### MECHANICAL DATA

Dimensions in mm

Fig.1 SOT223.

#### Pinning:

- 1 = gate  
2 = drain  
3 = source  
4 = drain



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                  |               |      |                                         |
|----------------------------------------------------------------------------------|---------------|------|-----------------------------------------|
| Drain-source voltage                                                             | $V_{DS}$      | max. | 200 V                                   |
| Gate-source voltage (open drain)                                                 | $\pm V_{GSO}$ | max. | 20 V                                    |
| Drain current (DC)                                                               | $I_D$         | max. | 350 mA                                  |
| Drain current (peak)                                                             | $I_{DM}$      | max. | 1.2 A                                   |
| Total power dissipation up to<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1.5 W                                   |
| Storage temperature range                                                        | $T_{stg}$     |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                             | $T_j$         | max. | $150\text{ }^{\circ}\text{C}$           |

**THERMAL RESISTANCE**

|                                   |             |   |          |
|-----------------------------------|-------------|---|----------|
| From junction to ambient (note 1) | $R_{thj-a}$ | = | 83.3 K/W |
|-----------------------------------|-------------|---|----------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                 |               |      |                          |
|-----------------------------------------------------------------------------------------------------------------|---------------|------|--------------------------|
| Drain-source breakdown voltage<br>$I_D = 10\text{ }\mu\text{A}$ ; $V_{GS} = 0$                                  | $V_{(BR)DSS}$ | min. | 200 V                    |
| Drain-source leakage current<br>$V_{DS} = 160\text{ V}$ ; $V_{GS} = 0$<br>$V_{DS} = 60\text{ V}$ ; $V_{GS} = 0$ | $I_{DSS}$     | max. | $1.0\text{ }\mu\text{A}$ |
|                                                                                                                 | $I_{DSS}$     | max. | 200 nA                   |
| Gate-source leakage current<br>$\pm V_{GS} = 20\text{ V}$ ; $V_{DS} = 0$                                        | $\pm I_{GSS}$ | max. | 100 nA                   |
| Gate threshold voltage<br>$I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$                                               | $V_{GS(th)}$  | min. | 0.8 V                    |
|                                                                                                                 |               | max. | 2.8 V                    |
| Drain-source on-resistance<br>$I_D = 400\text{ mA}$ ; $V_{GS} = 10\text{ V}$                                    | $R_{DS(on)}$  | typ. | $4.5\text{ }\Omega$      |
|                                                                                                                 |               | max. | $6.0\text{ }\Omega$      |
| Transfer admittance<br>$I_D = 400\text{ mA}$ ; $V_{DS} = 25\text{ V}$                                           | $ Y_{fs} $    | min. | 200 mS                   |
|                                                                                                                 |               | typ. | 350 mS                   |
| Input capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                                | $C_{iss}$     | typ. | 45 pF                    |
|                                                                                                                 |               | max. | 60 pF                    |
| Output capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                               | $C_{oss}$     | typ. | 15 pF                    |
|                                                                                                                 |               | max. | 25 pF                    |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                             | $C_{rss}$     | typ. | 3.5 pF                   |
|                                                                                                                 |               | max. | 10 pF                    |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min.  $6\text{ cm}^2$ .

Switching times (see Figs 2 and 3)

$I_D = 250 \text{ mA}$ ;  $V_{DD} = 50 \text{ V}$ ;  $V_{GS} = 0 \text{ to } 10 \text{ V}$

|           |      |       |
|-----------|------|-------|
| $t_{on}$  | typ. | 5 ns  |
|           | max. | 10 ns |
| $t_{off}$ | typ. | 15 ns |
|           | max. | 20 ns |

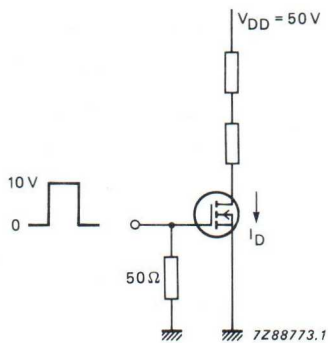


Fig.2 Switching time test circuit

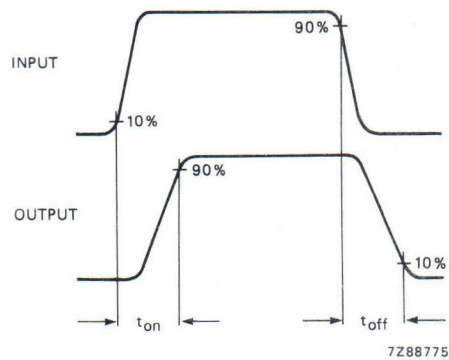


Fig.3 Input and output waveforms.

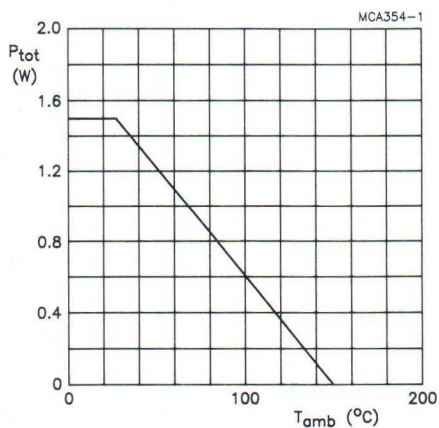


Fig.4 Power derating curve.

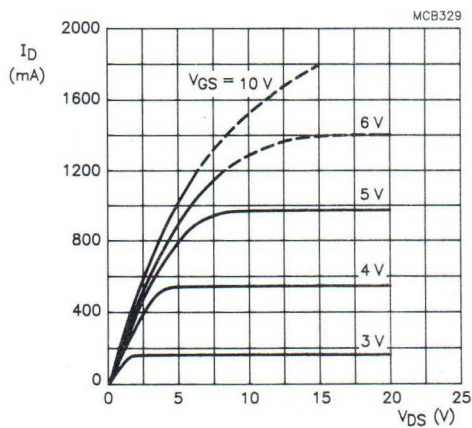


Fig.5 Output characteristic;  
 $T_j = 25^\circ\text{C}$ ; typical value.

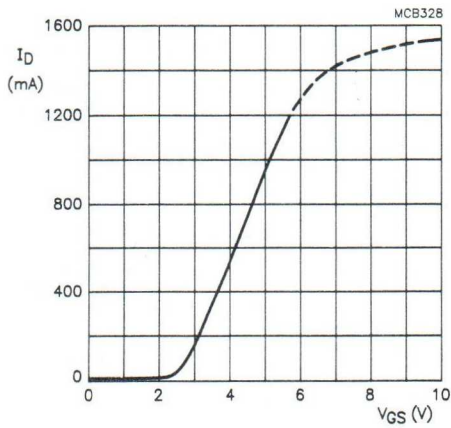


Fig.6 Transfer characteristic;  
 $V_{DS} = 10 \text{ V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.

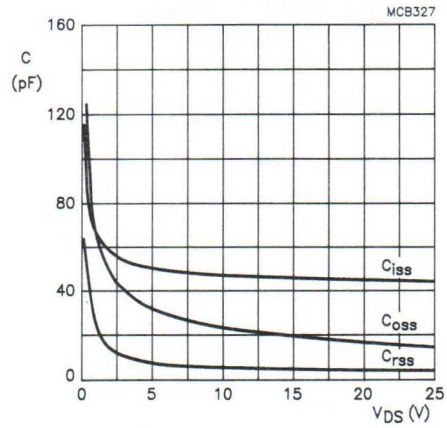


Fig.7 Capacitance as a function of  
 drain-source voltage;  $V_{GS} = 0$ ;  
 $f = 1 \text{ MHz}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.

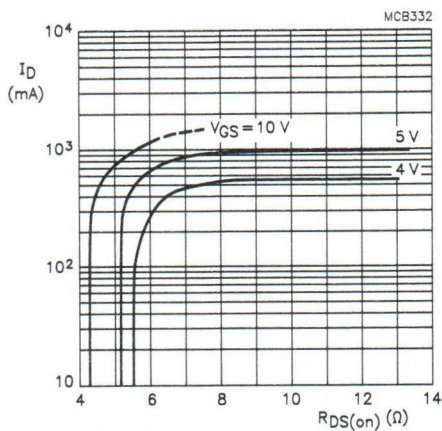


Fig.8  $T_j = 25^\circ\text{C}$ ; typical values.

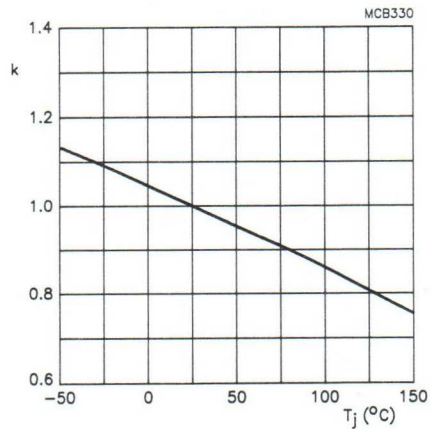


Fig.9  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ;  $V_{GS(th)}$   
 at  $1 \text{ mA}$ ; typical values.



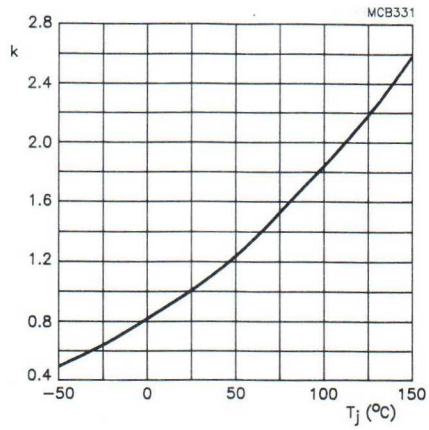
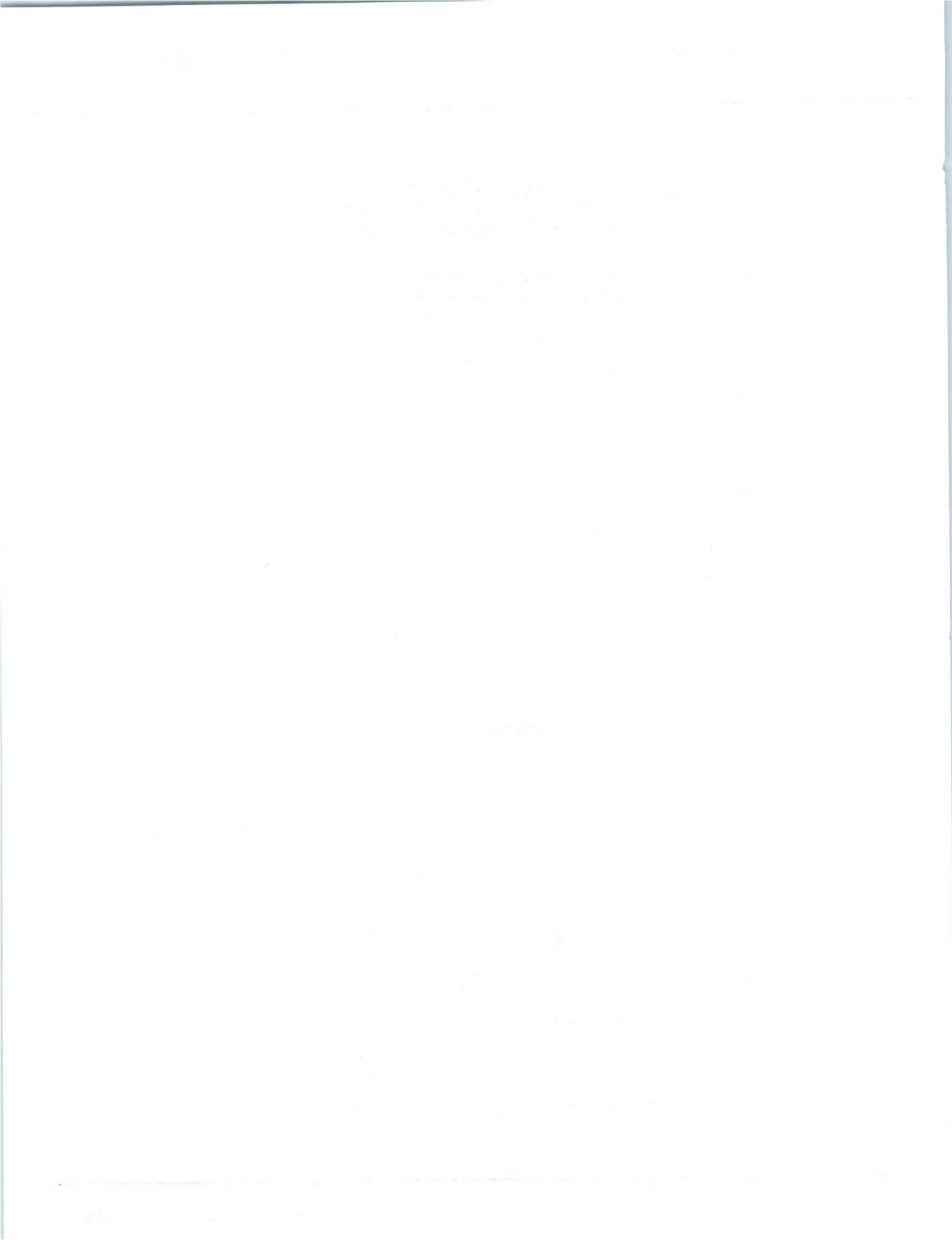


Fig.10  $k = \frac{R_{DS(on)} \text{ at } T_j}{R_{DS(on)} \text{ at } 25^{\circ}\text{C}}$ ; at 400 mA/10V;  
typical values.



## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and designed for use as a line interrupter in telephone sets and for application in relay, high-speed and line-transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching.
- No secondary breakdown.

### QUICK REFERENCE DATA

|                                                                              |              |              |                              |
|------------------------------------------------------------------------------|--------------|--------------|------------------------------|
| Drain-source voltage                                                         | $V_{DS}$     | max.         | 250 V                        |
| Drain current (DC)                                                           | $I_D$        | max.         | 350 mA                       |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$         | $P_{tot}$    | max.         | 1.5 W                        |
| Drain-source on-resistance<br>$I_D = 300\text{ mA}$ ; $V_{GS} = 10\text{ V}$ | $R_{DS(on)}$ | typ.<br>max. | 5.0 $\Omega$<br>7.0 $\Omega$ |
| Gate-source threshold voltage                                                | $V_{GS(th)}$ | max.         | 2 V                          |

### MECHANICAL DATA

Dimensions in mm

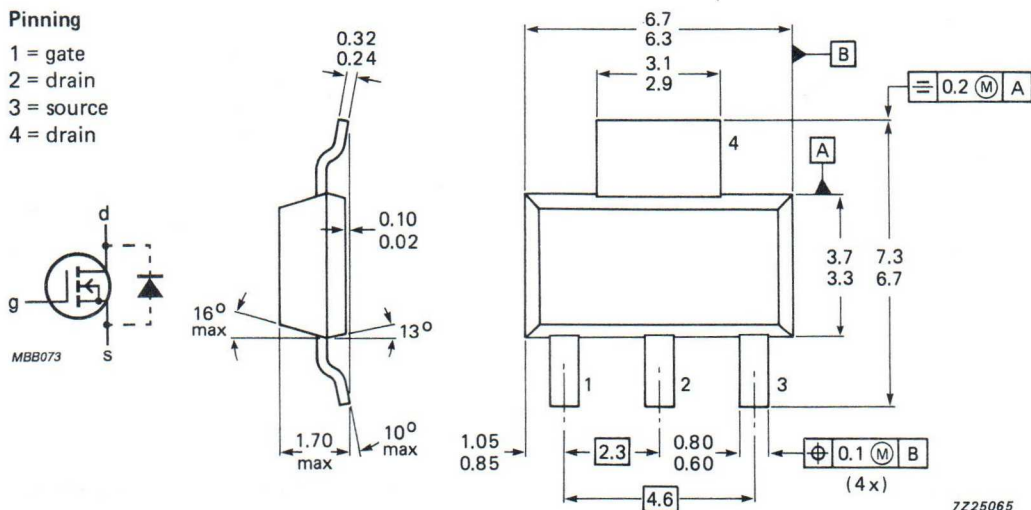
Marking code

Fig.1 SOT223.

BSP126

### Pinning

- 1 = gate  
2 = drain  
3 = source  
4 = drain



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                 |
|-------------------------------------------------------------------------------|---------------|------|---------------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max. | 250 V                           |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max. | 20 V                            |
| Drain current (DC)                                                            | $I_D$         | max. | 350 mA                          |
| Drain current (peak)                                                          | $I_{DM}$      | max. | 1.2 A                           |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1.5 W                           |
| Storage temperature range                                                     | $T_{stg}$     |      | -65 to + 150 $^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | 150 $^{\circ}\text{C}$          |

**THERMAL RESISTANCE**

|                                   |               |   |          |
|-----------------------------------|---------------|---|----------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 83.3 K/W |
|-----------------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                   |               |              |                             |
|-----------------------------------------------------------------------------------|---------------|--------------|-----------------------------|
| Drain-source breakdown voltage<br>$I_D = 10\text{ }\mu\text{A}; V_{GS} = 0$       | $V_{(BR)DSS}$ | min.         | 250 V                       |
| Drain-source leakage current<br>$V_{DS} = 200\text{ V}; V_{GS} = 0$               | $I_{DSS}$     | max.         | 1.0 $\mu\text{A}$           |
| Gate-source leakage current<br>$\pm V_{GS} = 20\text{ V}; V_{DS} = 0$             | $\pm I_{GSS}$ | max.         | 100 nA                      |
| Gate threshold voltage<br>$I_D = 1\text{ mA}; V_{DS} = V_{GS}$                    | $V_{GS(th)}$  | min.<br>max. | 0.8 V<br>2.0 V              |
| Drain-source on-resistance<br>$I_D = 300\text{ mA}; V_{GS} = 10\text{ V}$         | $R_{DS(on)}$  | typ.         | 5.0 $\Omega$                |
| $I_D = 20\text{ mA}; V_{GS} = 2.4\text{ V}$                                       | $R_{DS(on)}$  | max.         | 7.0 $\Omega$<br>10 $\Omega$ |
| Transfer admittance<br>$I_D = 300\text{ mA}; V_{DS} = 25\text{ V}$                | $ Y_{fs} $    | min.<br>typ. | 200 mS<br>400 mS            |
| Input capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 25\text{ V}; V_{GS} = 0$    | $C_{iss}$     | typ.<br>max. | 65 pF<br>90 pF              |
| Output capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 25\text{ V}; V_{GS} = 0$   | $C_{oss}$     | typ.<br>max. | 20 pF<br>30 pF              |
| Feedback capacitance at $f = 1\text{ MHz};$<br>$V_{DS} = 25\text{ V}; V_{GS} = 0$ | $C_{rss}$     | typ.<br>max. | 5 pF<br>15 pF               |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min. 6 cm<sup>2</sup>.

Switching times (see Figs 2 and 3)

$I_D = 250 \text{ mA}$ ;  $V_{DD} = 50 \text{ V}$ ;

$V_{GS} = 0 \text{ to } 10 \text{ V}$

|           |      |       |
|-----------|------|-------|
| $t_{on}$  | typ. | 5 ns  |
|           | max. | 10 ns |
| $t_{off}$ | typ. | 20 ns |
|           | max. | 30 ns |

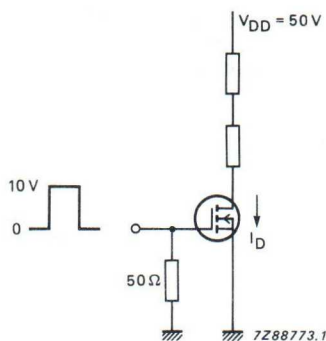


Fig.2 Switching time test circuit.

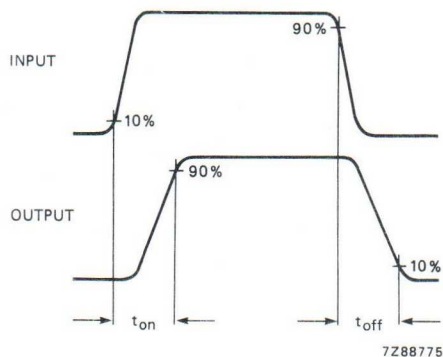


Fig.3 Input and output waveforms.

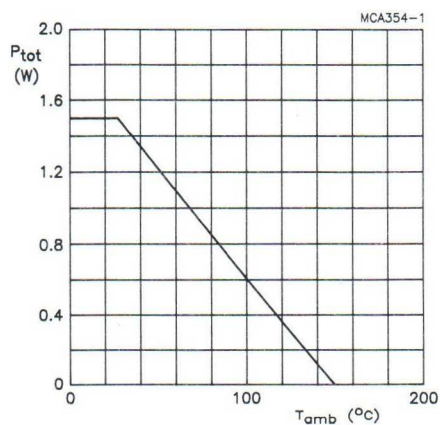


Fig.4 Power derating curve.

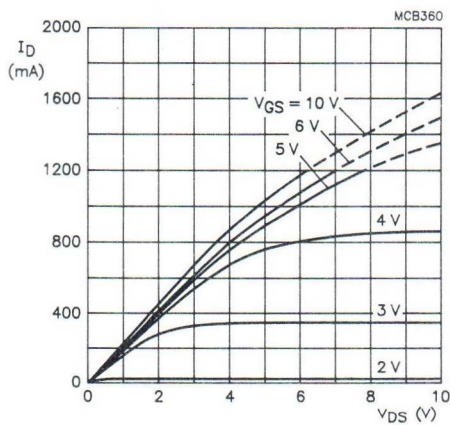


Fig.5 Output characteristics;  $T_j = 25^\circ\text{C}$ ; typical values.



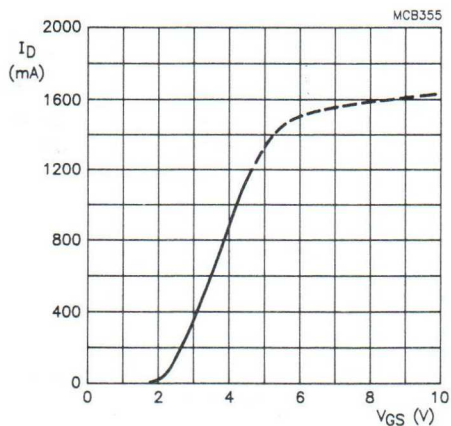


Fig.6 Transfer characteristic;  $V_{DS} = 10\text{ V}$ ;  
 $T_j = 25\text{ }^{\circ}\text{C}$ ; typical value.

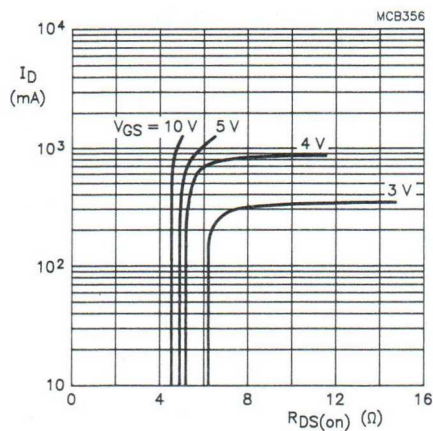


Fig.7 On-resistance as a function of drain  
current;  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

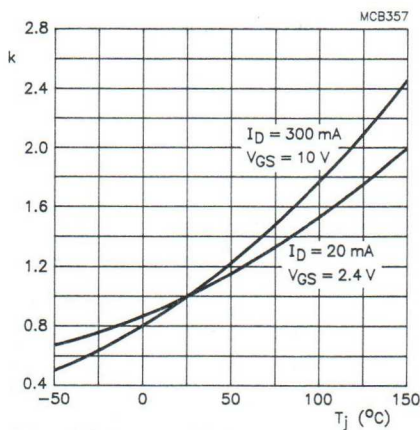


Fig.8  $k = \frac{R_{DS(on)} \text{ at } T_j}{R_{DS(on)} \text{ at } 25\text{ }^{\circ}\text{C}}$ ;  
typical values.

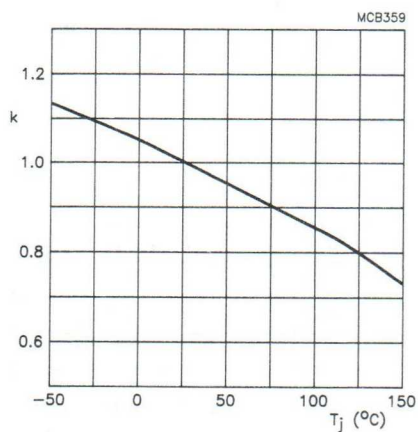


Fig.9  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25\text{ }^{\circ}\text{C}}$ ;  
 $V_{GS(th)}$  at 1 mA; typical values.

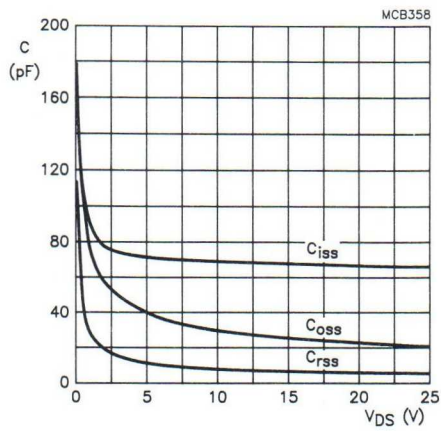


Fig.10 Capacitances as a function of drain-source voltage;  $V_{GS} = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C; typical values.



## P-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

P-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use in relay, high-speed and line-transformer drivers.

## Features

- Very low  $r_{DS(on)}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

## QUICK REFERENCE DATA

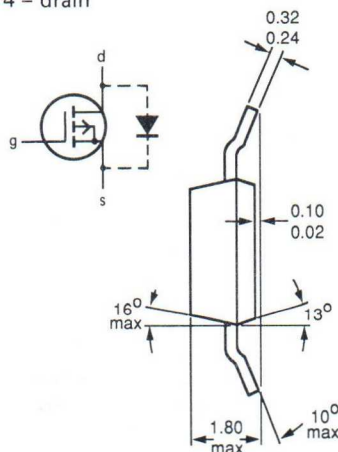
|                                                 |               |      |             |
|-------------------------------------------------|---------------|------|-------------|
| Drain-source voltage                            | $-V_{DS}$     | max. | 60 V        |
| Drain current (DC)                              | $-I_D$        | max. | 275 mA      |
| Drain-source ON-resistance                      |               |      |             |
| $-I_D = 200 \text{ mA}; -V_{GS} = 10 \text{ V}$ | $r_{DS(on)}$  | max. | $10 \Omega$ |
| Gate threshold voltage                          | $-V_{GS(th)}$ | max. | 3.5 V       |

## MECHANICAL DATA

Fig.1 SOT223.

### Pinning:

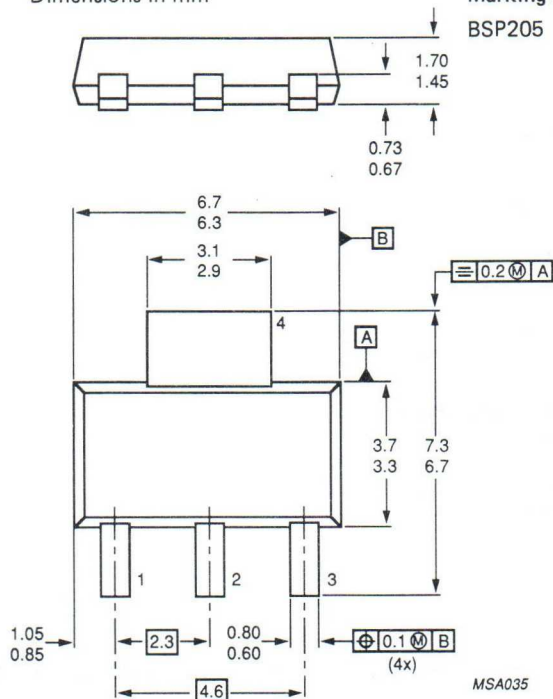
- 1 = gate  
2 = drain  
3 = source  
4 = drain



Dimensions in mm

Marking code

BSP205



MSA035

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |               |      |                               |
|---------------------------------------------------------------------|---------------|------|-------------------------------|
| Drain-source voltage                                                | $-V_{DS}$     | max. | 60 V                          |
| Gate-source voltage (open drain)                                    | $\pm V_{GS0}$ | max. | 20 V                          |
| Drain current (DC)                                                  | $-I_D$        | max. | 275 mA                        |
| Drain current (peak)                                                | $-I_{DM}$     | max. | 550 mA                        |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ (note 1) | $P_{tot}$     | max. | 1.5 W                         |
| Storage temperature range                                           | $T_{stg}$     |      | $-65$ to $+150^\circ\text{C}$ |
| Junction temperature                                                | $T_j$         | max. | $150^\circ\text{C}$           |

**THERMAL RESISTANCE**

|                                   |               |   |          |
|-----------------------------------|---------------|---|----------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 83.3 K/W |
|-----------------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25^\circ\text{C}$  unless otherwise specified

|                                                                                                                        |                |              |                               |
|------------------------------------------------------------------------------------------------------------------------|----------------|--------------|-------------------------------|
| Drain-source breakdown voltage<br>$-I_D = 10\ \mu\text{A}; V_{GS} = 0$                                                 | $-V_{(BR)DSS}$ | min.         | 60 V                          |
| Drain-source leakage current<br>$-V_{DS} = 48\text{ V}; V_{GS} = 0$                                                    | $-I_{DSS}$     | max.         | $1.0\ \mu\text{A}$            |
| Gate-source leakage current<br>$\pm V_{GS} = 20\text{ V}; V_{DS} = 0$                                                  | $\pm I_{GSS}$  | max.         | 100 nA                        |
| Gate threshold voltage<br>$-I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                        | $-V_{GS(th)}$  | min.<br>max. | 1.5 V<br>3.5 V                |
| Drain-source ON-resistance<br>$-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$                                            | $r_{DS(on)}$   | typ.<br>max. | $7.5\ \Omega$<br>$10\ \Omega$ |
| Transfer admittance<br>$-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$                                                   | $ Y_{fs} $     | min.<br>typ. | 60 mS<br>125 mS               |
| Input capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                        | $C_{iss}$      | typ.<br>max. | 30 pF<br>45 pF                |
| Output capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                       | $C_{oss}$      | typ.<br>max. | 20 pF<br>30 pF                |
| Feedback capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                     | $C_{rss}$      | typ.<br>max. | 5 pF<br>10 pF                 |
| Switching times (see Figs 2 and 3)<br>$-I_D = 200\text{ mA}; -V_{DD} = 50\text{ V};$<br>$-V_{GS} = 0$ to $10\text{ V}$ | $t_{on}$       | typ.<br>max. | 3 ns<br>6 ns                  |
|                                                                                                                        | $t_{off}$      | typ.<br>max. | 10 ns<br>15 ns                |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min.  $6\text{ cm}^2$ .



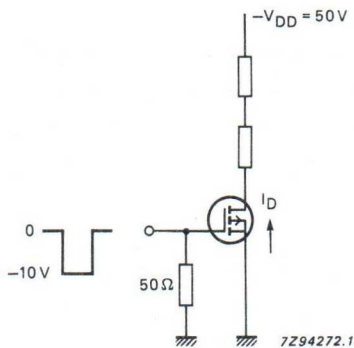


Fig.2 Switching time test circuit.

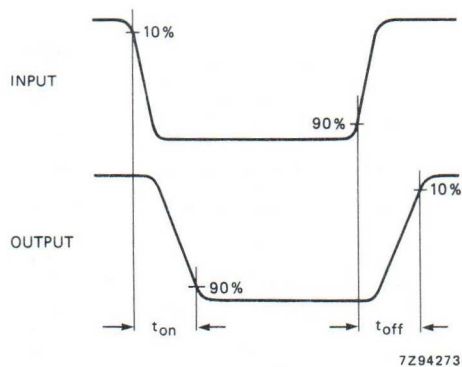


Fig.3 Input and output waveforms.

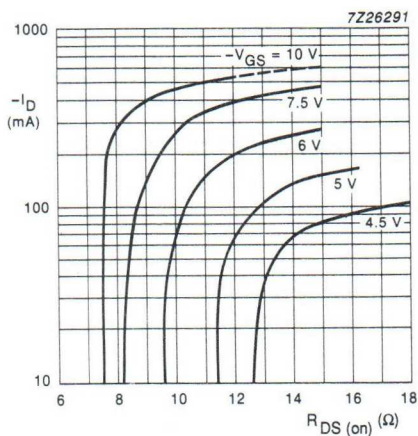
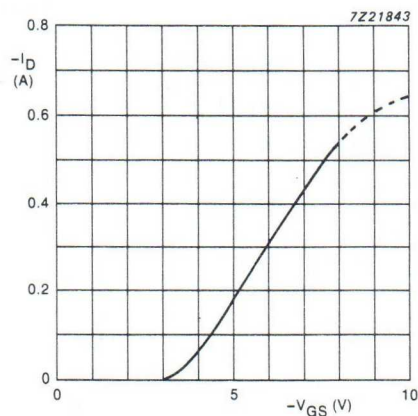
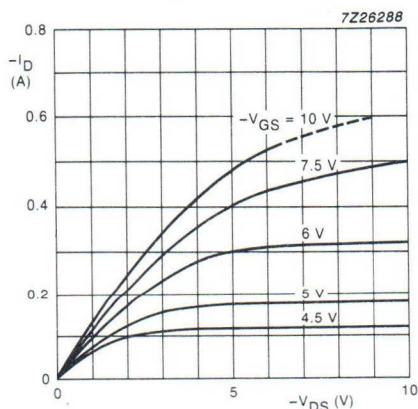
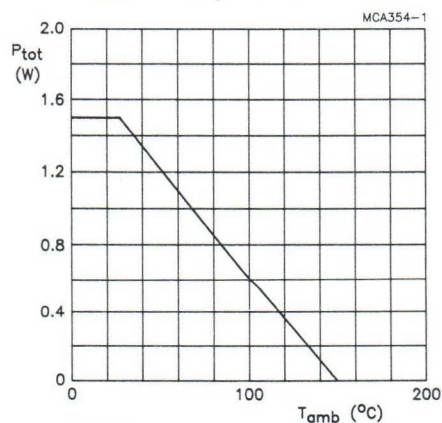
Fig.4 ON-resistance as a function of drain current;  $T_j = 25^\circ\text{C}$ ; typical values.Fig.5 Transfer characteristics;  $-V_{DS} = 10\text{ V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.Fig.6 Output characteristics;  $T_j = 25^\circ\text{C}$ ; typical values.

Fig.7 Power derating curve.

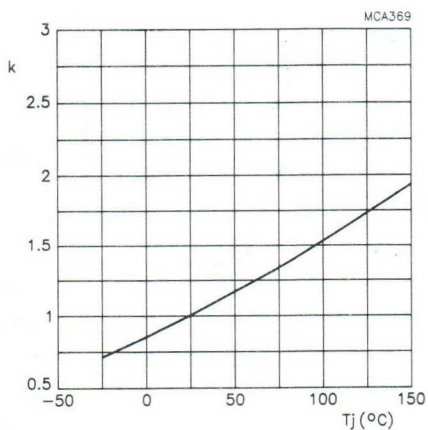


Fig.8  $k = \frac{r_{DS(on)} \text{ at } T_j}{r_{DS(on)} \text{ at } 25^{\circ}\text{C}}$ ; at  $-200 \text{ mA}/-10 \text{ V}$ ;

typical values.

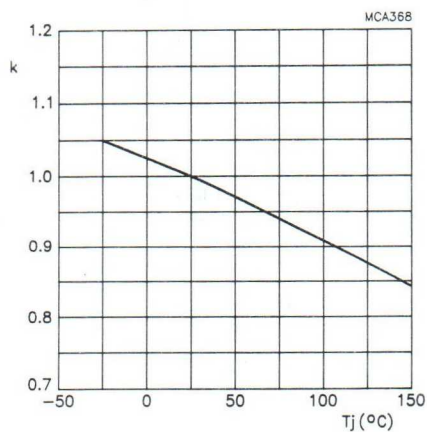


Fig.9  $k = \frac{-V_{GS(th)} \text{ at } T_j}{-V_{GS(th)} \text{ at } 25^{\circ}\text{C}}$ ;

$-V_{GS(th)}$  at  $-1 \text{ mA}$ ; typical values.

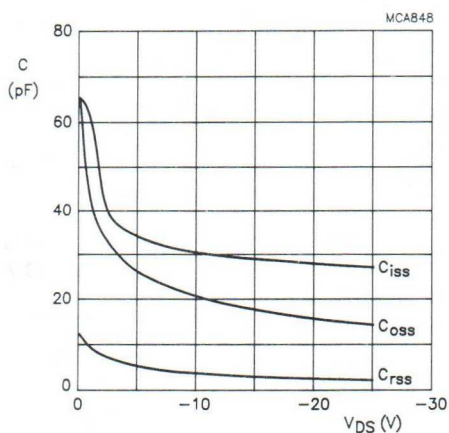


Fig.10  $T_j = 25^{\circ}\text{C}$ ;  $V_{GS} = 0$ ;  $f = 1 \text{ MHz}$ ; typical values.

## P-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

P-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use in relay, high-speed and line-transformer drivers.

### Features

- Very low  $r_{DS(on)}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

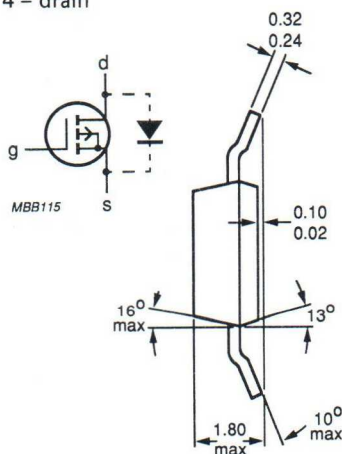
|                                                                               |               |      |            |
|-------------------------------------------------------------------------------|---------------|------|------------|
| Drain-source voltage                                                          | $-V_{DS}$     | max. | 60 V       |
| Drain current (DC)                                                            | $-I_D$        | max. | 350 mA     |
| Drain-source ON-resistance<br>$-I_D = 200 \text{ mA}; -V_{GS} = 10 \text{ V}$ | $r_{DS(on)}$  | max. | 6 $\Omega$ |
| Gate threshold voltage                                                        | $-V_{GS(th)}$ | max. | 3.5 V      |

### MECHANICAL DATA

Fig.1 SOT223.

#### Pinning:

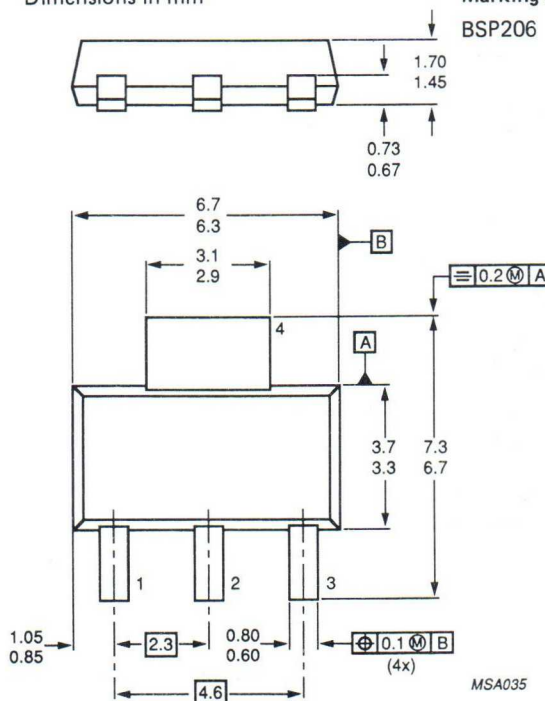
- 1 = gate  
2 = drain  
3 = source  
4 = drain



Dimensions in mm

Marking code

BSP206



MSA035

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                         |
|-------------------------------------------------------------------------------|---------------|------|-----------------------------------------|
| Drain-source voltage                                                          | $-V_{DS}$     | max. | 60 V                                    |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max. | 20 V                                    |
| Drain current (DC)                                                            | $-I_D$        | max. | 350 mA                                  |
| Drain current (peak)                                                          | $-I_{DM}$     | max. | 700 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1.5 W                                   |
| Storage temperature range                                                     | $T_{stg}$     |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | $150\text{ }^{\circ}\text{C}$           |

**THERMAL RESISTANCE**

From junction to ambient (note 1)

$$R_{th\ j-a} = 83.3\text{ K/W}$$

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                        |                |              |                                          |
|------------------------------------------------------------------------------------------------------------------------|----------------|--------------|------------------------------------------|
| Drain-source breakdown voltage<br>$-I_D = 10\text{ }\mu\text{A}; V_{GS} = 0$                                           | $-V_{(BR)DSS}$ | min.         | 60 V                                     |
| Drain-source leakage current<br>$-V_{DS} = 48\text{ V}; V_{GS} = 0$                                                    | $-I_{DSS}$     | max.         | $1.0\text{ }\mu\text{A}$                 |
| Gate-source leakage current<br>$\pm V_{GS} = 20\text{ V}; V_{DS} = 0$                                                  | $\pm I_{GSS}$  | max.         | 100 nA                                   |
| Gate threshold voltage<br>$-I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                        | $-V_{GS(th)}$  | min.<br>max. | 1.5 V<br>3.5 V                           |
| Drain-source ON-resistance<br>$-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$                                            | $r_{DS(on)}$   | typ.<br>max. | $4.5\text{ }\Omega$<br>$6\text{ }\Omega$ |
| Transfer admittance<br>$-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$                                                   | $ Y_{fs} $     | min.<br>typ. | 100 mS<br>200 mS                         |
| Input capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                        | $C_{iss}$      | typ.<br>max. | 55 pF<br>70 pF                           |
| Output capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                       | $C_{oss}$      | typ.<br>max. | 30 pF<br>45 pF                           |
| Feedback capacitance at $f = 1\text{ MHz};$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                     | $C_{rss}$      | typ.<br>max. | 8 pF<br>12 pF                            |
| Switching times (see Figs 2 and 3)<br>$-I_D = 200\text{ mA}; -V_{DD} = 50\text{ V};$<br>$-V_{GS} = 0$ to $10\text{ V}$ | $t_{on}$       | typ.<br>max. | 4 ns<br>8 ns                             |
|                                                                                                                        | $t_{off}$      | typ.<br>max. | 15 ns<br>25 ns                           |

**Note**

1. Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1.5 mm; mounting pad for the drain lead min.  $6\text{ cm}^2$ .

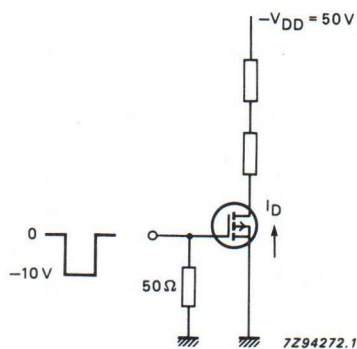


Fig.2 Switching time test circuit.

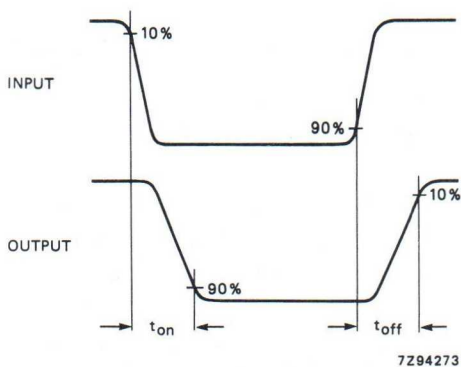


Fig.3 Input and output waveforms.

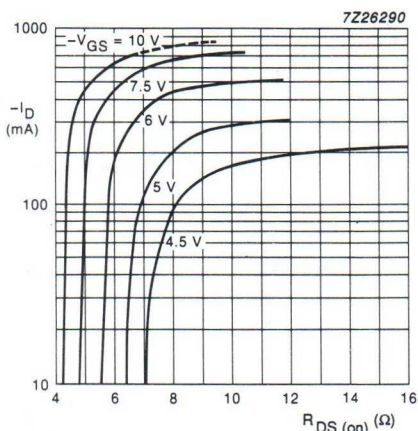
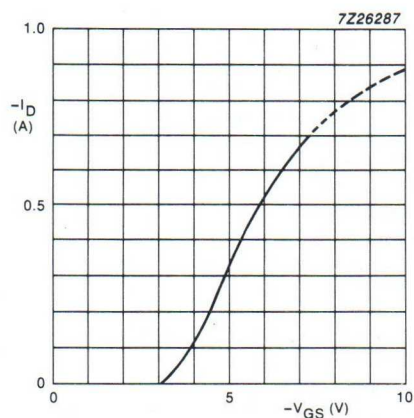
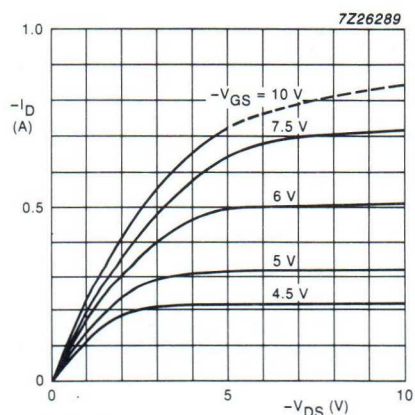
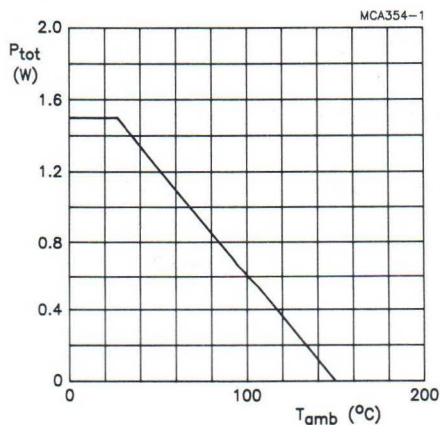
Fig.4 ON-resistance as a function of drain current;  $T_j = 25^\circ\text{C}$ ; typical values.Fig.5 Transfer characteristics;  $-V_{DS} = 10\text{ V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.Fig.6 Output characteristics;  $T_j = 25^\circ\text{C}$ ; typical values.

Fig.7 Power derating curve.



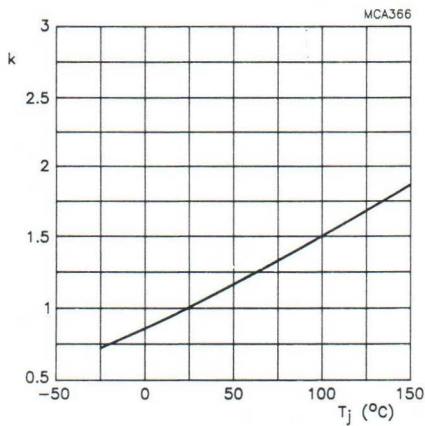


Fig. 8  $k = \frac{r_{DS(on)} \text{ at } T_j}{r_{DS(on)} \text{ at } 25^\circ\text{C}}$ ; at  $-200 \text{ mA}/-10\text{V}$ ;

typical values.

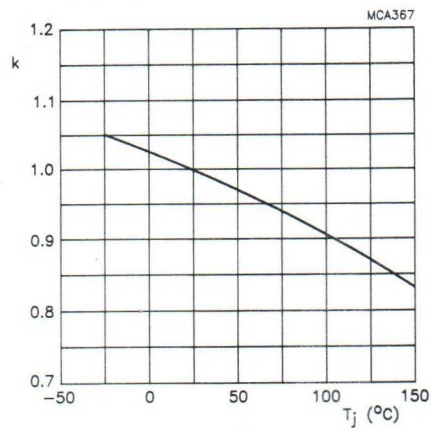


Fig. 9  $k = \frac{-V_{GS(th)} \text{ at } T_j}{-V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ;

$-V_{GS(th)}$  at  $-1 \text{ mA}$ ; typical values.

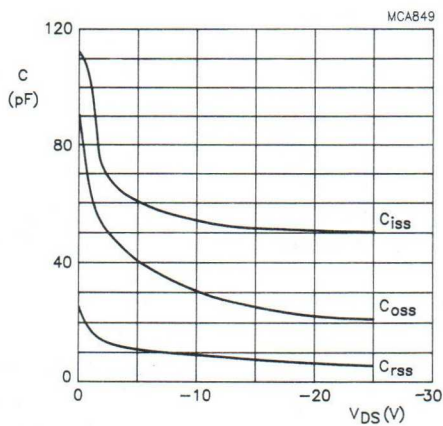


Fig. 10  $T_j = 25^\circ\text{C}$ ;  $V_{GS} = 0$ ;  $f = 1 \text{ MHz}$ ; typical values.

| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# BSP220

## P-channel enhancement mode vertical D-MOS transistor

### FEATURES

- Low  $R_{DS(on)}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.

### DESCRIPTION

P-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope and intended for use in relay, high-speed and line transformer drivers.

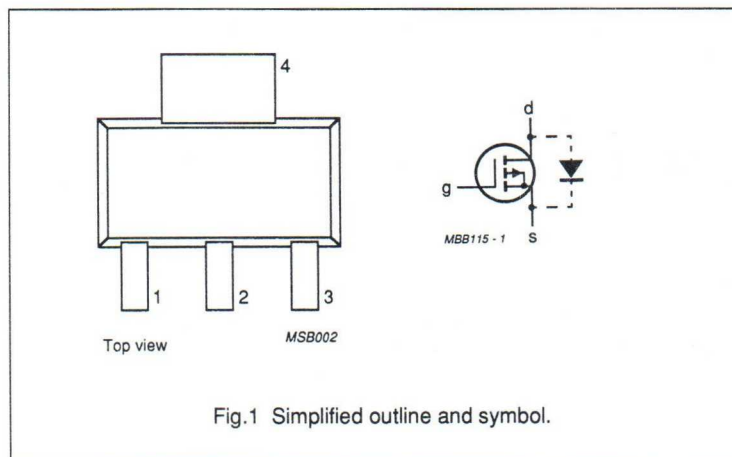
### PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | drain       |
| 3   | source      |
| 4   | drain       |

### QUICK REFERENCE DATA

| SYMBOL        | PARAMETER                     | CONDITIONS                                          | MAX. | UNIT     |
|---------------|-------------------------------|-----------------------------------------------------|------|----------|
| $-V_{DS}$     | drain-source voltage          |                                                     | 200  | V        |
| $-I_D$        | drain current                 | DC value                                            | 225  | mA       |
| $R_{DS(on)}$  | drain-source on-resistance    | $-I_D = 200 \text{ mA}$<br>$-V_{GS} = 10 \text{ V}$ | 12   | $\Omega$ |
| $-V_{GS(th)}$ | gate-source threshold voltage |                                                     | 2.8  | V        |

### PIN CONFIGURATION



# P-channel enhancement mode vertical D-MOS transistor

**BSP220**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                               | MIN. | MAX. | UNIT               |
|---------------|---------------------------|----------------------------------------------------------|------|------|--------------------|
| $-V_{DS}$     | drain-source voltage      |                                                          | –    | 200  | V                  |
| $\pm V_{GSO}$ | gate-source voltage       | open drain                                               | –    | 20   | V                  |
| $-I_D$        | drain current             | DC value                                                 | –    | 225  | mA                 |
| $-I_{DM}$     | drain current             | peak value                                               | –    | 600  | mA                 |
| $P_{tot}$     | total power dissipation   | up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>(note 1) | –    | 1.5  | W                  |
| $T_{stg}$     | storage temperature range |                                                          | –65  | 150  | $^{\circ}\text{C}$ |
| $T_J$         | junction temperature      |                                                          | –    | 150  | $^{\circ}\text{C}$ |

## Note

1. Device mounted on an epoxy printed-circuit board 40 x 40 x 1.5 mm; mounting pad for the drain lead minimum 6 cm<sup>2</sup>.

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                            | VALUE | UNIT |
|---------------|--------------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient<br>(note 1) | 83.3  | K/W  |

## Note

1. Device mounted on an epoxy printed-circuit board 40 x 40 x 1.5 mm; mounting pad for the drain lead minimum 6 cm<sup>2</sup>.

# P-channel enhancement mode vertical D-MOS transistor

**BSP220**

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                               | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------|------|------|------|---------------|
| $-V_{(BR)DSS}$                            | drain-source breakdown voltage | $-I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                           | 200  | —    | —    | V             |
| $-I_{DSS}$                                | drain-source leakage current   | $-V_{DS} = 160\text{ V}$<br>$V_{GS} = 0$                                                 | —    | —    | 1    | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $\pm V_{GS} = 20\text{ V}$<br>$V_{DS} = 0$                                               | —    | —    | 100  | nA            |
| $-V_{GS(th)}$                             | gate-source threshold voltage  | $-I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                                | 0.8  | —    | 2.8  | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $-I_D = 200\text{ mA}$<br>$-V_{GS} = 10\text{ V}$                                        | —    | 10   | 12   | $\Omega$      |
| $ Y_{fs} $                                | transfer admittance            | $-I_D = 200\text{ mA}$<br>$-V_{DS} = 25\text{ V}$                                        | 100  | 200  | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 65   | 90   | pF            |
| $C_{oss}$                                 | output capacitance             | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 20   | 30   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 6    | 15   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                          |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 5    | 20   | ns            |
| $t_{off}$                                 | turn-off time                  | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 20   | 30   | ns            |

# P-channel enhancement mode vertical D-MOS transistor

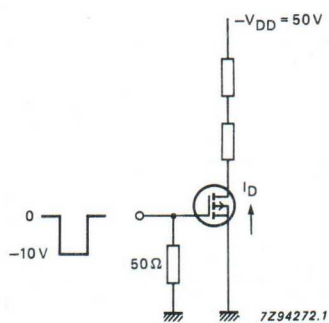
**BSP220**


Fig.2 Switching time test circuit.

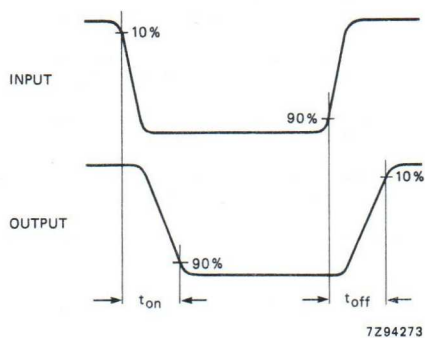


Fig.3 Input and output waveforms.

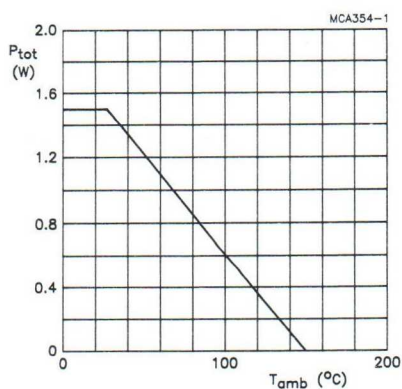
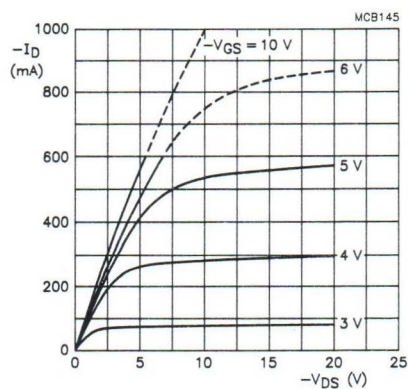


Fig.4 Power derating curve.


 Fig.5 Typical output characteristics;  $T_j = 25\text{ }^{\circ}\text{C}$ .



# P-channel enhancement mode vertical D-MOS transistor

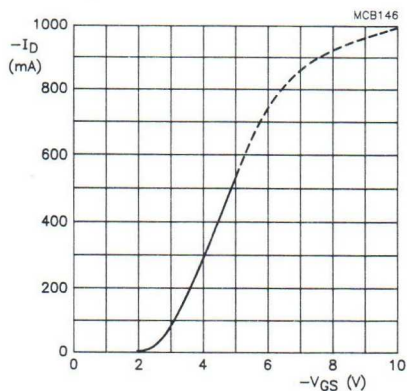
**BSP220**


Fig.6 Typical transfer characteristic;  
 $-V_{DS} = 10$  V;  $T_J = 25$  °C.

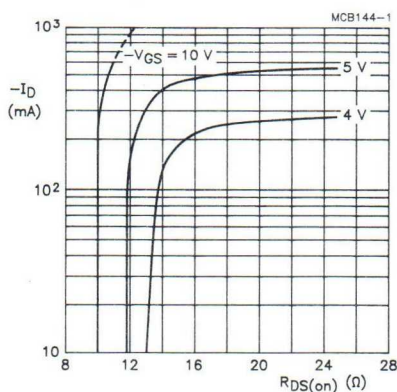


Fig.7 Typical on-resistance as a function of  
drain current;  $T_J = 25$  °C.

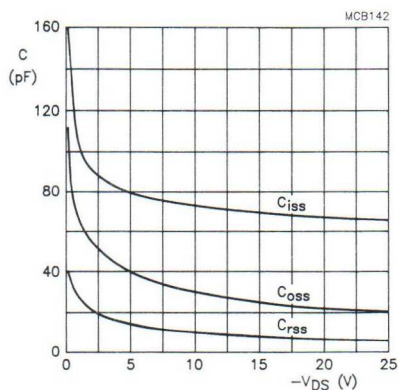


Fig.8 Typical capacitances as a function of  
drain-source voltage;  $V_{GS} = 0$ ;  $f = 1$  MHz;  
 $T_J = 25$  °C.

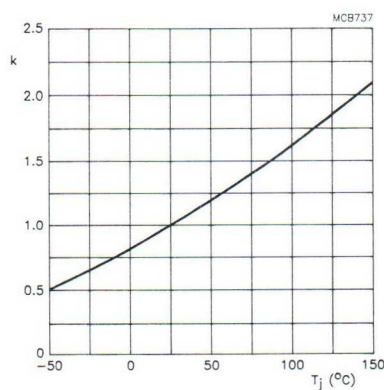


Fig.9 Temperature coefficient of drain-source  
on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_J}{R_{DS(on)} \text{ at } 25 \text{ °C}}$ ; typical  
 $R_{DS(on)}$  at  $-200$  mA/ $-10$  V.

# P-channel enhancement mode vertical D-MOS transistor

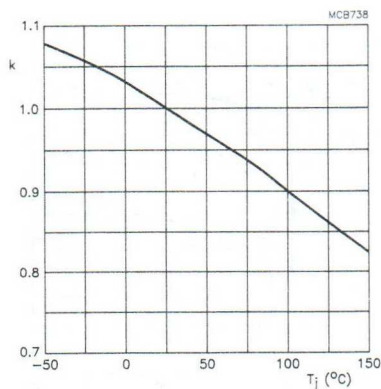
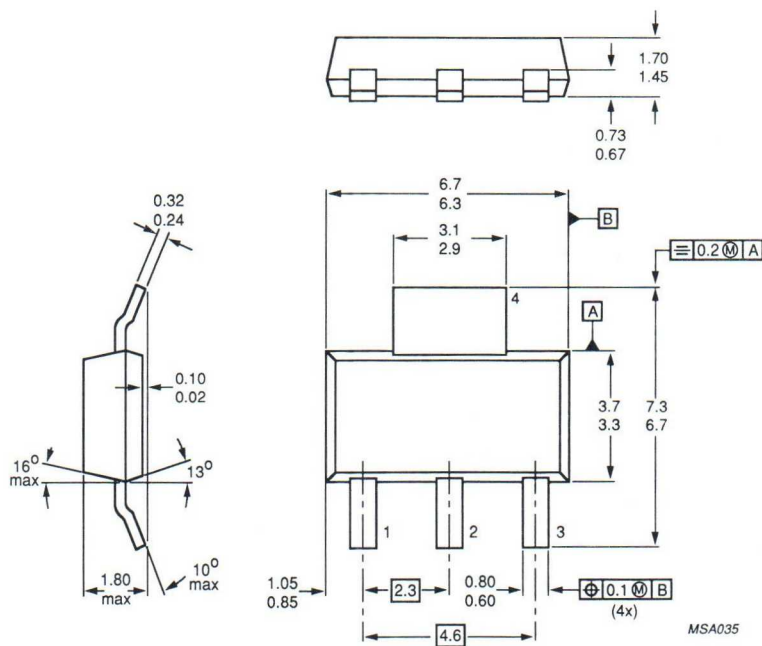
**BSP220**


Fig.10 Temperature coefficient of gate-source threshold voltage;  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^{\circ}\text{C}}$ ; typical  $-V_{GS(th)}$  at  $-1 \text{ mA}$ .

### P-channel enhancement mode vertical D-MOS transistor

BSP220

## PACKAGE OUTLINE



Dimensions in mm.

**Marking code:** BSP220.

Fig.11 SOT223.



| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | November 1990         |
|               |                       |

# BSP225

## P-channel enhancement mode vertical D-MOS transistor

### FEATURES

- Low  $R_{DS(on)}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.

### DESCRIPTION

P-channel enhancement mode vertical D-MOS transistor in a miniature SOT223 envelope, intended for use in relay, high-speed and line transformer drivers.

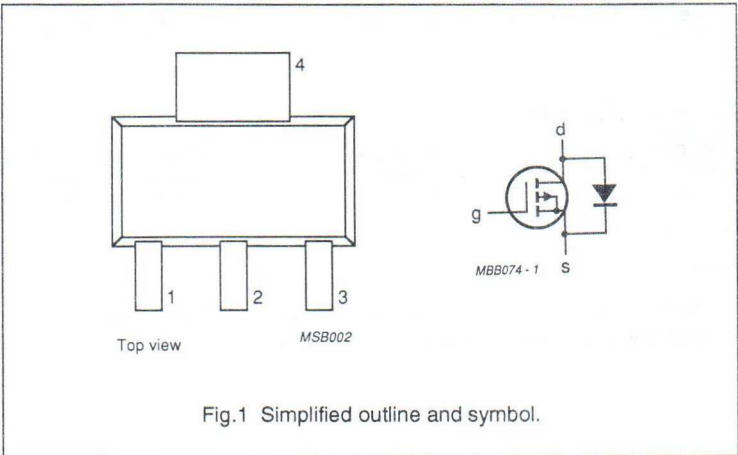
### PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | drain       |
| 3   | source      |
| 4   | drain       |

### QUICK REFERENCE DATA

| SYMBOL        | PARAMETER                     | CONDITIONS                                          | MAX. | UNIT     |
|---------------|-------------------------------|-----------------------------------------------------|------|----------|
| $-V_{DS}$     | drain-source voltage          |                                                     | 250  | V        |
| $-I_D$        | drain current                 | DC value                                            | 225  | mA       |
| $R_{DS(on)}$  | drain-source on-resistance    | $-I_D = 200 \text{ mA}$<br>$-V_{GS} = 10 \text{ V}$ | 15   | $\Omega$ |
| $-V_{GS(th)}$ | gate-source threshold voltage | $-I_D = 1 \text{ mA}$<br>$V_{GS} = V_{DS}$          | 2.8  | V        |

### PIN CONFIGURATION





# P-channel enhancement mode vertical D-MOS transistor

**BSP225**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                               | MIN. | MAX. | UNIT               |
|---------------|---------------------------|----------------------------------------------------------|------|------|--------------------|
| $-V_{DS}$     | drain-source voltage      |                                                          | –    | 250  | V                  |
| $\pm V_{GSO}$ | gate-source voltage       | open drain                                               | –    | 20   | V                  |
| $-I_D$        | drain current             | DC value                                                 | –    | 225  | mA                 |
| $-I_{DM}$     | drain current             | peak value                                               | –    | 600  | mA                 |
| $P_{tot}$     | total power dissipation   | up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>(note 1) | –    | 1.5  | W                  |
| $T_{stg}$     | storage temperature range |                                                          | –65  | 150  | $^{\circ}\text{C}$ |
| $T_j$         | junction temperature      |                                                          | –    | 150  | $^{\circ}\text{C}$ |

## Note

1. Device mounted on an epoxy printed-circuit board, 40 x 40 x 1.5 mm, mounting pad for the drain lead minimum 6 cm<sup>2</sup>.

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                            | VALUE | UNIT |
|---------------|--------------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient<br>(note 1) | 83.3  | K/W  |

## Note

1. Device mounted on an epoxy printed-circuit board, 40 x 40 x 1.5 mm, mounting pad for the drain lead minimum 6 cm<sup>2</sup>.

# P-channel enhancement mode vertical D-MOS transistor

**BSP225**
**CHARACTERISTICS**
 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                               | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------|------|------|------|---------------|
| $-V_{(BR)DSS}$                            | drain-source breakdown voltage | $-I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                           | 250  | —    | —    | V             |
| $-I_{DSS}$                                | drain-source leakage current   | $-V_{DS} = 200\text{ V}$<br>$V_{GS} = 0$                                                 | —    | —    | 1    | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $V_{DS} = 0$<br>$\pm V_{GS} = 20\text{ V}$                                               | —    | —    | 100  | nA            |
| $-V_{GS(th)}$                             | gate-source threshold voltage  | $-I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                                | 0.8  | —    | 2.8  | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $-I_D = 200\text{ mA}$<br>$-V_{GS} = 10\text{ V}$                                        | —    | 10   | 15   | $\Omega$      |
| $ y_{fs} $                                | transfer admittance            | $-I_D = 200\text{ mA}$<br>$-V_{DS} = 25\text{ V}$                                        | 100  | 200  | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $-V_{DS} = 25\text{ V}$<br>$-V_{GS} = 0$<br>$f = 1\text{ MHz}$                           | —    | 65   | 90   | pF            |
| $C_{oss}$                                 | output capacitance             | $-V_{DS} = 25\text{ V}$<br>$-V_{GS} = 0$<br>$f = 1\text{ MHz}$                           | —    | 20   | 30   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $-V_{DS} = 25\text{ V}$<br>$-V_{GS} = 0$<br>$f = 1\text{ MHz}$                           | —    | 6    | 15   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                          |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 5    | 10   | ns            |
| $t_{off}$                                 | turn-off time                  | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 20   | 30   | ns            |

# P-channel enhancement mode vertical D-MOS transistor

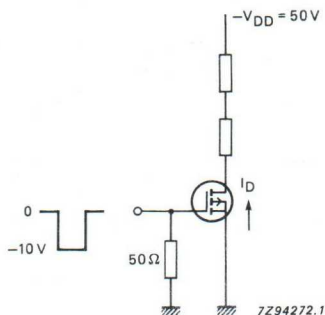
**BSP225**


Fig.2 Switching time test circuit.

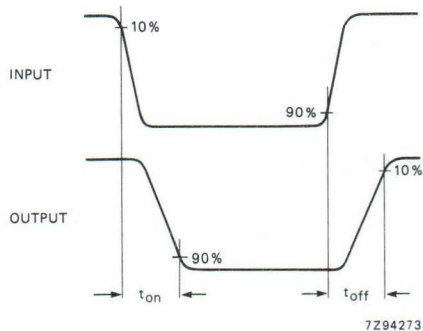


Fig.3 Input and output waveforms.

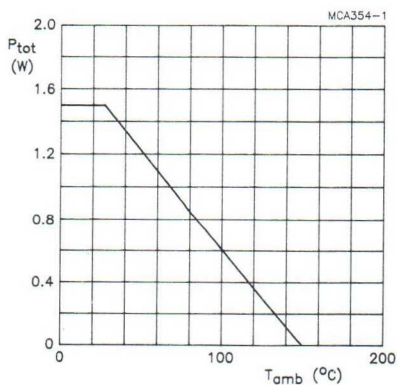
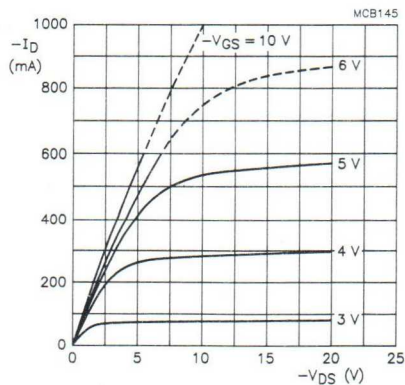


Fig.4 Power derating curve.


 Fig.5 Typical output characteristics;  $T_j = 25^\circ\text{C}$ .

# P-channel enhancement mode vertical D-MOS transistor

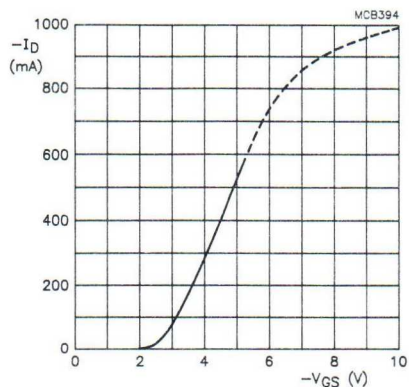
**BSP225**


Fig.6 Typical transfer characteristic;  
 $-V_{DS} = 10$  V;  $T_j = 25$  °C.

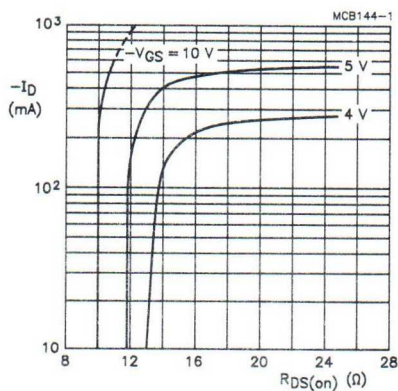


Fig.7 Typical on-resistance as a function of  
drain current;  $T_j = 25$  °C;  $R_{DS(on)} = f(I_D)$ .

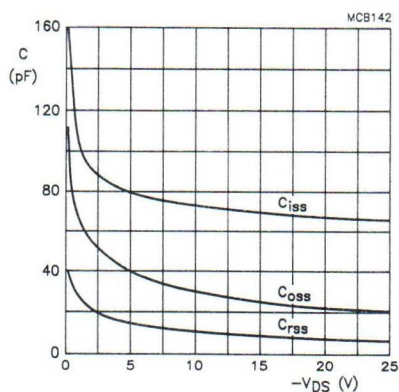


Fig.8 Typical capacitances as a function of  
drain-source voltage;  $V_{GS} = 0$ ;  $f = 1$  MHz;  
 $T_j = 25$  °C.

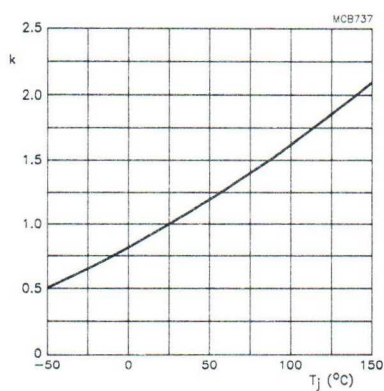


Fig.9 Temperature coefficient of drain-source  
on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_j}{R_{DS(on)} \text{ at } 25 \text{ °C}}$ ; typical  $R_{DS(on)}$   
at  $-200$  mA/ $-10$  V.

# P-channel enhancement mode vertical D-MOS transistor

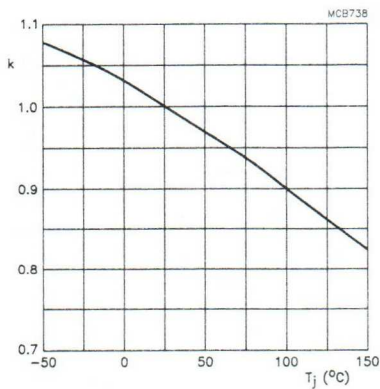
**BSP225**


Fig.10 Temperature coefficient of gate-source

threshold voltage;  $k = \frac{-V_{GS(th)} \text{ at } T_j}{-V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ; typical  
 $V_{GS(th)}$  at -1 mA.



## BSP225

**Marking code:** BSP225.

Fig.11 SOT223.



## SILICON LOW-POWER SWITCHING TRANSISTORS

P-N-P silicon transistor in a microminiature plastic envelope. It is intended for high-speed, saturated switching applications for industrial service in thick and thin-film circuits.

### QUICK REFERENCE DATA

|                                                                      |            |      |                        |
|----------------------------------------------------------------------|------------|------|------------------------|
| Collector-base voltage (open emitter)                                | $-V_{CBO}$ | max. | 15 V                   |
| Collector-emitter voltage (open base)                                | $-V_{CEO}$ | max. | 15 V                   |
| Collector current (peak value)                                       | $-I_{CM}$  | max. | 200 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW                 |
| Junction temperature                                                 | $T_j$      | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                    |            |      |                        |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                          | $h_{FE}$   | >    | 30                     |
| $-I_C = 50\text{ mA}; -V_{CE} = 1\text{ V}$                          | $h_{FE}$   |      | 30 to 120              |
| Transition frequency at $f = 500\text{ MHz}$                         | $f_T$      | >    | 1,5 GHz                |
| Turn-off time                                                        | $t_{off}$  | <    | 30 ns                  |
| $-I_{Con} = 30\text{ mA}; -I_{Bon} = +I_{Boff} = 3,0\text{ mA}$      |            |      |                        |

### MECHANICAL DATA

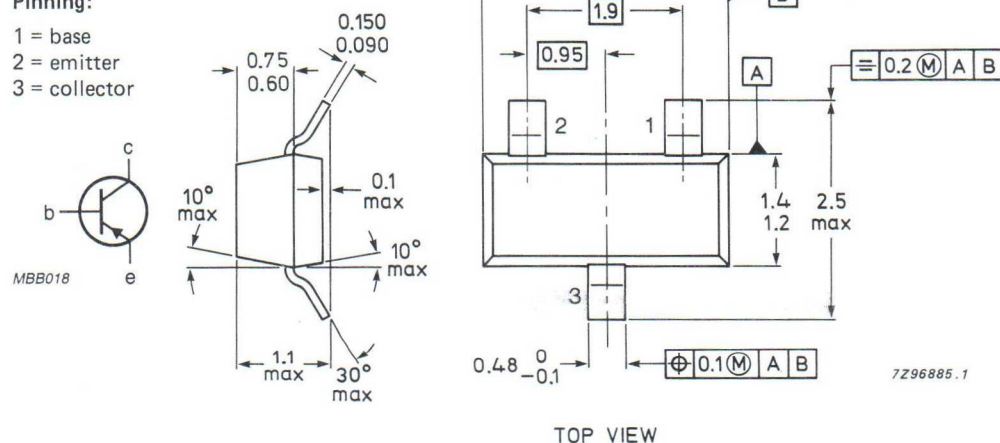
Dimensions in mm

Marking code

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



Reverse pinning types are available on request.

See also *Soldering recommendations*.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |            |      |                                         |
|----------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                | $-V_{CBO}$ | max. | 15 V                                    |
| Collector-emitter voltage (open base)                                | $-V_{CEO}$ | max. | 15 V                                    |
| Emitter-base voltage (open collector)                                | $-V_{EBO}$ | max. | 3 V                                     |
| Collector current (d.c.)                                             | $-I_C$     | max. | 100 mA                                  |
| Collector current (peak value)                                       | $-I_{CM}$  | max. | 200 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW                                  |
| Storage temperature                                                  | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$      | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

|                                                                         |            |   |                 |
|-------------------------------------------------------------------------|------------|---|-----------------|
| $I_E = 0; -V_{CB} = 10\text{ V}$                                        | $-I_{CBO}$ | < | 50 nA           |
| $I_E = 0; -V_{CB} = 10\text{ V}; T_{amb} = 125\text{ }^{\circ}\text{C}$ | $-I_{CBO}$ | < | 5 $\mu\text{A}$ |
| $V_{BE} = 0; -V_{CE} = 10\text{ V}$                                     | $-I_{CES}$ | < | 50 nA           |

Breakdown voltages

|                                            |                |   |      |
|--------------------------------------------|----------------|---|------|
| $I_E = 0; -I_C = 10\text{ }\mu\text{A}$    | $-V_{(BR)CBO}$ | > | 15 V |
| $V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$ | $-V_{(BR)CES}$ | > | 15 V |
| $I_C = 0; -I_E = 100\text{ }\mu\text{A}$   | $-V_{(BR)EBO}$ | > | 3 V  |

Collector-emitter sustaining voltage

|                                |                   |   |      |
|--------------------------------|-------------------|---|------|
| $I_B = 0; -I_C = 10\text{ mA}$ | $-V_{CEO_{sust}}$ | > | 15 V |
|--------------------------------|-------------------|---|------|

Saturation voltages\*\*

|                                             |                 |      |                |
|---------------------------------------------|-----------------|------|----------------|
| $-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$   | $-V_{CE_{sat}}$ | <    | 130 mV         |
|                                             | $-V_{BE_{sat}}$ |      | 725 to 920 mV  |
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$   | $-V_{CE_{sat}}$ | typ. | 180 mV         |
|                                             | $-V_{BE_{sat}}$ | <    | 270 mV         |
|                                             | $-V_{BE_{sat}}$ |      | 800 to 1150 mV |
| $-I_C = 100\text{ mA}; -I_B = 10\text{ mA}$ | $-V_{CE_{sat}}$ | <    | 450 mV         |
|                                             | $-V_{BE_{sat}}$ |      | 900 to 1500 mV |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

\*\* Measured under pulse conditions;  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta = 0,01$ .

## D.C. current gain \*

|                                                                           |          |           |    |
|---------------------------------------------------------------------------|----------|-----------|----|
| $-I_C = 1 \text{ mA}; -V_{CE} = 1 \text{ V}$                              | $h_{FE}$ | $>$       | 30 |
| $-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$                             | $h_{FE}$ | $>$       | 30 |
| $-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}$                             | $h_{FE}$ | 30 to 120 |    |
| $-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}; T_{amb} = 55^\circ\text{C}$ | $h_{FE}$ | $>$       | 30 |
| $-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$                            | $h_{FE}$ | $>$       | 20 |

Transition frequency at  $f = 500 \text{ MHz}$ 

|                                                |       |     |         |
|------------------------------------------------|-------|-----|---------|
| $-I_C = 50 \text{ mA}; -V_{CE} = 10 \text{ V}$ | $f_T$ | $>$ | 1,5 GHz |
|------------------------------------------------|-------|-----|---------|

## Collector capacitance

|                                        |       |     |        |
|----------------------------------------|-------|-----|--------|
| $I_E = I_e = 0; -V_{CB} = 5 \text{ V}$ | $C_C$ | $<$ | 4,5 pF |
|----------------------------------------|-------|-----|--------|

## Emitter capacitance

|                                          |       |     |        |
|------------------------------------------|-------|-----|--------|
| $I_C = I_c = 0; -V_{EB} = 0,5 \text{ V}$ | $C_e$ | $<$ | 6,0 pF |
|------------------------------------------|-------|-----|--------|

## Switching times

|              |          |     |       |
|--------------|----------|-----|-------|
| Turn-on time | $t_{on}$ | $<$ | 20 ns |
|--------------|----------|-----|-------|

|               |           |     |       |
|---------------|-----------|-----|-------|
| Turn-off time | $t_{off}$ | $<$ | 30 ns |
|---------------|-----------|-----|-------|

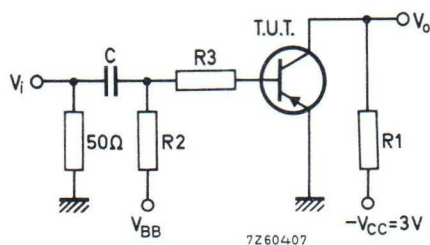


Fig. 2 Test circuit switching times.

## Pulse generator

|                  |                        |
|------------------|------------------------|
| Pulse duration   | $t_p = 400 \text{ ns}$ |
| Rise time        | $t_r < 1 \text{ ns}$   |
| Output impedance | $Z_o = 50 \Omega$      |

## Sampling scope

|                 |                             |
|-----------------|-----------------------------|
| Rise time       | $t_r < 1 \text{ ns}$        |
| Input impedance | $Z_i = 100 \text{ k}\Omega$ |

|           | $V_i$<br>V | $V_{BB}$<br>V | $R1$<br>$\Omega$ | $R2$<br>$\text{k}\Omega$ | $R3$<br>$\text{k}\Omega$ | $-I_{Con}$<br>mA | $-I_{Bon}$<br>mA | $I_{Boff}$<br>mA | $C$<br>$\mu\text{F}$ |
|-----------|------------|---------------|------------------|--------------------------|--------------------------|------------------|------------------|------------------|----------------------|
| $t_{on}$  | -6,85      | 0             | 94               | 1,0                      | 2,0                      | 30               | 3,0              | —                | 0,1                  |
| $t_{off}$ | 11,7       | -9,85         | 94               | 1,0                      | 2,0                      | 30               | 3,0              | 3,0              | 0,1                  |

\* Measured under pulse conditions;  $t_p = 300 \mu\text{s}$ ;  $\delta = 0,01$ .



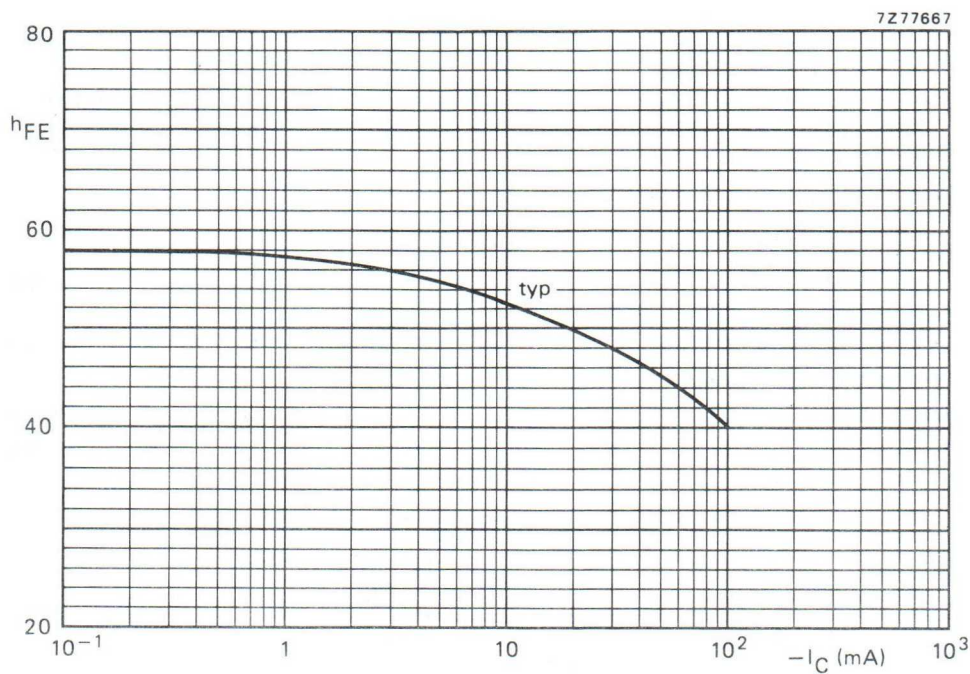


Fig. 3  $-V_{CE} = 1$  V;  $T_{amb} = 25$  °C.

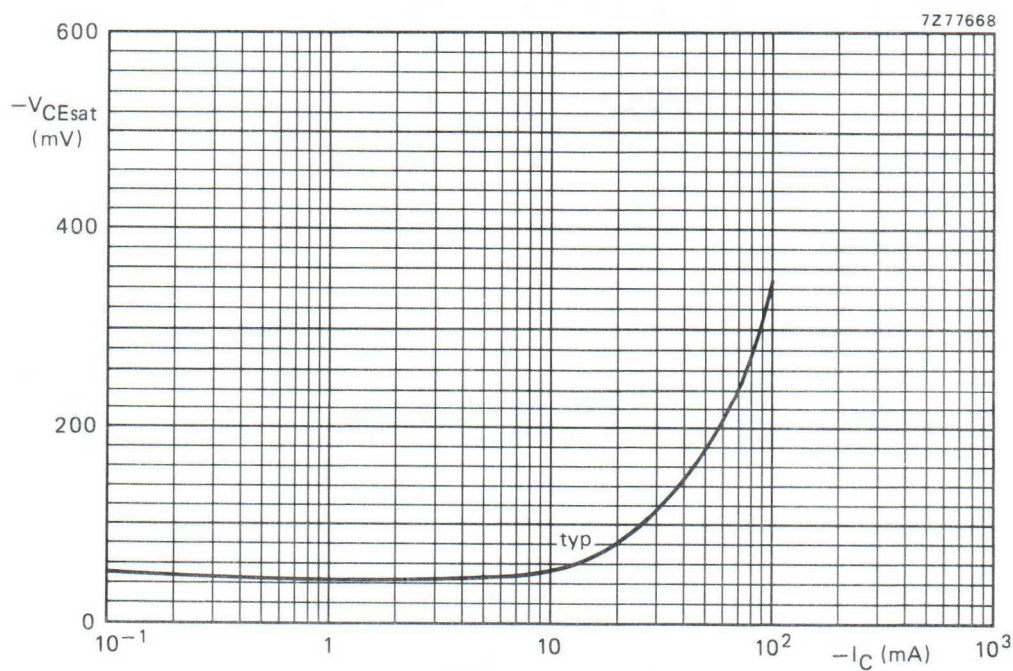


Fig. 4  $V_{CEsat}$  as a function of  $I_C$  at  $I_C/I_B = 10$ .

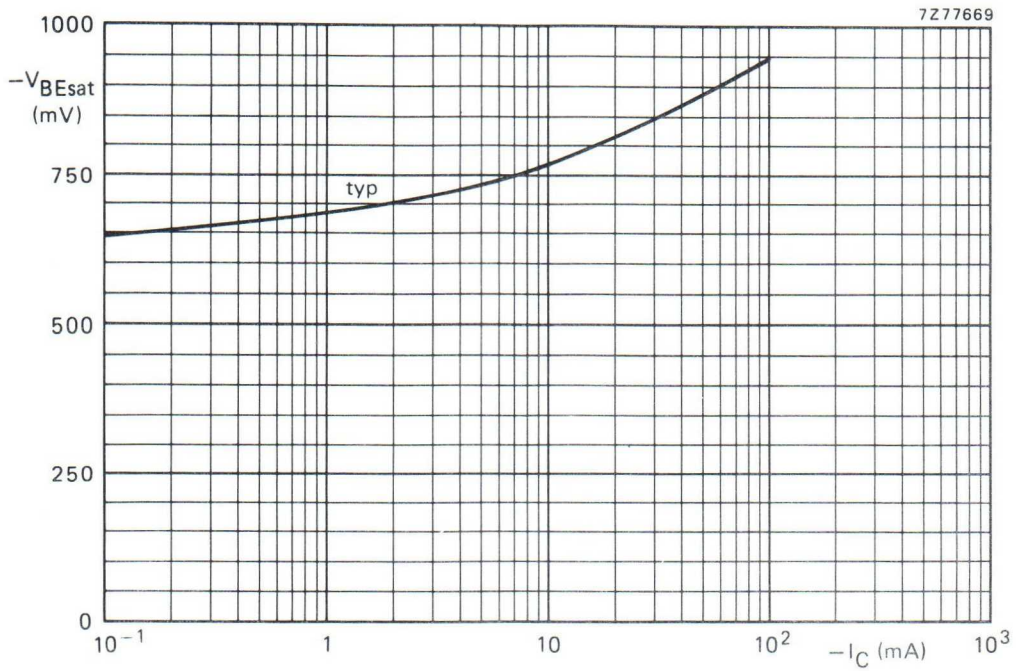


Fig. 5  $V_{BE(sat)}$  as a function of  $I_C$  at  $I_C/I_B = 10$ .

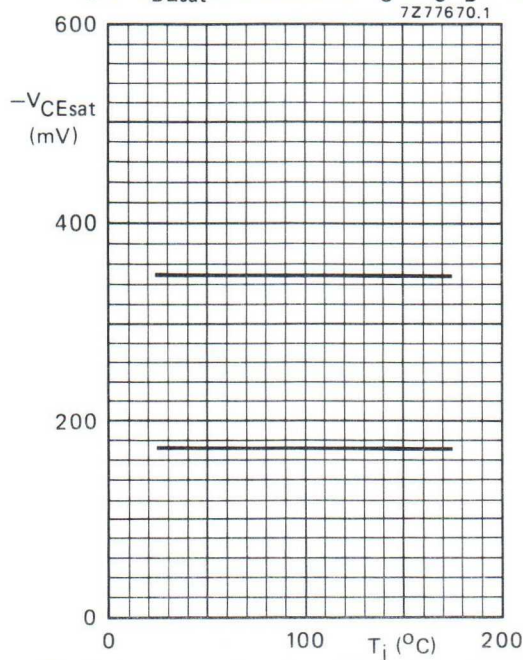


Fig. 6  $V_{CE(sat)}$  as a function of  $T_j$ ; typical values.

Upper graph at  $I_C = 100$  mA;  $I_B = 10$  mA. Lower graph at  $I_C = 50$  mA and  $I_B = 5$  mA.



## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistors, in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                            |           | BSR13      | BSR14            |
|------------------------------------------------------------|-----------|------------|------------------|
| Collector-base voltage (open emitter)                      | $V_{CB0}$ | max. 60    | 75 V             |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. 30    | 40 V             |
| Emitter-base voltage (open collector)                      | $V_{EBO}$ | max. 5     | 6 V              |
| Collector current (d.c.)                                   | $I_C$     | max. 800   | mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. 250   | mW               |
| Junction temperature                                       | $T_j$     | max. 150   | $^\circ\text{C}$ |
| D.C. current gain                                          |           | 100 to 300 |                  |
| $I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$                | $h_{FE}$  | > 30       | 40               |
| $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$                | $h_{FE}$  |            |                  |
| Transition frequency at $f = 100\text{ MHz}$               |           |            |                  |
| $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$                 | $f_T$     | > 250      | 300 MHz          |

## MECHANICAL DATA

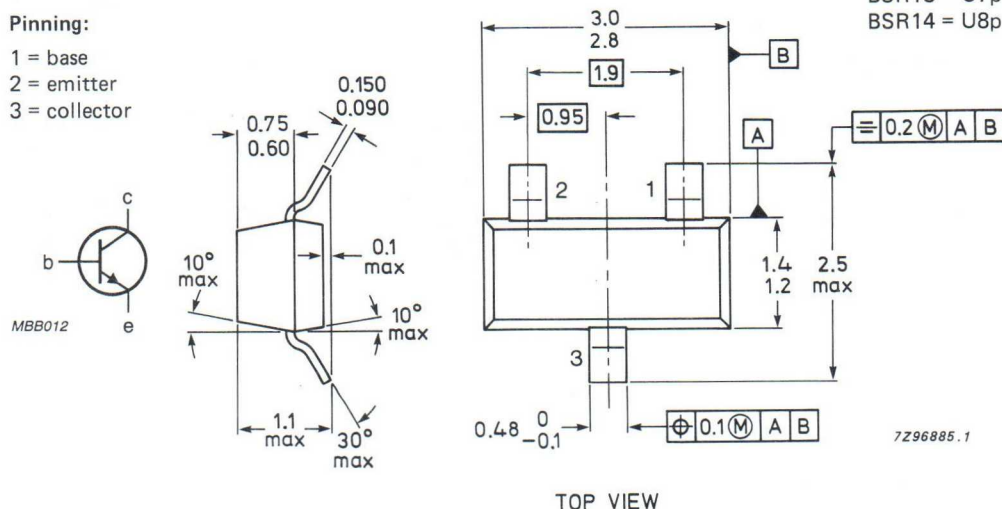
Dimensions in mm

Marking code

Fig. 1 SOT-23.

## Pinning:

- 1 = base  
2 = emitter  
3 = collector



Reverse pinning types are available on request.  
See also Soldering recommendations.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |                | BSR13        | BSR14 |                    |
|-------------------------------------------------------------------------|----------------|--------------|-------|--------------------|
| Collector-base voltage (open emitter)                                   | $V_{CBO}$ max. | 60           | 75    | V                  |
| Collector-emitter voltage (open base)                                   | $V_{CEO}$ max. | 30           | 40    | V                  |
| Emitter-base voltage (open collector)                                   | $V_{EBO}$ max. | 5            | 6     | V                  |
| Collector current (d.c.)                                                | $I_C$ max.     | 800          |       | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ max. | 250          |       | mW                 |
| Storage temperature                                                     | $T_{stg}$      | -65 to + 150 |       | $^{\circ}\text{C}$ |
| Junction temperature                                                    | $T_j$ max.     | 150          |       | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                           |                 |     |     |
|---------------------------|-----------------|-----|-----|
| From junction to ambient* | $R_{th\ j-a}$ = | 500 | K/W |
|---------------------------|-----------------|-----|-----|

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                    |               | BSR13 | BSR14      |               |
|--------------------------------------------------------------------|---------------|-------|------------|---------------|
| Collector cut-off current                                          |               |       |            |               |
| $I_E = 0; V_{CB} = 50\text{ V}$                                    | $I_{CBO} <$   | 30    | —          | nA            |
| $I_E = 0; V_{CB} = 60\text{ V}$                                    | $I_{CBO} <$   | —     | 10         | nA            |
| $I_E = 0; V_{CB} = 50\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $I_{CBO} <$   | 10    | —          | $\mu\text{A}$ |
| $I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $I_{CBO} <$   | —     | 10         | $\mu\text{A}$ |
| $V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$                        | $I_{CEX} <$   | —     | 10         | nA            |
| Base current                                                       |               |       |            |               |
| with reverse biased emitter junction                               |               |       |            |               |
| $V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$                        | $I_{BEX} <$   | —     | 20         | nA            |
| Emitter cut-off current                                            |               |       |            |               |
| $I_C = 0; V_{EB} = 3\text{ V}$                                     | $I_{EBO} <$   | 30    | 15         | nA            |
| Saturation voltages                                                |               |       |            |               |
| $I_C = 150\text{ mA}; I_B = 15\text{ mA}$                          | $V_{CEsat} <$ | 400   | 300        | mV            |
|                                                                    | $V_{BEsat} <$ | 1300  | —          | mV            |
|                                                                    | $V_{BEsat}$   | —     | 0,6 to 1,2 | V             |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$                          | $V_{CEsat} <$ | 1600  | 1000       | mV            |
|                                                                    | $V_{BEsat} <$ | 2600  | 2000       | mV            |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



## D.C. current gain \*

 $I_C = 0,1 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$  $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$  BSR13; R $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$  BSR14; R

|          |            |
|----------|------------|
| $h_{FE}$ | > 35       |
| $h_{FE}$ | > 50       |
| $h_{FE}$ | > 75       |
| $h_{FE}$ | 100 to 300 |
| $h_{FE}$ | > 50       |
| $h_{FE}$ | > 30       |
| $h_{FE}$ | > 40       |

Transition frequency at  $f = 100 \text{ MHz}$  $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$  BSR13; R $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$  BSR14; R

|       |       |     |
|-------|-------|-----|
| $f_T$ | > 250 | MHz |
| $f_T$ | > 300 | MHz |

Collector capacitance at  $f = 1 \text{ MHz}$  $I_E = I_e = 0; V_{CB} = 10 \text{ V}$ 

|       |     |    |
|-------|-----|----|
| $C_C$ | < 8 | pF |
|-------|-----|----|

h parameters (common emitter) at  $f = 1 \text{ kHz}$  $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$ 

input impedance

reverse voltage transfer ratio

small signal current gain

output admittance

 $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$ 

input impedance

reverse voltage transfer ratio

small signal current gain

output admittance

|          |                     |           |
|----------|---------------------|-----------|
|          | <u>BSR14</u>        |           |
| $h_{ie}$ | 2 to 8              | $k\Omega$ |
| $h_{re}$ | < $8 \cdot 10^{-4}$ |           |
| $h_{fe}$ | 50 to 300           |           |
| $h_{oe}$ | 5 to 35             | $\mu S$   |
|          | <u>BSR13</u>        |           |
| $h_{ie}$ | 0,25 to 1,25        | $k\Omega$ |
| $h_{re}$ | < $4 \cdot 10^{-4}$ |           |
| $h_{fe}$ | 75 to 375           |           |
| $h_{oe}$ | 25 to 200           | $\mu S$   |

\* Measured under pulsed conditions to avoid excessive dissipation; pulse duration  $t_p \leq 300 \mu s$ ; duty factor  $\delta \leq 0,02$ .

Switching times (between 10% and 90% levels)

Turn-on time switched to  $I_C = 150$  mA (see Fig. 2)

delay time

rise time

Turn-off time switched from  $I_C = 150$  mA (see Fig. 3)

storage time

fall time

BSR14

|       |   |    |    |
|-------|---|----|----|
| $t_d$ | < | 10 | ns |
| $t_r$ | < | 25 | ns |

|       |   |     |    |
|-------|---|-----|----|
| $t_s$ | < | 225 | ns |
| $t_f$ | < | 60  | ns |

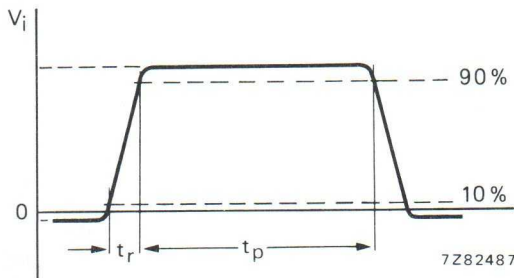


Fig. 2 Waveform and test circuit delay and rise time.

$V_i = -0,5$  to  $+9,9$  V;  $V_{CC} = 30$  V;  $R_1 = 619 \Omega$ ;  $R_2 = 200 \Omega$ .

Pulse generator:

pulse duration

rise time

duty factor

|          |        |     |    |
|----------|--------|-----|----|
| $t_p$    | $\leq$ | 200 | ns |
| $t_r$    | $\leq$ | 2   | ns |
| $\delta$ | $=$    | 2   | %  |

Oscilloscope:

input impedance

input capacitance

rise time

|       |     |     |            |
|-------|-----|-----|------------|
| $Z_i$ | $>$ | 100 | k $\Omega$ |
| $C_i$ | $<$ | 12  | pF         |
| $t_r$ | $<$ | 5   | ns         |

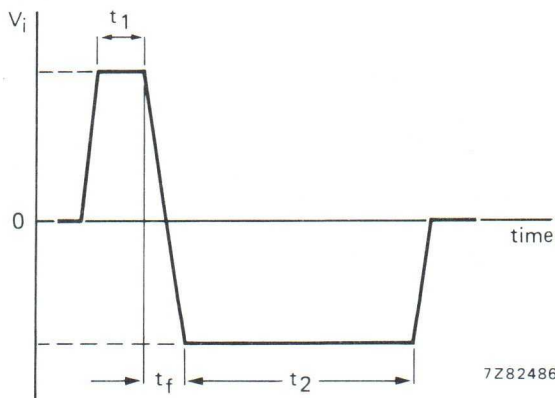


Fig. 3 Waveform and test circuit storage and fall time.

$V_i = -13,8$  to  $+16,2$  V;  $V_{CC} = 30$  V;  $-V_{BB} = 3$  V;  $R_1 = 1$  k $\Omega$ ;  $R_2 = 200 \Omega$ .

Pulse generator:

fall time

pulse time

|       |     |     |         |
|-------|-----|-----|---------|
| $t_f$ | $<$ | 5   | ns      |
| $t_1$ | $=$ | 100 | $\mu$ s |
| $t_2$ | $=$ | 500 | $\mu$ s |

Oscilloscope:

input impedance

input capacitance

rise time

|       |     |     |            |
|-------|-----|-----|------------|
| $Z_i$ | $>$ | 100 | k $\Omega$ |
| $C_i$ | $<$ | 12  | pF         |
| $t_r$ | $<$ | 5   | ns         |

## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon transistors, in a microminiature plastic envelope, intended for medium power switching and general purpose amplifier applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

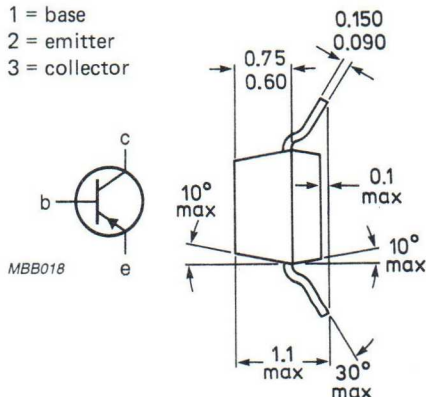
|                                                                |            |      | BSR15 | BSR16 |                  |
|----------------------------------------------------------------|------------|------|-------|-------|------------------|
| Collector-base voltage (open emitter)                          | $-V_{CBO}$ | max. | 60    | 60    | V                |
| Collector-emitter voltage (open base)                          | $-V_{CEO}$ | max. | 40    | 60    | V                |
| Emitter-base voltage (open collector)                          | $-V_{EBO}$ | max. |       | 5     | V                |
| Collector current (d.c.)                                       | $-I_C$     | max. |       | 600   | mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$     | $P_{tot}$  | max. |       | 250   | mW               |
| Junction temperature                                           | $T_j$      | max. |       | 150   | $^\circ\text{C}$ |
| D.C. current gain                                              |            |      |       |       |                  |
| $-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$                  | $h_{FE}$   | >    | 30    | 50    |                  |
| Turn-off switching time                                        |            |      |       |       |                  |
| $-I_{Con} = 150\text{ mA}; -I_{Bon} = I_{Boff} = 15\text{ mA}$ | $t_{off}$  | >    |       | 100   | ns               |
| Transition frequency at $f = 100\text{ MHz}$                   |            |      |       |       |                  |
| $-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$                   | $f_T$      | >    |       | 200   | MHz              |

## MECHANICAL DATA

Fig. 1 SOT-23.

## Pinning:

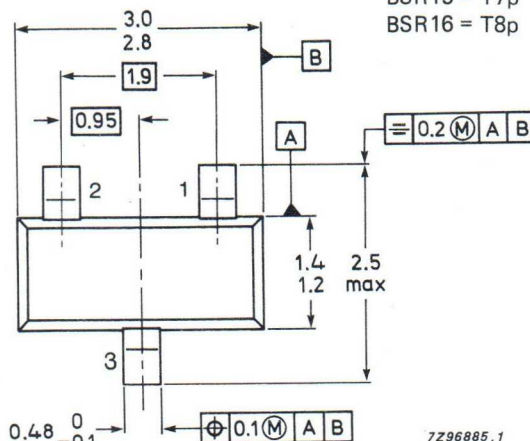
- 1 = base  
2 = emitter  
3 = collector



## Dimensions in mm

## Marking code

BSR15 = T7p  
BSR16 = T8p



TOP VIEW

Reverse pinning types are available on request.  
See also Soldering recommendations.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |                 | BSR15       | BSR16 |                    |
|----------------------------------------------------------------|-----------------|-------------|-------|--------------------|
| Collector-base voltage (open emitter)                          | $-V_{CBO}$ max. | 60          | 60    | V                  |
| Collector-emitter voltage (open base)                          | $-V_{CEO}$ max. | 40          | 60    | V                  |
| Emitter-base voltage (open collector)                          | $-V_{EBO}$ max. | 5           | 5     | V                  |
| Collector current (d.c.)                                       | $-I_C$ max.     |             | 600   | mA                 |
| Power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ max.  |             | 250   | mW                 |
| Storage temperature                                            | $T_{stg}$       | -65 to +150 |       | $^{\circ}\text{C}$ |
| Junction temperature                                           | $T_j$ max.      |             | 150   | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                           |                 |     |     |
|---------------------------|-----------------|-----|-----|
| From junction to ambient* | $R_{th\ j-a}$ = | 500 | K/W |
|---------------------------|-----------------|-----|-----|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                     |                | BSR15 | BSR16 |               |
|---------------------------------------------------------------------|----------------|-------|-------|---------------|
| Collector cut-off current                                           |                |       |       |               |
| $I_E = 0; -V_{CB} = 50\text{ V}$                                    | $-I_{CBO} <$   | 20    | 10    | nA            |
| $I_E = 0; -V_{CB} = 50\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $-I_{CBO} <$   | 20    | 10    | $\mu\text{A}$ |
| $-V_{EB} = 0,5\text{ V}; -V_{CE} = 30\text{ V}$                     | $-I_{CEX} <$   |       | 50    | nA            |
| Base current                                                        |                |       |       |               |
| with reverse biased emitter junction                                |                |       |       |               |
| $-V_{EB} = 3\text{ V}; -V_{CE} = 30\text{ V}$                       | $-I_{BEX} <$   |       | 50    | nA            |
| Saturation voltages                                                 |                |       |       |               |
| $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$                         | $-V_{CEsat} <$ |       | 0,4   | V             |
|                                                                     | $-V_{BEsat} <$ |       | 1,3   | V             |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$                         | $-V_{CEsat} <$ |       | 1,6   | V             |
|                                                                     | $-V_{BEsat} <$ |       | 2,6   | V             |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

## D.C. current gain \*

$-I_C = 0,1 \text{ mA}; -V_{CE} = 10 \text{ V}$

$h_{FE} > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 35 & 75 \end{array}$

$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$

$h_{FE} > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 50 & 100 \end{array}$

$-I_C = 10 \text{ mA}; -V_{CE} = 10 \text{ V}$

$h_{FE} > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 75 & 100 \end{array}$

$-I_C = 150 \text{ mA}; -V_{CE} = 10 \text{ V}$

$h_{FE} > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 100 \text{ to } 300 & \end{array}$

$-I_C = 500 \text{ mA}; -V_{CE} = 10 \text{ V}$

$h_{FE} > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 30 & 50 \end{array}$

Transition frequency at  $f = 100 \text{ MHz}$ 

$-I_C = 50 \text{ mA}; -V_{CE} = 20 \text{ V}; T_{\text{amb}} = 25^\circ \text{C}$

$f_T > \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 200 & \text{MHz} \end{array}$

Collector capacitance at  $f = 1 \text{ MHz}$ 

$I_E = I_C = 0; -V_{CB} = 10 \text{ V}$

$C_c < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 8 & \text{pF} \end{array}$

Emitter capacitance at  $f = 1 \text{ MHz}$ 

$I_C = I_E = 0; -V_{EB} = 2 \text{ V}$

$C_e < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 30 & \text{pF} \end{array}$

## Switching times (between 10% and 90% levels)

## Turn-on time when switched to

$-I_C = 150 \text{ mA}; -I_B = 15 \text{ mA}; \text{ (see Fig. 3)}$

delay time

$t_d < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 10 & \text{ns} \end{array}$

rise time

$t_r < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 40 & \text{ns} \end{array}$

turn-on time ( $t_d + t_r$ )

$t_{\text{on}} < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 45 & \text{ns} \end{array}$

## Turn-off time when switched from

$-I_C = 150 \text{ mA}; -I_B = 15 \text{ mA}$

to cut-off with  $+I_{BM} = 15 \text{ mA}$  (see Fig. 4)

storage time

$t_s < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 80 & \text{ns} \end{array}$

fall time

$t_f < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 30 & \text{ns} \end{array}$

turn-off time ( $t_s + t_f$ )

$t_{\text{off}} < \begin{array}{c|c} \text{BSR15} & \text{BSR16} \\ \hline 100 & \text{ns} \end{array}$

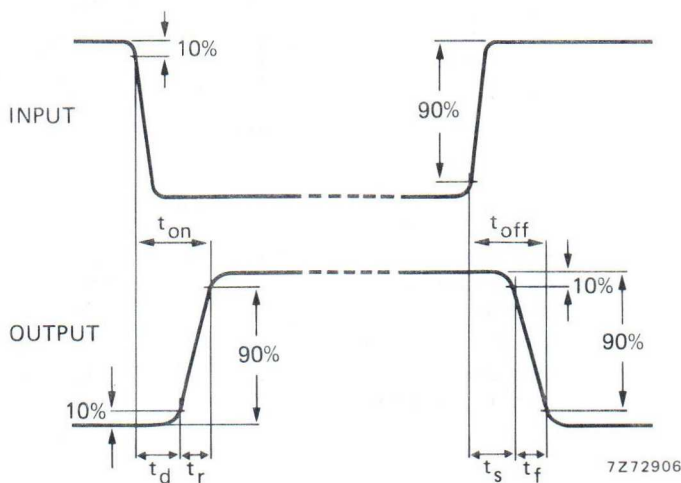


Fig. 2 Switching time waveforms.

\* Measured under pulsed conditions to avoid excessive dissipation; pulse duration  $t_p \leq 300 \mu\text{s}$ ; duty factor  $\delta \leq 0,02$ .



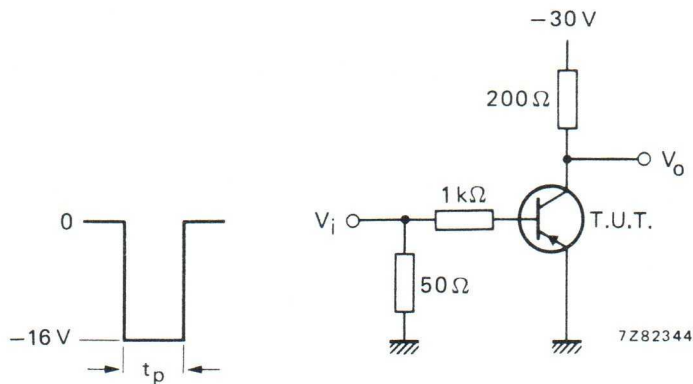


Fig. 3 Turn-on switching time test circuit.

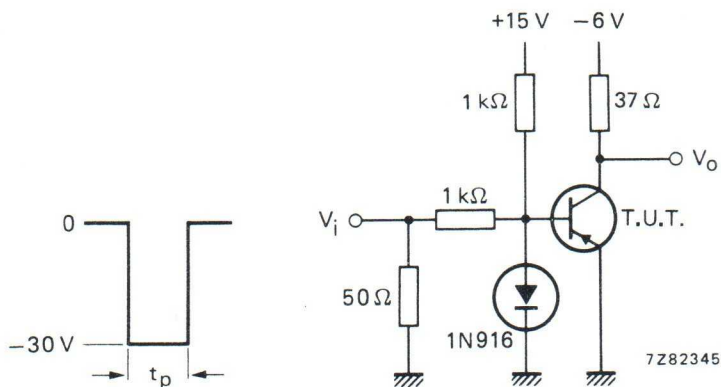


Fig. 4 Turn-off switching time test circuit.

|                                             |                  |       |        |     |            |
|---------------------------------------------|------------------|-------|--------|-----|------------|
| Input pulse generator:<br>Fig. 3 and Fig. 4 | frequency        | $f$   | =      | 150 | Hz         |
|                                             | pulse duration   | $t_p$ | =      | 200 | ns         |
|                                             | rise time        | $t_r$ | $\leq$ | 2   | ns         |
|                                             | output impedance | $Z_o$ | =      | 50  | $\Omega$   |
| Output oscilloscope:<br>Fig. 3 and Fig. 4   | rise time        | $t_r$ | $\leq$ | 5   | ns         |
|                                             | input impedance  | $Z_i$ | =      | 10  | M $\Omega$ |

## SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistor in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

### QUICK REFERENCE DATA

|                                                                      |           |            |                        |
|----------------------------------------------------------------------|-----------|------------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max.       | 60 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max.       | 40 V                   |
| Emitter-base voltage (open collector)                                | $V_{EBO}$ | max.       | 6 V                    |
| Collector current (DC)                                               | $I_C$     | max.       | 200 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max.       | 250 mW                 |
| Junction temperature                                                 | $T_j$     | max.       | 150 $^{\circ}\text{C}$ |
| DC current gain                                                      | $h_{FE}$  | 100 to 300 |                        |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                            |           |            |                        |
| Transition frequency at $f = 500\text{ MHz}$                         | $f_T$     | > 300 MHz  |                        |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                           |           |            |                        |

### MECHANICAL DATA

Dimensions in mm

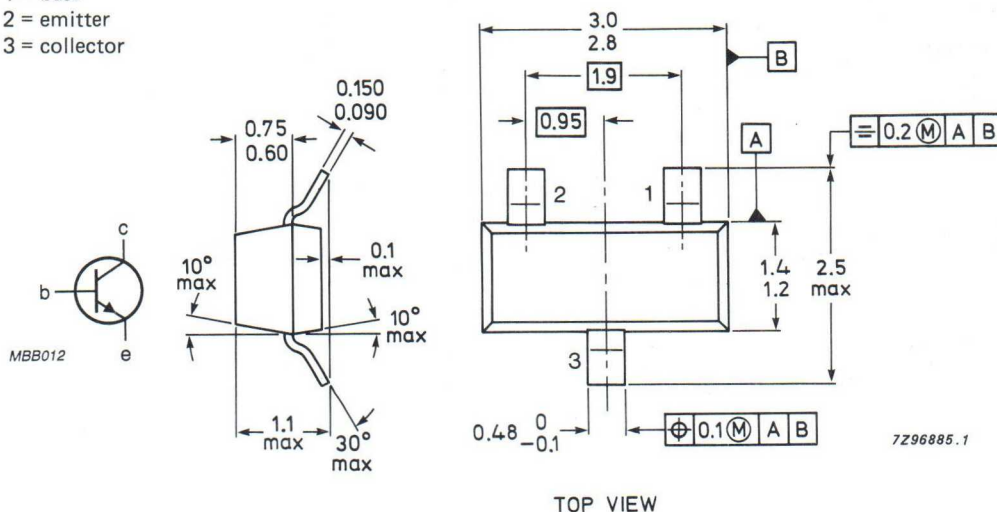
Marking code

Fig.1 SOT-23.

BSR17A = U92

### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



Reverse pinning types are available on request.  
See also *Soldering recommendations*.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |           |      |                                         |
|----------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                          | $V_{CBO}$ | max. | 60 V                                    |
| Collector-emitter voltage (open base)                          | $V_{CEO}$ | max. | 40 V                                    |
| Emitter base voltage (open collector)                          | $V_{EBO}$ | max. | 6 V                                     |
| Collector current (d.c.)                                       | $I_C$     | max. | 200 mA                                  |
| Power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW                                  |
| Storage temperature                                            | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                           | $T_j$     | max. | 150 $^{\circ}\text{C}$                  |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Collector cut-off current

 $I_E = 0; V_{CB} = 30\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$  $V_{EB} = 3\text{ V}; V_{CE} = 30\text{ V}$ 

|           |   |                 |
|-----------|---|-----------------|
| $I_{CBO}$ | < | 5 $\mu\text{A}$ |
| $I_{CEX}$ | < | 50 nA           |

Base current

with reverse biased emitter junction

 $V_{EB} = 3\text{ V}; V_{CE} = 30\text{ V}$ 

|           |   |       |
|-----------|---|-------|
| $I_{BEX}$ | < | 50 nA |
|-----------|---|-------|

Saturation voltages \*

 $I_C = 10\text{ mA}; I_B = 1\text{ mA}$ 

|             |   |               |
|-------------|---|---------------|
| $V_{CEsat}$ | < | 200 mV        |
| $V_{BEsat}$ |   | 650 to 850 mV |
| $V_{CEsat}$ | < | 300 mV        |
| $V_{BEsat}$ | < | 950 mV        |

 $I_C = 50\text{ mA}; I_B = 5\text{ mA}$ Collector capacitance at  $f = 1\text{ MHz}$  $I_E = I_e = 0; V_{CB} = 5\text{ V}$ 

|       |   |      |
|-------|---|------|
| $C_c$ | < | 4 pF |
|-------|---|------|

Emitter capacitance at  $f = 1\text{ MHz}$  $I_C = I_c = 0; V_{EB} = 0,5\text{ V}$ 

|       |   |      |
|-------|---|------|
| $C_e$ | < | 8 pF |
|-------|---|------|

\* Measured under pulsed conditions; pulse duration  $t_p \leq 300\text{ }\mu\text{s}$ ; duty factor  $\delta \leq 0,02$ .

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

## D.C. current gain\*

$$I_C = 0,1 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$I_C = 10 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$I_C = 50 \text{ mA}; V_{CE} = 1 \text{ V}$$

$$I_C = 100 \text{ mA}; V_{CE} = 1 \text{ V}$$

Transition frequency at  $f = 100 \text{ MHz}$ 

$$I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V}$$

$$h_{FE} > 40$$

$$h_{FE} > 70$$

$$h_{FE} > 100$$

$$h_{FE} < 300$$

$$h_{FE} > 60$$

$$h_{FE} > 30$$

$$f_T > 300 \text{ MHz}$$

## h-parameters (common emitter)

$$I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$$

Input impedance

Reverse voltage transfer ratio

Small-signal current gain

Output admittance

$$h_{ie} \quad 1 \text{ to } 10 \text{ k}\Omega$$

$$h_{re} \quad 0,5 \text{ to } 8 \cdot 10^{-4}$$

$$h_{fe} \quad 100 \text{ to } 400$$

$$h_{oe} \quad 1 \text{ to } 40 \text{ }\mu\text{S}$$

Switching times (between 10% and 90% levels)

Turn on time switched to

$$I_C = 10 \text{ mA}; I_B = 1 \text{ mA}; V_{EB} = 0,5 \text{ V}$$

delay time

rise time

$$t_d < 35 \text{ ns}$$

$$t_r < 35 \text{ ns}$$

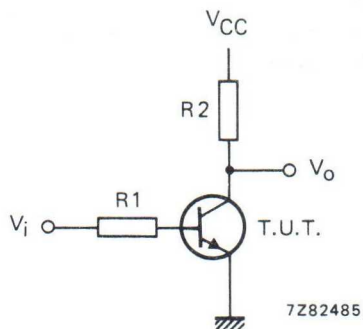
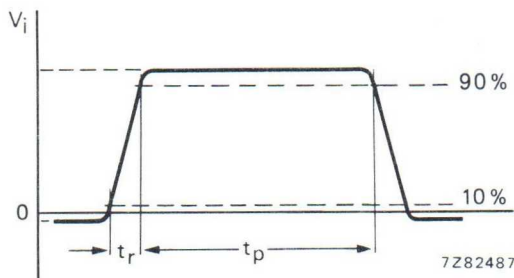


Fig. 2 Delay and rise time equivalent circuit.

$$V_i = -0,5 \text{ to } +10,6 \text{ V}; V_{CC} = 3 \text{ V}; R_1 = 10 \text{ k}\Omega; R_2 = 275 \text{ }\Omega;$$

$$\text{total shunt capacitance of test jig and connectors} = C_s \leq 4 \text{ pF}.$$

Pulse generator: pulse duration 300 ns; fall time  $< 1 \text{ ns}$ ; duty factor 2%.

Turn off time switched from

$$I_C = 10 \text{ mA}; I_{\text{Bon}} = -I_{\text{Boff}} = 1 \text{ mA}$$

storage time

fall time

$$\begin{array}{ll} t_s & < 200 \text{ ns} \\ t_f & < 50 \text{ ns} \end{array}$$

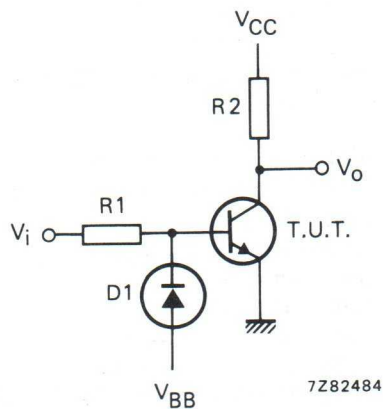
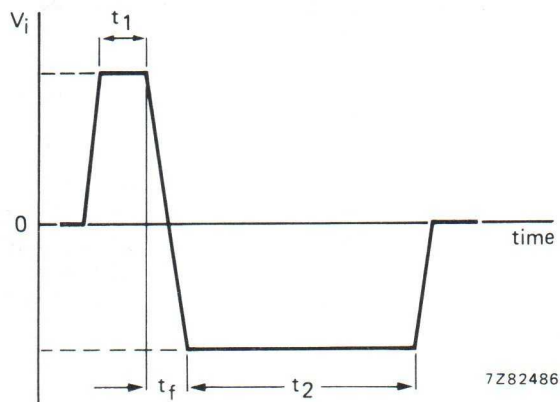


Fig. 3 Storage and fall time equivalent test circuit.

$V_i = -9,1$  to  $+10,9$  V;  $V_{CC} = 3$  V;  $V_{BB} = 0$  V (ground);  $R1 = 10 \text{ k}\Omega$ ;  $R2 = 275 \Omega$ ; total shunt capacitance of test jig and connectors =  $C_s \leq 4 \text{ pF}$ .

Pulse generator: pulse duration  $t_1 = 10$  to  $500 \mu\text{s}$ ; fall time  $t_f < 1 \text{ ns}$ ; duty factor  $\delta = 2\%$ .



## SILICON LOW-POWER SWITCHING TRANSISTORS

P-N-P silicon transistor in a microminiature plastic envelope, intended for switching and linear applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                                      |            |            |                        |
|----------------------------------------------------------------------|------------|------------|------------------------|
| Collector-base voltage (open emitter)                                | $-V_{CBO}$ | max.       | 40 V                   |
| Collector-emitter voltage (open base)                                | $-V_{CEO}$ | max.       | 40 V                   |
| Collector current (DC)                                               | $-I_C$     | max.       | 200 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max.       | 250 mW                 |
| Junction temperature                                                 | $T_j$      | max.       | 150 $^{\circ}\text{C}$ |
| DC current gain                                                      |            |            |                        |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                          | $h_{FE}$   | 100 to 300 |                        |
| Transition frequency at $f = 500\text{ MHz}$                         |            |            |                        |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$                         | $f_T$      | >          | 250 MHz                |

## MECHANICAL DATA

Dimensions in mm

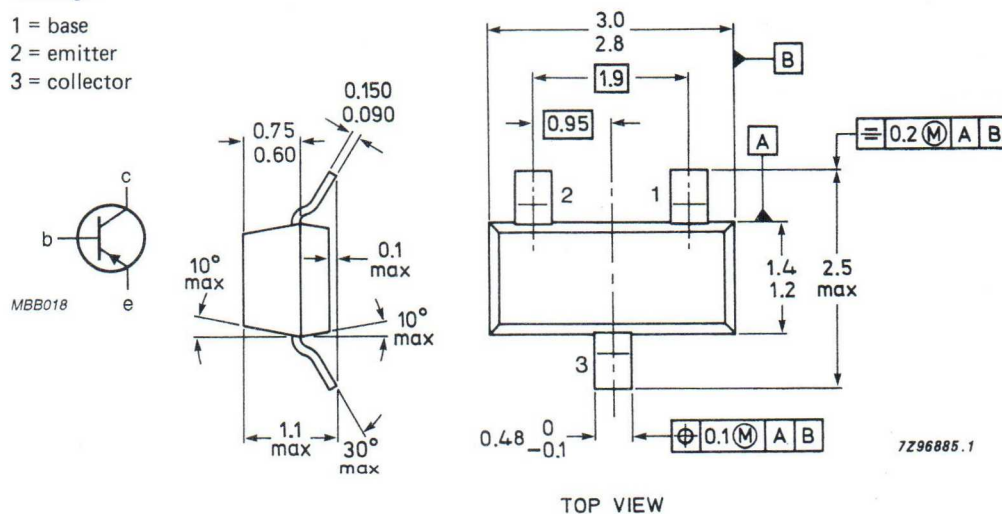
## Marking code

Fig.1 SOT-23.

BSR18A = T92

## Pinning:

- 1 = base  
2 = emitter  
3 = collector



Reverse pinning types are available on request.  
See also *Soldering recommendations*.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |            |      |                                         |
|----------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                | $-V_{CBO}$ | max. | 40 V                                    |
| Collector-emitter voltage (open base)                                | $-V_{CEO}$ | max. | 40 V                                    |
| Emitter-base voltage (open collector)                                | $-V_{EBO}$ | max. | 5 V                                     |
| Collector current (d.c.)                                             | $-I_C$     | max. | 200 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW                                  |
| Storage temperature                                                  | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$      | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

|                                  |            |   |       |
|----------------------------------|------------|---|-------|
| $I_E = 0; -V_{CB} = 30\text{ V}$ | $-I_{CBO}$ | < | 50 nA |
|----------------------------------|------------|---|-------|

Emitter cut-off current

|                                 |            |   |       |
|---------------------------------|------------|---|-------|
| $I_C = 0; -V_{EB} = 3\text{ V}$ | $-I_{EBO}$ | < | 50 nA |
|---------------------------------|------------|---|-------|

Saturation voltages \*

|                                           |              |   |               |
|-------------------------------------------|--------------|---|---------------|
| $-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$ | $-V_{CEsat}$ | < | 250 mV        |
|                                           | $-V_{BEsat}$ |   | 650 to 850 mV |

|                                           |              |   |        |
|-------------------------------------------|--------------|---|--------|
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$ | $-V_{CEsat}$ | < | 400 mV |
|                                           | $-V_{BEsat}$ | < | 950 mV |

Collector capacitance at  $f = 100\text{ kHz}$ 

|                                       |       |   |        |
|---------------------------------------|-------|---|--------|
| $I_E = I_e = 0; -V_{CB} = 5\text{ V}$ | $C_c$ | < | 4,5 pF |
|---------------------------------------|-------|---|--------|

Emitter capacitance at  $f = 100\text{ kHz}$ 

|                                         |       |   |       |
|-----------------------------------------|-------|---|-------|
| $I_C = I_c = 0; -V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 10 pF |
|-----------------------------------------|-------|---|-------|

\* Mounted on a ceramic substrate of  $8\text{ mm} \times 10\text{ mm} \times 0,7\text{ mm}$ .\* Measured under pulse conditions;  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta = 0,01$ .

## D.C. current gain\*

$$-I_C = 0,1 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 1,0 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$$

Transition frequency at  $f = 100 \text{ MHz}$ 

$$-I_C = 10 \text{ mA}; -V_{CE} = 20 \text{ V}$$

Noise figure at  $R_S = 1 \text{ k}\Omega$ 

$$-I_C = 100 \text{ }\mu\text{A}; -V_{CE} = 5 \text{ V}$$

$$f = 10 \text{ to } 15 \text{ 700 Hz}$$

h parameters (common emitter) at  $f = 1 \text{ kHz}$ 

$$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$$

input impedance

reverse voltage transfer ratio

small signal current gain

output admittance

## Switching times (between 10% and 90% levels)

$$-I_C = 10 \text{ mA}; -I_{B\text{on}} = +I_{B\text{off}} = 1 \text{ mA}$$

delay time

rise time

$$h_{FE} > 60$$

$$h_{FE} > 80$$

$$h_{FE} 100 \text{ to } 300$$

$$h_{FE} > 60$$

$$h_{FE} > 30$$

$$f_T > 250 \text{ MHz}$$

$$F < 4 \text{ dB}$$

$$h_{ie} 2 \text{ to } 12 \text{ k}\Omega$$

$$h_{re} 1 \text{ to } 10 \cdot 10^{-4}$$

$$h_{fe} 100 \text{ to } 400$$

$$h_{oe} 3 \text{ to } 60 \text{ }\mu\text{S}$$

$$t_d < 35 \text{ ns}$$

$$t_r < 35 \text{ ns}$$

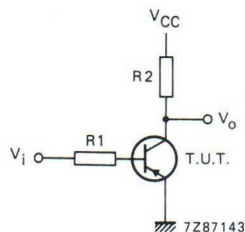
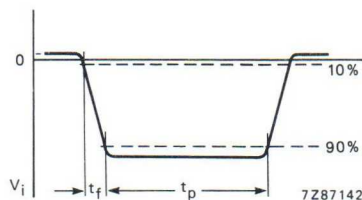


Fig. 2 Waveform and test circuit delay and rise time.

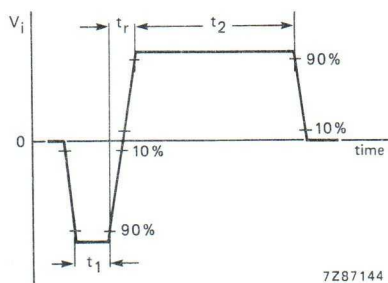
 $V_i = +0,5 \text{ to } -10,6 \text{ V}; -V_{CC} = 3 \text{ V}; R_1 = 10 \text{ k}\Omega; R_2 = 275 \Omega.$ 
Total shunt capacitance of test jig and connectors =  $C_s \leq 4 \text{ pF}$ .Pulse generator: pulse duration 300 ns; fall time  $< 1 \text{ ns}$ ; duty factor 2%.

Switching times (between 10% and 90% levels)

$-I_C = 10 \text{ mA}$ ,  $-I_{B\text{on}} = I_{B\text{off}} = 1 \text{ mA}$

storage time

fall time



$$\begin{array}{rcl} t_s & < & 225 \text{ ns} \\ t_r & < & 75 \text{ ns} \end{array}$$

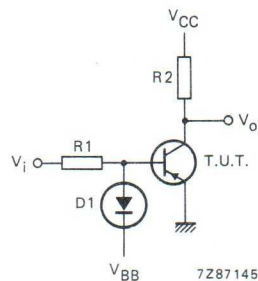


Fig. 3 Waveform and test circuit fall and storage time.

$V_i = -9,1 \text{ to } +10,9 \text{ V}$ ;  $V_{CC} = 3 \text{ V}$ ;  $V_{BB} = 0 \text{ V}$  (ground);  $R1 = 10 \text{ k}\Omega$ ;  $R2 = 275 \Omega$ ;  $D1 = 1N916$ .

Total shunt capacitance of test jig and connectors =  $C_s \leq 4 \text{ pF}$ .

Pulse generator: pulse duration  $t_1 = 10 \text{ to } 500 \mu\text{s}$ ; rise time  $t_r < 1 \text{ ns}$ ; duty factor  $\delta = 2\%$ .

## SILICON N-P-N HIGH-VOLTAGE TRANSISTORS

N-P-N high-voltage small-signal transistors for general purposes and especially telephony applications and encapsulated in a SOT-23 envelope.

P-N-P complements are BSR20 and BSR20A.

### QUICK REFERENCE DATA

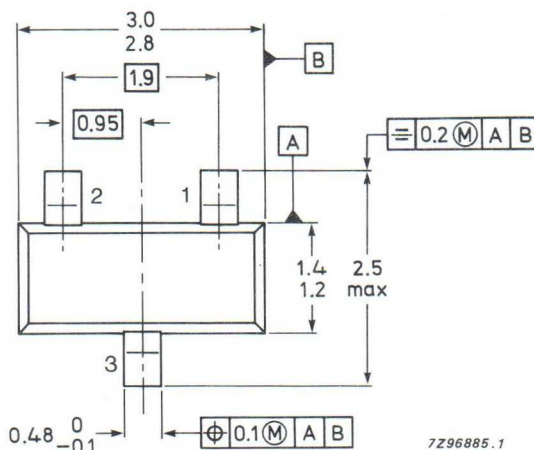
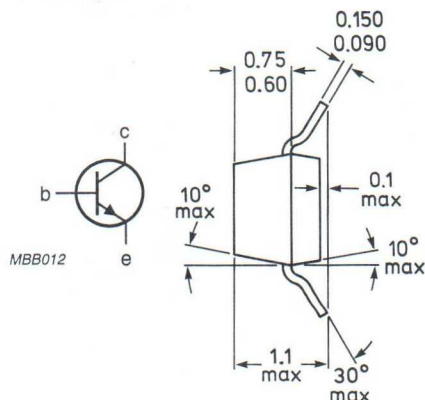
|                                                                                    |             |      | BSR19 | BSR19A                 |
|------------------------------------------------------------------------------------|-------------|------|-------|------------------------|
| Collector-base voltage (open emitter)                                              | $V_{CBO}$   | max. | 160   | 180 V                  |
| Collector-emitter voltage (open base)                                              | $V_{CEO}$   | max. | 140   | 160 V                  |
| Collector current                                                                  | $I_C$       | max. | 600   | 600 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$               | $P_{tot}$   | max. | 250   | 250 mW                 |
| Junction temperature                                                               | $T_j$       | max. | 150   | 150 $^{\circ}\text{C}$ |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ | $V_{CEsat}$ | max. | 0,25  | 0,20 V                 |
| D.C. current gain<br>$I_C = 10\text{ mA}$ ; $V_{CE} = 5\text{ V}$                  | $h_{FE}$    | min. | 60    | 80                     |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

Dimensions in mm

#### Marking code

BSR19 = U35

BSR19A = U36

7Z96885.1



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |           |               | BSR19        | BSR19A             |
|-------------------------------------------------------------------------|-----------|---------------|--------------|--------------------|
| Collector-base voltage (open emitter)                                   | $V_{CBO}$ | max.          | 160          | 180 V              |
| Collector-emitter voltage (open base)                                   | $V_{CEO}$ | max.          | 140          | 160 V              |
| Emitter-base voltage (open collector)                                   | $V_{EBO}$ | max.          | 6            | V                  |
| Collector current                                                       | $I_C$     | max.          | 600          | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max.          | 250          | mW                 |
| Junction temperature                                                    | $T_j$     | max.          | 150          | $^{\circ}\text{C}$ |
| Storage temperature                                                     | $T_{stg}$ |               | -65 to + 150 | $^{\circ}\text{C}$ |
| <b>THERMAL RESISTANCE</b>                                               |           |               |              |                    |
| From junction to ambient*                                               |           | $R_{th\ j-a}$ | = 500        | K/W                |

# CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                         |               |      | BSR19 | BSR19A           |
|-------------------------------------------------------------------------|---------------|------|-------|------------------|
| Collector cut-off current                                               |               |      |       |                  |
| $I_E = 0; V_{CB} = 100\text{ V}$                                        | $I_{CBO}$     | max. | 100   | nA               |
| $I_E = 0; V_{CB} = 120\text{ V}$                                        | $I_{CBO}$     | max. |       | 50 nA            |
| $I_E = 0; V_{CB} = 100\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$ | $I_{CBO}$     | max. | 100   | $\mu\text{A}$    |
| $I_E = 0; V_{CB} = 120\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$ | $I_{CBO}$     | max. |       | 50 $\mu\text{A}$ |
| Emitter cut-off current                                                 |               |      |       |                  |
| $I_C = 0; V_{EB} = 4,0\text{ V}$                                        | $I_{EBO}$     | max. | 50    | 50 nA            |
| Breakdown voltages                                                      |               |      |       |                  |
| $I_C = 1,0\text{ mA}; I_B = 0$                                          | $V_{(BR)CEO}$ | min. | 140   | 160 V            |
| $I_C = 100\text{ }\mu\text{A}; I_E = 0$                                 | $V_{(BR)CBO}$ | min. | 160   | 180 V            |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$                                  | $V_{(BR)EBO}$ | min. | 6,0   | 6,0 V            |
| Saturation voltages                                                     |               |      |       |                  |
| $I_C = 10\text{ mA}; I_B = 1,0\text{ mA}$                               | $V_{CEsat}$   | max. | 0,15  | 0,15 V           |
|                                                                         | $V_{BEsat}$   | max. | 1,0   | 1,0 V            |
| $I_C = 50\text{ mA}; I_B = 5,0\text{ mA}$                               | $V_{CEsat}$   | max. | 0,25  | 0,20 V           |
|                                                                         | $V_{BEsat}$   | max. | 1,2   | 1,0 V            |
| D.C. current gain                                                       |               |      |       |                  |
| $I_C = 1,0\text{ mA}; V_{CE} = 5\text{ V}$                              | $h_{FE}$      | min. | 60    | 80               |
| $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$                               | $h_{FE}$      | min. | 60    | 80               |
|                                                                         | $h_{FE}$      | max. | 250   | 250              |
| $I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$                               | $h_{FE}$      | min. | 20    | 30               |
| Small-signal current gain                                               |               |      |       |                  |
| $I_C = 1,0\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$           | $h_{fe}$      | min. | 50    | 50               |
|                                                                         |               | max. | 200   | 200              |
| Output capacitance at $f = 1\text{ MHz}$                                |               |      |       |                  |
| $I_E = 0; V_{CB} = 10\text{ V}$                                         | $C_o$         | max. | 6     | 6 pF             |

\* Substrate size 8 mm x 10 mm x 0.7 mm.

|                                                                                                                                          |       |              | BSR19      | BSR19A             |
|------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------|------------|--------------------|
| Input capacitance at $f = 1 \text{ MHz}$<br>$I_C = 0$ ; $V_{EB} = 0,5 \text{ V}$                                                         | $C_i$ | max.         | 30         | 30 pF              |
| Transition frequency at $f = 100 \text{ MHz}$<br>$I_C = 10 \text{ mA}$ ; $V_{CE} = 10 \text{ V}$                                         | $f_T$ | min.<br>max. | 100<br>300 | 100 MHz<br>300 MHz |
| Noise figure at $R_S = 1 \text{ k}\Omega$<br>$I_C = 250 \mu\text{A}$ ; $V_{CE} = 5 \text{ V}$ ; $f = 10 \text{ Hz to } 15,7 \text{ kHz}$ | F     | max.         | 10         | 8 dB               |



## SILICON P-N-P HIGH-VOLTAGE TRANSISTORS

P-N-P high-voltage small-signal transistors for general purposes and especially in telephony applications and encapsulated in a SOT-23 envelope.

N-P-N complements are BSR19 and BSR19A.

### QUICK REFERENCE DATA

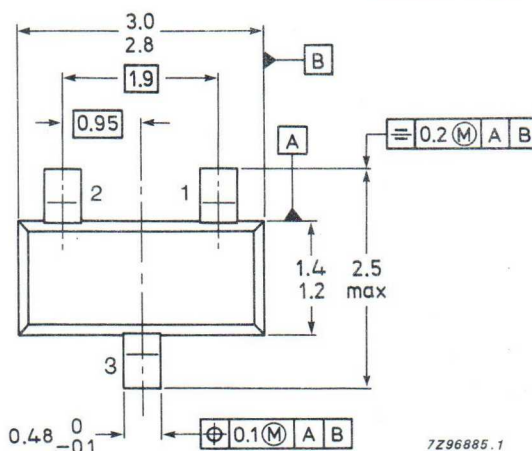
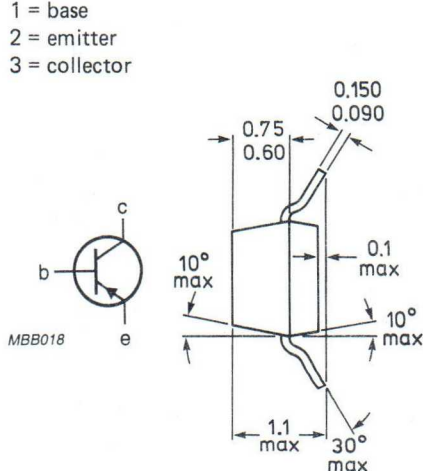
|                                                                                    |                  | BSR20 | BSR20A                 |
|------------------------------------------------------------------------------------|------------------|-------|------------------------|
| Collector-base voltage (open emitter)                                              | $-V_{CBO}$ max.  | 130   | 160 V                  |
| Collector-emitter voltage (open base)                                              | $-V_{CEO}$ max.  | 120   | 150 V                  |
| Collector current                                                                  | $-I_C$ max.      | 600   | 600 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$               | $P_{tot}$ max.   | 250   | 250 mW                 |
| Junction temperature                                                               | $T_j$ max.       | 150   | 150 $^{\circ}\text{C}$ |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ | $V_{CEsat}$ max. | 0,5   | 0,5 V                  |
| D.C. current gain<br>$I_C = 10\text{ mA}$ ; $V_{CE} = -5\text{ V}$                 | $h_{FE}$ min.    | 40    | 60                     |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

Dimensions in mm

#### Marking code

BSR20 = T35  
BSR20A = T36

# BSR20 BSR20A

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |            |               | BSR20        | BSR20A             |
|-------------------------------------------------------------------------|------------|---------------|--------------|--------------------|
| Collector-base voltage (open emitter)                                   | $-V_{CBO}$ | max.          | 130          | 160 V              |
| Collector-emitter voltage (open base)                                   | $-V_{CEO}$ | max.          | 120          | 150 V              |
| Emitter-base voltage (open collector)                                   | $-V_{EBO}$ | max.          | 5            | V                  |
| Collector current                                                       | $-I_C$     | max.          | 600          | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max.          | 250          | mW                 |
| Junction temperature                                                    | $T_j$      | max.          | 150          | $^{\circ}\text{C}$ |
| Storage temperature                                                     | $T_{stg}$  |               | -65 to + 150 | $^{\circ}\text{C}$ |
| <b>THERMAL RESISTANCE</b>                                               |            |               |              |                    |
| From junction to ambient*                                               |            | $R_{th\ j-a}$ | = 500        | K/W                |

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                          |                |      | BSR20 | BSR20A           |
|--------------------------------------------------------------------------|----------------|------|-------|------------------|
| <b>Collector cut-off current</b>                                         |                |      |       |                  |
| $I_E = 0; -V_{CB} = 100\text{ V}$                                        | $-I_{CBO}$     | max. | 100   | nA               |
| $I_E = 0; -V_{CB} = 120\text{ V}$                                        | $-I_{CBO}$     | max. |       | 50 nA            |
| $I_E = 0; -V_{CB} = 100\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$ | $-I_{CBO}$     | max. | 100   | $\mu\text{A}$    |
| $I_E = 0; -V_{CB} = 120\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$ | $-I_{CBO}$     | max. |       | 50 $\mu\text{A}$ |
| <b>Emitter cut-off current</b>                                           |                |      |       |                  |
| $I_C = 0; -V_{EB} = 4,0\text{ V}$                                        | $-I_{EBO}$     | max. | 50    | 50 nA            |
| <b>Breakdown voltages</b>                                                |                |      |       |                  |
| $I_C = 1,0\text{ mA}; I_B = 0$                                           | $-V_{(BR)CEO}$ | min. | 120   | 150 V            |
| $I_C = 100\text{ }\mu\text{A}; I_E = 0$                                  | $-V_{(BR)CBO}$ | min. | 130   | 160 V            |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$                                   | $-V_{(BR)EBO}$ | min. | 5,0   | 5,0 V            |
| <b>Saturation voltages</b>                                               |                |      |       |                  |
| $-I_C = 10\text{ mA}; -I_B = 1,0\text{ mA}$                              | $-V_{CEsat}$   | max. | 0,2   | 0,2 V            |
|                                                                          | $-V_{BEsat}$   | max. | 1,0   | 1,0 V            |
| $-I_C = 50\text{ mA}; -I_B = 5,0\text{ mA}$                              | $-V_{CEsat}$   | max. | 0,5   | 0,5 V            |
|                                                                          | $-V_{BEsat}$   | max. | 1,0   | 1,0 V            |
| <b>D.C. current gain</b>                                                 |                |      |       |                  |
| $I_C = 1,0\text{ mA}; -V_{CE} = 5\text{ V}$                              | $h_{FE}$       | min. | 30    | 50               |
| $I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$                               | $h_{FE}$       | min. | 40    | 60               |
| $I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$                               | $h_{FE}$       | max. | 180   | 240              |
|                                                                          | $h_{FE}$       | min. | 40    | 50               |
| <b>Small-signal current gain</b>                                         |                |      |       |                  |
| $I_C = 1,0\text{ mA}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$           | $h_{fe}$       | min. | 30    | 40               |
|                                                                          |                | max. | 200   | 200              |
| <b>Output capacitance at <math>f = 1\text{ MHz}</math></b>               |                |      |       |                  |
| $I_E = 0; -V_{CB} = 10\text{ V}$                                         | $C_o$          | max. | 6     | 6 pF             |

\* Substrate size 8 mm x 10 mm x 0.7 mm.



Transition frequency at  $f = 100$  MHz  
 $-I_C = 10$  mA;  $-V_{CE} = 10$  V

 $f_T$ 

min.  
max.

BSR20

100  
400

BSR20A

100 MHz  
300 MHz

Noise figure at  $R_S = 1$  k $\Omega$   
 $I_C = 250$   $\mu$ A;  $-V_{CE} = 5$  V;  
 $f = 10$  Hz to 15,7 kHz

F

max.

8

8 dB



## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

### QUICK REFERENCE DATA

|                                                            |            |      | BSR30 | BSR31 | BSR32 | BSR33                |
|------------------------------------------------------------|------------|------|-------|-------|-------|----------------------|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ | max. | 70    | 70    | 90    | 90 V                 |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ | max. | 60    | 60    | 80    | 80 V                 |
| Collector current (d.c.)                                   | $-I_C$     | max. | 1     | 1     | 1     | 1 A                  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 1     | 1     | 1     | 1 W                  |
| Junction temperature                                       | $T_j$      | max. | 150   | 150   | 150   | 150 $^\circ\text{C}$ |
| D.C. current gain                                          |            |      |       |       |       |                      |
| $-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$               | $h_{FE}$   | $>$  | 40    | 100   | 40    | 100                  |
|                                                            |            | $<$  | 120   | 300   | 120   | 300                  |
| Transition frequency at $f = 35\text{ MHz}$                |            |      |       |       |       |                      |
| $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$               | $f_T$      | $>$  | 100   | 100   | 100   | 100 MHz              |

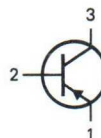
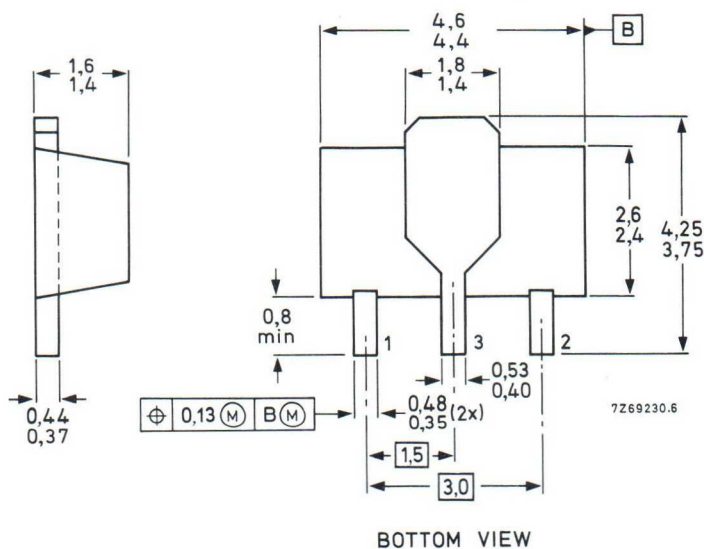
### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-89.

BSR30 = BR1  
BSR31 = BR2  
BSR32 = BR3  
BSR33 = BR4



See also *Soldering recommendations*.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                                  |                 |      | BSR30 | BSR31       | BSR32 | BSR33              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------|-------|-------------|-------|--------------------|
| Collector-base voltage (open emitter)                                                                                                                            | $-V_{CBO}$      | max. | 70    | 70          | 90    | 90 V               |
| Collector-emitter voltage (open base)                                                                                                                            | $-V_{CEO}$      | max. | 60    | 60          | 80    | 80 V               |
| Emitter-base voltage (open collector)                                                                                                                            | $-V_{EBO}$      | max. | 5     | 5           | 5     | 5 V                |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Collector current (d.c.)                                                                                                                                         | $-I_C$          | max. |       |             | 1     | A                  |
| Base current (d.c.)                                                                                                                                              | $-I_B$          | max. |       |             | 0,1   | A                  |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>mounted on a ceramic substrate<br>area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ mm}$ |                 |      |       |             |       |                    |
|                                                                                                                                                                  | $P_{tot}$       | max. |       |             | 1     | W                  |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Storage temperature                                                                                                                                              | $T_{stg}$       |      |       | -65 to +150 |       | $^{\circ}\text{C}$ |
| Junction temperature                                                                                                                                             | $T_j$           | max. |       | 150         |       | $^{\circ}\text{C}$ |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| <b>THERMAL RESISTANCE</b>                                                                                                                                        |                 |      |       |             |       |                    |
| From junction to collector tab                                                                                                                                   | $R_{th\ j-tab}$ | =    |       |             | 10    | K/W                |
| From junction to ambient in free air<br>mounted on a ceramic substrate<br>area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ mm}$                                 | $R_{th\ j-a}$   | =    |       |             | 125   | K/W                |

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified**Collector cut-off current**

|                                                                     |            |   |     |               |
|---------------------------------------------------------------------|------------|---|-----|---------------|
| $I_E = 0; -V_{CB} = 60\text{ V}$                                    | $-I_{CBO}$ | < | 100 | nA            |
| $I_E = 0; -V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $-I_{CBO}$ | < | 50  | $\mu\text{A}$ |

**Breakdown voltages**

|                                            |                | BSR30 | BSR31 | BSR32 | BSR33 |   |
|--------------------------------------------|----------------|-------|-------|-------|-------|---|
| $I_B = 0; -I_C = 10\text{ mA}$             | $-V_{(BR)CEO}$ | > 60  | 60    | 80    | 80    | V |
| $V_{BE} = 0; -I_C = 10\text{ }\mu\text{A}$ | $-V_{(BR)CES}$ | > 70  | 70    | 90    | 90    | V |
| $I_C = 0; -I_E = 10\text{ }\mu\text{A}$    | $-V_{(BR)EBO}$ | > 5   | 5     | 5     | 5     | V |

**Saturation voltages \***

|                                             |              |        |      |      |      |   |
|---------------------------------------------|--------------|--------|------|------|------|---|
| $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$ | $-V_{CEsat}$ | < 0,25 | 0,25 | 0,25 | 0,25 | V |
|                                             | $-V_{BEsat}$ | < 1,0  | 1,0  | 1,0  | 1,0  | V |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$ | $-V_{CEsat}$ | < 0,5  | 0,5  | 0,5  | 0,5  | V |
|                                             | $-V_{BEsat}$ | < 1,2  | 1,2  | 1,2  | 1,2  | V |

**D.C. current gain \***

|                                                      |          |       |     |     |     |
|------------------------------------------------------|----------|-------|-----|-----|-----|
| $-I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ | $h_{FE}$ | > 10  | 30  | 10  | 30  |
| $-I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > 40  | 100 | 40  | 100 |
|                                                      |          | < 120 | 300 | 120 | 300 |
| $-I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > 30  | 50  | 30  | 50  |

**Transition frequency at  $f = 35\text{ MHz}$** 

|                                              |       |   |     |     |
|----------------------------------------------|-------|---|-----|-----|
| $-I_C = 50\text{ mA}; -V_{CE} = 10\text{ V}$ | $f_T$ | > | 100 | MHz |
|----------------------------------------------|-------|---|-----|-----|

**Collector capacitance at  $f = 1\text{ MHz}$** 

|                                        |       |   |    |    |
|----------------------------------------|-------|---|----|----|
| $I_E = I_E = 0; -V_{CB} = 10\text{ V}$ | $C_c$ | < | 20 | pF |
|----------------------------------------|-------|---|----|----|

**Emitter capacitance at  $f = 1\text{ MHz}$** 

|                                         |       |   |     |    |
|-----------------------------------------|-------|---|-----|----|
| $I_C = I_C = 0; -V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 120 | pF |
|-----------------------------------------|-------|---|-----|----|

Switching times see next page.

\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta < 0,01$ .



## CHARACTERISTICS (continued)

 $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ 

## Switching times

 $-I_{\text{Con}} = 100\text{ mA}; -I_{\text{Bon}} = +I_{\text{Boff}} = 5\text{ mA}$ 

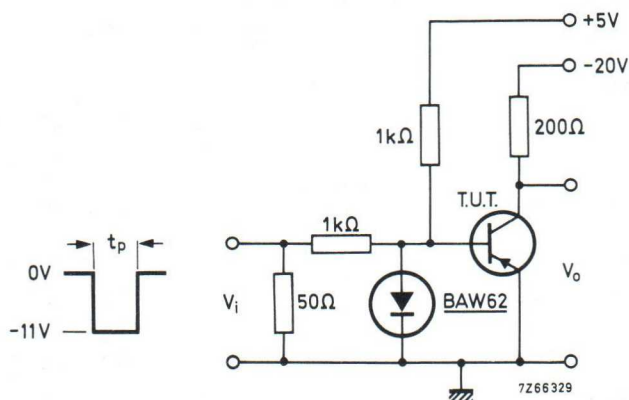
Turn-on time

 $t_{\text{on}} < 500\text{ ns}$ 

Turn-off time

 $t_{\text{off}} < 650\text{ ns}$ 

Test circuit



Pulse generator:

Pulse duration  $t_p = 10\text{ }\mu\text{s}$ Rise time  $t_r \leq 15\text{ ns}$ Fall time  $t_f \leq 15\text{ ns}$ Source impedance  $Z_S = 50\text{ }\Omega$ 

Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$ Input impedance  $Z_I \geq 100\text{ k}\Omega$

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in miniature plastic envelopes intended for application in thick and thin-film circuits. They are intended for use in telephony and general industrial applications.

QUICK REFERENCE DATA

|                                                                      |                | BSR40 | BSR41 | BSR42 | BSR43                  |
|----------------------------------------------------------------------|----------------|-------|-------|-------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ max. | 70    | 70    | 90    | 90 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ max. | 60    | 60    | 80    | 80 V                   |
| Collector current (d.c.)                                             | $I_C$ max.     | 1     | 1     | 1     | 1 A                    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ max. | 1     | 1     | 1     | 1 W                    |
| Junction temperature                                                 | $T_j$ max.     | 150   | 150   | 150   | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                    |                |       |       |       |                        |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                           | $h_{FE}$ >     | 40    | 100   | 40    | 100                    |
|                                                                      | $h_{FE}$ <     | 120   | 300   | 120   | 300                    |
| Transition frequency at $f = 35\text{ MHz}$                          |                |       |       |       |                        |
| $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$                           | $f_T$ >        | 100   | 100   | 100   | 100 MHz                |

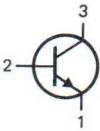
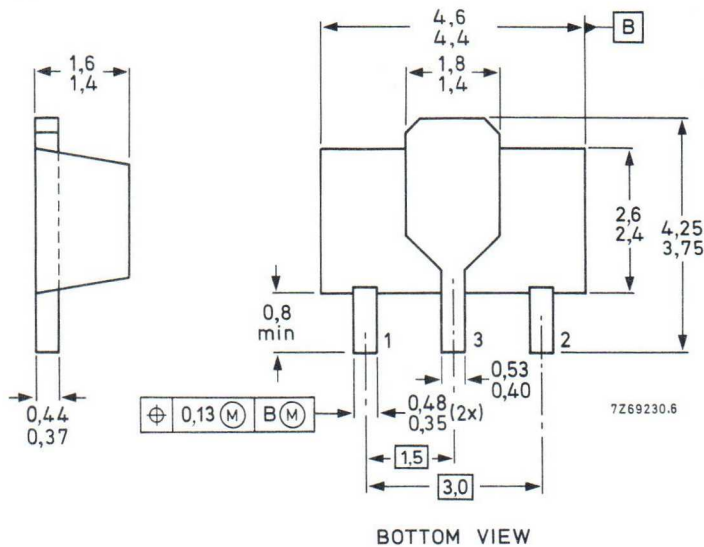
MECHANICAL DATA

Fig. 1 SOT-89.

Dimensions in mm

Marking code

- BSR40 = AR1
- BSR41 = AR2
- BSR42 = AR3
- BSR43 = AR4



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                                  |                 |      | BSR40 | BSR41       | BSR42 | BSR43              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------|-------|-------------|-------|--------------------|
| Collector-base voltage (open emitter)                                                                                                                            | $V_{CBO}$       | max. | 70    | 70          | 90    | 90 V               |
| Collector-emitter voltage (open base)                                                                                                                            | $V_{CEO}$       | max. | 60    | 60          | 80    | 80 V               |
| Emitter-base voltage (open collector)                                                                                                                            | $V_{EBO}$       | max. | 5     | 5           | 5     | 5 V                |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Collector current (d.c.)                                                                                                                                         | $I_C$           | max. |       |             | 1     | A                  |
| Base current (d.c.)                                                                                                                                              | $I_B$           | max. |       |             | 0,1   | A                  |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$<br>mounted on a ceramic substrate<br>area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ mm}$ |                 |      |       |             |       |                    |
|                                                                                                                                                                  | $P_{tot}$       | max. |       |             | 1     | W                  |
|                                                                                                                                                                  |                 |      |       |             |       |                    |
| Storage temperature                                                                                                                                              | $T_{stg}$       |      |       | -65 to +150 |       | $^{\circ}\text{C}$ |
| Junction temperature                                                                                                                                             | $T_j$           | max. |       | 150         |       | $^{\circ}\text{C}$ |
| <b>THERMAL RESISTANCE</b>                                                                                                                                        |                 |      |       |             |       |                    |
| From junction to collector tab                                                                                                                                   | $R_{th\ j-tab}$ | =    |       |             | 10    | K/W                |
| From junction to ambient in free air<br>mounted on a ceramic substrate<br>area = $2,5\text{ cm}^2$ ; thickness = $0,7\text{ mm}$                                 | $R_{th\ j-a}$   | =    |       |             | 125   | K/W                |

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

## Collector cut-off current

|                                                                    |           |   |     |               |
|--------------------------------------------------------------------|-----------|---|-----|---------------|
| $I_E = 0; V_{CB} = 60\text{ V}$                                    | $I_{CBO}$ | < | 100 | nA            |
| $I_E = 0; V_{CB} = 60\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | $I_{CBO}$ | < | 50  | $\mu\text{A}$ |

## Breakdown voltages

|                                           |               |   | BSR40 | BSR41 | BSR42 | BSR43 |   |
|-------------------------------------------|---------------|---|-------|-------|-------|-------|---|
| $I_B = 0; I_C = 10\text{ mA}$             | $V_{(BR)CEO}$ | > | 60    | 60    | 80    | 80    | V |
| $V_{BE} = 0; I_C = 10\text{ }\mu\text{A}$ | $V_{(BR)CES}$ | > | 70    | 70    | 90    | 90    | V |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$    | $V_{(BR)EBO}$ | > | 5     | 5     | 5     | 5     | V |

## Saturation voltages \*

|                                           |             |   |      |      |      |      |   |
|-------------------------------------------|-------------|---|------|------|------|------|---|
| $I_C = 150\text{ mA}; I_B = 15\text{ mA}$ | $V_{CEsat}$ | < | 0,25 | 0,25 | 0,25 | 0,25 | V |
|                                           | $V_{BEsat}$ | < | 1,0  | 1,0  | 1,0  | 1,0  | V |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$ | $V_{CEsat}$ | < | 0,5  | 0,5  | 0,5  | 0,5  | V |
|                                           | $V_{BEsat}$ | < | 1,2  | 1,2  | 1,2  | 1,2  | V |

## D.C. current gain \*

|                                                     |          |   |     |     |     |     |
|-----------------------------------------------------|----------|---|-----|-----|-----|-----|
| $I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$ | $h_{FE}$ | > | 10  | 30  | 10  | 30  |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 40  | 100 | 40  | 100 |
|                                                     |          | < | 120 | 300 | 120 | 300 |
| $I_C = 500\text{ mA}; V_{CE} = 5\text{ V}$          | $h_{FE}$ | > | 30  | 50  | 30  | 50  |

Transition frequency at  $f = 35\text{ MHz}$ 

|                                            |       |   |     |     |
|--------------------------------------------|-------|---|-----|-----|
| $I_C = 50\text{ mA}; V_{CE} = 10\text{ V}$ | $f_T$ | > | 100 | MHz |
|--------------------------------------------|-------|---|-----|-----|

Collector capacitance at  $f = 1\text{ MHz}$ 

|                                       |       |   |    |    |
|---------------------------------------|-------|---|----|----|
| $I_E = I_e = 0; V_{CB} = 10\text{ V}$ | $C_c$ | < | 12 | pF |
|---------------------------------------|-------|---|----|----|

Emitter capacitance at  $f = 1\text{ MHz}$ 

|                                        |       |   |    |    |
|----------------------------------------|-------|---|----|----|
| $I_C = I_c = 0; V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 90 | pF |
|----------------------------------------|-------|---|----|----|

Switching times see next page.

\* Measured under pulse conditions:  $t_p = 300\text{ }\mu\text{s}; \delta < 0,01$ .

## CHARACTERISTICS (continued)

 $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ 

## Switching times

 $I_{\text{Con}} = 100\text{ mA}; I_{\text{Bon}} = -I_{\text{Boff}} = 5\text{ mA}$ 

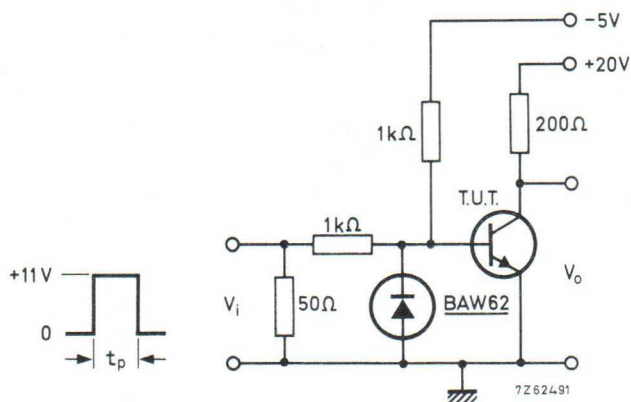
Turn-on time

 $t_{\text{on}} < 250\text{ ns}$ 

Turn-off time

 $t_{\text{off}} < 1000\text{ ns}$ 

## Test circuit



## Pulse generator:

Pulse duration  $t_p = 10\text{ }\mu\text{s}$   
 Rise time  $t_r \leq 15\text{ ns}$   
 Fall time  $t_f \leq 15\text{ ns}$   
 Source impedance  $Z_S = 50\text{ }\Omega$

## Oscilloscope:

Rise time  $t_r \leq 15\text{ ns}$   
 Input impedance  $Z_I \geq 100\text{ k}\Omega$



## N-CHANNEL FETS

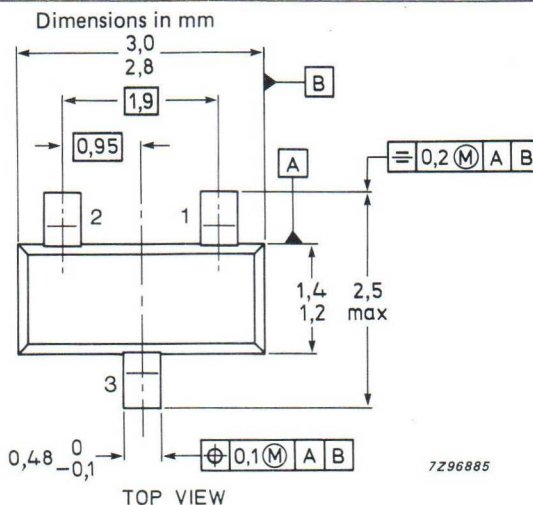
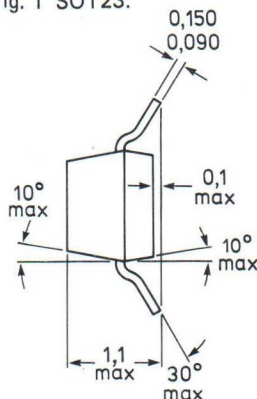
Symmetrical silicon n-channel depletion type junction field-effect transistors in a plastic microminiature envelope intended for application in thick and thin-film circuits. The transistors are intended for low-power, chopper or switching applications in industrial service.

## QUICK REFERENCE DATA

|                                                      |              |      | BSR56 | BSR57 | BSR58       |
|------------------------------------------------------|--------------|------|-------|-------|-------------|
| Drain-source voltage                                 | $\pm V_{DS}$ | max. | 40    | 40    | 40 V        |
| Total power dissipation up to $T_{amb} = 40^\circ C$ | $P_{tot}$    | max. | 250   | 250   | 250 mW      |
| Drain current                                        |              |      |       |       |             |
| $V_{DS} = 15 V; V_{GS} = 0$                          | $I_{DSS}$    | $>$  | 50    | 20    | 8 mA        |
|                                                      |              | $<$  | —     | 100   | 80 mA       |
| Gate-source cut-off voltage                          |              |      |       |       |             |
| $V_{DS} = 15 V; I_D = 0.5 nA$                        | $-V_{(P)GS}$ | $>$  | 4     | 2     | 0.8 V       |
|                                                      |              | $<$  | 10    | 6     | 4 V         |
| Drain-source resistance (on) at $f = 1 kHz$          |              |      |       |       |             |
| $I_D = 0; V_{GS} = 0$                                | $r_{ds on}$  | $<$  | 25    | 40    | 60 $\Omega$ |
| Feedback capacitance at $f = 1 MHz$                  |              |      |       |       |             |
| $-V_{GS} = 10 V; V_{DS} = 0$                         | $C_{rs}$     | $<$  | 5     | 5     | 5 pF        |
| Turn-off time                                        |              |      |       |       |             |
| $V_{DD} = 10 V; V_{GS} = 0$                          |              |      |       |       |             |
| $I_D = 20 mA; -V_{GSM} = 10 V$                       | $t_{off}$    | $<$  | 25    | —     | — ns        |
| $I_D = 10 mA; -V_{GSM} = 6 V$                        | $t_{off}$    | $<$  | —     | 50    | — ns        |
| $I_D = 5 mA; -V_{GSM} = 4 V$                         | $t_{off}$    | $<$  | —     | —     | 100 ns      |

## MECHANICAL DATA

Fig. 1 SOT23.



## Marking code

BSR56 = M4p  
BSR57 = M5p  
BSR58 = M6p

## Pinning

1 = drain  
2 = source  
3 = gate



7296885

Note: Drain and source are interchangeable.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |              |              |                        |
|-------------------------------------------------------------------------------|--------------|--------------|------------------------|
| Drain-source voltage                                                          | $\pm V_{DS}$ | max.         | 40 V                   |
| Drain-gate voltage                                                            | $V_{DGO}$    | max.         | 40 V                   |
| Gate-source voltage                                                           | $-V_{GSO}$   | max.         | 40 V                   |
| Forward gate current                                                          | $I_{GF}$     | max.         | 50 mA                  |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$    | max.         | 250 mW                 |
| Storage temperature range                                                     | $T_{stg}$    | -65 to + 150 | $^{\circ}\text{C}$     |
| Junction temperature                                                          | $T_j$        | max.         | 150 $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 430 K/W |
|-----------------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                             |            |      |        |
|-----------------------------------------------------------------------------|------------|------|--------|
| Gate-source cut-off current<br>$V_{DS} = 0\text{ V}; -V_{GS} = 20\text{ V}$ | $-I_{GSS}$ | max. | 1.0 nA |
| Drain cut-off current<br>$V_{DS} = 15\text{ V}; -V_{GS} = 10\text{ V}$      | $I_{DSX}$  | max. | 1.0 nA |

|                                                                                                               |                |                                      | BSR56                                 | BSR57                                   | BSR58                                                     |
|---------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------|---------------------------------------|-----------------------------------------|-----------------------------------------------------------|
| Drain current<br>$V_{DS} = 15\text{ V}; V_{GS} = 0$                                                           | $I_{DSS}$      | $\begin{matrix} > \\ < \end{matrix}$ | $\begin{matrix} 50 \\ - \end{matrix}$ | $\begin{matrix} 20 \\ 100 \end{matrix}$ | $\begin{matrix} 8\text{ mA} \\ 80\text{ mA} \end{matrix}$ |
| Gate-source breakdown voltage<br>$-I_G = 1\text{ }\mu\text{A}; V_{DS} = 0$                                    | $-V_{(BR)GSS}$ | $>$                                  | 40                                    | 40                                      | 40 V                                                      |
| Gate-source cut-off voltage<br>$I_D = 0,5\text{ nA}; V_{DS} = 15\text{ V}$                                    | $-V_{(P)GS}$   | $\begin{matrix} > \\ < \end{matrix}$ | $\begin{matrix} 4 \\ 10 \end{matrix}$ | $\begin{matrix} 2 \\ 6 \end{matrix}$    | $\begin{matrix} 0,8\text{ V} \\ 4\text{ V} \end{matrix}$  |
| Drain-source voltage (on)<br>$I_D = 20\text{ mA}; V_{GS} = 0$                                                 | $V_{DSon}$     | $<$                                  | 750                                   | —                                       | — mV                                                      |
| $I_D = 10\text{ mA}; V_{GS} = 0$                                                                              | $V_{DSon}$     | $<$                                  | —                                     | 500                                     | — mV                                                      |
| $I_D = 5\text{ mA}; V_{GS} = 0$                                                                               | $V_{DSon}$     | $<$                                  | —                                     | —                                       | 400 mV                                                    |
| Drain-source resistance (on) at $f = 1\text{ kHz}$<br>$I_D = 0; V_{GS} = 0; T_a = 25\text{ }^{\circ}\text{C}$ | $r_{ds\ on}$   | $<$                                  | 25                                    | 40                                      | 60 $\Omega$                                               |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$-V_{GS} = 10\text{ V}; V_{DS} = 0$                             | $C_{rss}$      | $<$                                  | 5                                     | 5                                       | 5 pF                                                      |

## Notes

1. Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

## Switching times

 $V_{DD} = 10\text{ V}; V_{GS} = 0$ Conditions  $I_D$  and  $-V_{GSM}$ 

Delay time

Rise time

Turn-off time

|               |           |   | BSR56 | BSR57 | BSR58  |
|---------------|-----------|---|-------|-------|--------|
| $I_D$         | =         |   | 20    | 10    | 5 mA   |
| $-V_{GSM}$    | =         |   | 10    | 6     | 4 V    |
| Delay time    | $t_d$     | < | 6     | 6     | 10 ns  |
| Rise time     | $t_r$     | < | 3     | 4     | 10 ns  |
| Turn-off time | $t_{off}$ | < | 25    | 50    | 100 ns |

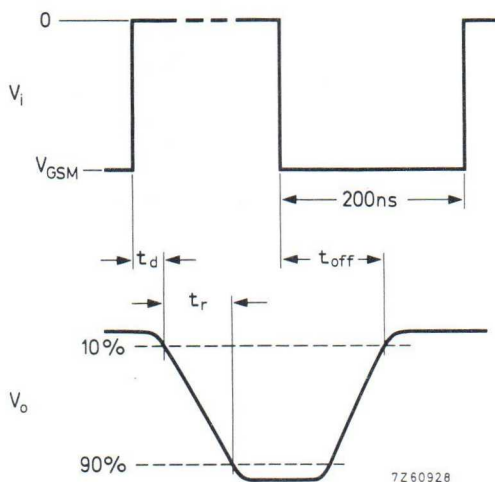


Fig. 2 Switching times waveforms.

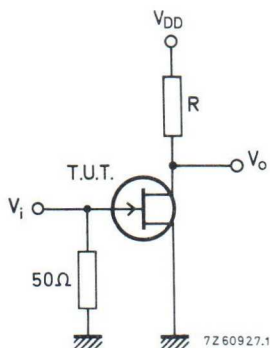


Fig. 3 Test circuit.

BSR56;  $R = 464\ \Omega$ BSR57;  $R = 953\ \Omega$ BSR58;  $R = 1910\ \Omega$ 

## Pulse generator

 $t_r = t_f \leq 1\text{ ns}$  $\delta = 0.02$  $Z_o = 50\ \Omega$ 

## Oscilloscope

 $t_r \leq 0.75\text{ ns}$  $R_i \geq 1\text{ M}\Omega$  $C_i \leq 2.5\text{ pF}$

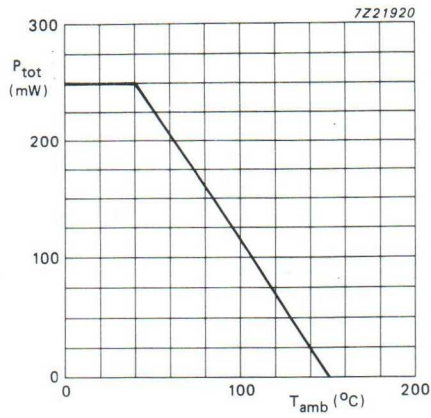


Fig.4 Power derating curve.

## HIGH VOLTAGE P-N-P TRANSISTORS

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high voltage general purpose and switching applications.

### QUICK REFERENCE DATA

|                                                                                                        |            |           |                        |
|--------------------------------------------------------------------------------------------------------|------------|-----------|------------------------|
| Collector-base voltage (open emitter)                                                                  | $-V_{CBO}$ | max.      | 110 V                  |
| Collector-emitter voltage (open base)                                                                  | $-V_{CEO}$ | max.      | 100 V                  |
| Collector current (peak value)                                                                         | $-I_{CM}$  | max.      | 100 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                   | $P_{tot}$  | max.      | 250 mW                 |
| Junction temperature                                                                                   | $T_j$      | max.      | 150 $^{\circ}\text{C}$ |
| D.C. current gain at $T_j = 25\text{ }^{\circ}\text{C}$<br>$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$ | $h_{FE}$   | >         | 30                     |
| Transition frequency at $f = 35\text{ MHz}$<br>$-I_C = 25\text{ mA}; -V_{CE} = 5\text{ V}$             | $f_T$      | ><br>typ. | 50 MHz<br>85 MHz       |

### MECHANICAL DATA

Dimensions in mm

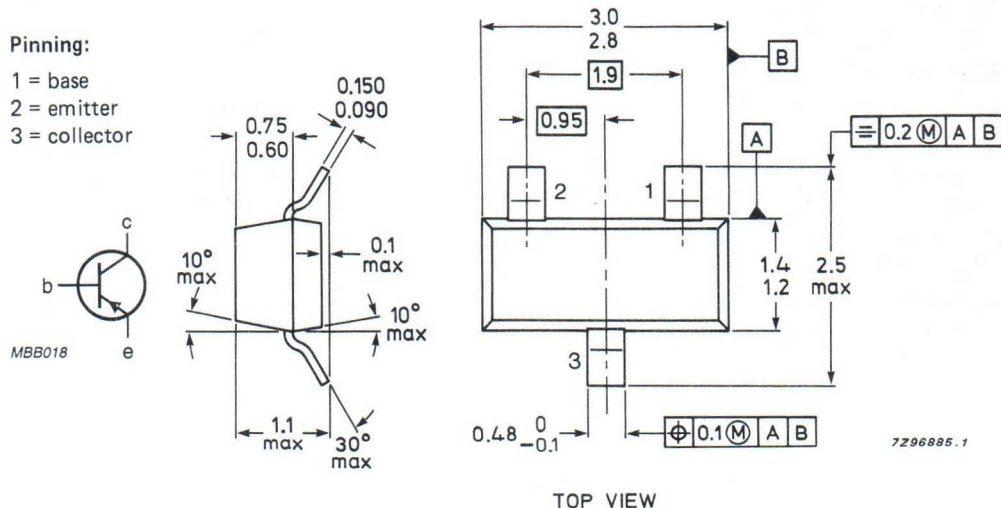
Marking code

Fig. 1 SOT-23.

BSS63 = BMp

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



Reverse pinning types are available on request.

See also *Soldering recommendations*.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                             |            |          |                |
|-------------------------------------------------------------|------------|----------|----------------|
| Collector-base voltage (open emitter)<br>$-I_C = 10 \mu A$  | $-V_{CBO}$ | max.     | 110 V          |
| Collector-emitter voltage (open base)<br>$-I_C = 100 \mu A$ | $-V_{CEO}$ | max.     | 100 V          |
| Emitter-base voltage (open collector)<br>$-I_E = 10 \mu A$  | $-V_{EBO}$ | max.     | 6 V            |
| Collector current (d.c.)                                    | $-I_C$     | max.     | 100 mA         |
| Collector current (peak value)                              | $-I_{CM}$  | max.     | 100 mA         |
| Base current (peak value)                                   | $-I_{BM}$  | max.     | 100 mA         |
| Total power dissipation up to $T_{amb} = 25^\circ C$        | $P_{tot}$  | max.     | 250 mW         |
| Storage temperature                                         | $T_{stg}$  | -65 to + | 150 $^\circ C$ |
| Junction temperature                                        | $T_j$      | max.     | 150 $^\circ C$ |

## THERMAL RESISTANCE

|                           |              |   |         |
|---------------------------|--------------|---|---------|
| From junction to ambient* | $R_{th j-a}$ | = | 500 K/W |
|---------------------------|--------------|---|---------|

## CHARACTERISTICS

 $T_j = 25^\circ C$  unless otherwise specified

|                                                                         |              |           |                  |
|-------------------------------------------------------------------------|--------------|-----------|------------------|
| Collector cut-off current<br>$I_E = 0; -V_{CB} = 90 V$                  | $-I_{CBO}$   | <         | 100 nA           |
| $I_E = 0; -V_{CB} = 90 V; T_j = 150^\circ C$                            | $-I_{CBO}$   | <         | 50 $\mu A$       |
| Emitter cut-off current<br>$I_C = 0; -V_{EB} = 6 V$                     | $-I_{EBO}$   | <         | 200 nA           |
| Saturation voltage<br>$-I_C = 25 mA; -I_B = 2,5 mA$                     | $-V_{CEsat}$ | <         | 250 mV           |
|                                                                         | $-V_{BEsat}$ | <         | 900 mV           |
| D.C. current gain<br>$-I_C = 10 mA; -V_{CE} = 1 V$                      | $h_{FE}$     | >         | 30               |
| $-I_C = 25 mA; -V_{CE} = 1 V$                                           | $h_{FE}$     | >         | 30               |
| Collector capacitance at $f = 1 MHz$<br>$I_E = I_e = 0; -V_{CB} = 10 V$ | $C_C$        | typ.      | 3 pF             |
| Transition frequency at $f = 35 MHz$<br>$-I_C = 25 mA; -V_{CE} = 5 V$   | $f_T$        | ><br>typ. | 50 MHz<br>85 MHz |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

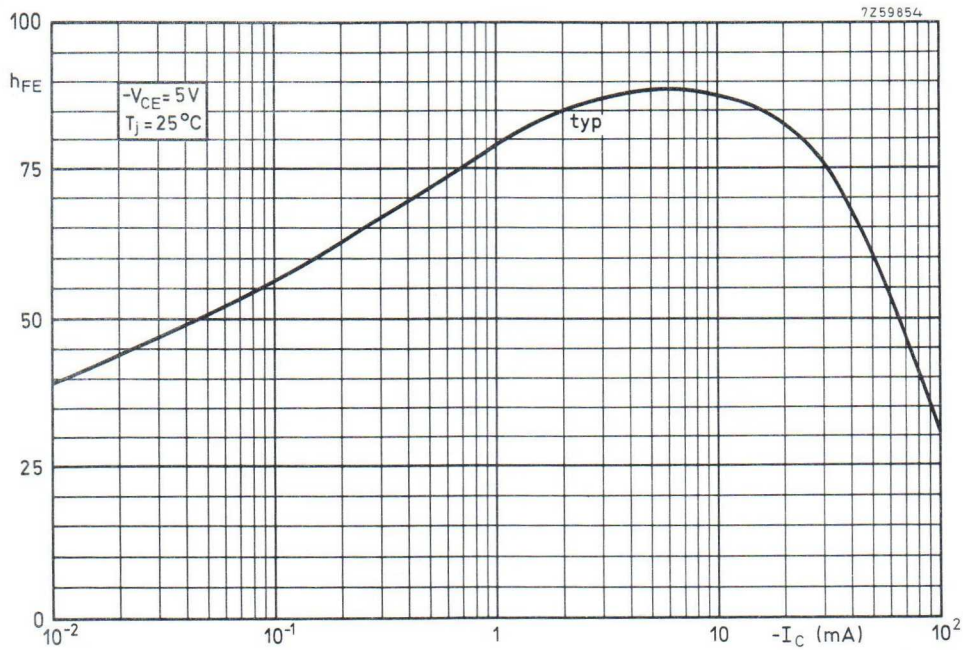


Fig. 2.

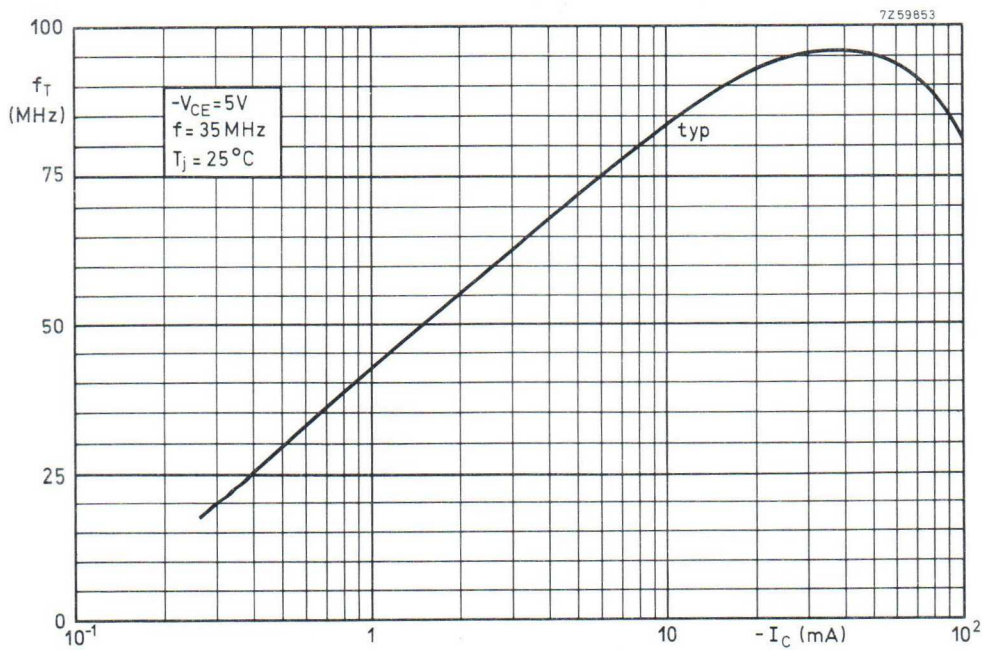


Fig. 3.

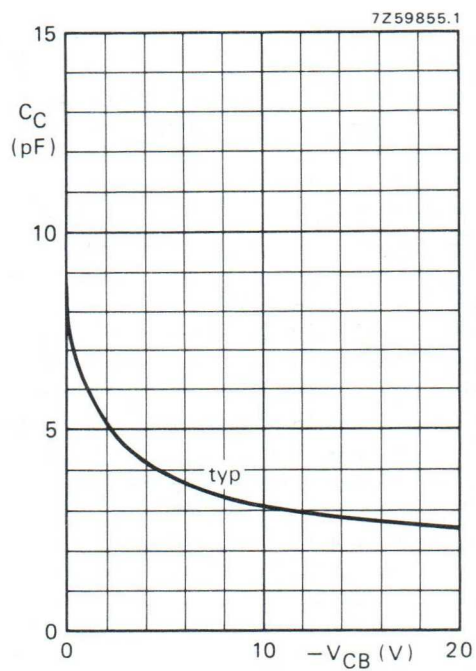


Fig. 4 Typical values collector capacitance as a function of collector-base voltage.  
 $I_E = I_c = 0$ ;  $T_j = 25^\circ\text{C}$ ;  $f = 1\text{ MHz}$ .

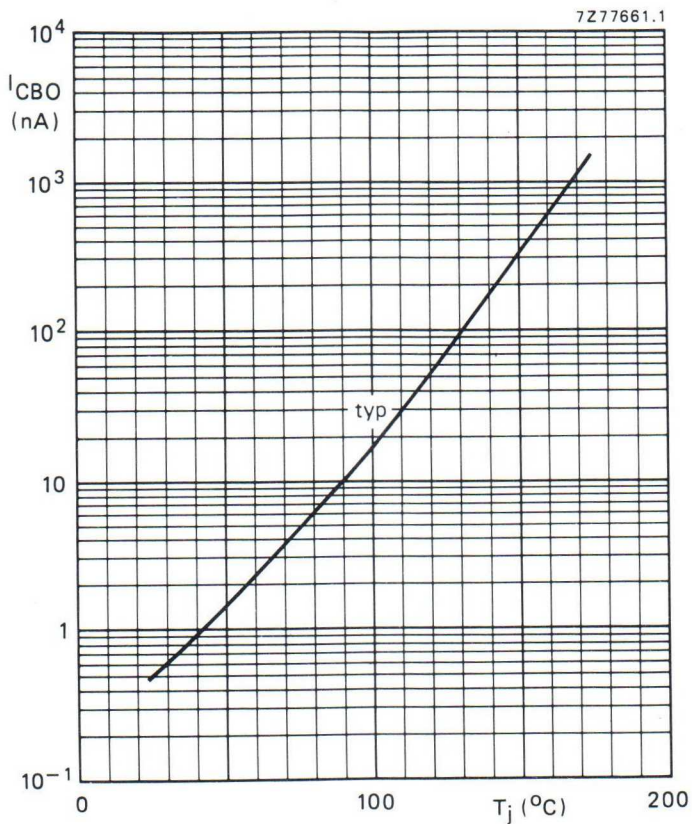


Fig. 5 Typical values collector-base currents as a function of the junction temperature at a collector-base voltage of 90 V.





## HIGH VOLTAGE N-P-N TRANSISTORS

Silicon planar epitaxial transistor in a microminiature plastic envelope intended for application in thick and thin-film circuits. This transistor is intended for high-voltage general purpose and switching applications.

## QUICK REFERENCE DATA

|                                                                             |           |        |                        |
|-----------------------------------------------------------------------------|-----------|--------|------------------------|
| Collector-base voltage (open emitter)                                       | $V_{CBO}$ | max.   | 120 V                  |
| Collector-emitter voltage (open base)                                       | $V_{CEO}$ | max.   | 80 V                   |
| Collector current (peak value)                                              | $I_{CM}$  | max.   | 250 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$        | $P_{tot}$ | max.   | 250 mW                 |
| Junction temperature                                                        | $T_j$     | max.   | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                           | $h_{FE}$  | > typ. | 20<br>80               |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_j = 25\text{ }^{\circ}\text{C}$ |           |        |                        |
| Transition frequency at $f = 35\text{ MHz}$                                 | $f_T$     | >      | 60 MHz                 |
| $I_C = 4\text{ mA}; V_{CE} = 10\text{ V}$                                   |           |        |                        |
| Turn-off time                                                               | $t_{off}$ | <      | 1 $\mu\text{s}$        |
| $I_C = 15\text{ mA}; I_{B(on)} = -I_{B(off)} = 1\text{ mA}$                 |           |        |                        |

## MECHANICAL DATA

Dimensions in mm

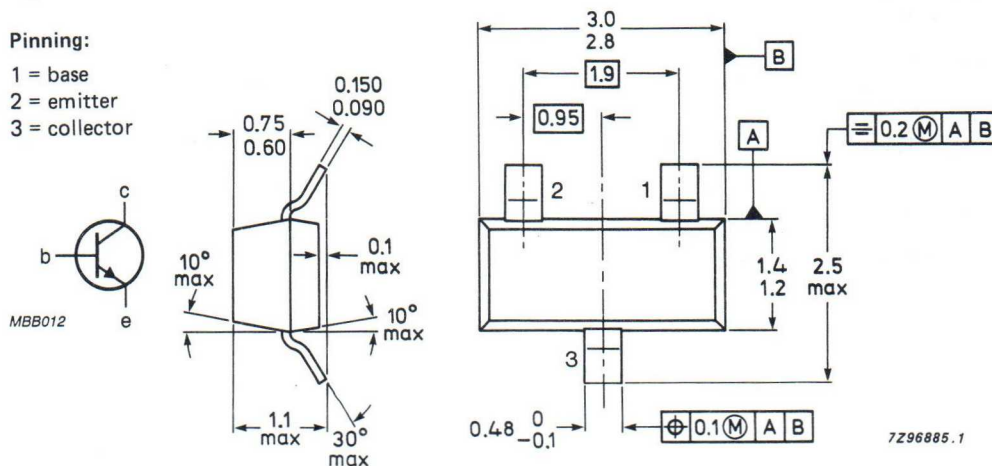
Marking code

Fig. 1 SOT-23.

BSS64 = AMp

## Pinning:

- 1 = base  
2 = emitter  
3 = collector



Reverse pinning types are available on request.

TOP VIEW

See also *Soldering recommendations*.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |              |                      |
|---------------------------------------------------------------------|-----------|--------------|----------------------|
| Collector-base voltage (open emitter)<br>$I_C = 100 \mu A$          | $V_{CBO}$ | max.         | 120 V                |
| Collector-emitter voltage (open base)<br>$I_C = 4 \text{ mA}$       | $V_{CEO}$ | max.         | 80 V                 |
| Emitter-base voltage (open collector)<br>$I_E = 100 \mu A$          | $V_{EBO}$ | max.         | 5 V                  |
| Collector current<br>(d.c. or averaged over any 20 ms period)       | $I_C$     | max.         | 100 mA               |
| Collector current (peak value)                                      | $I_{CM}$  | max.         | 250 mA               |
| Base current (peak value)                                           | $I_{BM}$  | max.         | 100 mA               |
| Total power dissipation up to $T_{amb} = 25 \text{ }^\circ\text{C}$ | $P_{tot}$ | max.         | 250 mW               |
| Storage temperature                                                 | $T_{stg}$ | -65 to + 150 | $^\circ\text{C}$     |
| Junction temperature                                                | $T_j$     | max.         | 150 $^\circ\text{C}$ |

**THERMAL RESISTANCE**

|                           |                      |   |         |
|---------------------------|----------------------|---|---------|
| From junction to ambient* | $R_{th \text{ j-a}}$ | = | 500 K/W |
|---------------------------|----------------------|---|---------|

**CHARACTERISTICS** $T_j = 25 \text{ }^\circ\text{C}$  unless otherwise specified

|                                                                    |             |           |                  |
|--------------------------------------------------------------------|-------------|-----------|------------------|
| Collector cut-off current<br>$I_E = 0; V_{CB} = 90 \text{ V}$      | $I_{CBO}$   | <         | 100 nA           |
| $I_E = 0; V_{CB} = 90 \text{ V}; T_j = 150 \text{ }^\circ\text{C}$ | $I_{CBO}$   | <         | 50 $\mu A$       |
| Emitter cut-off current<br>$I_C = 0; V_{EB} = 5 \text{ V}$         | $I_{EBO}$   | typ.<br>< | 0,5 nA<br>200 nA |
| Saturation voltages<br>$I_C = 4 \text{ mA}; I_B = 400 \mu A$       | $V_{CEsat}$ | <         | 150 mV           |
|                                                                    | $V_{BEsat}$ | <         | 1200 mV          |
| $I_C = 50 \text{ mA}; I_B = 15 \text{ mA}$                         | $V_{CEsat}$ | <         | 200 mV           |
| D.C. current gain<br>$I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}$    | $h_{FE}$    | typ.      | 60               |
| $I_C = 10 \text{ mA}; V_{CE} = 1 \text{ V}$                        | $h_{FE}$    | ><br>typ. | 20<br>80         |
| $I_C = 20 \text{ mA}; V_{CE} = 1 \text{ V}$                        | $h_{FE}$    | typ.      | 55               |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Transition frequency at  $f = 35$  MHz

$$I_C = 4 \text{ mA}; V_{CE} = 10 \text{ V}$$

|       |      |         |
|-------|------|---------|
| $f_T$ | >    | 60 MHz  |
|       | typ. | 100 MHz |

Collector capacitance at  $f = 1$  MHz

$$I_E = I_e = 0; V_{CB} = 10 \text{ V}$$

|       |      |      |
|-------|------|------|
| $C_c$ | typ. | 3 pF |
|-------|------|------|

Turn-off switching time

$$I_{Con} = 15 \text{ mA}; I_{Bon} = -I_{Boff} = 1 \text{ mA}$$

|           |   |           |
|-----------|---|-----------|
| $t_{off}$ | < | 1 $\mu$ s |
|-----------|---|-----------|

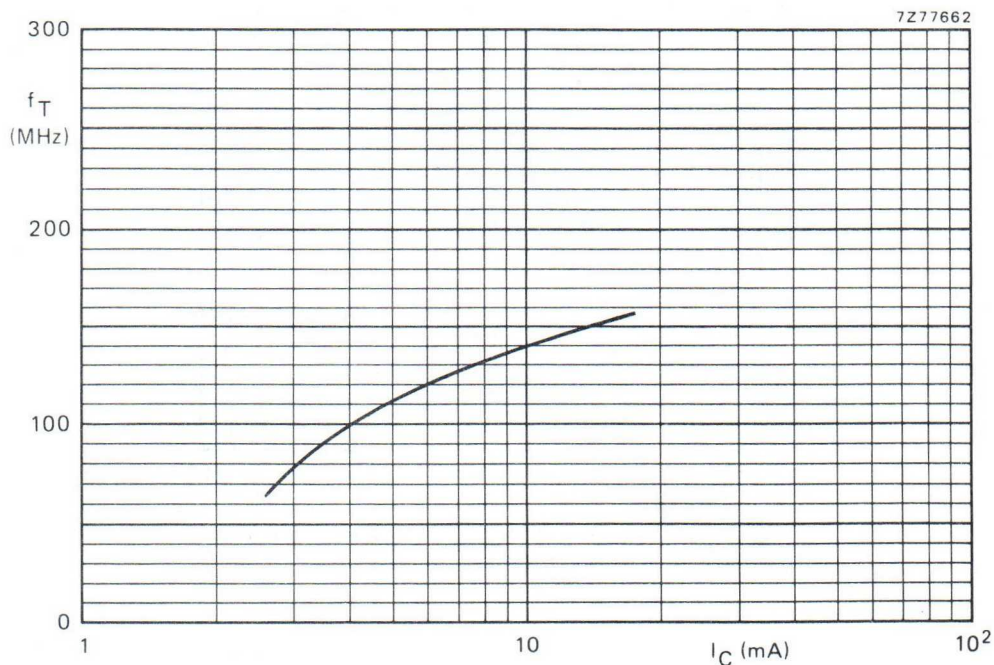


Fig. 2 Typical values transition frequency.  $V_{CE} = 10 \text{ V}$ ;  $f = 35 \text{ MHz}$ ;  $T_j = 25^\circ\text{C}$ .

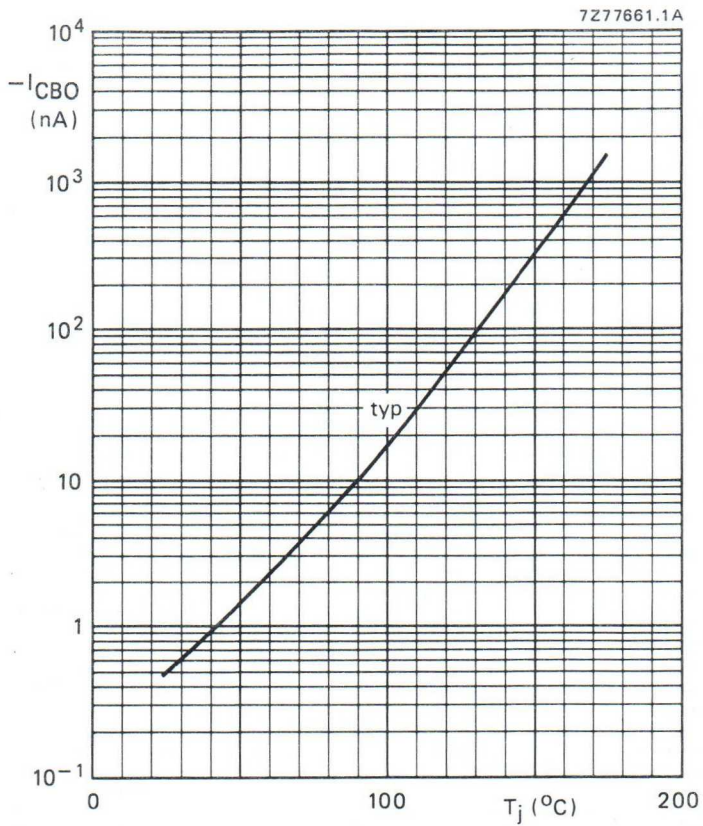


Fig. 3 Typical values collector-base current as a function of the junction temperature at a collector-base voltage of  $-90$  V.

## MOSFET N-CHANNEL ENHANCEMENT SWITCHING TRANSISTOR

Symmetrical insulated-gate silicon MOS field-effect transistor of the N-channel enhancement mode type. The transistor is sealed in a SOT143 envelope and features a low ON resistance and low capacitances. The transistor is protected against excessive input voltages by integrated back-to-back diodes between gate and substrate.

### Applications:

- analog and/or digital switch
- switch driver

### QUICK REFERENCE DATA

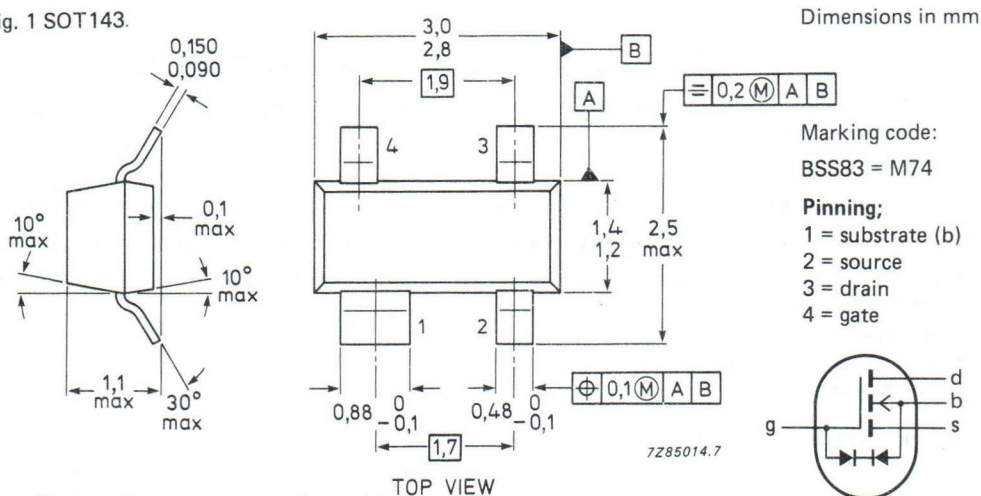
|                                                                                                        |              |            |                |
|--------------------------------------------------------------------------------------------------------|--------------|------------|----------------|
| Drain-source voltage                                                                                   | $V_{DS}$     | max.       | 10 V           |
| Source-drain voltage                                                                                   | $V_{SD}$     | max.       | 10 V           |
| Drain-substrate voltage                                                                                | $V_{DB}$     | max.       | 15 V           |
| Source-substrate voltage                                                                               | $V_{SB}$     | max.       | 15 V           |
| Drain current (DC)                                                                                     | $I_D$        | max.       | 50 mA          |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                   | $P_{tot}$    | max.       | 230 mW         |
| Gate-source threshold voltage<br>$V_{DS} = V_{GS}; V_{SB} = 0;$<br>$I_D = 1\text{ }\mu\text{A}$        | $V_{GS(th)}$ | $>$<br>$<$ | 0.1 V<br>2.0 V |
| Drain-source ON-resistance<br>$V_{GS} = 10\text{ V}; V_{SB} = 0; I_D = 0.1\text{ mA}$                  | $R_{DSon}$   | $<$        | 45 $\Omega$    |
| Feed-back capacitance<br>$V_{GS} = V_{BS} = -15\text{ V};$<br>$V_{DS} = 10\text{ V}; f = 1\text{ MHz}$ | $C_{rss}$    | typ.       | 0.6 pF         |

### MECHANICAL DATA

SOT143 (see Fig. 1).



Fig. 1 SOT143.



Note: Drain and source are interchangeable.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                                              |
|------------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Drain-source voltage                                                   | $V_{DS}$  | max. | 10 V                                         |
| Source-drain voltage                                                   | $V_{SD}$  | max. | 10 V                                         |
| Drain-substrate voltage                                                | $V_{DB}$  | max. | 15 V                                         |
| Source-substrate voltage                                               | $V_{SB}$  | max. | 15 V                                         |
| Drain current (DC)                                                     | $I_D$     | max. | 50 mA                                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 230 mW                                       |
| Storage temperature range                                              | $T_{stg}$ |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | 125 $^{\circ}\text{C}$                       |

## THERMAL RESISTANCE

|                                       |               |   |         |
|---------------------------------------|---------------|---|---------|
| From junction to ambient in free air* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                        |               |   |       |
|----------------------------------------------------------------------------------------|---------------|---|-------|
| Drain-source breakdown voltage<br>$V_{GS} = V_{BS} = -5\text{ V}; I_D = 10\text{ nA}$  | $V_{(BR)DSX}$ | > | 10 V  |
| Source-drain breakdown voltage<br>$V_{GD} = V_{BD} = -5\text{ V}; I_D = 10\text{ nA}$  | $V_{(BR)SDX}$ | > | 10 V  |
| Drain-substrate breakdown voltage<br>$V_{GB} = 0; I_D = 10\text{ nA};$ open source     | $V_{(BR)DBO}$ | > | 15 V  |
| Source-substrate breakdown voltage<br>$V_{GB} = 0; I_D = 10\text{ nA};$ open drain     | $V_{(BR)SBO}$ | > | 15 V  |
| Drain-source leakage current<br>$V_{GS} = V_{BS} = -2\text{ V}; V_{DS} = 6,6\text{ V}$ | $I_{DSoff}$   | < | 10 nA |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Source-drain leakage current

$$V_{GD} = V_{BD} = -2 \text{ V}; V_{SD} = 6,6 \text{ V}$$

Forward transconductance at  $f = 1 \text{ kHz}$ 

$$V_{DS} = 10 \text{ V}; V_{SB} = 0; I_D = 20 \text{ mA}$$

Gate-source threshold voltage

$$V_{DS} = V_{GS}; V_{SB} = 0; I_D = 1 \mu\text{A}$$

Drain-source ON-resistance

$$I_D = 0,1 \text{ mA};$$

$$V_{GS} = 5 \text{ V}; V_{SB} = 0$$

$$V_{GS} = 10 \text{ V}; V_{SB} = 0$$

$$V_{GS} = 3,2 \text{ V}; V_{SB} = 6,8 \text{ V (see Fig. 4)}$$

Gate-substrate zener voltages

$$V_{DB} = V_{SB} = 0; -I_G = 10 \mu\text{A}$$

$$V_{DB} = V_{SB} = 0; I_G = 10 \mu\text{A}$$

Capacitances at  $f = 1 \text{ MHz}$ 

$$V_{GS} = V_{BS} = -15 \text{ V}; V_{DS} = 10 \text{ V}$$

Feed-back capacitance

Input capacitance

Output capacitance

Switching times (see Fig. 2)

$$V_{DD} = 10 \text{ V}; V_i = 5 \text{ V}$$

Pulse generator:

$$R_i = 50 \Omega$$

$$t_r < 0,5 \text{ ns}$$

$$t_f < 1,0 \text{ ns}$$

$$t_p = 20 \text{ ns}$$

$$\delta < 0,01$$

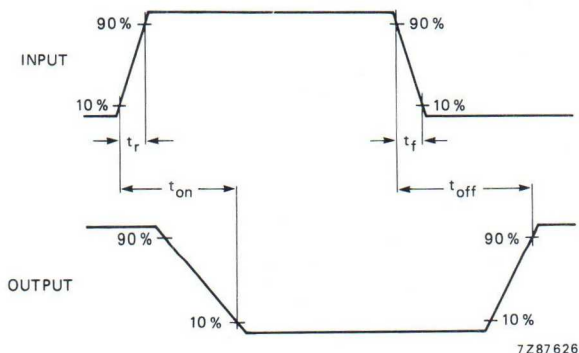
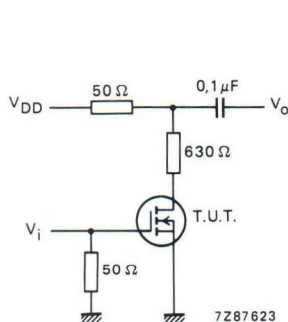


Fig. 2 Switching times test circuit and input and output waveforms.

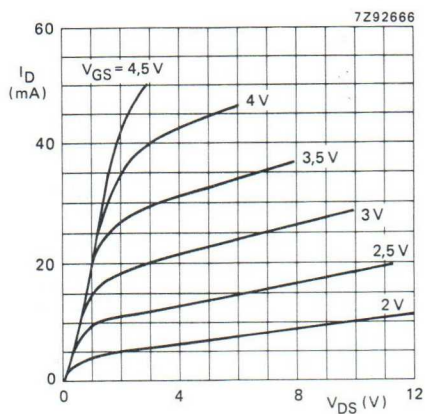


Fig. 3  $V_{SB} = 0$ ; typical values.

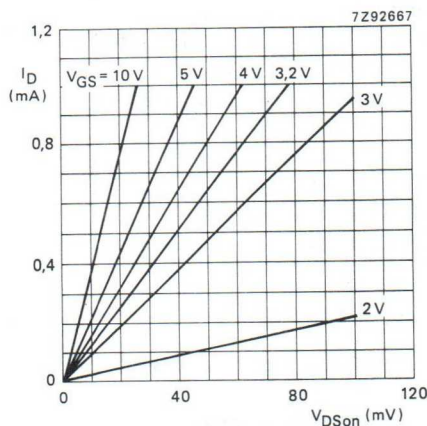


Fig. 4  $V_{SB} = 6.8$  V; typical values.

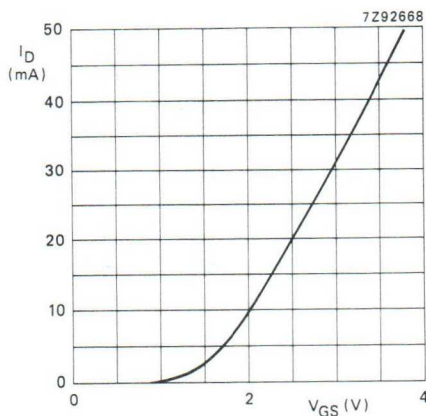


Fig. 5  $V_{DS} = 10$  V;  $V_{BS} = 0$ ; typical values.

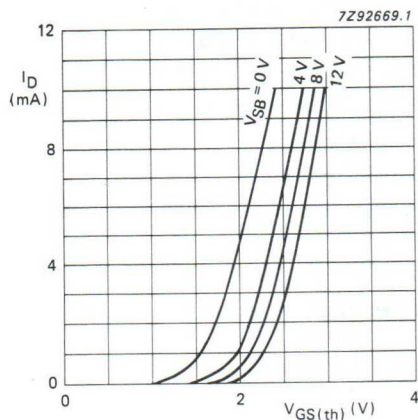


Fig. 6  $V_{DS} = V_{GS} = V_{GS(th)}$ .

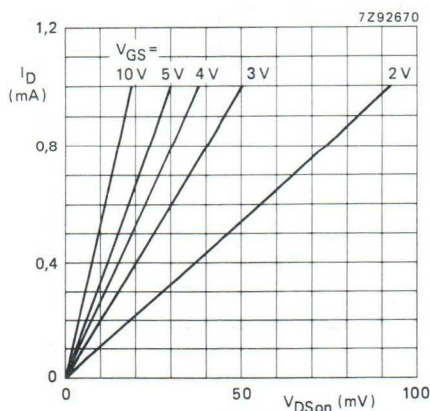


Fig. 7  $V_{SB} = 0$ ; typical values.

Conditions for Figs 3, 4, 5, 6 and 7:  
 $T_j = 25$  °C.

| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

BSS84

P-channel enhancement mode vertical  
D-MOS FET

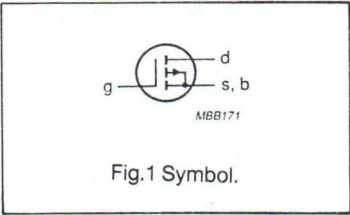
DESCRIPTION

Silicon p-channel enhancement mode vertical D-MOS transistor in a SOT23 envelope. It is intended for use in general purpose and high-speed switching applications, such as relays, multiplexers, choppers and line transformer drivers.

PINNING - SOT23

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | source      |
| 3   | drain       |

PIN CONFIGURATION



QUICK REFERENCE DATA

| SYMBOL        | PARAMETER                     | MAX. | UNIT     |
|---------------|-------------------------------|------|----------|
| $-V_{DS}$     | drain-source voltage          | 50   | V        |
| $-I_D$        | drain current                 | 130  | mA       |
| $R_{DS(on)}$  | drain-source on resistance    | 10   | $\Omega$ |
| $-V_{GS(th)}$ | gate-source threshold voltage | 2    | V        |

# P-channel enhancement mode vertical D-MOS FET

**BSS84**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL     | PARAMETER                 | CONDITIONS                                | MIN. | MAX. | UNIT               |
|------------|---------------------------|-------------------------------------------|------|------|--------------------|
| $-V_{DS}$  | drain-source voltage      |                                           | -    | 50   | V                  |
| $-V_{GSO}$ | gate-source voltage       | open drain<br>$I_D = 0$                   | -    | 20   | V                  |
| $-I_D$     | drain current             | average value                             | -    | 130  | mA                 |
| $-I_{DM}$  | drain current             | peak value                                | -    | 520  | mA                 |
| $P_{tot}$  | total power dissipation   | $T_{amb} \leq 25\text{ }^{\circ}\text{C}$ | -    | 360  | mW                 |
| $T_{stg}$  | storage temperature range |                                           | -55  | 150  | $^{\circ}\text{C}$ |
| $T_j$      | junction temperature      |                                           | -    | 150  | $^{\circ}\text{C}$ |

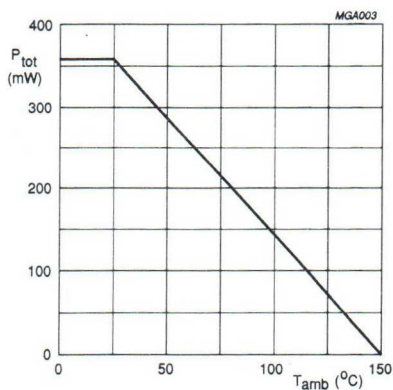


Fig.2 Total power dissipation as a function of ambient temperature.

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                | VALUE | UNIT |
|---------------|--------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient | 500   | K/W  |



# P-channel enhancement mode vertical D-MOS FET

**BSS84****CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

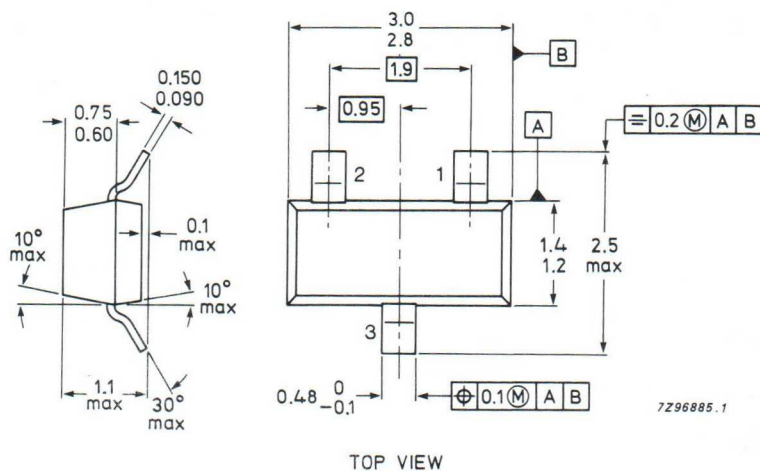
| SYMBOL         | PARAMETER                      | CONDITIONS                                                                     | MIN. | TYP. | MAX. | UNIT          |
|----------------|--------------------------------|--------------------------------------------------------------------------------|------|------|------|---------------|
| $-V_{(BR)DSS}$ | drain-source breakdown voltage | $V_{GS} = 0$<br>$-I_D = 250\text{ }\mu\text{A}$                                | 50   | -    | -    | V             |
| $-I_{DSS}$     | drain-source leakage current   | $V_{GS} = 0$<br>$-V_{DS} = 25\text{ V}$                                        | -    | -    | 0.1  | $\mu\text{A}$ |
|                |                                | $V_{GS} = 0$<br>$-V_{DS} = 50\text{ V}$                                        | -    | -    | 15   | $\mu\text{A}$ |
|                |                                | $V_{GS} = 0$<br>$-V_{DS} = 50\text{ V}$<br>$T_j = 125\text{ }^{\circ}\text{C}$ | -    | -    | 60   | $\mu\text{A}$ |
| $-I_{GSS}$     | gate-source leakage current    | $V_{DS} = 0$<br>$-V_{GS} = 20\text{ V}$                                        | -    | -    | 60   | $\mu\text{A}$ |
| $-V_{GS(th)}$  | gate-source threshold voltage  | $-I_D = 1\text{ mA}$<br>$V_{DS} = V_{GS}$                                      | 0.8  | -    | 2    | V             |
| $R_{DS(on)}$   | drain-source on resistance     | $-V_{GS} = 5\text{ V}$<br>$-I_D = 100\text{ mA}$                               | -    | 6    | 10   | $\Omega$      |
| $ y_{fs} $     | transfer admittance            | $-V_{DS} = 25\text{ V}$<br>$-I_D = 100\text{ mA}$<br>$f = 1\text{ kHz}$        | 50   | 70   | -    | mS            |
| $C_{iss}$      | input capacitance              | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 40   | -    | pF            |
| $C_{oss}$      | output capacitance             | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 15   | -    | pF            |
| $C_{rss}$      | feedback capacitance           | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                  | -    | 6    | -    | pF            |
| $t_{on}$       | turn-on time                   | $-V_{CC} = 30\text{ V}$<br>$-I_D = 0.27\text{ A}$<br>$-V_{GS} = 0/5\text{ V}$  | -    | 20   | -    | ns            |
| $t_{off}$      | turn-off time                  | $-V_{CC} = 30\text{ V}$<br>$-I_D = 0.27\text{ A}$<br>$-V_{GS} = 0/5\text{ V}$  | -    | 43   | -    | ns            |

## P-channel enhancement mode vertical D-MOS FET

# BSS84

## PACKAGE OUTLINE

Dimensions in mm



**Marking: SP**

Fig.3 SOT23.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel vertical D-MOS transistor in a SOT89 envelope.

Designed primarily as a line current interrupter in telephone sets, it can also be applied in other applications such as in relays, line and high-speed transformer drivers etc.

## Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.
- Low RDS on

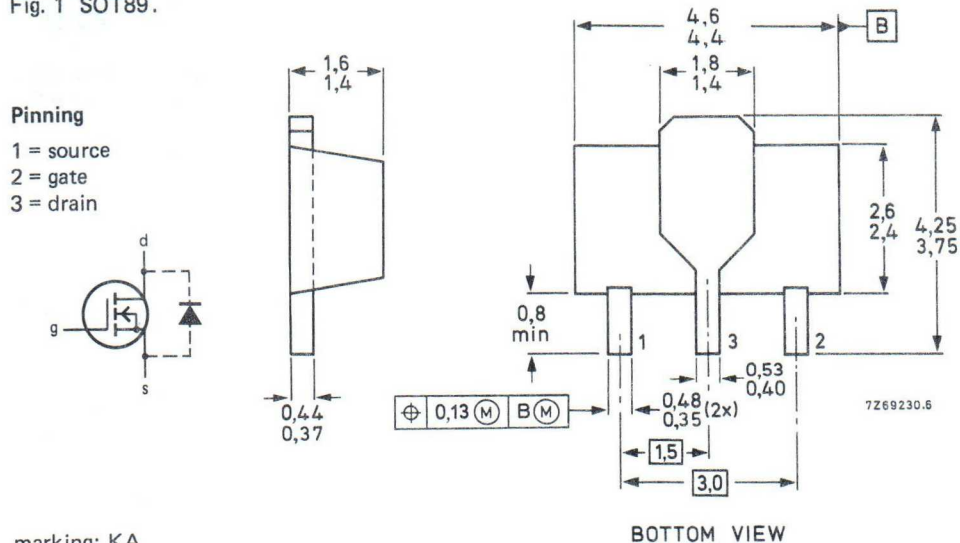
## QUICK REFERENCE DATA

|                                                                           |               |              |                            |
|---------------------------------------------------------------------------|---------------|--------------|----------------------------|
| Drain-source voltage                                                      | $V_{DS}$      | max.         | 200 V                      |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$ | max.         | 20 V                       |
| Drain current (DC)                                                        | $I_D$         | max.         | 280 mA                     |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$      | $P_{tot}$     | max.         | 1 W                        |
| Drain-source on-resistance<br>$I_D = 400\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DS(on)}$  | max.<br>typ. | 6 $\Omega$<br>4.5 $\Omega$ |
| Transfer admittance<br>$I_D = 400\text{ mA}; V_{DS} = 25\text{ V}$        | $ y_{fs} $    | typ.<br>min. | 350 mS<br>140 mS           |

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT89.



marking: KA

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |               |      |                                         |
|------------------------------------------------------------------------|---------------|------|-----------------------------------------|
| Drain-source voltage                                                   | $V_{DS}$      | max. | 200 V                                   |
| Gate-source voltage (open drain)                                       | $\pm V_{GS0}$ | max. | 20 V                                    |
| Drain current (DC)                                                     | $I_D$         | max. | 280 mA                                  |
| Drain current (peak)                                                   | $I_{DM}$      | max. | 1.1 A                                   |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$     | max. | 1 W                                     |
| Storage temperature range                                              | $T_{stg}$     |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$         | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                            |               |   |         |
|----------------------------|---------------|---|---------|
| From junction to ambient * | $R_{th\ j-a}$ | = | 125 K/W |
|----------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                 |               |      |                  |
|-----------------------------------------------------------------------------------------------------------------|---------------|------|------------------|
| Drain-source breakdown voltage<br>$I_D = 250\text{ }\mu\text{A}$ ; $V_{GS} = 0$                                 | $V_{(BR)DSS}$ | min. | 200 V            |
| Drain-source leakage current<br>$V_{DS} = 60\text{ V}$ ; $V_{GS} = 0$<br>$V_{DS} = 200\text{ V}$ ; $V_{GS} = 0$ | $I_{DSS}$     | max. | 200 nA           |
|                                                                                                                 | $I_{DSS}$     | max. | 60 $\mu\text{A}$ |
|                                                                                                                 |               | typ. | 100 nA           |
| Gate-source leakage current<br>$V_{GS} = 20\text{ V}$ ; $V_{DS} = 0$                                            | $I_{GSS}$     | max. | 100 nA           |
| Gate threshold voltage<br>$I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$                                               | $V_{GS(th)}$  | min. | 0.8 V            |
|                                                                                                                 |               | max. | 2.8 V            |
| Drain-source on-resistance<br>$I_D = 400\text{ mA}$ ; $V_{GS} = 10\text{ V}$                                    | $R_{DS(on)}$  | max. | 6 $\Omega$       |
|                                                                                                                 |               | typ. | 4.5 $\Omega$     |
| Transfer admittance<br>$I_D = 400\text{ mA}$ ; $V_{DS} = 25\text{ V}$                                           | $ y_{fs} $    | typ. | 350 mS           |
|                                                                                                                 |               | min. | 140 mS           |
| Input capacitance $f = 1\text{ MHz}$ ;<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                                 | $C_{iss}$     | max. | 60 pF            |
|                                                                                                                 |               | typ. | 45 pF            |
| Output capacitance $f = 1\text{ MHz}$ ;<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                                | $C_{oss}$     | max. | 25 pF            |
|                                                                                                                 |               | typ. | 15 pF            |
| Feedback capacitance $f = 1\text{ MHz}$ ;<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                              | $C_{rss}$     | max. | 10 pF            |
|                                                                                                                 |               | typ. | 3.5 pF           |
| Switching times (see Figs 2 and 3)<br>$I_D = 250\text{ mA}$ ; $V_{DD} = 50\text{ V}$ ;<br>$V_{GS} = 0$ to 10    | $t_{on}$      | typ. | 5 ns             |
|                                                                                                                 |               | max. | 10 ns            |
|                                                                                                                 | $t_{off}$     | typ. | 15 ns            |
|                                                                                                                 |               | max. | 25 ns            |

\* Transistor mounted on ceramic substrate area  $2.5\text{ cm}^2$ , thickness 0.7 mm.

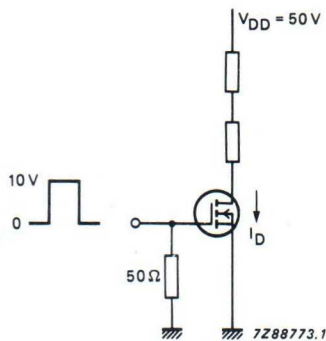


Fig. 2 Switching times test circuit.

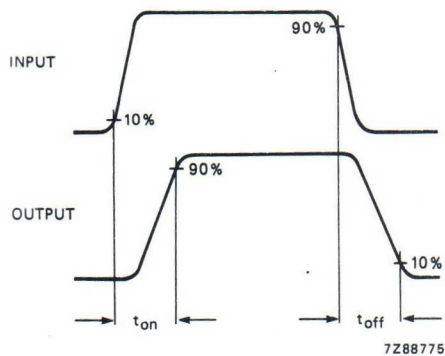


Fig. 3 Input and output waveforms.





| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

DESCRIPTION

Silicon n-channel enhancement mode vertical D-MOS transistor in a SOT23 envelope. It is intended for use in general purpose and high-speed switching applications, such as relays, multiplexers, choppers and line transformer drivers.

PINNING - SOT23

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | source      |
| 3   | drain       |

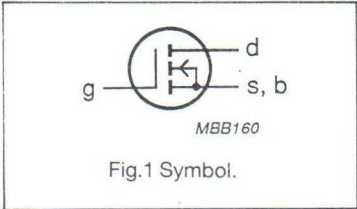
BSS131

N-channel enhancement mode vertical D-MOS FET

QUICK REFERENCE DATA

| SYMBOL        | PARAMETER                     | MAX. | UNIT     |
|---------------|-------------------------------|------|----------|
| $V_{DS}$      | drain-source voltage          | 240  | V        |
| $I_D$         | drain current                 | 100  | mA       |
| $R_{DS(on)}$  | drain-source on resistance    | 16   | $\Omega$ |
| $-V_{GS(th)}$ | gate-source threshold voltage | 2.8  | V        |

PIN CONFIGURATION



N-channel enhancement mode vertical  
D-MOS FET

BSS131

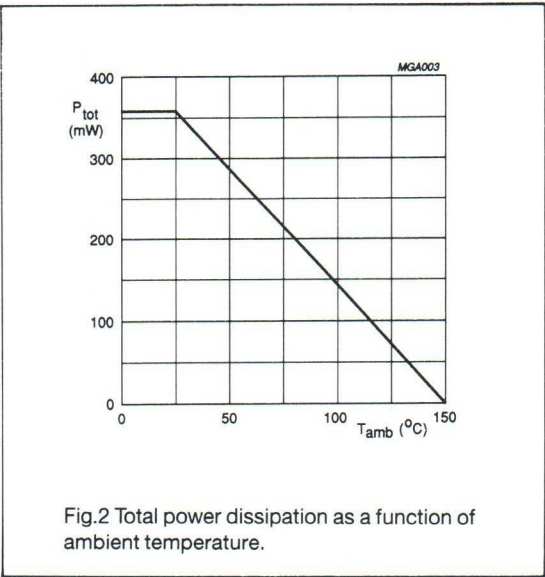
LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL           | PARAMETER                 | CONDITIONS                       | MIN. | MAX. | UNIT |
|------------------|---------------------------|----------------------------------|------|------|------|
| V <sub>DS</sub>  | drain-source voltage      |                                  | -    | 240  | V    |
| V <sub>GSO</sub> | gate-source voltage       | open drain<br>I <sub>D</sub> = 0 | -    | 20   | V    |
| I <sub>D</sub>   | drain current             | average value                    | -    | 100  | mA   |
| I <sub>DM</sub>  | drain current             | peak value                       | -    | 400  | mA   |
| P <sub>tot</sub> | total power dissipation   | T <sub>amb</sub> ≤ 25 °C         | -    | 360  | mW   |
| T <sub>stg</sub> | storage temperature range |                                  | -55  | 150  | °C   |
| T <sub>j</sub>   | junction temperature      |                                  | -    | 150  | °C   |

THERMAL RESISTANCE

| SYMBOL              | PARAMETER                | VALUE | UNIT |
|---------------------|--------------------------|-------|------|
| R <sub>th j-a</sub> | from junction to ambient | 350   | K/W  |



# N-channel enhancement mode vertical D-MOS FET

**BSS131****CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

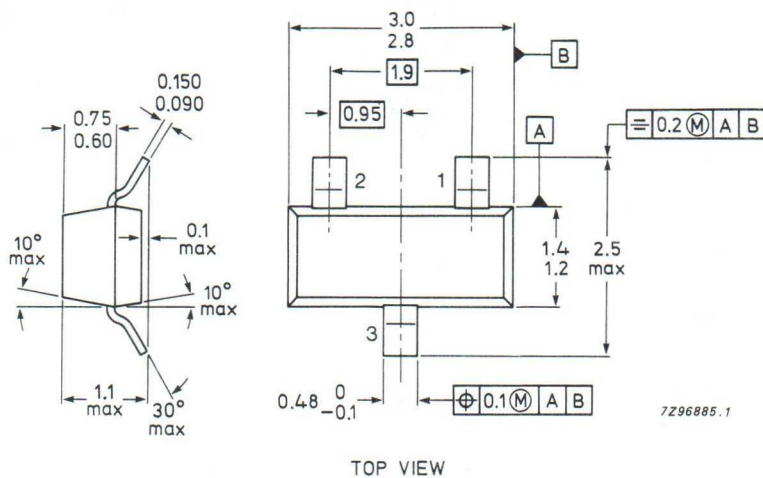
| SYMBOL        | PARAMETER                      | CONDITIONS                                                                     | MIN. | TYP. | MAX. | UNIT          |
|---------------|--------------------------------|--------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $V_{GS} = 0$<br>$I_D = 250\text{ }\mu\text{A}$                                 | 240  | -    | -    | V             |
| $I_{DSS}$     | drain-source leakage current   | $V_{GS} = 0$<br>$V_{DS} = 130\text{ V}$                                        | -    | -    | 30   | nA            |
|               |                                | $V_{GS} = 0$<br>$V_{DS} = 240\text{ V}$                                        | -    | -    | 15   | $\mu\text{A}$ |
|               |                                | $V_{GS} = 0$<br>$V_{DS} = 240\text{ V}$<br>$T_j = 125\text{ }^{\circ}\text{C}$ | -    | -    | 60   | $\mu\text{A}$ |
| $I_{GSS}$     | gate-source leakage current    | $V_{DS} = 0$<br>$V_{GS} = 20\text{ V}$                                         | -    | -    | 10   | nA            |
| $V_{GS(th)}$  | gate-source threshold voltage  | $I_D = 1\text{ mA}$<br>$V_{DS} = V_{GS}$                                       | 0.8  | -    | 2.8  | V             |
| $R_{DS(on)}$  | drain-source on resistance     | $V_{GS} = 10\text{ V}$<br>$I_D = 100\text{ mA}$                                | -    | -    | 16   | $\Omega$      |
| $ Y_{fs} $    | transfer admittance            | $V_{DS} = 25\text{ V}$<br>$I_D = 100\text{ mA}$<br>$f = 1\text{ kHz}$          | 60   | 100  | -    | mS            |
| $C_{iss}$     | input capacitance              | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                   | -    | 20   | -    | pF            |
| $C_{oss}$     | output capacitance             | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                   | -    | 6    | -    | pF            |
| $C_{rss}$     | feedback capacitance           | $V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                   | -    | 2.5  | -    | pF            |
| $t_{on}$      | turn-on time                   | $V_{CC} = 30\text{ V}$<br>$I_D = 0.28\text{ A}$<br>$V_{GS} = 0-5\text{ V}$     | -    | 20   | -    | ns            |
| $t_{off}$     | turn-off time                  | $V_{CC} = 30\text{ V}$<br>$I_D = 0.28\text{ A}$<br>$V_{GS} = 0-5\text{ V}$     | -    | 40   | -    | ns            |

## N-channel enhancement mode vertical D-MOS FET

**BSS131**

## PACKAGE OUTLINE

Dimensions in mm



**Marking:** SR

Fig.3 SOT23.



| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# BSS192

## P-channel enhancement mode vertical D-MOS transistor

FEATURES

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.

DESCRIPTION

P-channel enhancement mode vertical D-MOS transistor in a SOT89 envelope, intended for use in relay, high-speed and line transformer drivers, and as a line current interruptor in telephony applications.

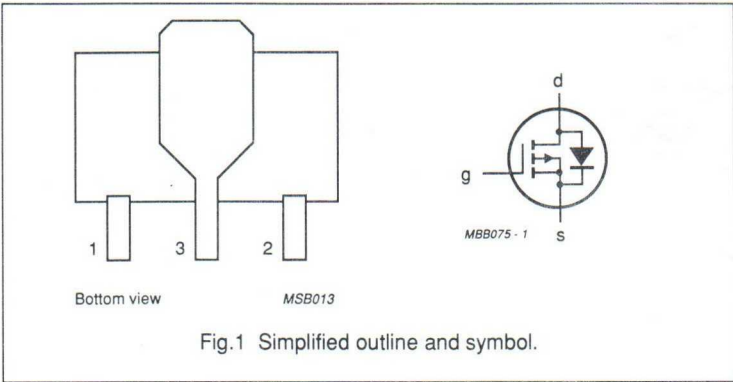
PINNING - SOT89

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | source      |
| 2   | gate        |
| 3   | drain       |

QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                     | CONDITIONS                                        | MAX. | UNIT     |
|--------------|-------------------------------|---------------------------------------------------|------|----------|
| $-V_{DS}$    | drain-source voltage          |                                                   | 200  | V        |
| $-I_D$       | drain current                 | DC value                                          | 150  | mA       |
| $R_{DS(on)}$ | drain-source on-resistance    | $-I_D = 100\text{ mA}$<br>$-V_{GS} = 10\text{ V}$ | 20   | $\Omega$ |
| $V_{GS(th)}$ | gate-source threshold voltage | $-I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$         | 2.8  | V        |

PIN CONFIGURATION



# P-channel enhancement mode vertical D-MOS transistor

**BSS192**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                 | MIN. | MAX. | UNIT |
|---------------|---------------------------|--------------------------------------------|------|------|------|
| $-V_{DS}$     | drain-source voltage      |                                            | –    | 200  | V    |
| $\pm V_{GSO}$ | gate-source voltage       | open drain                                 | –    | 20   | V    |
| $-I_D$        | drain current             | DC value                                   | –    | 150  | mA   |
| $-I_{DM}$     | drain current             | peak value                                 | –    | 600  | mA   |
| $P_{tot}$     | total power dissipation   | up to $T_{amb} = 25\text{ °C}$<br>(note 1) | –    | 1    | W    |
| $T_{stg}$     | storage temperature range |                                            | –65  | 150  | °C   |
| $T_j$         | junction temperature      |                                            | –    | 150  | °C   |

## Note

1. Transistor mounted on a ceramic substrate, area 2.5 cm<sup>2</sup>, thickness 0.7 mm.

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                            | VALUE | UNIT |
|---------------|--------------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient<br>(note 1) | 125   | K/W  |

## Note

1. Transistor mounted on a ceramic substrate, area 2.5 cm<sup>2</sup>, thickness 0.7 mm.

# P-channel enhancement mode vertical D-MOS transistor

**BSS192**

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                               | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------|------|------|------|---------------|
| $-V_{(BR)DSS}$                            | drain-source breakdown voltage | $-I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                           | 200  | —    | —    | V             |
| $-I_{DSS}$                                | drain-source leakage current   | $-V_{DS} = 60\text{ V}$<br>$V_{GS} = 0$                                                  | —    | —    | 0.2  | $\mu\text{A}$ |
|                                           |                                | $-V_{DS} = 200\text{ V}$<br>$-V_{GS} = 0.2\text{ V}$                                     | —    | 0.1  | 60   | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $\pm V_{GS} = 20\text{ V}$<br>$V_{DS} = 0$                                               | —    | —    | 100  | nA            |
| $-V_{GS(th)}$                             | gate-source threshold voltage  | $-I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                                | 0.8  | —    | 2.8  | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $-I_D = 100\text{ mA}$<br>$-V_{GS} = 10\text{ V}$                                        | —    | 10   | 20   | $\Omega$      |
| $ Y_{fs} $                                | transfer admittance            | $-I_D = 200\text{ mA}$<br>$-V_{DS} = 25\text{ V}$                                        | 60   | 200  | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 55   | 90   | pF            |
| $C_{oss}$                                 | output capacitance             | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 20   | 30   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $-V_{DS} = 25\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                            | —    | 5    | 15   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                          |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 5    | 10   | ns            |
| $t_{off}$                                 | turn-off time                  | $-I_D = 250\text{ mA}$<br>$-V_{DD} = 50\text{ V}$<br>$-V_{GS} = 0\text{ to }10\text{ V}$ | —    | 20   | 30   | ns            |

# P-channel enhancement mode vertical D-MOS transistor

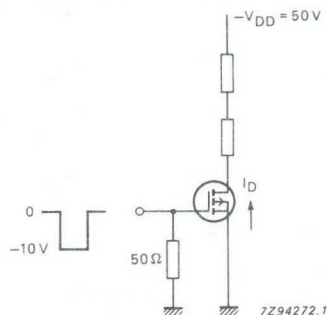
**BSS192**


Fig.2 Switching time test circuit.

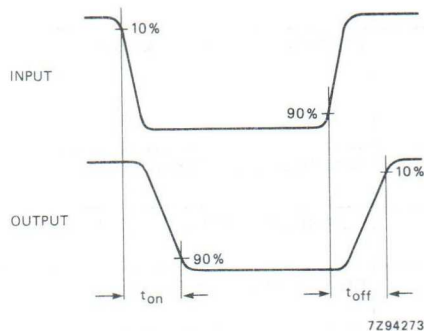


Fig.3 Input and output waveforms.

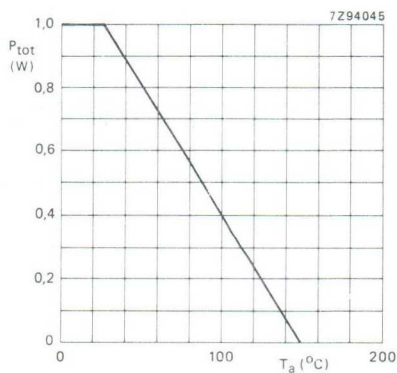
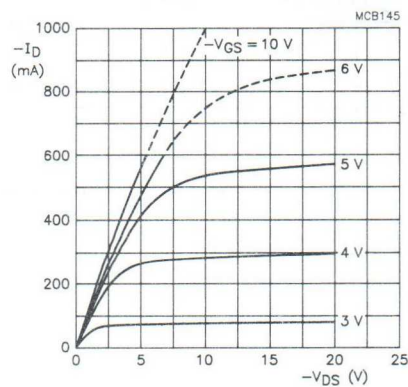


Fig.4 Power derating curve.


Fig.5 Typical output characteristics; T<sub>j</sub> = 25 °C.

# P-channel enhancement mode vertical D-MOS transistor

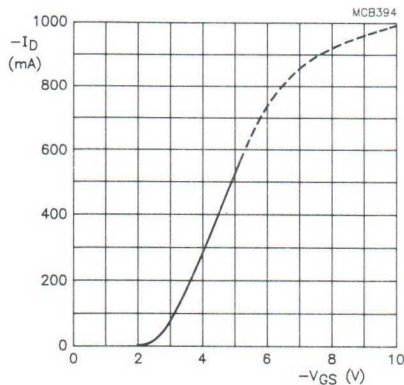
**BSS192**


Fig.6 Typical transfer characteristic;  
 $-V_{DS} = 10 \text{ V}$ ;  $T_J = 25^\circ\text{C}$ .

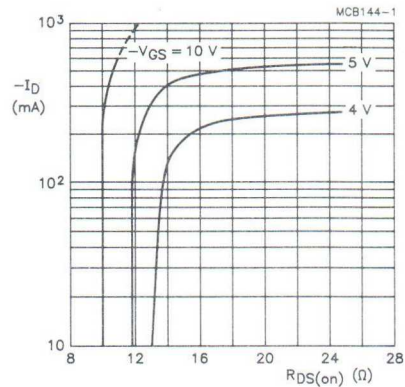


Fig.7 Typical on-resistance as a function of  
drain current;  $T_J = 25^\circ\text{C}$ .

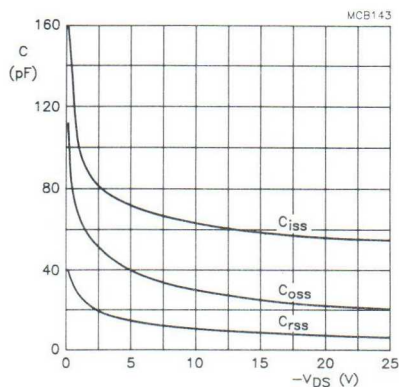


Fig.8 Typical capacitances as a function of  
drain-source voltage;  $V_{GS} = 0$ ;  $f = 1 \text{ MHz}$ ;  
 $T_J = 25^\circ\text{C}$ .

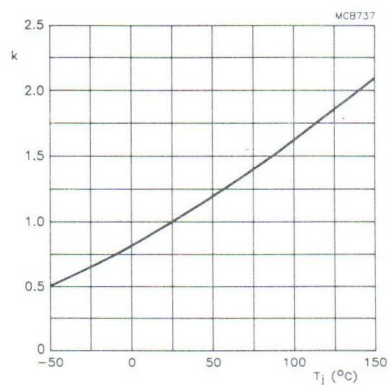


Fig.9 Temperature coefficient of drain-source  
on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_J}{R_{DS(on)} \text{ at } 25^\circ\text{C}}$ ; typical  $R_{DS(on)}$   
at  $-200 \text{ mA}/-10 \text{ V}$ .



# P-channel enhancement mode vertical D-MOS transistor

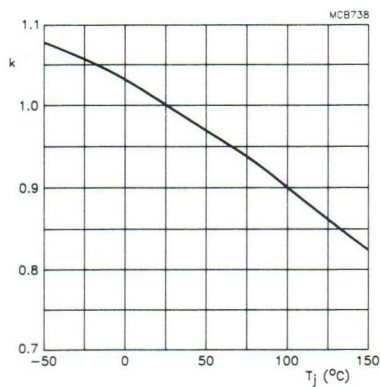
**BSS192**


Fig.10 Temperature coefficient of gate-source threshold voltage;  $k = \frac{-V_{GS(th)} \text{ at } T_j}{-V_{GS(th)} \text{ at } 25^{\circ}\text{C}}$ ; typical  $V_{GS(th)}$  at -1 mA.

## SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in miniature plastic envelopes intended for use in amplifier and switching applications. Complementary types are BST39/40.

### QUICK REFERENCE DATA

|                                                            |                 | BST15     | BST16            |
|------------------------------------------------------------|-----------------|-----------|------------------|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ max. | 200       | 350 V            |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ max. | 200       | 300 V            |
| Collector current (d.c.)                                   | $-I_C$ max.     | 1         | A                |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ max.  | 1         | W                |
| Junction temperature                                       | $T_j$ max.      | 150       | $^\circ\text{C}$ |
| D.C. current gain                                          | $h_{FE}$        | 30 to 150 | 30 to 120        |
| Transition frequency                                       | $f_T$           | > 15      | MHz              |
| $-V_{CE} = 10\text{ V}; -I_C = 50\text{ mA}$               |                 |           |                  |
| $-V_{CE} = 10\text{ V}; -I_C = 10\text{ mA}$               |                 |           |                  |

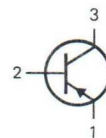
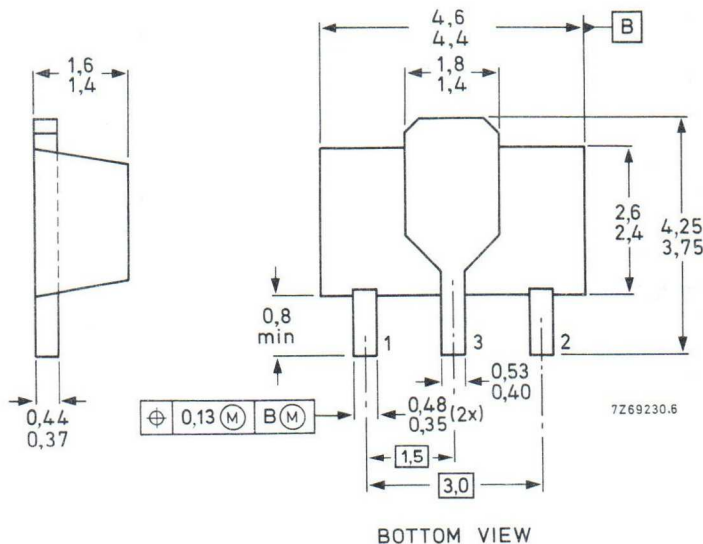
### MECHANICAL DATA

Fig. 1 SOT-89.

Dimensions in mm

Marking code

BST15 = BT1  
BST16 = BT2



See also *Soldering Recommendations*

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |            | BST15      | BST16              |
|------------------------------------------------------------------------|------------|------------|--------------------|
| Collector-base voltage (open emitter)                                  | $-V_{CBO}$ | max. 200   | 350 V              |
| Collector-emitter voltage (open base)                                  | $-V_{CEO}$ | max. 200   | 300 V              |
| Emitter-base voltage (open collector)                                  | $-V_{EBO}$ | max. 4     | 6 V                |
| Collector current (d.c.)                                               | $-I_C$     | max. 1     | A                  |
| Base current                                                           | $-I_B$     | max. 0,5   | A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. 1     | W                  |
| Junction temperature                                                   | $T_j$      | max. 150   | $^{\circ}\text{C}$ |
| Storage temperature                                                    | $T_{stg}$  | -65 to 150 | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                                |                 |   |     |     |
|--------------------------------|-----------------|---|-----|-----|
| from junction to ambient*      | $R_{th\ j-mb}$  | = | 125 | K/W |
| from junction to collector tab | $R_{th\ j-tab}$ | = | 10  | K/W |

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                  |                | BST15     | BST16            |
|--------------------------------------------------|----------------|-----------|------------------|
| Collector cut-off current                        |                |           |                  |
| $I_E = 0; -V_{CB} = 175\text{ V}$                | $-I_{CBO}$     | < 1       | — $\mu\text{A}$  |
| $I_E = 0; -V_{CB} = 280\text{ V}$                | $-I_{CBO}$     | < —       | 1 $\mu\text{A}$  |
| $I_B = 0; -V_{CE} = 150\text{ V}$                | $-I_{CEO}$     | < 50      | — $\mu\text{A}$  |
| $I_B = 0; -V_{CE} = 250\text{ V}$                | $-I_{CEO}$     | < —       | 50 $\mu\text{A}$ |
| Emitter cut-off current                          |                |           |                  |
| $I_C = 0; -V_{EB} = 4\text{ V}$                  | $-I_{EBO}$     | < 20      | — $\mu\text{A}$  |
| $I_C = 0; -V_{EB} = 6\text{ V}$                  | $-I_{EBO}$     | < —       | 20 $\mu\text{A}$ |
| Collector-emitter breakdown voltage              |                |           |                  |
| $I_B = 0; -I_C = 50\text{ mA}; L = 25\text{ mH}$ | $-V_{(BR)CEO}$ | > 200     | 300 V            |
| Collector-emitter saturation voltage             |                |           |                  |
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$        | $-V_{CEsat}$   | < 2,5     | 2,0 V            |
| D.C. current gain                                |                |           |                  |
| $-V_{CE} = 10\text{ V}; -I_C = 50\text{ mA}$     | $h_{FE}$       | 30 to 150 | 30 to 120        |
| Transition frequency at $f = 30\text{ MHz}$      |                |           |                  |
| $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$     | $f_T$          | > 15      | MHz              |
| Collector capacitance at $f = 1\text{ MHz}$      |                |           |                  |
| $I_E = I_e = 0; -V_{CB} = 10\text{ V}$           | $C_c$          | < 15      | pF               |

\* Mounted on an area of  $2,5\text{ cm}^2$  of a ceramic substrate; thickness 0,7 mm.

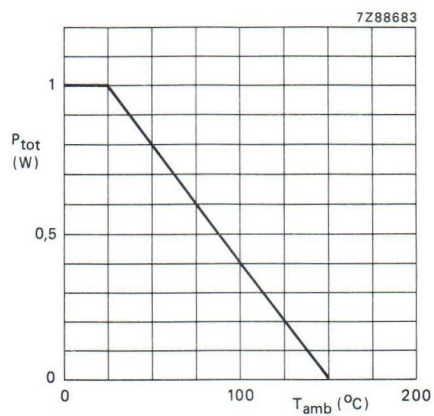


Fig. 2 Power derating curve.







# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      | BST39 | BST40      |                    |
|------------------------------------------------------------------------|-----------|------|-------|------------|--------------------|
| Collector-base voltage (open emitter)                                  | $V_{CBO}$ | max. | 400   | 300        | V                  |
| Collector-emitter voltage (open base)                                  | $V_{CEO}$ | max. | 350   | 250        | V                  |
| Emitter-base voltage (open collector)                                  | $V_{EBO}$ | max. |       | 5          | V                  |
| Collector current (d.c.)                                               | $I_C$     | max. |       | 1          | A                  |
| Base current                                                           | $I_B$     | max. |       | 0,5        | A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$ | max. |       | 1          | W                  |
| Junction temperature                                                   | $T_j$     | max. |       | 150        | $^{\circ}\text{C}$ |
| Storage temperature                                                    | $T_{stg}$ |      |       | -65 to 150 | $^{\circ}\text{C}$ |

# **THERMAL RESISTANCE**

|                           |             |   |     |     |
|---------------------------|-------------|---|-----|-----|
| from junction to ambient* | $R_{thj-a}$ | = | 125 | K/W |
|---------------------------|-------------|---|-----|-----|

# **CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                          |             |        |     |               |
|------------------------------------------------------------------------------------------|-------------|--------|-----|---------------|
| Collector cut-off current<br>$I_B = 0; V_{CE} = 300\text{ V}$                            | $I_{CBO}$   | $\leq$ | 20  | nA            |
| Emitter cut-off current<br>$I_C = 0; V_{EB} = 5\text{ V}$                                | $I_{EBO}$   | $\leq$ | 10  | $\mu\text{A}$ |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}; I_B = 4\text{ mA}$          | $V_{CEsat}$ | $\leq$ | 0,5 | V             |
| Base-emitter saturation voltage<br>$I_C = 50\text{ mA}; I_B = 4\text{ mA}$               | $V_{BEsat}$ | $\leq$ | 1,3 | V             |
| D.C. current gain<br>$V_{CE} = 10\text{ V}; I_C = 20\text{ mA}$                          | $h_{FE}$    | $\leq$ | 40  |               |
| Collector capacitance at $f = 1\text{ MHz}$<br>$I_E = I_C = 0; V_{CB} = 10\text{ V}$     | $C_c$       | $\leq$ | 2   | pF            |
| Emitter capacitance at $f = 1\text{ MHz}$<br>$I_C = I_E = 0; V_{EB} = 5\text{ V}$        | $C_e$       | $\leq$ | 20  | pF            |
| Transition frequency at $f = 5\text{ MHz}$<br>$V_{CE} = 10\text{ V}; I_C = 10\text{ mA}$ | $f_T$       | $\geq$ | 70  | MHz           |

\* Mounted on an area of  $2,5\text{ cm}^2$  of a ceramic substrate; thickness 0,7 mm.

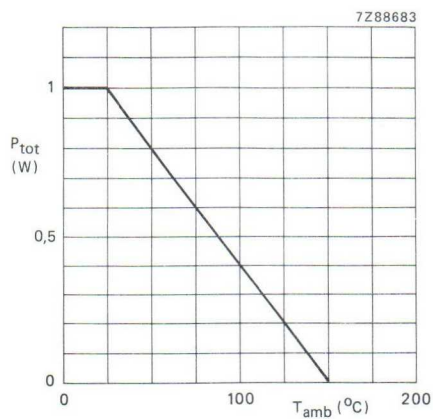


Fig. 2 Power derating curve.







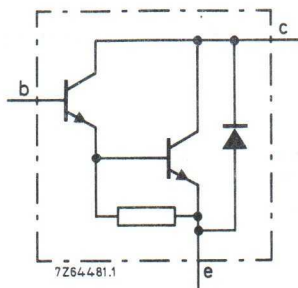


Fig. 2 Circuit diagram.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      | BST50        | BST51 | BST52              |
|---------------------------------------------------------------------------|-----------|------|--------------|-------|--------------------|
| Collector-base voltage (open emitter)                                     | $V_{CBO}$ | max. | 60           | 80    | 90 V               |
| Collector-emitter voltage *                                               | $V_{CER}$ | max. | 45           | 60    | 80 V               |
| Emitter-base voltage (open collector)                                     | $V_{EBO}$ | max. | 5            |       | V                  |
| Collector current (d.c.)                                                  | $I_C$     | max. | 0,5          |       | A                  |
| Collector current (peak)                                                  | $I_{CM}$  | max. | 1,5          |       | A                  |
| Base current (d.c.)                                                       | $I_B$     | max. | 0,1          |       | A                  |
| Total power dissipation ▲<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 1            |       | W                  |
| Storage temperature                                                       | $T_{stg}$ |      | -65 to + 150 |       | $^{\circ}\text{C}$ |
| Junction temperature **                                                   | $T_j$     | max. | 150          |       | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE \*\*

|                            |                 |   |     |     |
|----------------------------|-----------------|---|-----|-----|
| From junction to ambient ▲ | $R_{th\ j-a}$   | = | 125 | K/W |
| From junction to tab       | $R_{th\ j-tab}$ | = | 10  | K/W |

\* External  $R_{BE}$  not to exceed value shown in Fig. 5.

\*\* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

▲ Device mounted on a ceramic substrate; area = 2,5 cm<sup>2</sup>, thickness = 0,7 mm.

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$V_{BE} = 0; V_{CE} = V_{CEr\max}$

$I_{CES} < 10\text{ }\mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\text{ V}$

$I_{EBO} < 10\text{ }\mu\text{A}$

D.C. current gain\*

$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 1000$

$I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$

$h_{FE} > 2000$

Collector-emitter saturation voltage

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

$V_{CEsat} < 1,3\text{ V}$

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}; T_j = 150\text{ }^{\circ}\text{C}$

$V_{CEsat} < 1,3\text{ V}$

Base-emitter saturation voltage

$I_C = 500\text{ mA}; I_B = 0,5\text{ mA}$

$V_{BEsat} < 1,9\text{ V}$

Switching times (see also Fig. 3 and Fig. 4)

$I_C = 500\text{ mA}; I_{Bon} = -I_{Boff} = 0,5\text{ mA}$

Turn-on time

$t_{on}$  typ. 400 ns

Turn-off time

$t_{off}$  typ. 1500 ns

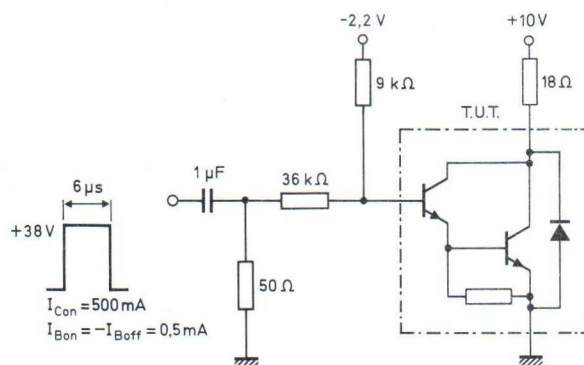


Fig. 3 Switching times test circuit.

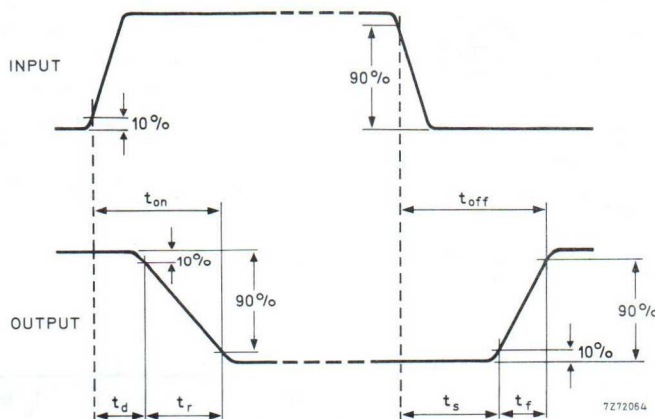


Fig. 4 Switching times waveform.

\* Measured under pulsed conditions.

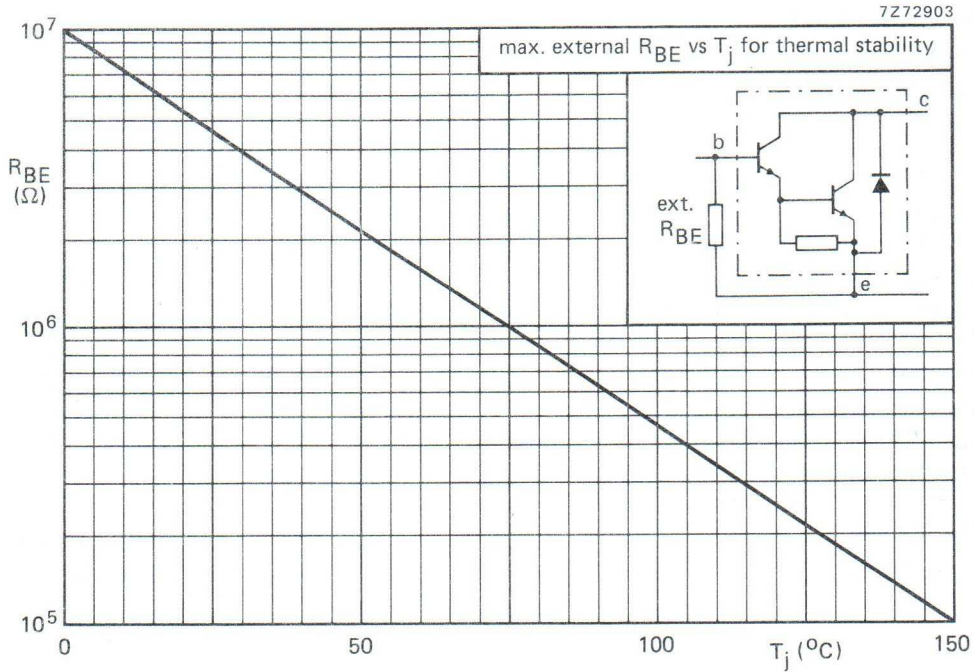


Fig. 5 Maximum values external  $R_{BE}$  as a function of junction temperature.

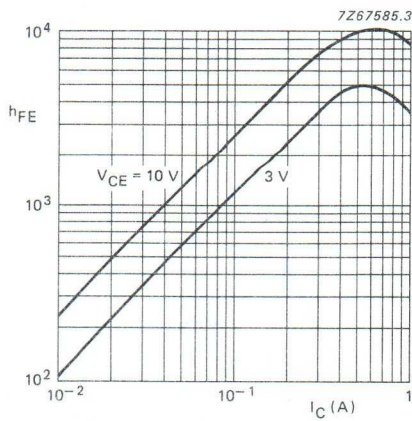


Fig. 6  $T_j = 25^{\circ}\text{C}$ .

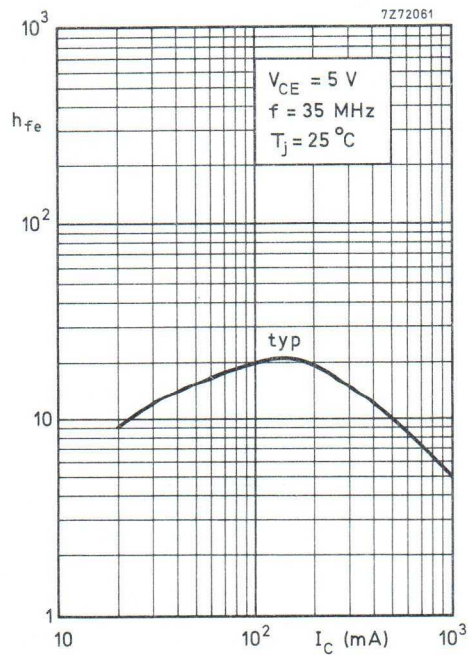


Fig. 7.

## P-N-P SILICON PLANAR DARLINGTON TRANSISTORS

Silicon p-n-p planar Darlington transistors for industrial switching applications, e.g. print hammer, solenoid, relay and lamp driving. Encapsulated in a microminiature plastic SOT-89 envelope.

N-P-N complements are BST50, BST51 and BST52 respectively.

### QUICK REFERENCE DATA

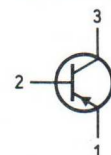
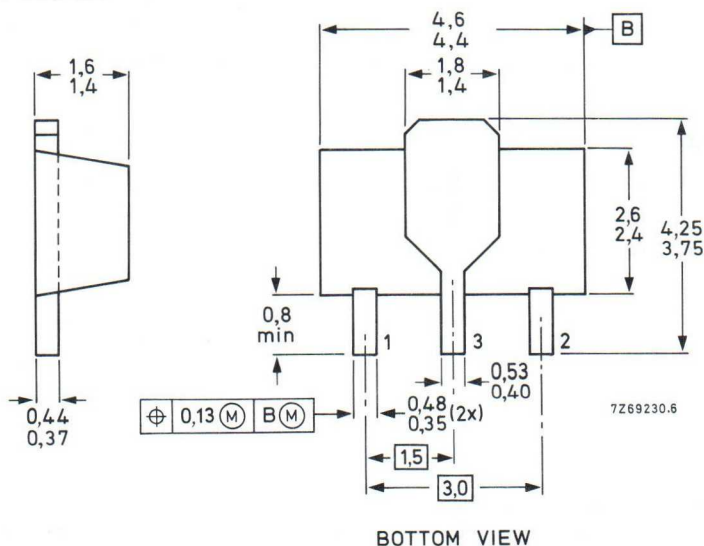
|                                                                                     |              |      | BST60 | BST61 | BST62 |    |
|-------------------------------------------------------------------------------------|--------------|------|-------|-------|-------|----|
| Collector-base voltage (open emitter)                                               | $-V_{CBO}$   | max. | 60    | 80    | 90    | V  |
| Collector-emitter voltage                                                           | $-V_{CER}$   | max. | 45    | 60    | 80    | V  |
| Collector current                                                                   | $-I_C$       | max. | 0,5   | 0,5   | 0,5   | A  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$             | $P_{tot}$    | max. | 1     |       |       | W  |
| D.C. current gain<br>$-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$                  | $h_{FE}$     | >    | 2000  |       |       |    |
| Collector-emitter saturation voltage<br>$-I_C = 0,5\text{ A}; -I_B = 0,5\text{ mA}$ | $-V_{CEsat}$ | <    | 1,3   |       |       | V  |
| Turn-off time<br>$-I_C = 500\text{ mA}; -I_{Bon} = I_{Boff} = 0,5\text{ mA}$        | $t_{off}$    | typ. | 1500  |       |       | ns |

### MECHANICAL DATA

Dimensions in mm

Marking code

Fig. 1 SOT-89.



See also *Soldering recommendations*.

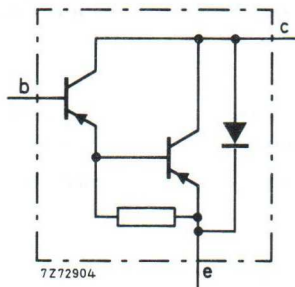


Fig. 2 Circuit diagram.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      | BST60           | BST61 | BST62 |                    |
|---------------------------------------------------------------------------|------------|------|-----------------|-------|-------|--------------------|
| Collector-base voltage (open emitter)                                     | $-V_{CBO}$ | max. | 60              | 80    | 90    | V                  |
| Collector-emitter voltage*                                                | $-V_{CER}$ | max. | 45              | 60    | 80    | V                  |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 5               |       |       | V                  |
| Collector current (d.c.)                                                  | $-I_C$     | max. | 0,5             |       |       | A                  |
| Collector current (peak)                                                  | $-I_{CM}$  | max. | 1,5             |       |       | A                  |
| Base current (d.c.)                                                       | $-I_B$     | max. | 0,1             |       |       | A                  |
| Total power dissipation ▲<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 1               |       |       | W                  |
| Storage temperature                                                       | $T_{stg}$  |      | $-65$ to $+150$ |       |       | $^{\circ}\text{C}$ |
| Junction temperature **                                                   | $T_j$      | max. | 150             |       |       | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE \*\*

|                            |                 |   |     |     |
|----------------------------|-----------------|---|-----|-----|
| From junction to ambient ▲ | $R_{th\ j-a}$   | = | 125 | K/W |
| From junction to tab       | $R_{th\ j-tab}$ | = | 10  | K/W |

\* External  $R_{BE}$  not to exceed value shown in Fig. 5.

\*\* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

▲ Device mounted on a ceramic substrate area  $2,5\text{ cm}^2$ , thickness =  $0,7\text{ mm}$ .



## CHARACTERISTICS

 $T_j = 25^\circ\text{C}$  unless otherwise specified

Collector cut-off current

$V_{BE} = 0; -V_{CE} = -V_{CE\text{max}}$

$-I_{CES} < 10\ \mu\text{A}$

Emitter cut-off current

$I_C = 0; V_{EB} = 4\ \text{V}$

$-I_{EBO} < 10\ \mu\text{A}$

D.C. current gain\*

$-I_C = 150\ \text{mA}; -V_{CE} = 10\ \text{V}$

$h_{FE} > 1000$

$-I_C = 500\ \text{mA}; -V_{CE} = 10\ \text{V}$

$h_{FE} > 2000$

Collector-emitter saturation voltage

$-I_C = 500\ \text{mA}; -I_B = 0,5\ \text{mA}$

$-V_{CE\text{sat}} < 1,3\ \text{V}$

$-I_C = 500\ \text{mA}; -I_B = 0,5\ \text{mA}; T_j = 150^\circ\text{C}$

$-V_{CE\text{sat}} < 1,3\ \text{V}$

Base-emitter saturation voltage

$-I_C = 500\ \text{mA}; -I_B = 0,5\ \text{mA}$

$-V_{BE\text{sat}} < 1,9\ \text{V}$

Switching times (see also Fig. 3 and Fig. 4)

$-I_C = 500\ \text{mA}; -I_{B\text{on}} = -I_{B\text{off}} = 0,5\ \text{mA}$

Turn-on time

$t_{\text{on}} \text{ typ. } 400\ \text{ns}$

Turn-off time

$t_{\text{off}} \text{ typ. } 1500\ \text{ns}$

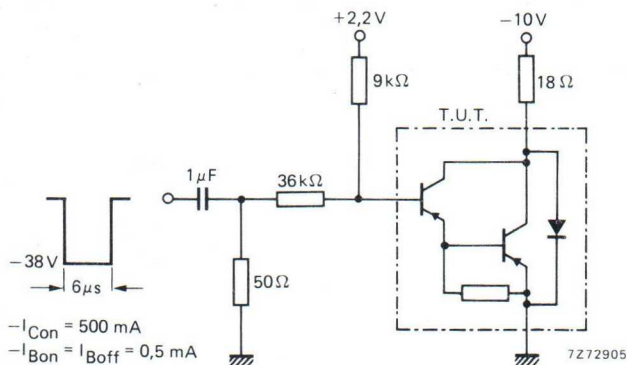


Fig. 3 Switching times test circuit.

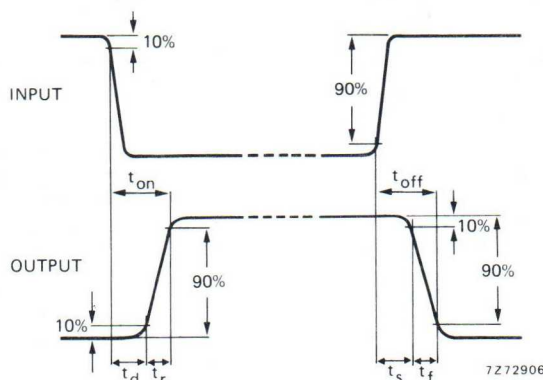


Fig. 4 Switching times waveform.

\* Measured under pulsed conditions.

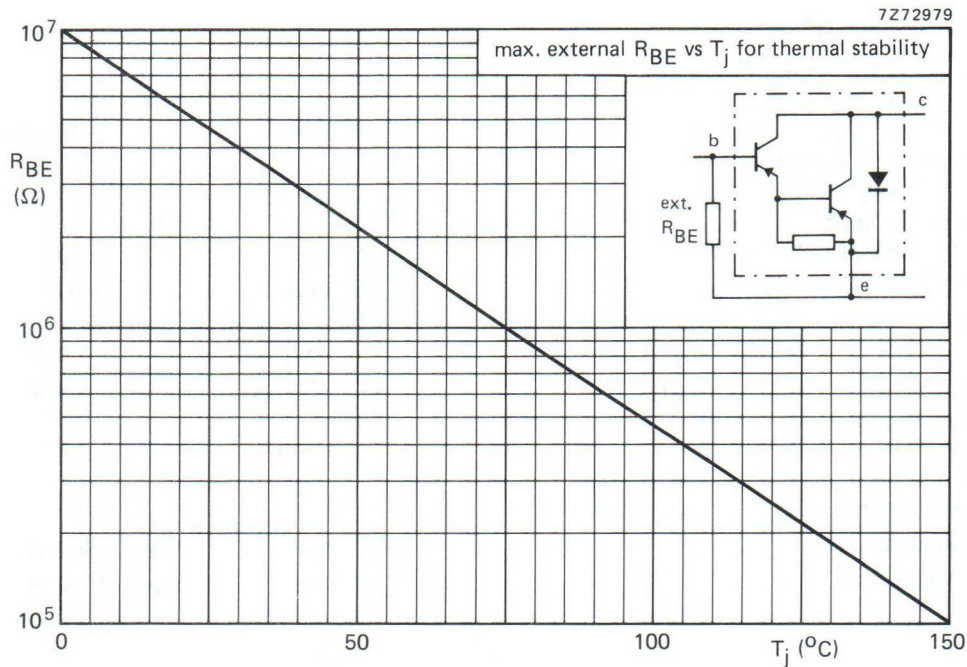


Fig. 5 Maximum values external  $R_{BE}$  as a function of junction temperature.

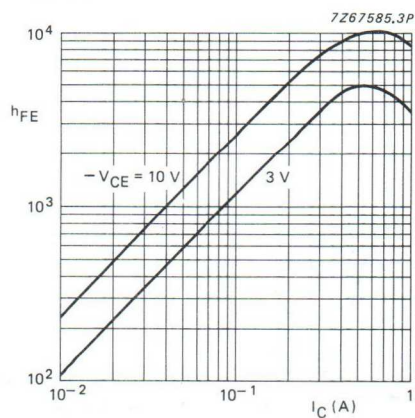


Fig. 6  $T_j = 25^{\circ}\text{C}$ .

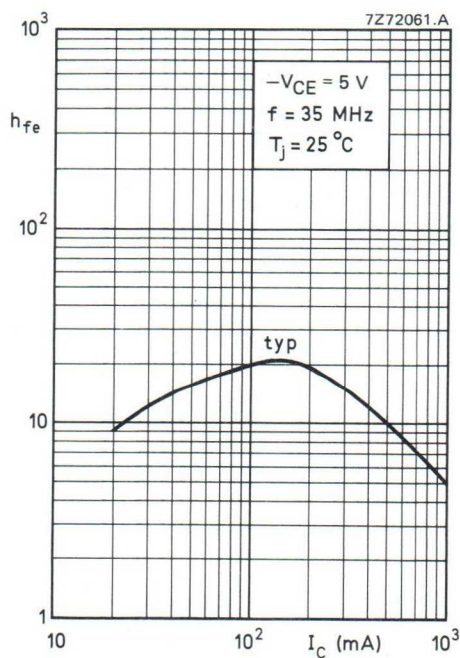


Fig. 7.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in SOT89 envelope and designed for use as Surface Mounted Device (SMD) in thin and thick-film circuits for application with relay, high-speed and line-transformer drivers.

### Features

- Low  $R_{DS\ on}$
- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No second breakdown

### QUICK REFERENCE DATA

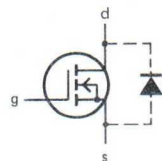
|                                                                           |               |              |                              |
|---------------------------------------------------------------------------|---------------|--------------|------------------------------|
| Drain-source voltage                                                      | $V_{DS}$      | max.         | 80 V                         |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$ | max.         | 20 V                         |
| Drain current (DC)                                                        | $I_D$         | max.         | 0.5 A                        |
| Total power dissipation up to $T_{amb} = 25\ ^\circ\text{C}$              | $P_{tot}$     | max.         | 1 W                          |
| Drain-source ON-resistance<br>$I_D = 500\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DSon}$    | typ.<br>max. | 2.0 $\Omega$<br>4.0 $\Omega$ |
| Transfer admittance<br>$I_D = 500\text{ mA}; V_{DS} = 15\text{ V}$        | $ y_{fs} $    | typ.         | 300 mS                       |

### MECHANICAL DATA

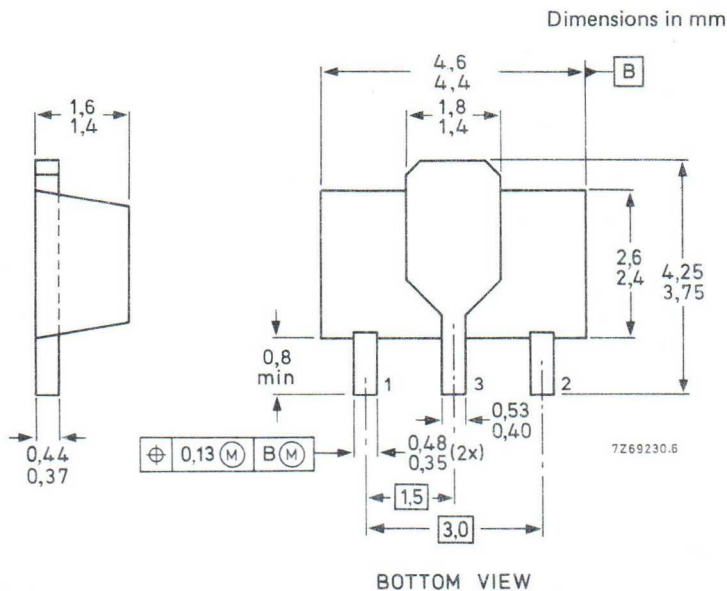
Fig.1 SOT89.

#### Pinning

- 1 = source  
2 = gate  
3 = drain



Marking: KM



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |              |                        |
|-------------------------------------------------------------------------------|---------------|--------------|------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max.         | 80 V                   |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max.         | 20 V                   |
| Drain current (DC)                                                            | $I_D$         | max.         | 0.5 A                  |
| Drain current (peak)                                                          | $I_{DM}$      | max.         | 1.0 A                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max.         | 1 W                    |
| Storage temperature range                                                     | $T_{stg}$     | —65 to + 150 | $^{\circ}\text{C}$     |
| Junction temperature                                                          | $T_j$         | max.         | 150 $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 125 K/W |
|-----------------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                     |                       |              |                              |
|---------------------------------------------------------------------------------------------------------------------|-----------------------|--------------|------------------------------|
| Drain-source breakdown voltage<br>$I_D = 100\text{ }\mu\text{A}; V_{GS} = 0$                                        | $V_{(BR)DSS}$         | min.         | 80 V                         |
| Drain-source leakage current<br>$V_{DS} = 60\text{ V}; V_{GS} = 0$                                                  | $I_{DSS}$             | max.         | 10 $\mu\text{A}$             |
| Gate-source leakage current<br>$V_{GS} = 20\text{ V}; V_{DS} = 0$                                                   | $I_{GSS}$             | max.         | 100 nA                       |
| Gate threshold voltage<br>$I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                      | $V_{GS(th)}$          | min.<br>max. | 1.5 V<br>3.5 V               |
| Drain-source ON-resistance<br>$I_D = 500\text{ mA}; V_{GS} = 10\text{ V}$                                           | $R_{DSon}$            | typ.<br>max. | 2.0 $\Omega$<br>4.0 $\Omega$ |
| Transfer admittance<br>$I_D = 500\text{ mA}; V_{DS} = 15\text{ V}$                                                  | $ y_{fs} $            | typ.         | 300 mS                       |
| Input capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                       | $C_{iss}$             | typ.<br>max. | 45 pF<br>60 pF               |
| Output capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                      | $C_{oss}$             | typ.<br>max. | 30 pF<br>45 pF               |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                    | $C_{rss}$             | typ.<br>max. | 8 pF<br>12 pF                |
| Switching times (see Figs 2 and 3)<br>$I_D = 500\text{ mA}; V_{DD} = 50\text{ V}; V_{GS} = 0\text{ to }10\text{ V}$ | $t_{on}$<br>$t_{off}$ | max.<br>max. | 10 ns<br>15 ns               |

## Note

1. Transistors mounted on a substrate with surface area of 2.5 cm<sup>2</sup> and thickness of 0.7 mm.

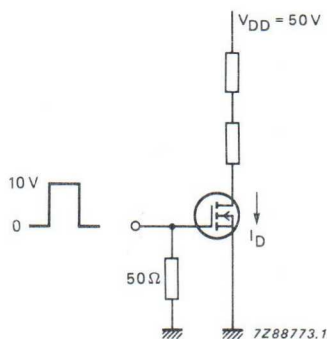


Fig.2 Switching times test circuit.

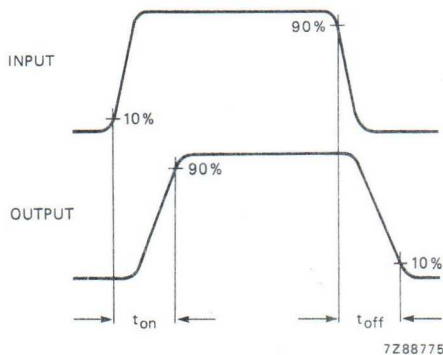


Fig.3 Input and output waveforms.

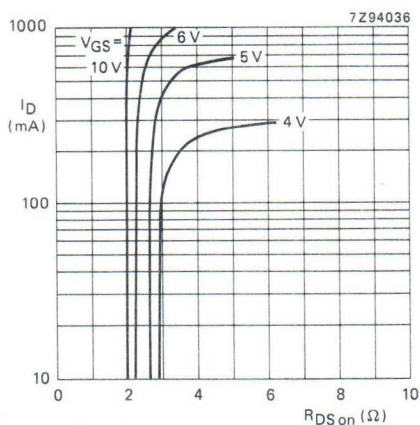
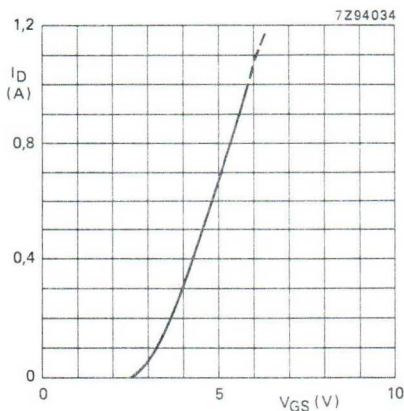
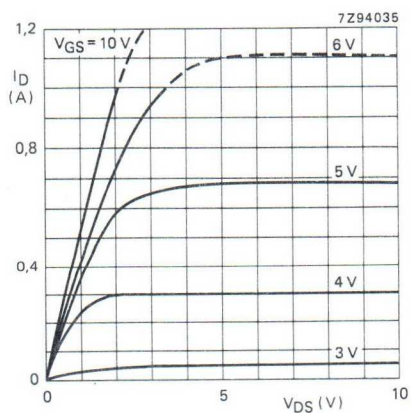
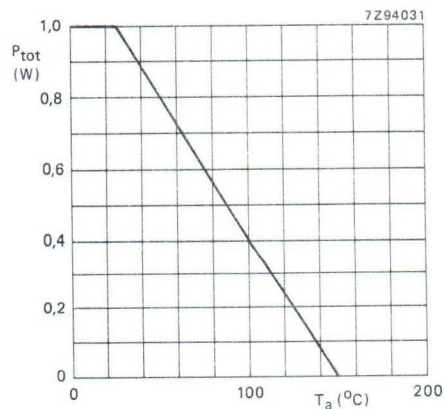
Fig.4  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.Fig.5  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values at  $V_{DS} = 10\text{ V}$ .Fig.6  $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.

Fig.7 Power derating curve.



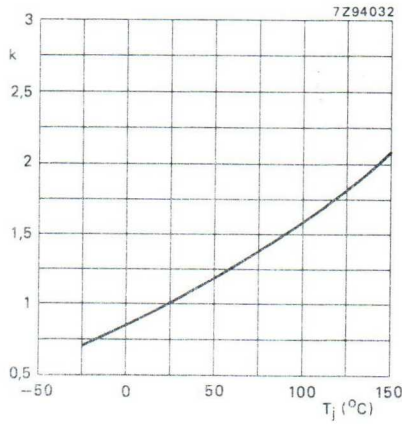


Fig. 8  $k = \frac{R_{DS\ on\ at\ T_j}}{R_{DS\ on\ at\ 25\ ^\circ C}}$ ; typ. values.  
at 500 mA/10 V.

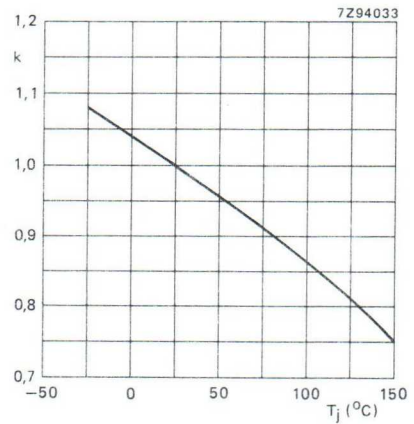


Fig. 9  $k = \frac{V_{GS(th)\ at\ T_j}}{V_{GS(th)\ at\ 25\ ^\circ C}}$ ;  $V_{GS(th)}$  at 1 mA;  
typical values.

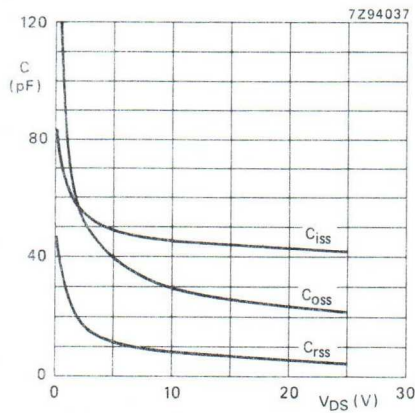


Fig. 10  $T_j = 25\ ^\circ C$ ;  $V_{GS} = 0$ ;  $f = 1\ MHz$ ; typical values.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in SOT23 envelope and designed for use as Surface Mounted Device (SMD) in thin and thick-film circuits for telephone ringer and for application with relay, high-speed and line transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No second breakdown
- Low  $R_{DS\ on}$

### QUICK REFERENCE DATA

|                                                              |               |              |                           |
|--------------------------------------------------------------|---------------|--------------|---------------------------|
| Drain-source voltage                                         | $V_{DS}$      | max.         | 80 V                      |
| Drain-source voltage (non-repetitive peak; $t_p \leq 2$ ms)  | $V_{DS(SM)}$  | max.         | 100 V                     |
| Gate-source voltage (open drain)                             | $\pm V_{GSO}$ | max.         | 20 V                      |
| Drain current (DC)                                           | $I_D$         | max.         | 175 mA                    |
| Total power dissipation up to $T_{amb} = 25^\circ C$         | $P_{tot}$     | max.         | 300 mW                    |
| Drain-source ON-resistance<br>$I_D = 150$ mA; $V_{GS} = 5$ V | $R_{DSon}$    | typ.<br>max. | 7 $\Omega$<br>10 $\Omega$ |
| Transfer admittance<br>$I_D = 175$ mA; $V_{DS} = 5$ V        | $ y_{fs} $    | typ.         | 150 mS                    |

### MECHANICAL DATA

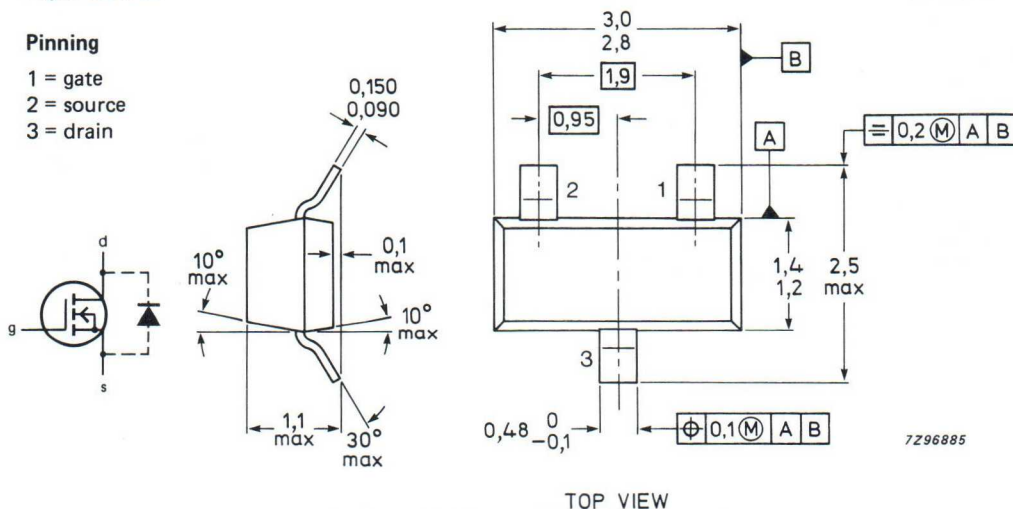
Fig.1 SOT23.

Dimensions in mm

Marking: 02p

#### Pinning

- 1 = gate  
2 = source  
3 = drain



7Z96885

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                             |               |      |                 |
|-------------------------------------------------------------|---------------|------|-----------------|
| Drain-source voltage                                        | $V_{DS}$      | max. | 80 V            |
| Drain-source voltage (non-repetitive peak; $t_p \leq 2$ ms) | $V_{DS(SM)}$  | max. | 100 V           |
| Gate-source voltage (open drain)                            | $\pm V_{GSO}$ | max. | 20 V            |
| Drain current (DC)                                          | $I_D$         | max. | 175 mA          |
| Drain current (peak)                                        | $I_{DM}$      | max. | 600 mA          |
| Total power dissipation up to $T_{amb} = 25$ °C (note 1)    | $P_{tot}$     | max. | 300 mW          |
| Storage temperature range                                   | $T_{stg}$     |      | -65 to + 150 °C |
| Junction temperature                                        | $T_j$         | max. | 150 °C          |

## THERMAL RESISTANCE

From junction to ambient (note 1)

|               |   |         |
|---------------|---|---------|
| $R_{th\ j-a}$ | = | 430 K/W |
|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25$  °C unless otherwise specified

Drain-source breakdown voltage

$I_D = 100$   $\mu$ A;  $V_{GS} = 0$

|               |      |      |
|---------------|------|------|
| $V_{(BR)DSS}$ | min. | 80 V |
|---------------|------|------|

Drain-source leakage current

$V_{DS} = 60$  V;  $V_{GS} = 0$

|           |      |             |
|-----------|------|-------------|
| $I_{DSS}$ | max. | 1.0 $\mu$ A |
|-----------|------|-------------|

Gate-source leakage current

$V_{GS} = 20$  V;  $V_{DS} = 0$

|           |      |        |
|-----------|------|--------|
| $I_{GSS}$ | max. | 100 nA |
|-----------|------|--------|

Gate-source cut-off voltage

$I_D = 1$  mA;  $V_{DS} = V_{GS}$

|             |      |       |
|-------------|------|-------|
| $V_{(P)GS}$ | min. | 1.5 V |
|             | max. | 3.5 V |

Drain-source ON-resistance

$I_D = 150$  mA;  $V_{GS} = 5$  V

|            |      |             |
|------------|------|-------------|
| $R_{DSon}$ | typ. | 7 $\Omega$  |
|            | max. | 10 $\Omega$ |

Transfer admittance

$I_D = 175$  mA;  $V_{DS} = 5$  V

|            |      |        |
|------------|------|--------|
| $ y_{fs} $ | typ. | 150 mS |
|------------|------|--------|

Input capacitance at  $f = 1$  MHz

$V_{DS} = 10$  V;  $V_{GS} = 0$

|           |      |       |
|-----------|------|-------|
| $C_{iss}$ | typ. | 15 pF |
|           | max. | 30 pF |

Output capacitance at  $f = 1$  MHz

$V_{DS} = 10$  V;  $V_{GS} = 0$

|           |      |       |
|-----------|------|-------|
| $C_{oss}$ | typ. | 13 pF |
|           | max. | 20 pF |

Feedback capacitance at  $f = 1$  MHz

$V_{DS} = 10$  V;  $V_{GS} = 0$

|           |      |      |
|-----------|------|------|
| $C_{rss}$ | typ. | 3 pF |
|           | max. | 6 pF |

Switching times (see Figs 2 and 3)

$I_D = 175$  mA;  $V_{DD} = 50$  V;  $V_{GS} = 0$  to 10 V

|           |      |       |
|-----------|------|-------|
| $t_{on}$  | typ. | 4 ns  |
|           | max. | 10 ns |
| $t_{off}$ | typ. | 4 ns  |
|           | max. | 10 ns |

## Note

1. Transistors mounted on a ceramic substrate of 7 mm x 5 mm x 0.7 mm.

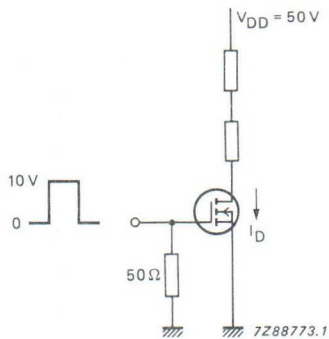


Fig.2 Switching times test circuit.

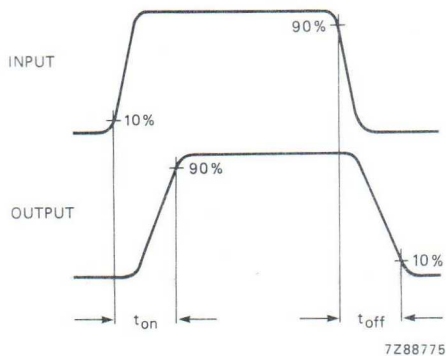


Fig.3 Input and output waveforms.

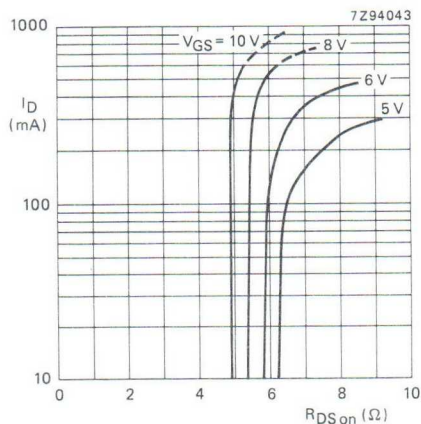
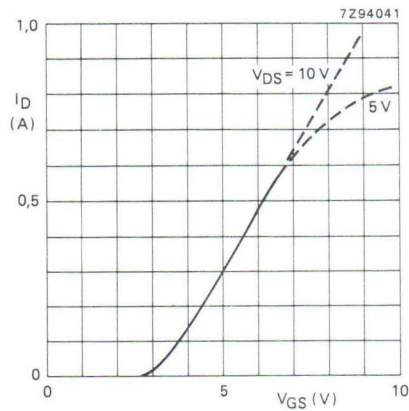
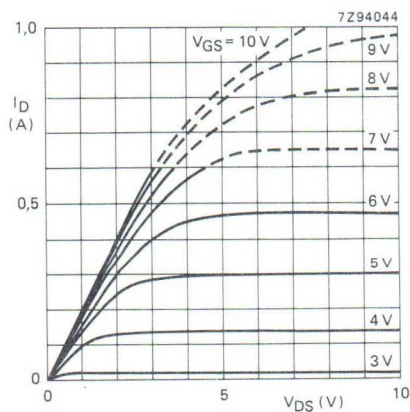
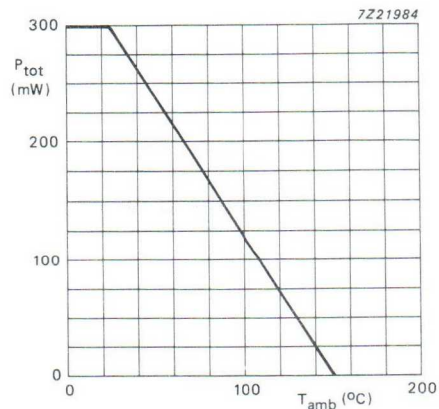
Fig.4  $T_j = 25^\circ\text{C}$ ; typical values.Fig.5  $T_j = 25^\circ\text{C}$ ; typical values.Fig.6  $T_j = 25^\circ\text{C}$ ; typical values.

Fig.7 Power derating curve.

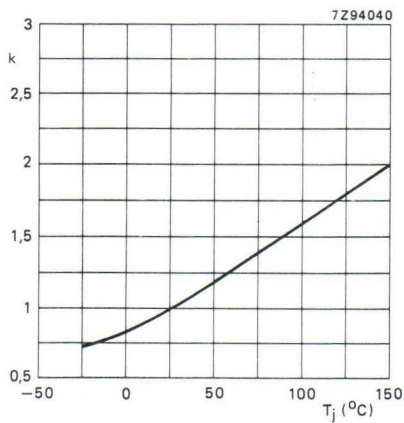


Fig. 8  $k = \frac{R_{DS\text{ on at } T_j}}{R_{DS\text{ on at } 25^\circ\text{C}}}$ ; typ. values at 150 mA/5 V.

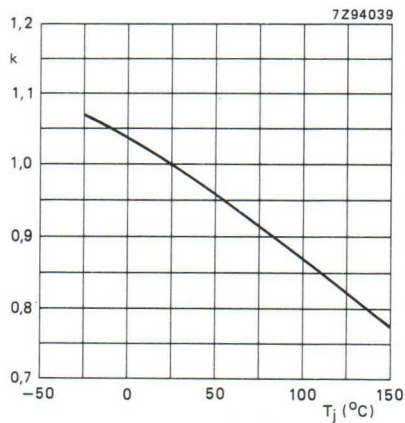


Fig. 9  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^\circ\text{C}}$ ;  $V_{GS(th)}$  at 1 mA; typical values.

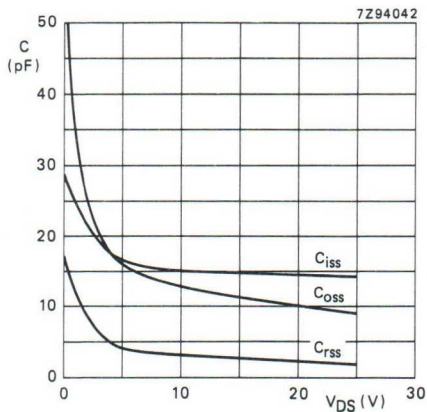


Fig. 10  $T_j = 25^\circ\text{C}$ ;  $V_{GS} = 0$ ;  $f = 1\text{ MHz}$ ; typical values.



## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel vertical D-MOS transistor in SOT89 envelope and designed for use as line current interrupter in telephone sets and for application in relay, high-speed and line-transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No second breakdown

### QUICK REFERENCE DATA

|                                                                           |               |              |                           |
|---------------------------------------------------------------------------|---------------|--------------|---------------------------|
| Drain-source voltage                                                      | $V_{DS}$      | max.         | 200 V                     |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$ | max.         | 20 V                      |
| Drain current (DC)                                                        | $I_D$         | max.         | 250 mA                    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$      | $P_{tot}$     | max.         | 1 W                       |
| Drain-source ON-resistance<br>$I_D = 250\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DSon}$    | typ.<br>max. | 6 $\Omega$<br>12 $\Omega$ |
| Transfer admittance<br>$I_D = 250\text{ mA}; V_{DS} = 15\text{ V}$        | $ y_{fs} $    | typ.         | 250 mS                    |

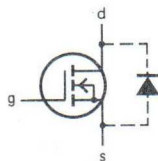
### MECHANICAL DATA

Dimensions in mm

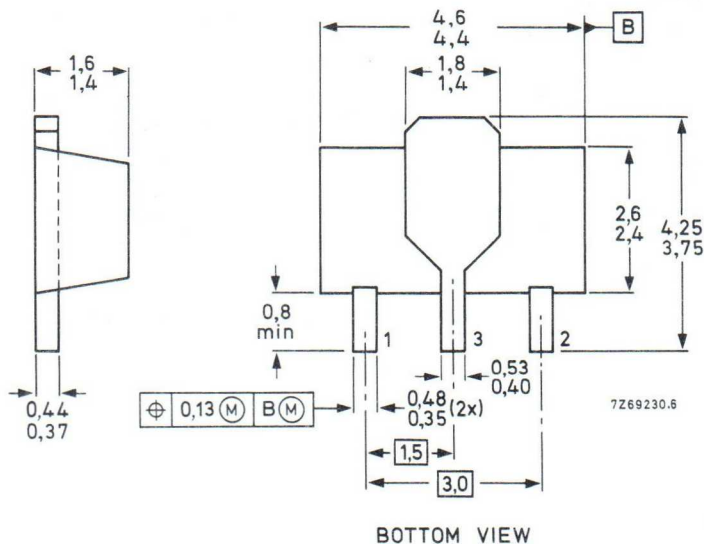
Fig. 1 SOT89.

Pinning:

- 1 = source  
2 = gate  
3 = drain



Marking: KN



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                              |
|-------------------------------------------------------------------------------|---------------|------|----------------------------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max. | 200 V                                        |
| Gate-source voltage (open drain)                                              | $\pm V_{GS0}$ | max. | 20 V                                         |
| Drain current (DC)                                                            | $I_D$         | max. | 250 mA                                       |
| Drain current (peak)                                                          | $I_{DM}$      | max. | 800 mA                                       |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1 W                                          |
| Storage temperature range                                                     | $T_{stg}$     |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | 150 $^{\circ}\text{C}$                       |

# THERMAL RESISTANCE

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 125 K/W |
|-----------------------------------|---------------|---|---------|

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                     |               |              |                           |
|---------------------------------------------------------------------------------------------------------------------|---------------|--------------|---------------------------|
| Drain-source breakdown voltage<br>$I_D = 100\text{ }\mu\text{A}; V_{GS} = 0$                                        | $V_{(BR)DSS}$ | min.         | 200 V                     |
| Drain-source leakage current<br>$V_{DS} = 160\text{ V}; V_{GS} = 0$                                                 | $I_{DSS}$     | max.         | 10 $\mu\text{A}$          |
| Gate-source leakage current<br>$V_{GS} = 20\text{ V}; V_{DS} = 0$                                                   | $I_{GSS}$     | max.         | 100 nA                    |
| Gate threshold voltage<br>$I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                      | $V_{GS(th)}$  | min.<br>max. | 0.8 V<br>2.8 V            |
| Drain-source ON-resistance<br>$I_D = 250\text{ mA}; V_{GS} = 10\text{ V}$                                           | $R_{DSon}$    | typ.<br>max. | 6 $\Omega$<br>12 $\Omega$ |
| Transfer admittance<br>$I_D = 250\text{ mA}; V_{DS} = 15\text{ V}$                                                  | $ y_{fs} $    | typ.         | 250 mS                    |
| Input capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                       | $C_{iss}$     | typ.<br>max. | 70 pF<br>90 pF            |
| Output capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                      | $C_{oss}$     | typ.<br>max. | 20 pF<br>30 pF            |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$V_{DS} = 10\text{ V}; V_{GS} = 0$                                    | $C_{rss}$     | typ.<br>max. | 5 pF<br>10 pF             |
| Switching times (see Figs 2 and 3)<br>$I_D = 250\text{ mA}; V_{DD} = 50\text{ V}; V_{GS} = 0\text{ to }10\text{ V}$ | $t_{on}$      | typ.<br>max. | 4 ns<br>10 ns             |
|                                                                                                                     | $t_{off}$     | typ.<br>max. | 15 ns<br>25 ns            |

# Note

1. Transistor mounted on a ceramic substrate with area of  $2.5\text{ cm}^2$  and thickness of 0.7 mm.

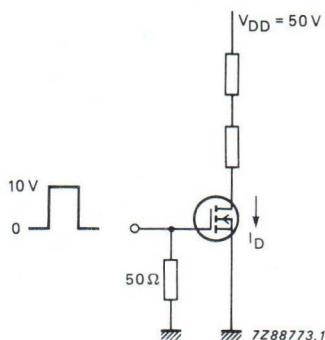


Fig. 2 Switching times test circuit.

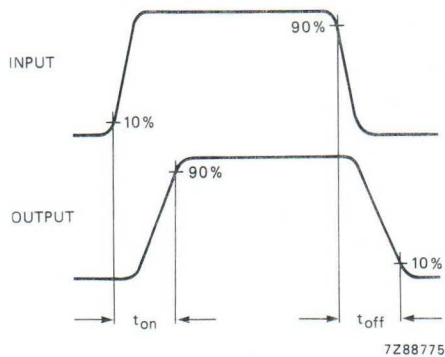


Fig. 3 Input and output waveforms.

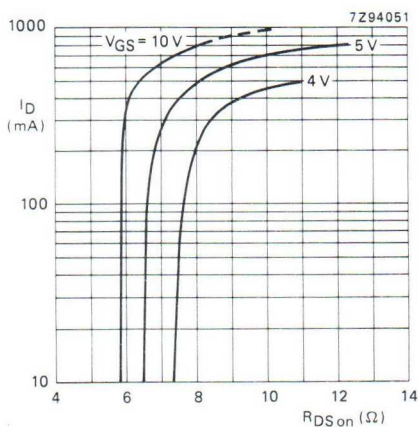
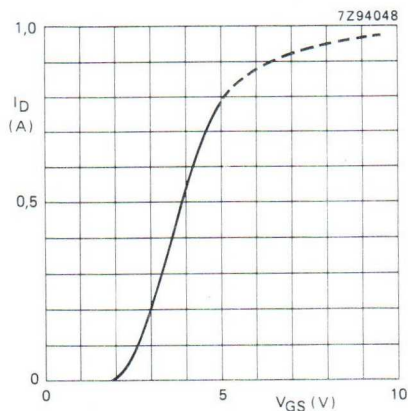
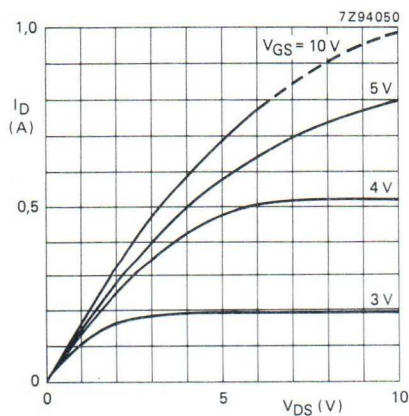
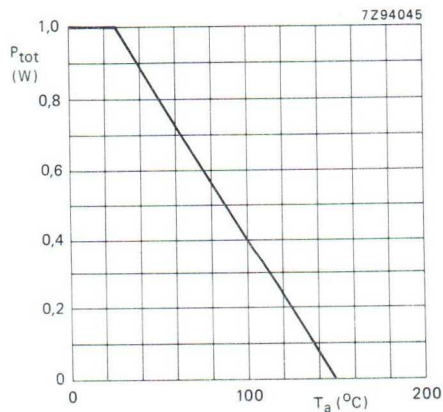
Fig. 4  $T_j = 25^\circ\text{C}$ ; typical values.Fig. 5  $T_j = 25^\circ\text{C}$ ;  $V_{DS} = 10\text{ V}$ ; typical values.Fig. 6  $T_j = 25^\circ\text{C}$ ; typical values.

Fig. 7 Power derating curve.

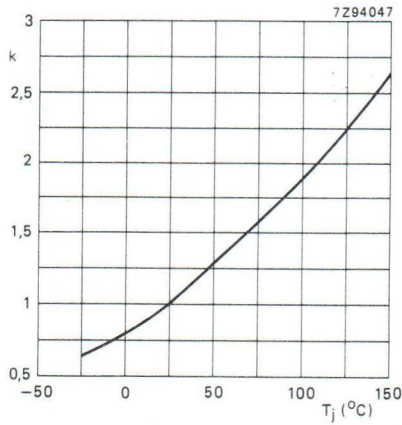


Fig. 8  $k = \frac{R_{DS\ on\ at\ T_j}}{R_{DS\ on\ at\ 25\ ^\circ C}}$ ; at 400 mA/10 V;  
typical values.

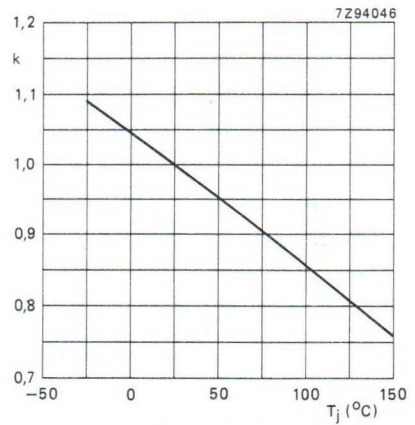


Fig. 9  $k = \frac{V_{GS(th)\ at\ T_j}}{V_{GS(th)\ at\ 25\ ^\circ C}}$ ;  $V_{GS(th)}$  at 1 mA;  
typical values.

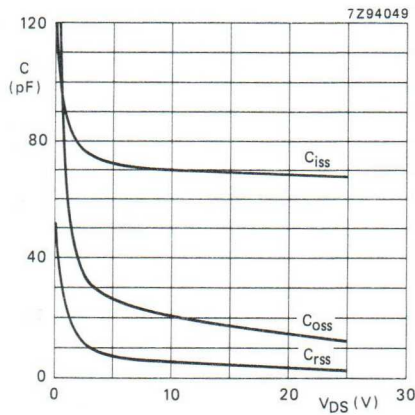


Fig. 10  $T_j = 25\ ^\circ C$ ;  $V_{GS} = 0$ ;  $f = 1\ MHz$ ; typical values.

## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in SOT89 envelope and designed for use as Surface Mounted Device (SMD) in thin and thick-film circuits for application with relay, high-speed and line-transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No second breakdown

### QUICK REFERENCE DATA

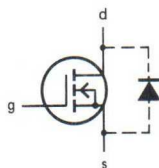
|                                                             |               |              |                           |
|-------------------------------------------------------------|---------------|--------------|---------------------------|
| Drain-source voltage                                        | $V_{DS}$      | max.         | 180 V                     |
| Drain-source voltage (non-repetitive peak; $t_p \leq 2$ ms) | $V_{DS(SM)}$  | max.         | 200 V                     |
| Gate-source voltage (open drain)                            | $\pm V_{GSO}$ | max.         | 20 V                      |
| Drain current (DC)                                          | $I_D$         | max.         | 300 mA                    |
| Total power dissipation up to $T_{amb} = 25$ °C             | $P_{tot}$     | max.         | 1 W                       |
| Drain-source ON-resistance<br>$I_D = 15$ mA; $V_{GS} = 3$ V | $R_{DS(on)}$  | typ.<br>max. | 7 $\Omega$<br>10 $\Omega$ |
| Transfer admittance<br>$I_D = 300$ mA; $V_{DS} = 15$ V      | $ y_{fs} $    | typ.         | 250 mS                    |

### MECHANICAL DATA

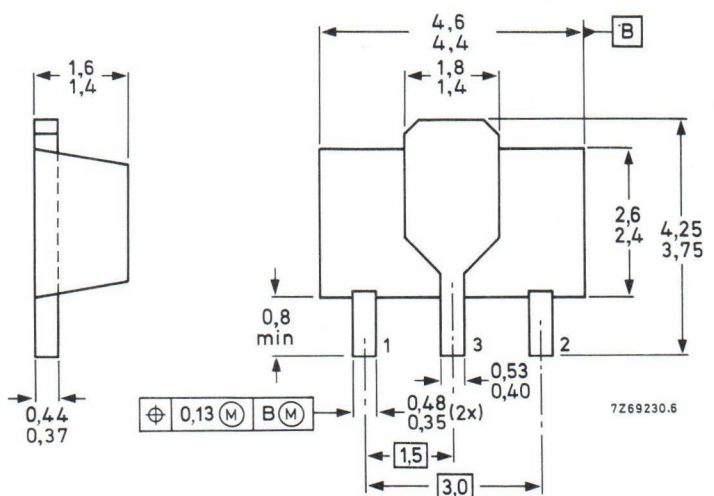
Fig.1 SOT89.

#### Pinning

- 1 = source  
2 = gate  
3 = drain



Marking: K0



BOTTOM VIEW



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                             |               |              |        |
|-------------------------------------------------------------|---------------|--------------|--------|
| Drain-source voltage                                        | $V_{DS}$      | max.         | 180 V  |
| Drain-source voltage (non-repetitive peak; $t_p \leq 2$ ms) | $V_{DS(SM)}$  | max.         | 200 V  |
| Gate-source voltage (open drain)                            | $\pm V_{GSO}$ | max.         | 20 V   |
| Drain current (DC)                                          | $I_D$         | max.         | 300 mA |
| Drain current (peak)                                        | $I_{DM}$      | max.         | 800 mA |
| Total power dissipation up to $T_{amb} = 25$ °C (note 1)    | $P_{tot}$     | max.         | 1 W    |
| Storage temperature range                                   | $T_{stg}$     | –65 to + 150 | °C     |
| Junction temperature                                        | $T_j$         | max.         | 150 °C |

## THERMAL RESISTANCE

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 125 K/W |
|-----------------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25$  °C unless otherwise specified

|                                                                                             |                       |              |                           |
|---------------------------------------------------------------------------------------------|-----------------------|--------------|---------------------------|
| Drain-source breakdown voltage<br>$I_D = 100$ $\mu$ A; $V_{GS} = 0$                         | $V_{(BR)DSS}$         | min.         | 180 V                     |
| Drain-source leakage current<br>$V_{DS} = 120$ V; $V_{GS} = 0$                              | $I_{DSS}$             | max.         | 10 $\mu$ A                |
| Gate-source leakage current<br>$V_{GS} = 20$ V; $V_{DS} = 0$                                | $I_{GSS}$             | max.         | 100 nA                    |
| Gate threshold voltage<br>$I_D = 100$ $\mu$ A; $V_{DS} = V_{GS}$                            | $V_{GS(th)}$          | min.<br>max. | 0.7 V<br>2.7 V            |
| Drain-source ON-resistance<br>$I_D = 15$ mA; $V_{GS} = 3$ V                                 | $R_{DSon}$            | typ.<br>max. | 7 $\Omega$<br>10 $\Omega$ |
| $I_D = 300$ mA; $V_{GS} = 10$ V                                                             | $R_{DSon}$            | typ.         | 6 $\Omega$                |
| Transfer admittance<br>$I_D = 300$ mA; $V_{DS} = 15$ V                                      | $ y_{fs} $            | typ.         | 250 mS                    |
| Input capacitance at $f = 1$ MHz<br>$V_{DS} = 10$ V; $V_{GS} = 0$                           | $C_{iss}$             | typ.<br>max. | 50 pF<br>65 pF            |
| Output capacitance at $f = 1$ MHz<br>$V_{DS} = 10$ V; $V_{GS} = 0$                          | $C_{oss}$             | typ.<br>max. | 20 pF<br>30 pF            |
| Feedback capacitance at $f = 1$ MHz<br>$V_{DS} = 10$ V; $V_{GS} = 0$                        | $C_{rss}$             | typ.<br>max. | 6 pF<br>10 pF             |
| Switching times (see Figs 2 and 3)<br>$I_D = 300$ mA; $V_{DD} = 50$ V; $V_{GS} = 0$ to 10 V | $t_{on}$<br>$t_{off}$ | max.<br>max. | 10 ns<br>15 ns            |

1. Transistors mounted on a ceramic substrate with area of 2.5 cm<sup>2</sup> and thickness of 0.7 mm.

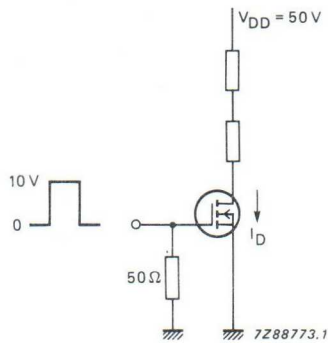


Fig.2 Switching times test circuit.

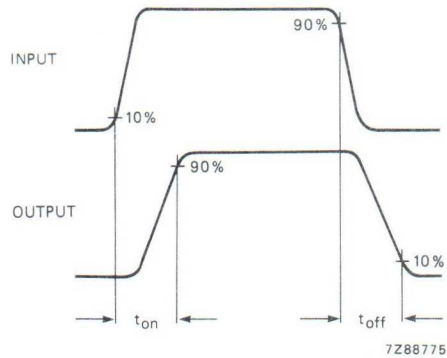


Fig.3 Input and output waveforms.

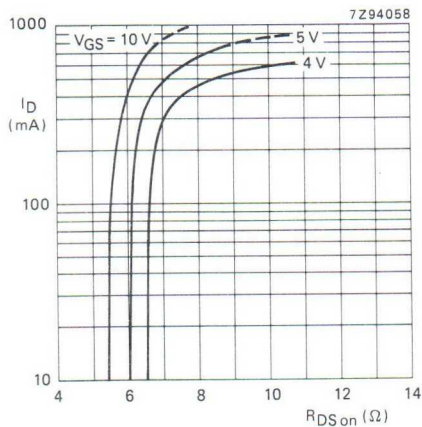
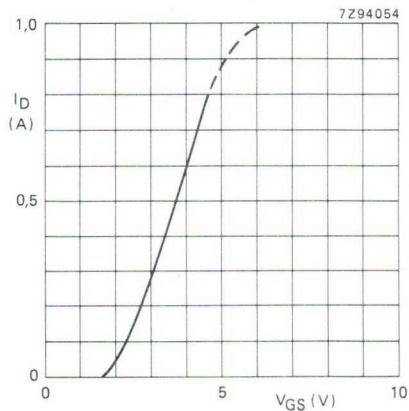
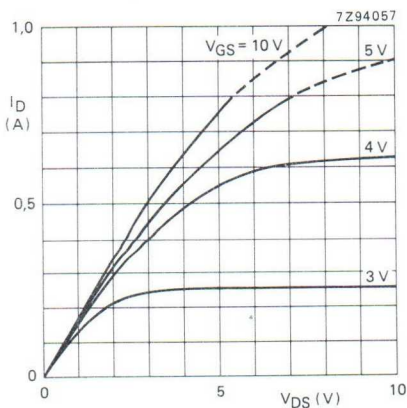
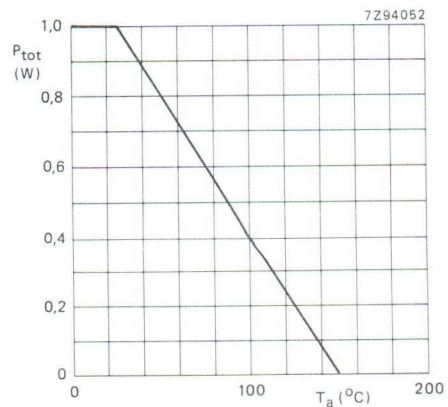
Fig.4  $T_j = 25^\circ\text{C}$ ; typical values.Fig.5  $T_j = 25^\circ\text{C}$ ;  $V_{DS} = 10\text{ V}$ ; typ. values.Fig.6  $T_j = 25^\circ\text{C}$ ; typical values.

Fig.7 Power derating curve.

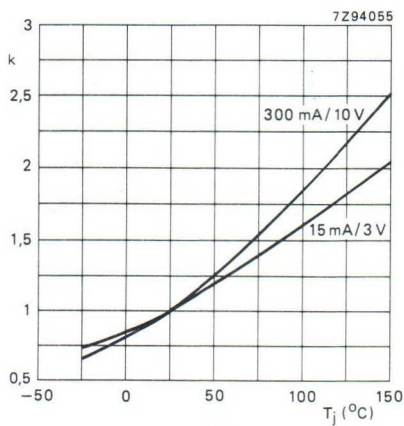


Fig.8  $k = \frac{R_{DS\ on\ at\ T_j}}{R_{DS\ on\ at\ 25\ ^\circ C}}$ ; typical values.

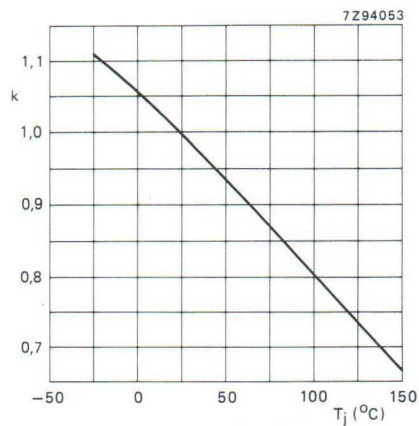


Fig.9  $k = \frac{V_{GS(th)\ at\ T_j}}{V_{GS(th)\ at\ 25\ ^\circ C}}$ ;  $V_{GS(th)}$  at 0.1 mA; typical values.

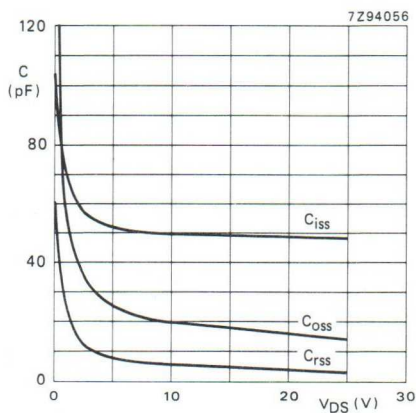


Fig.10  $T_j = 25\ ^\circ C$ ;  $V_{GS} = 0$ ;  $f = 1\ MHz$ ; typical values.

## P-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

P-channel vertical D-MOS transistor in SOT89 envelope and intended for use in relay, high-speed and line-transformer drivers, using SMD technology.

### Features

- Very low  $R_{DSon}$
- Direct interface to C-MOS
- High-speed switching
- No second breakdown

### QUICK REFERENCE DATA

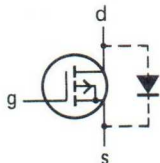
|                                                                      |               |      |              |
|----------------------------------------------------------------------|---------------|------|--------------|
| Drain-source voltage                                                 | $-V_{DS}$     | max. | 60 V         |
| Gate-source voltage (open drain)                                     | $\pm V_{GSO}$ | max. | 20 V         |
| Drain current (DC)                                                   | $-I_D$        | max. | 0,3 A        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$     | max. | 1 W          |
| Drain-source ON-resistance                                           | $R_{DSon}$    | typ. | 4,5 $\Omega$ |
| $-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$                        |               | max. | 6 $\Omega$   |
| Transfer admittance                                                  | $ y_{fs} $    | typ. | 200 mS       |
| $-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$                        |               |      |              |

### MECHANICAL DATA

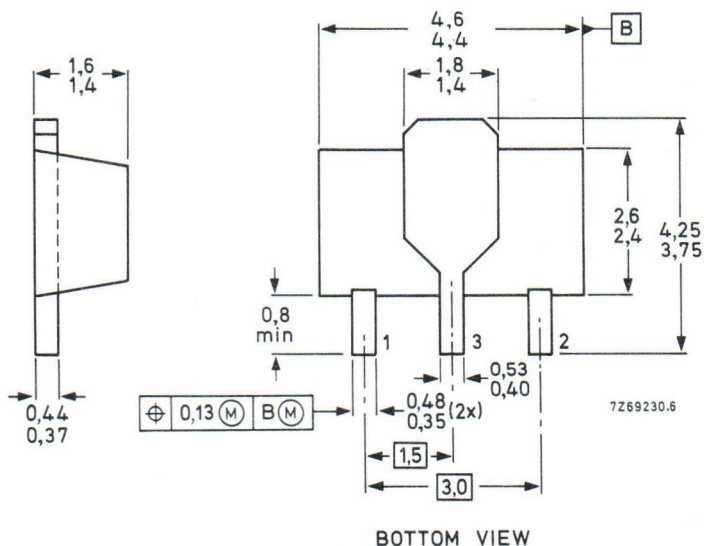
Dimensions in mm

Fig. 1 SOT89.

Pinning:  
1 = source  
2 = gate  
3 = drain



marking: LM



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                              |
|-------------------------------------------------------------------------------|---------------|------|----------------------------------------------|
| Drain-source voltage                                                          | $-V_{DS}$     | max. | 60 V                                         |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max. | 20 V                                         |
| Drain current (DC)                                                            | $-I_D$        | max. | 0.3 A                                        |
| Drain current (peak)                                                          | $-I_{DM}$     | max. | 0.8 A                                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 1 W                                          |
| Storage temperature range                                                     | $T_{stg}$     |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | $150\text{ }^{\circ}\text{C}$                |

**THERMAL RESISTANCE**

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 125 K/W |
|-----------------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                        |                       |              |                            |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------|----------------------------|
| Drain-source breakdown voltage<br>$-I_D = 100\text{ }\mu\text{A}; -V_{GS} = 0$                                         | $-V_{(BR)DSS}$        | min.         | 60 V                       |
| Drain-source leakage current<br>$-V_{DS} = 45\text{ V}; V_{GS} = 0$                                                    | $-I_{DSS}$            | max.         | $10\text{ }\mu\text{A}$    |
| Gate-source leakage current<br>$-V_{GS} = 20\text{ V}; V_{DS} = 0$                                                     | $-I_{GSS}$            | max.         | 100 nA                     |
| Gate threshold voltage<br>$-I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                        | $-V_{GS(th)}$         | min.<br>max. | 1.5 V<br>3.5 V             |
| Drain-source ON-resistance<br>$-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$                                            | $R_{DSon}$            | typ.<br>max. | 4.5 $\Omega$<br>6 $\Omega$ |
| Transfer admittance<br>$-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$                                                   | $ y_{fs} $            | typ.         | 200 mS                     |
| Input capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                         | $C_{iss}$             | typ.<br>max. | 55 pF<br>70 pF             |
| Output capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                        | $C_{oss}$             | typ.<br>max. | 30 pF<br>45 pF             |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                      | $C_{rss}$             | typ.<br>max. | 8 pF<br>12 pF              |
| Switching times (see Figs 2 and 3)<br>$-I_D = 200\text{ mA}; -V_{DD} = 50\text{ V}; -V_{GS} = 0\text{ to }10\text{ V}$ | $t_{on}$<br>$t_{off}$ | typ.<br>typ. | 4 ns<br>20 ns              |

**Note:**1. Transistor mounted on a ceramic substrate: area = 2,5 cm<sup>2</sup> and thickness = 0,7 mm.



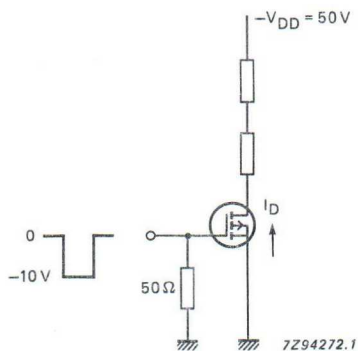


Fig.2 Switching times test circuit.

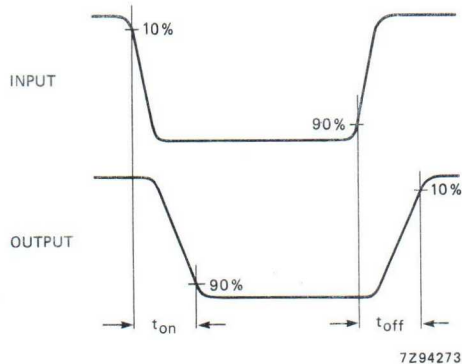
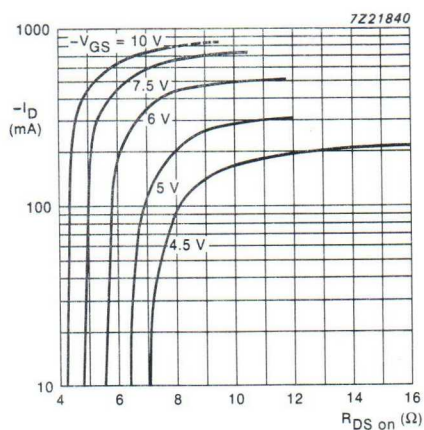
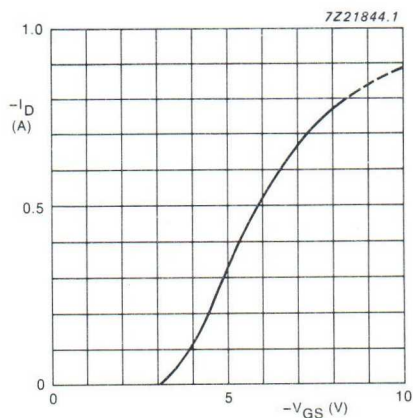
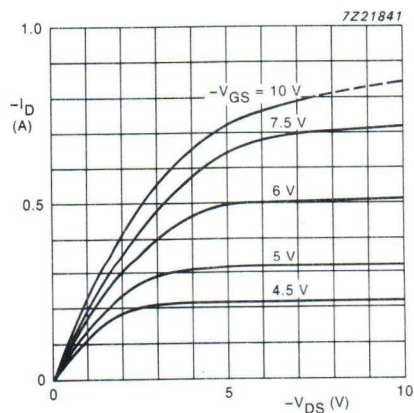


Fig.3 Input and output waveforms.

Fig.4 Drain current vs ON-resistance;  
 $T_j = 25^\circ\text{C}$ ; typical values.Fig.5 Transfer characteristics;  
 $T_j = 25^\circ\text{C}$ ;  $-V_{DS} = 10\text{ V}$ ; typical values.Fig.6 Output characteristics;  $T_j = 25^\circ\text{C}$ ; typical values.



## P-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

P-channel vertical D-MOS transistor in SOT89 envelope and intended for use in relay, high-speed and line-transformer drivers, using SMD-technology.

### Features

- Very low  $R_{DSon}$
- Direct interface to C-MOS, TTL
- High-speed switching
- No second breakdown

### QUICK REFERENCE DATA

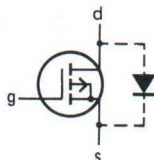
|                                                                             |               |              |                             |
|-----------------------------------------------------------------------------|---------------|--------------|-----------------------------|
| Drain-source voltage                                                        | $-V_{DS}$     | max.         | 50 V                        |
| Gate-source voltage (open drain)                                            | $\pm V_{GSO}$ | max.         | 20 V                        |
| Drain current (DC)                                                          | $-I_D$        | max.         | 0,25 A                      |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$        | $P_{tot}$     | max.         | 1 W                         |
| Drain-source ON-resistance<br>$-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$ | $R_{DSon}$    | max.<br>typ. | 10 $\Omega$<br>7.5 $\Omega$ |
| Transfer admittance<br>$-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$        | $ y_{fs} $    | typ.         | 125 mS                      |

### MECHANICAL DATA

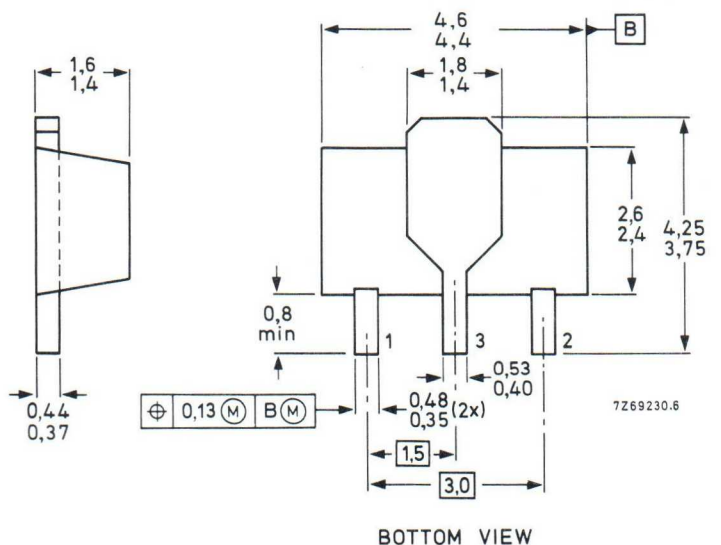
Fig. 1 SOT89.

#### Pinning:

- 1 = source  
2 = gate  
3 = drain



Marking: LN



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |               |      |                                              |
|----------------------------------------------------------------------|---------------|------|----------------------------------------------|
| Drain-source voltage                                                 | $-V_{DS}$     | max. | 50 V                                         |
| Gate-source voltage (open drain)                                     | $\pm V_{GSO}$ | max. | 20 V                                         |
| Drain current (DC)                                                   | $-I_D$        | max. | 0.25 A                                       |
| Drain current (peak)                                                 | $-I_{DM}$     | max. | 0.5 A                                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$     | max. | 1 W                                          |
| Storage temperature range                                            | $T_{stg}$     |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                 | $T_j$         | max. | 150 $^{\circ}\text{C}$                       |

**THERMAL RESISTANCE**

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 125 K/W |
|-----------------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                        |                       |               |                             |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|-----------------------------|
| Drain-source breakdown voltage<br>$-I_D = 100\text{ }\mu\text{A}; -V_{GS} = 0$                                         | $-V_{(BR)DSS}$        | min.          | 50 V                        |
| Drain-source leakage current<br>$-V_{DS} = 1\text{ V}; V_{GS} = 0$                                                     | $-I_{DSS}$            | max.          | 10 $\mu\text{A}$            |
| Gate-source leakage current<br>$-V_{GS} = 20\text{ V}; V_{DS} = 0$                                                     | $-I_{GSS}$            | max.          | 100 nA                      |
| Gate threshold voltage<br>$-I_D = 1\text{ mA}; V_{DS} = V_{GS}$                                                        | $-V_{GS(th)}$         | min.<br>max.  | 1.5 V<br>3.5 V              |
| Drain-source ON-resistance<br>$-I_D = 200\text{ mA}; -V_{GS} = 10\text{ V}$                                            | $R_{DSon}$            | max.<br>typ.. | 10 $\Omega$<br>7.5 $\Omega$ |
| Transfer admittance<br>$-I_D = 200\text{ mA}; -V_{DS} = 15\text{ V}$                                                   | $ y_{fs} $            | typ.          | 125 mS                      |
| Input capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                         | $C_{iss}$             | typ.<br>max.  | 30 pF<br>45 pF              |
| Output capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                        | $C_{oss}$             | typ.<br>max.  | 20 pF<br>30 pF              |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$-V_{DS} = 10\text{ V}; V_{GS} = 0$                                      | $C_{rss}$             | typ.<br>max.  | 5 pF<br>10 pF               |
| Switching times (see Figs 2 and 3)<br>$-I_D = 200\text{ mA}; -V_{DD} = 50\text{ V}; -V_{GS} = 0\text{ to }10\text{ V}$ | $t_{on}$<br>$t_{off}$ | typ.<br>typ.  | 4 ns<br>10 ns               |

**Note:**1. Transistor mounted on a ceramic substrate: area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm.

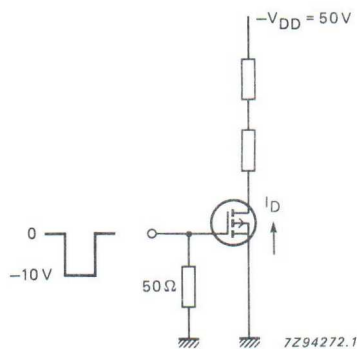


Fig. 2 Switching times test circuit.

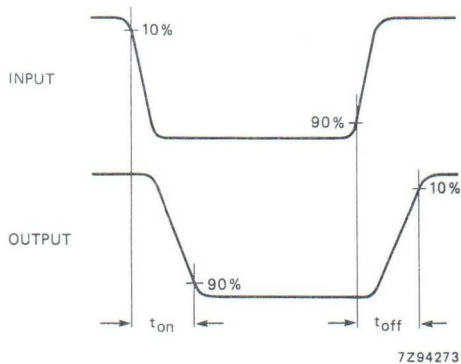
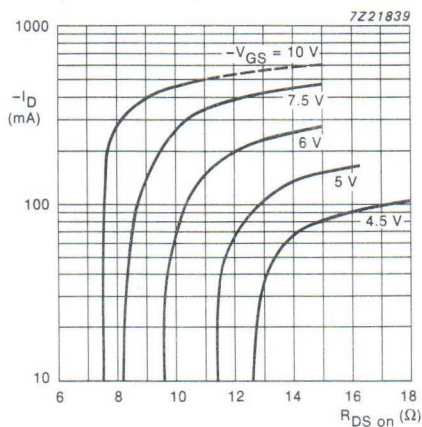
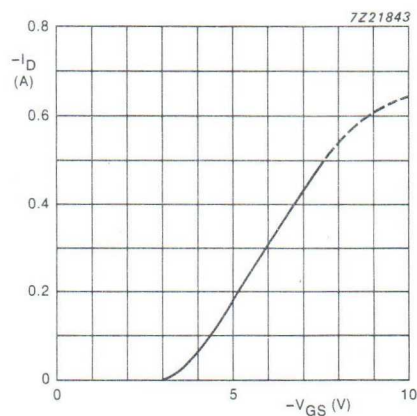
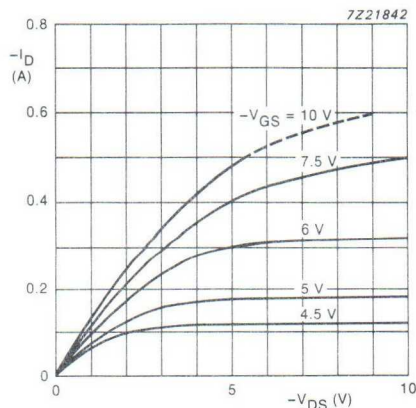


Fig. 3 Input and output waveforms.

Fig. 4 Drain current vs ON-resistance;  
 $T_j = 25^\circ\text{C}$ ; typical values.Fig. 5 Transfer characteristics;  
 $T_j = 25^\circ\text{C}$ ;  $-V_{DS} = 10\text{ V}$ ; typical values.Fig. 6 Output characteristics;  $T_j = 25^\circ\text{C}$ ; typical values.





## SILICON PLANAR EPITAXIAL TRANSISTORS

- High-speed switching

N-P-N transistor in a microminiature plastic envelope. It is intended for very high-speed saturated switching in thick and thin-film circuits.

## QUICK REFERENCE DATA

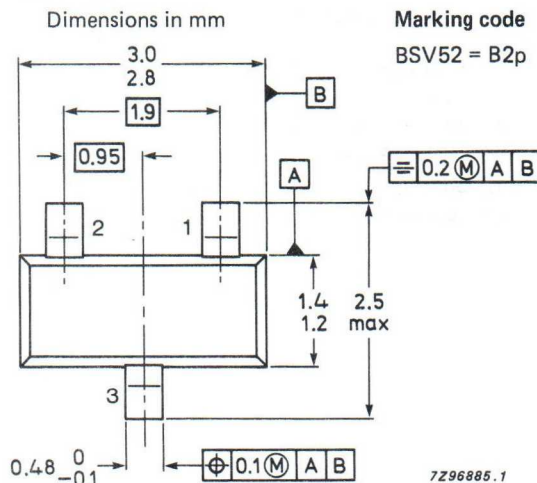
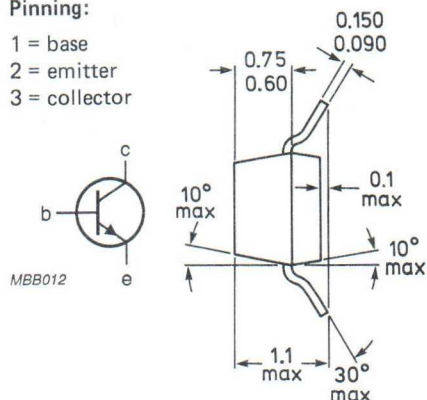
|                                                                      |           |      |                        |
|----------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 20 V                   |
| Collector-emitter voltage ( $V_{BE} = 0$ )                           | $V_{CES}$ | max. | 20 V                   |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 12 V                   |
| Collector current (peak value)                                       | $I_{CM}$  | max. | 200 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW                 |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                    |           |      |                        |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                            | $h_{FE}$  |      | 40 to 120              |
| $I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$                            | $h_{FE}$  | >    | 25                     |
| Transition frequency at $f = 100\text{ MHz}$                         |           |      |                        |
| $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$                           | $f_T$     | >    | 400 MHz                |
|                                                                      |           | typ. | 500 MHz                |
| Storage time                                                         |           |      |                        |
| $I_C = I_B = -I_{BM} = 10\text{ mA}$                                 | $t_s$     | <    | 13 ns                  |

## MECHANICAL DATA

Fig. 1 SOT-23.

## Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



Reverse pinning types are available on request.

See also *Soldering recommendations*.

TOP VIEW

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |              |        |
|---------------------------------------------------------------------|-----------|--------------|--------|
| Collector-base voltage (open emitter)                               | $V_{CBO}$ | max.         | 20 V   |
| Collector-emitter voltage ( $V_{BE} = 0$ )                          | $V_{CES}$ | max.         | 20 V   |
| Collector-emitter voltage (open base)<br>$I_C = 10$ mA (see Fig. 4) | $V_{CEO}$ | max.         | 12 V   |
| Emitter-base voltage (open collector)                               | $V_{EBO}$ | max.         | 5 V    |
| Collector current (d.c.)                                            | $I_C$     | max.         | 100 mA |
| Collector current (peak value)                                      | $I_{CM}$  | max.         | 200 mA |
| Total power dissipation up to $T_{amb} = 25$ °C                     | $P_{tot}$ | max.         | 250 mW |
| Storage temperature                                                 | $T_{stg}$ | –65 to + 150 | °C     |
| Junction temperature                                                | $T_j$     | max.         | 150 °C |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25$  °C unless otherwise specified

Collector cut-off current

 $I_E = 0$ ;  $V_{CB} = 10$  V $I_E = 0$ ;  $V_{CB} = 10$  V;  $T_j = 125$  °C

|           |   |           |
|-----------|---|-----------|
| $I_{CBO}$ | < | 100 nA    |
| $I_{CBO}$ | < | 5 $\mu$ A |

Saturation voltages

 $I_C = 10$  mA;  $I_B = 300$   $\mu$ A $I_C = 10$  mA;  $I_B = 1$  mA $I_C = 50$  mA;  $I_B = 5$  mA

|             |            |         |
|-------------|------------|---------|
| $V_{CEsat}$ | <          | 300 mV  |
| $V_{CEsat}$ | <          | 250 mV  |
| $V_{BEsat}$ | 700 to 850 | mV      |
| $V_{CEsat}$ | <          | 400 mV  |
| $V_{BEsat}$ | <          | 1200 mV |

D.C. current gain

 $I_C = 1$  mA;  $V_{CE} = 1$  V $I_C = 10$  mA;  $V_{CE} = 1$  V $I_C = 50$  mA;  $V_{CE} = 1$  V

|          |           |    |
|----------|-----------|----|
| $h_{FE}$ | >         | 25 |
| $h_{FE}$ | 40 to 120 |    |
| $h_{FE}$ | >         | 25 |

Transition frequency at  $f = 100$  MHz $I_C = 10$  mA;  $V_{CE} = 10$  V

|       |      |         |
|-------|------|---------|
| $f_T$ | >    | 400 MHz |
|       | typ. | 500 MHz |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

Collector capacitance at  $f = 1 \text{ MHz}$

$$I_E = I_e = 0; V_{CB} = 5 \text{ V}$$

$$C_c < 4 \text{ pF}$$

Emitter capacitance at  $f = 1 \text{ MHz}$

$$I_C = I_c = 0; V_{EB} = 1 \text{ V}$$

$$C_e < 4,5 \text{ pF}$$

Switching times

$$\text{Storage time } I_C = I_B = -I_{BM} = 10 \text{ mA}$$

$$t_s < 13 \text{ ns}$$

Turn on time when switched from

$$-V_{BE} = 1,5 \text{ V to } I_C = 10 \text{ mA}; I_B = 3 \text{ mA}$$

$$t_{on} < 12 \text{ ns}$$

Turn off time when switched from

$$I_C = 10 \text{ mA}; I_B = 3 \text{ mA}$$

to cut-off with  $-I_{BM} = 1,5 \text{ mA}$

$$t_{off} < 18 \text{ ns}$$

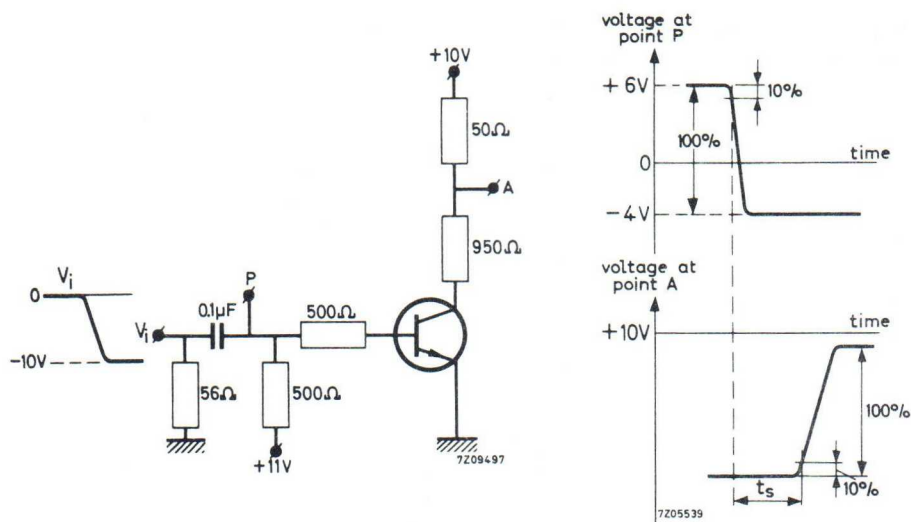


Fig. 2 Test circuit and waveform storage time.

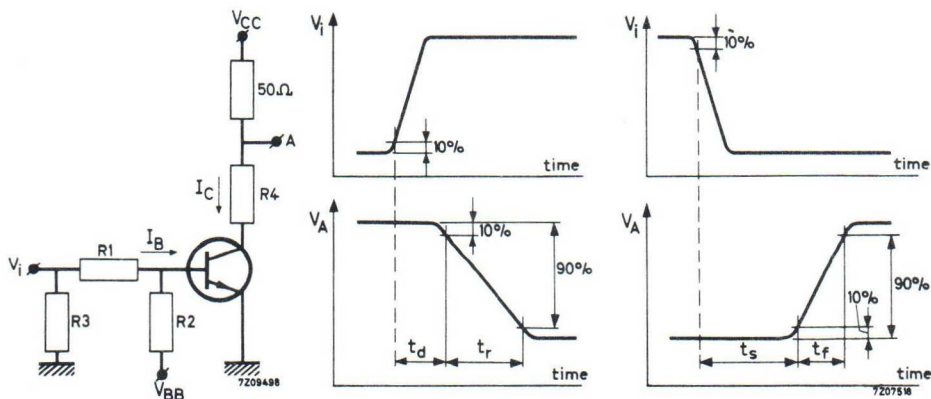


Fig. 3 Test circuit and waveforms turn on and turn off time.

Pulse generator:

Rise time  $t_r < 1 \text{ ns}$ Pulse duration  $t > 300 \text{ ns}$ Duty cycle  $\delta < 0,02$ Source impedance  $R_S = 50 \Omega$ 

Oscilloscope:

Input impedance  $R_i = 50 \Omega$ Rise time  $t_r < 1 \text{ ns}$ 

| $I_C$<br>mA | $I_B$<br>mA | $-I_{BM}$<br>mA | $V_{CC}$<br>V | $R_1; R_2$<br>k $\Omega$ | $R_3$<br>$\Omega$ | $R_4$<br>$\Omega$ | turn on time   |                | turn off time |               |             |
|-------------|-------------|-----------------|---------------|--------------------------|-------------------|-------------------|----------------|----------------|---------------|---------------|-------------|
|             |             |                 |               |                          |                   |                   | $-V_{BB}$<br>V | $-V_{BE}$<br>V | $V_i$<br>V    | $V_{BB}$<br>V | $-V_i$<br>V |
| 10          | 3           | 1,5             | 3             | 3,3                      | 50                | 220               | 3,0            | 1,5            | 15            | 12,0          | 15          |

$-I_{BM}$  is the reverse current that can flow during switching off. The indicated  $-I_{BM}$  is determined and limited by the applied cut-off voltage and series resistance.

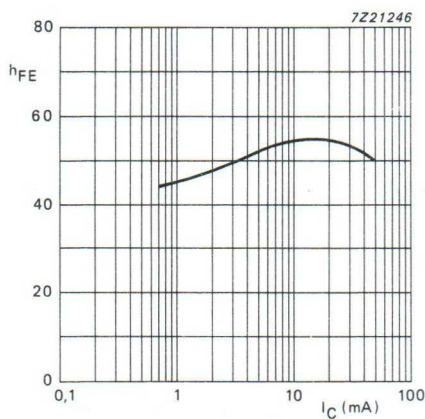


Fig. 4  $V_{CE} = 1 \text{ V}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.



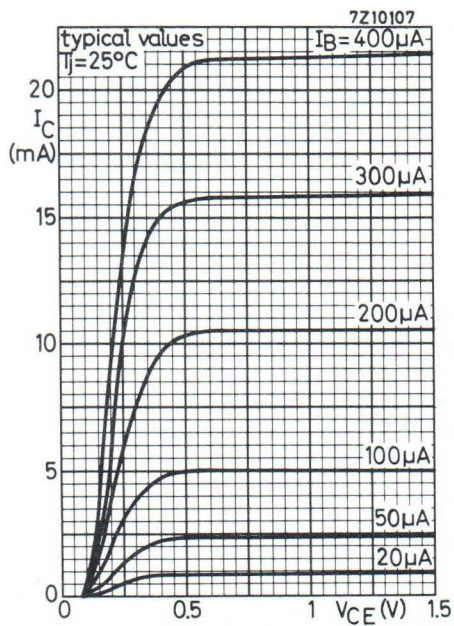


Fig. 5

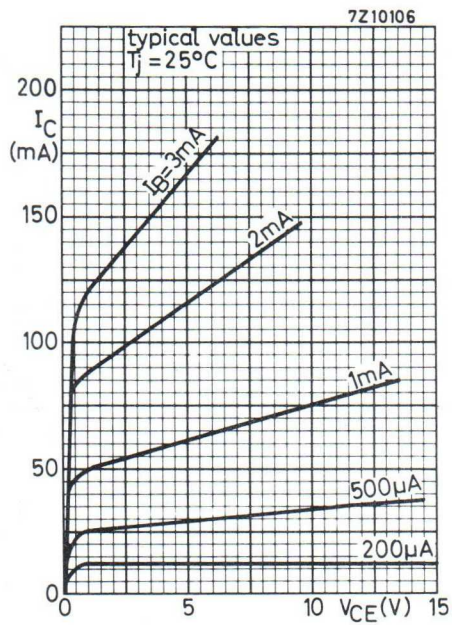


Fig. 6

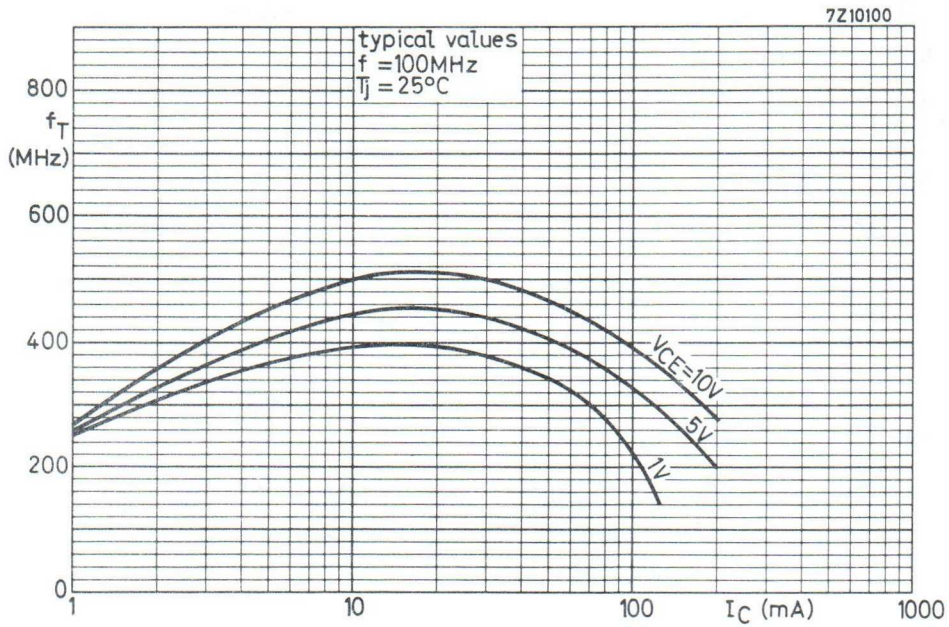


Fig. 7

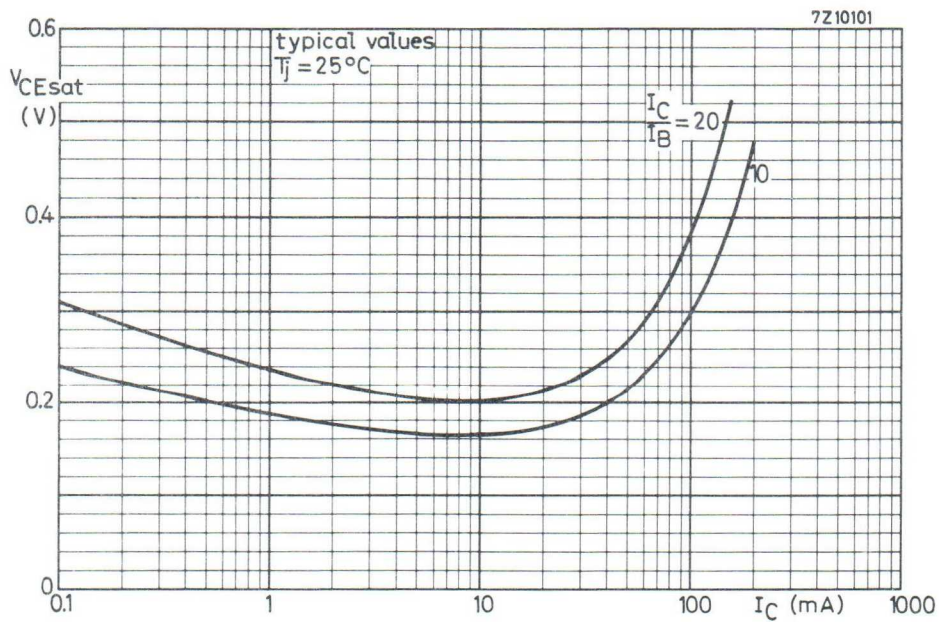


Fig. 8

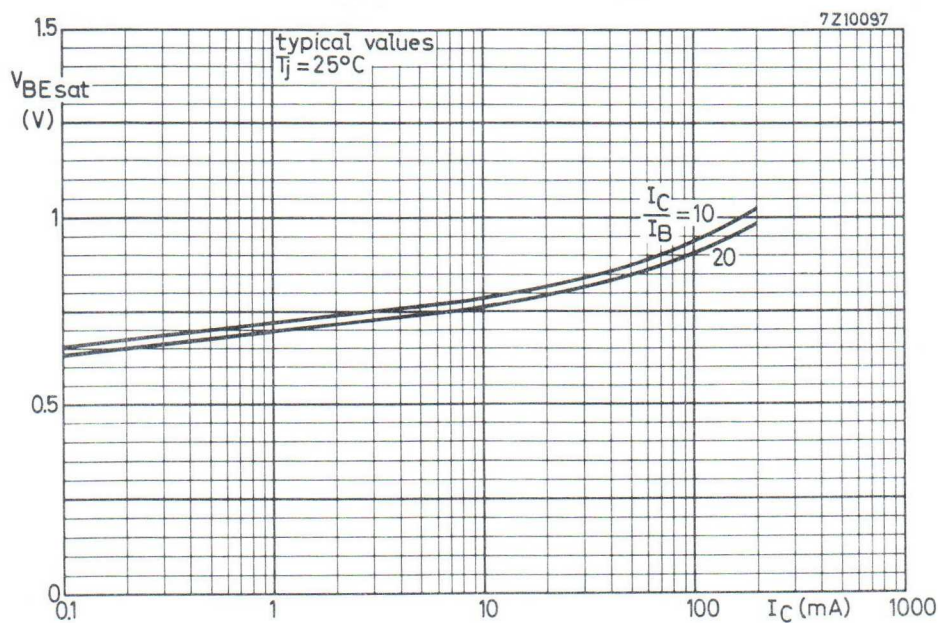


Fig. 9

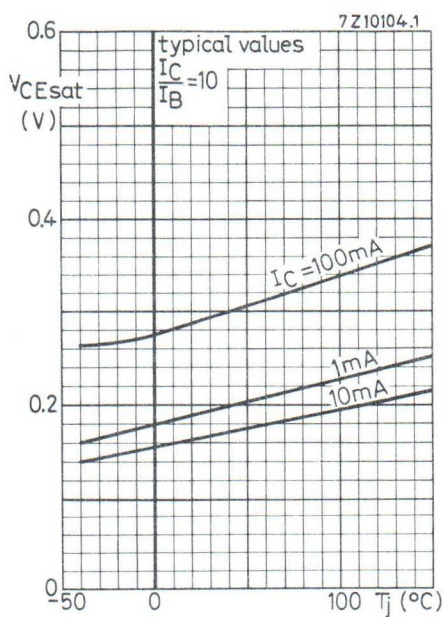


Fig. 10

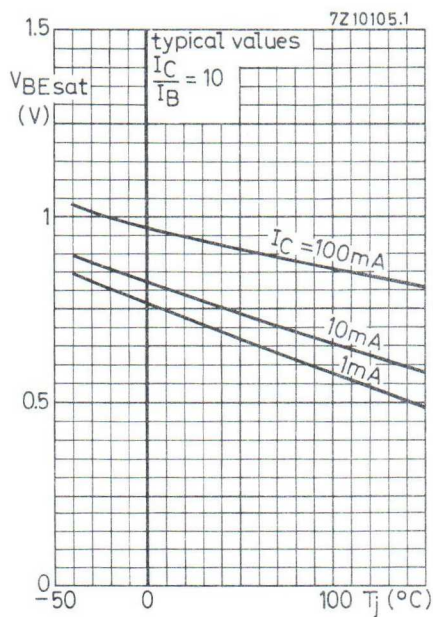


Fig. 11



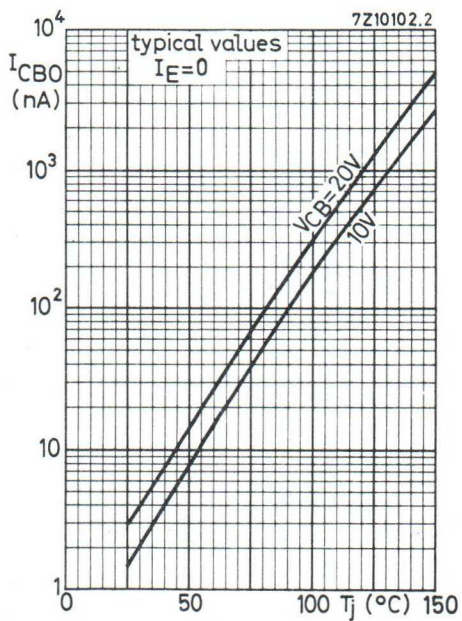


Fig. 12

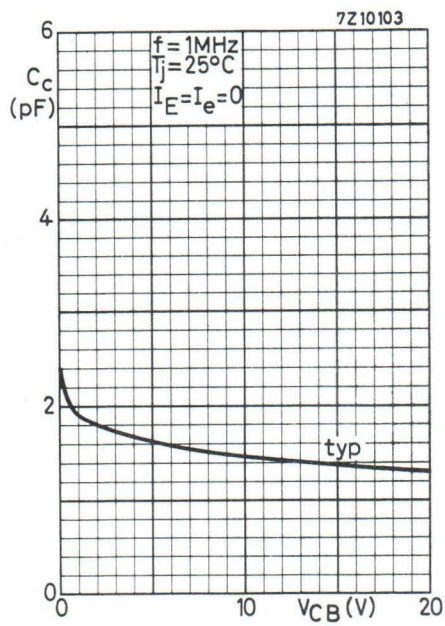


Fig. 13

## CONTROLLED AVALANCHE RECTIFIER DIODES

Glass passivated rectifier diodes in hermetically sealed leadless SMID\* envelopes and intended for general purpose rectifier applications.

The device is capable of absorbing reverse transient energy.

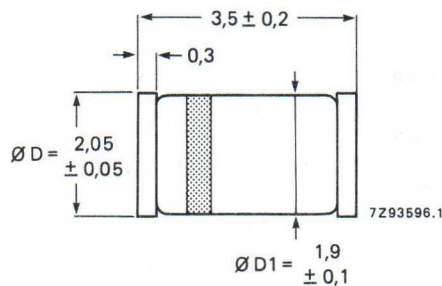
### QUICK REFERENCE DATA

|                                               |             |      | BYD17D | G    | J    | K    | M      |
|-----------------------------------------------|-------------|------|--------|------|------|------|--------|
| Crest working voltage                         | $V_{RWM}$   | max. | 200    | 400  | 600  | 800  | 1000 V |
| Reverse avalanche breakdown voltage           | $V_{(BR)R}$ | >    | 225    | 450  | 650  | 900  | 1100 V |
|                                               |             | <    | 1600   | 1600 | 1600 | 1600 | 1600 V |
| Average forward current                       | $I_{F(AV)}$ | max. |        |      | 1,5  |      | A      |
| Non-repetitive peak forward current           | $I_{FSM}$   | max. |        |      | 20   |      | A      |
| Non-repetitive peak reverse power dissipation | $P_{RSM}$   | max. |        |      | 0,4  |      | kW     |
| Junction temperature                          | $T_j$       | max. |        |      | 175  |      | °C     |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-87.



\* Surface-mounted implosion diode.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                 |             |      | BYD17D | G            | J   | K   | M                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------|--------|--------------|-----|-----|--------------------|
| Crest working reverse voltage                                                                                                                   | $V_{RWM}$   | max. | 200    | 400          | 600 | 800 | 1000 V             |
| Continuous reverse voltage                                                                                                                      | $V_R$       | max. | 200    | 400          | 600 | 800 | 1000 V             |
| Average forward current (averaged over any 20 ms period)                                                                                        |             |      |        |              |     |     |                    |
| $T_{tp} = 105\text{ }^{\circ}\text{C}$ ;                                                                                                        | $I_{F(AV)}$ | max. |        |              | 1,5 |     | A                  |
| $T_{amb} = 65\text{ }^{\circ}\text{C}$ ; p.c. board mounting                                                                                    | $I_{F(AV)}$ | max. |        |              | 0,6 |     | A                  |
| Repetitive peak forward current                                                                                                                 |             |      |        |              |     |     |                    |
| $T_{tp} = 55\text{ }^{\circ}\text{C}$ ; $f = 50\text{ Hz}$ ; $a = 3$ ;<br>(inclusive derating for $T_j$ max<br>at $V_{RRM} = 1000\text{ V}$ )   | $I_{FRM}$   | max. |        |              | 5,5 |     | A                  |
| Non-repetitive peak forward current                                                                                                             |             |      |        |              |     |     |                    |
| $t = 10\text{ ms}$ , half-sinewave;<br>$T_j = T_{j\text{ max}}$ prior to surge;<br>$V_R = V_{RWM\text{ max}}$                                   | $I_{FSM}$   | max. |        |              | 20  |     | A                  |
| Non-repetitive peak reverse power dissipation; $t = 20\text{ }\mu\text{s}$ (half-sinewave);<br>$T_j = T_{j\text{ max}}$ prior to surge          | $P_{RSM}$   | max. |        |              | 0,4 |     | kW                 |
| Non-repetitive peak reverse avalanche energy; $I_R = 0,34\text{ A}$ ; $T_j = T_{j\text{ max}}$ prior to surge; with inductive load switched off | $E_{RSM}$   | max. |        |              | 7   |     | mJ                 |
| Storage temperature                                                                                                                             | $T_{stg}$   |      |        | -65 to + 175 |     |     | $^{\circ}\text{C}$ |
| Junction temperature                                                                                                                            | $T_j$       | max. |        |              | 175 |     | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point  
 $R_{th\ j-tp} =$  30 K/W
2. Thermal resistance from junction to ambient; device mounted on an 1,5 mm thick epoxy-glass p.c. board;  
Cu-thickness  $\geq 40\text{ }\mu\text{m}$  (see Fig. 2)  
 $R_{th\ j-a} =$  150 K/W

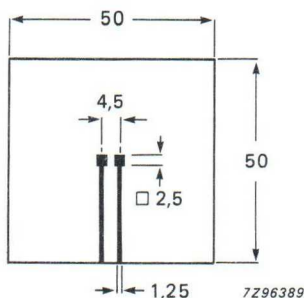


Fig. 2 Mounted on a p.c. board.

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                               |             |      | BYD17D | G    | J    | K    | M             |
|---------------------------------------------------------------|-------------|------|--------|------|------|------|---------------|
| Forward voltage*                                              |             |      |        |      |      |      |               |
| $I_F = 1\text{ A}; T_j = T_{j\text{ max}}$                    | $V_F$       | <    | 0,93   | 0,93 | 0,93 | 0,93 | 0,93 V        |
| $I_F = 1\text{ A}$                                            | $V_F$       | <    | 1,05   | 1,05 | 1,05 | 1,05 | 1,05 V        |
| Reverse avalanche breakdown voltage                           |             |      |        |      |      |      |               |
| $I_R = 0,1\text{ mA}$                                         | $V_{(BR)R}$ | >    | 225    | 450  | 650  | 900  | 1100 V        |
|                                                               |             | <    | 1600   | 1600 | 1600 | 1600 | 1600 V        |
| Reverse current                                               |             |      |        |      |      |      |               |
| $V_R = V_{RWM\text{ max}}$                                    | $I_R$       | <    |        |      | 1    |      | $\mu\text{A}$ |
| $V_R = V_{RWM\text{ max}}; T_j = 165\text{ }^{\circ}\text{C}$ | $I_R$       | <    |        |      | 100  |      | $\mu\text{A}$ |
| Diode capacitance                                             |             |      |        |      |      |      |               |
| $V_R = 0; f = 1\text{ MHz}$                                   | $C_d$       | typ. |        |      | 21   |      | pF            |

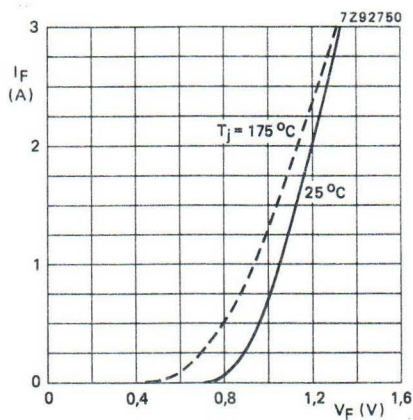


Fig. 3 Maximum forward voltage.

\* Measured under pulse conditions to avoid excessive dissipation.

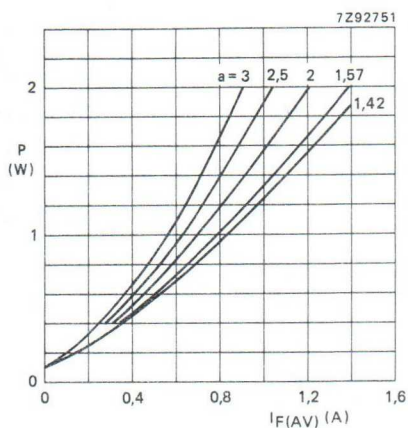


Fig. 4 Maximum values steady power dissipation (forward plus leakage current) as a function of the average (a) forward current.  
 $a = I_F(RMS)/I_F(AV)$ ;  $V_R = V_{RWMmax}$ .

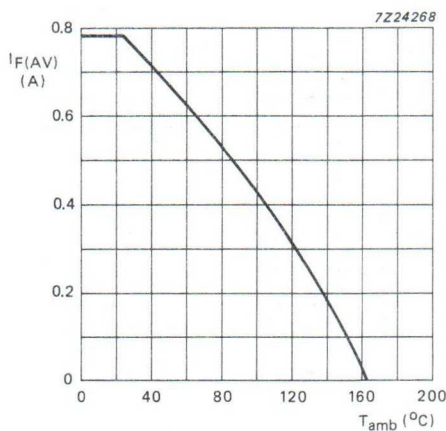


Fig. 5 Maximum average forward current as a function of temperature; the curves include losses due to reverse leakage.

$V_R = V_{RWMmax}$ ,  $\delta = 0.5$ ;  $a = 1.57$ .

— = ambient temperature and device mounted as shown in Fig. 2.

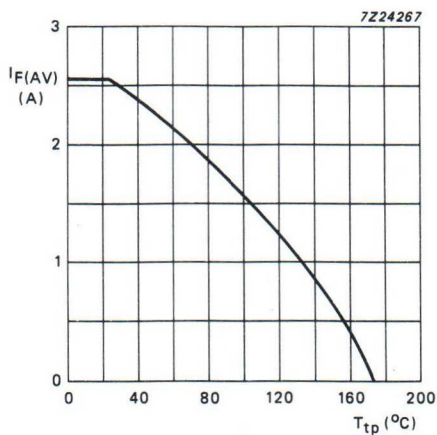


Fig. 6 Maximum average forward current as a function of temperature; the curves include losses due to reverse leakage.

$V_R = V_{RWMmax}$ ,  $\delta = 0.5$ ;  $a = 1.57$ .

— = tie-point temperature and device mounted as shown in Fig. 2.

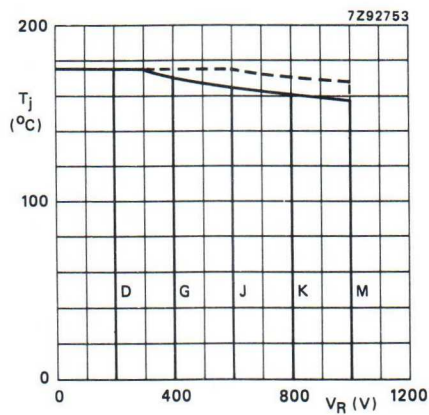


Fig. 7 Maximum permissible junction temperature as a function of reverse voltage;

— =  $V_R$ ; ---- =  $V_{RWM}$ ,  $\delta = 0.5$ .

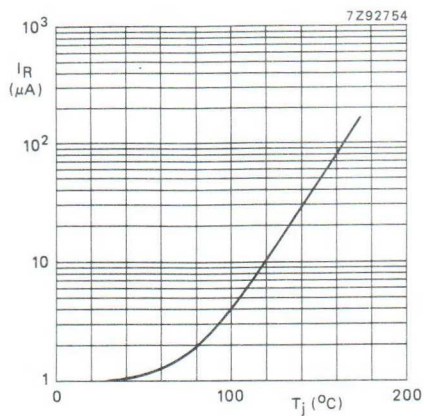


Fig. 8 Maximum values reverse current as a function of junction temperature;  $V_R = V_{RWMmax}$ .

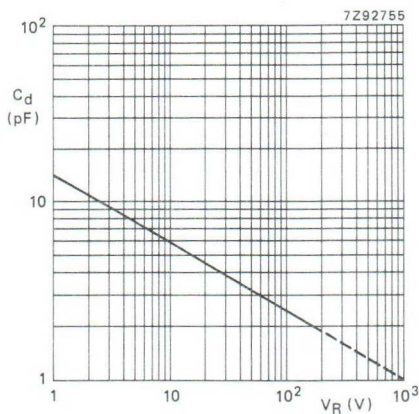


Fig. 9 Capacitance as a function of reverse voltage;  $f = 1$  MHz;  $T_j = 25$   $^{\circ}C$ ; typical values.



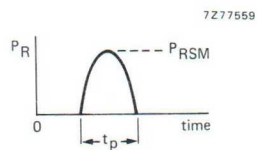
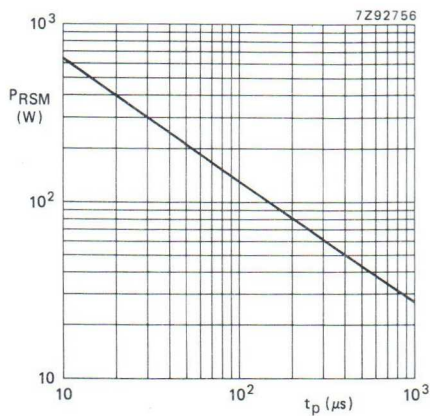


Fig. 10 Maximum permissible non-repetitive peak reverse power dissipation in the avalanche region;  $T_j = T_{jmax}$ .



## AVALANCHE FAST SOFT-RECOVERY RECTIFIER DIODES

Glass passivated rectifier diodes in hermetically sealed leadless SMID\* envelopes. They are intended for television and industrial applications, such as switched-mode power supplies, scan rectifiers in TV receivers and also for use in inverter and converter applications. The devices feature non-snap-off (soft-recovery) switching characteristics and are capable of absorbing reverse transient energy (e.g. during flashover in a picture tube).

### QUICK REFERENCE DATA

|                                     |           |      | BYD37D | G   | J   | K   | M    |   |
|-------------------------------------|-----------|------|--------|-----|-----|-----|------|---|
| Repetitive peak reverse voltage     | $V_{RRM}$ | max. | 200    | 400 | 600 | 800 | 1000 | V |
| Continuous reverse voltage          | $V_R$     | max. | 200    | 400 | 600 | 800 | 1000 | V |
| Average forward current             | $I_F(AV)$ | max. | 1.5    |     | 1.5 |     | A    |   |
| Non-repetitive peak forward current | $I_{FSM}$ | max. | 20     |     | 20  |     | A    |   |
| Non-repetitive peak reverse energy  | $E_{RSM}$ | max. | 10     |     | 7   |     | mJ   |   |
| Reverse recovery time               | $t_{rr}$  | <    | 250    |     | 300 |     | ns   |   |

### MECHANICAL DATA

Dimensions in mm

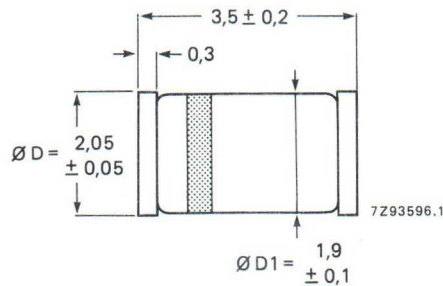


Fig. 1 SOD-87.

\* Implosion Diode

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                    |           |      | BYD37D | G            | J   | K   | M    |                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|--------|--------------|-----|-----|------|------------------|
| Repetitive peak reverse voltage                                                                                                                    | $V_{RRM}$ | max. | 200    | 400          | 600 | 800 | 1000 | V                |
| Continuous reverse voltage                                                                                                                         | $V_R$     | max. | 200    | 400          | 600 | 800 | 1000 | V                |
| Average forward current square wave;<br>$\delta = 0.5$                                                                                             |           |      |        |              |     |     |      |                  |
| $T_{tp} = 105^\circ\text{C}$                                                                                                                       | $I_F(AV)$ | max. |        | 1.5          |     | 1.5 |      | A                |
| $T_{amb} = 65^\circ\text{C}$ ; PCB mounting                                                                                                        | $I_F(AV)$ | max. |        | 0.6          |     | 0.6 |      | A                |
| Repetitive peak forward current                                                                                                                    |           |      |        | 12           |     | 12  |      | A                |
| Non-repetitive peak forward current<br>$t = 10\text{ ms}$ , half-sinewave;<br>$T_j = T_{jmax}$ prior to surge;<br>$V_R = V_{RRMmax}$               |           |      |        |              |     |     |      |                  |
|                                                                                                                                                    | $I_{FSM}$ | max. |        | 20           |     | 20  |      | A                |
| Non-repetitive peak reverse avalanche<br>energy; $I_R = 400\text{ mA}$ ; $T_j = T_{jmax}$ ,<br>prior to surge; with inductive load<br>switched off |           |      |        |              |     |     |      |                  |
|                                                                                                                                                    | $E_{RSM}$ | max. |        | 10           |     | 7   |      | mJ               |
| Storage temperature range                                                                                                                          | $T_{stg}$ |      |        | -65 to + 175 |     |     |      | $^\circ\text{C}$ |
| Junction temperature                                                                                                                               | $T_j$     | max. |        |              | 175 |     |      | $^\circ\text{C}$ |

## THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point  
 $R_{th\ j\text{-}tp} =$  30 K/W
2. Thermal resistance from junction to ambient; device mounted on an 1.5 mm thick epoxy-glass printed circuit board;  
Cu-thickness  $\geq 40\ \mu\text{m}$ ; Fig. 2  
 $R_{th\ j\text{-}a} =$  150 K/W

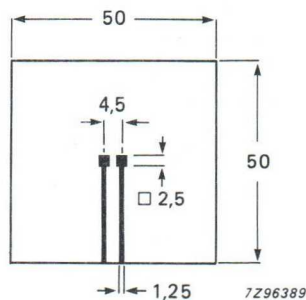


Fig. 2 Mounted on a PCB.

## CHARACTERISTICS

 $T_j = 25^\circ\text{C}$  unless otherwise specified

|                                                                                                                                                             |             |   | BYD37D | G   | J   | K   | M                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---|--------|-----|-----|-----|------------------------|
| Forward voltage *                                                                                                                                           |             |   |        |     |     |     |                        |
| $I_F = 1\text{ A}$                                                                                                                                          | $V_F$       | < | 1.3    | 1.3 | 1.3 | 1.3 | 1.3 V                  |
| $I_F = 1\text{ A}; T_j = T_{j\text{max}}$                                                                                                                   | $V_F$       | < | 1.1    | 1.1 | 1.1 | 1.1 | 1.1 V                  |
| Reverse avalanche breakdown voltage                                                                                                                         |             |   |        |     |     |     |                        |
| $I_R = 0.1\text{ mA}$                                                                                                                                       | $V_{(BR)R}$ | > | 300    | 500 | 700 | 900 | 1100 V                 |
| Reverse current                                                                                                                                             |             |   |        |     |     |     |                        |
| $V_R = V_{RRM\text{max}}$                                                                                                                                   | $I_R$       | < |        | 1   |     | 1   | $\mu\text{A}$          |
| $V_R = V_{RRM\text{max}}; T_j = 165^\circ\text{C}$                                                                                                          | $I_R$       | < |        | 100 |     | 100 | $\mu\text{A}$          |
| Reverse recovery when switched from<br>$I_F = 1\text{ A}$ to $V_R \leq 30\text{ V}$ with<br>$-dI_F/dt = 20\text{ A}/\mu\text{s}$                            |             |   |        |     |     |     |                        |
| recovery charge                                                                                                                                             | $Q_s$       | < |        | 250 |     | 400 | nC                     |
| recovery time                                                                                                                                               | $t_{rr}$    | < |        | 250 |     | 300 | ns                     |
| Maximum slope of reverse recovery<br>current when switched from<br>$I_F = 1\text{ A}$ to $V_R \geq 30\text{ V}$ with<br>$-dI_F/dt = 1\text{ A}/\mu\text{s}$ | $ dI_R/dt $ | < |        | 6   |     | 5   | $\text{A}/\mu\text{s}$ |

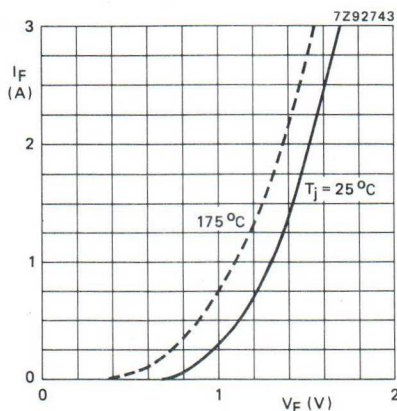


Fig. 3 Maximum forward voltage.

\* Measured under pulse conditions to avoid excessive dissipation.



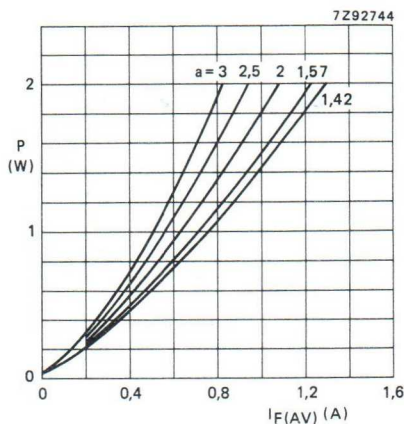


Fig. 4 Maximum values steady state power dissipation (forward plus leakage current) excluding switching losses as a function of the forward current. The graph is for switched-mode application.

$$a = I_F(\text{RMS})/I_F(\text{AV}); V_R = V_{\text{RRMmax}}$$

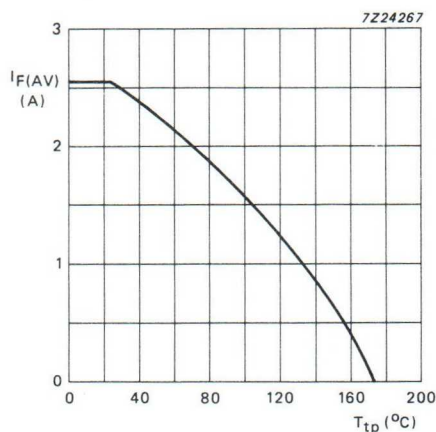


Fig. 5 Maximum average forward current as a function of temperature; the curve includes losses due to reverse leakage.

The graph is for switched-mode application.

$$V_R = V_{\text{RRMmax}}, \delta = 0.5; a = 1.42.$$

— = tie-point temperature.

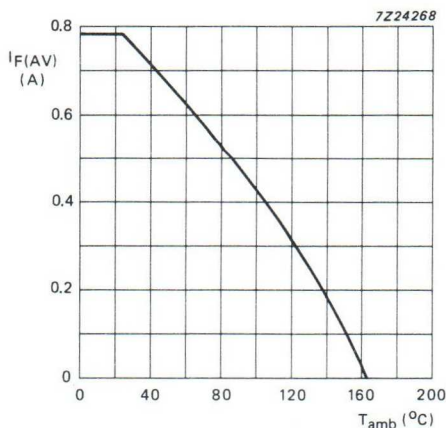


Fig. 6 Maximum average forward current as a function of temperature; the curve includes losses due to reverse leakage.

The graph is for switched-mode application.

$$V_R = V_{\text{RRMmax}}, \delta = 0.5; a = 1.42.$$

— = ambient temperature and device mounted as shown in Fig. 2.

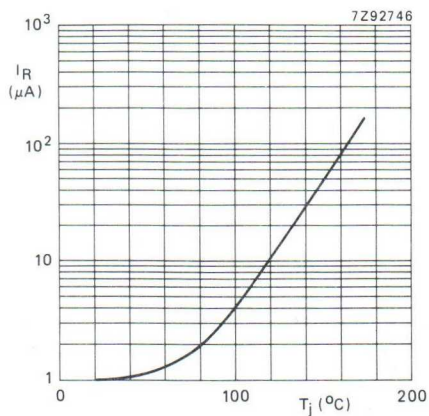


Fig. 7 Maximum values reverse current as a function of junction temperature.

$V_R = V_{RRMmax}$ .

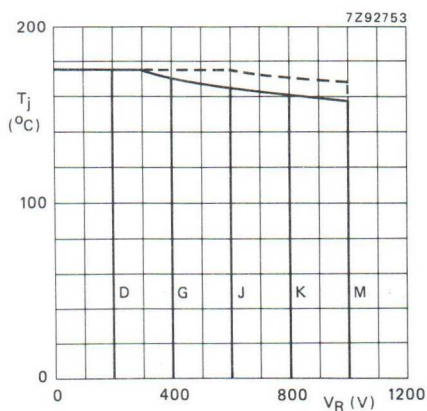


Fig. 8 Maximum permissible junction temperature as a function of reverse voltage.

— =  $V_R$ ; --- =  $V_{RRM}$ ;  $\delta = 0.5$ .

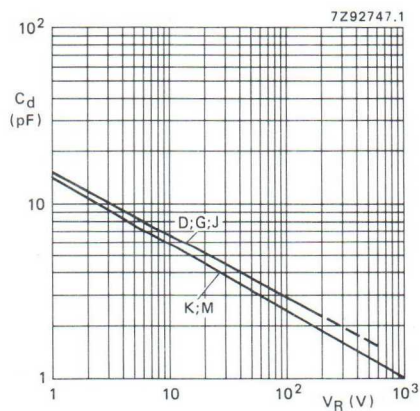


Fig. 9 Capacitance as a function of reverse voltage.  
 $f = 1 \text{ MHz}$ ;  $T_j = 25^\circ\text{C}$ ; typical values.



## EPITAXIAL AVALANCHE DIODES

Rectifier diodes in hermetically sealed leadless SMID\*-envelopes. They feature low forward voltage drop, very fast recovery, very low stored charge, non-snap-off switching characteristics and are capable of absorbing reverse transient energy (e.g. during flashover in a picture tube). These properties make the diodes very suitable for use in switched-mode power supplies and in general high-frequency circuits, where low conduction and switching losses are essential.

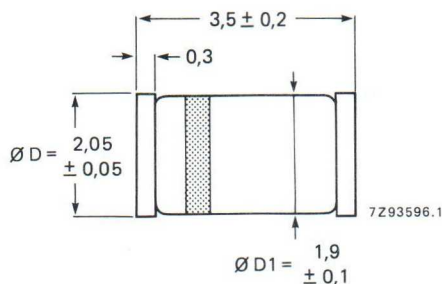
## QUICK REFERENCE DATA

|                                     |           | BYD77A |    | B   | C   | D   | E    | F    | G      |
|-------------------------------------|-----------|--------|----|-----|-----|-----|------|------|--------|
| Repetitive peak reverse voltage     | $V_{RRM}$ | max.   | 50 | 100 | 150 | 200 | 250  | 300  | 400 V  |
| Continuous reverse voltage          | $V_R$     | max.   | 50 | 100 | 150 | 200 | 250  | 300  | 400 V  |
| Average forward current             | $I_F(AV)$ | max.   | 2  | 2   | 2   | 2   | 1,85 | 1,85 | 1,85 A |
| Non-repetitive peak forward current | $I_{FSM}$ | max.   | 25 | 25  | 25  | 25  | 25   | 25   | 25 A   |
| Non-repetitive peak reverse energy  | $E_{RSM}$ | max.   | 20 | 20  | 20  | 20  | 20   | 20   | 20 mJ  |
| Reverse recovery time               | $t_{rr}$  | <      | 25 | 25  | 25  | 25  | 50   | 50   | 50 ns  |

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-87.



\* Surface-mounted implosion diode.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                                       |             | BYD77A    | B    | C    | D            | E    | F    | G                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|------|------|--------------|------|------|------------------|
| Repetitive peak reverse voltage                                                                                                                       | $V_{RRM}$   | max. 50   | 100  | 150  | 200          | 250  | 300  | 400 V            |
| Continuous reverse voltage                                                                                                                            | $V_R$       | max. 50   | 100  | 150  | 200          | 250  | 300  | 400 V            |
| Average forward current<br>square wave; $\delta = 0,5$<br>$T_{tp} = 105^\circ\text{C}$                                                                | $I_{F(AV)}$ | max. 2    | 2    | 2    | 2            | 1,85 | 1,85 | 1,85 A           |
| $T_{amb} = 60^\circ\text{C}$ ; p.c.b. mounting                                                                                                        | $I_{F(AV)}$ | max. 0,85 | 0,85 | 0,85 | 0,85         | 0,8  | 0,8  | 0,8 A            |
| Repetitive peak forward current                                                                                                                       | $I_{FRM}$   | max. 15   | 15   | 15   | 15           | 13   | 13   | 13 A             |
| Non-repetitive peak forward current<br>( $t = 10$ ms; half sine-wave)<br>$T_j = T_{j \text{ max}}$ prior to surge; with<br>reapplied $V_{RRM}$        | $I_{FSM}$   | max.      |      |      | 25           |      |      | A                |
| Non-repetitive peak reverse avalanche<br>energy; with inductive load<br>switched off:<br>$I_R = 600$ mA at $T_j = 25^\circ\text{C}$<br>prior to surge | $E_{RSM}$   | max.      |      |      | 20           |      |      | mJ               |
| $I_R = 400$ mA at $T_j = T_{j \text{ max}}$<br>prior to surge                                                                                         | $E_{RSM}$   | max.      |      |      | 10           |      |      | mJ               |
| Storage temperature                                                                                                                                   | $T_{stg}$   |           |      |      | -65 to + 175 |      |      | $^\circ\text{C}$ |
| Junction temperature                                                                                                                                  | $T_j$       | max.      |      |      | 175          |      |      | $^\circ\text{C}$ |

## THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction  
to tie-point

$$R_{th\ j\text{-}tp} = 30 \text{ K/W}$$

2. Thermal resistance from junction  
to ambient when mounted on a  
1,5 mm thick epoxy-glass printed-  
circuit board; Cu-thickness  
 $\geq 40 \mu\text{m}$ ; Fig 2.

$$R_{th\ j\text{-}a} = 150 \text{ K/W}$$

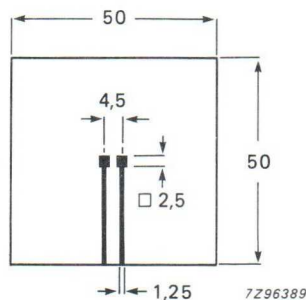


Fig 2. Mounted on a printed-circuit board.



## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                         |               | BYD77A | B    | C    | D    | E    | F    | G                 |
|-------------------------------------------------------------------------------------------------------------------------|---------------|--------|------|------|------|------|------|-------------------|
| Reverse avalanche breakdown voltage                                                                                     |               |        |      |      |      |      |      |                   |
| $I_R = 0,1\text{ mA}$                                                                                                   | $V_{(BR)R} >$ | 55     | 110  | 165  | 220  | 275  | 330  | 440 V             |
| Forward voltage*                                                                                                        |               |        |      |      |      |      |      |                   |
| $I_F = 1\text{ A}; T_j = T_{j\text{ max}}$                                                                              | $V_F <$       | 0,74   | 0,74 | 0,74 | 0,74 | 0,83 | 0,83 | 0,83 V            |
| $I_F = 1\text{ A}$                                                                                                      | $V_F <$       | 0,95   | 0,95 | 0,95 | 0,95 | 1,05 | 1,05 | 1,05 V            |
| Reverse current                                                                                                         |               |        |      |      |      |      |      |                   |
| $V_R = V_{RRM\text{ max}}$                                                                                              | $I_R <$       | 1      | 1    | 1    | 1    | 1    | 1    | 1 $\mu\text{A}$   |
| $V_R = V_{RRM\text{ max}}; T_j = 165\text{ }^{\circ}\text{C}$                                                           | $I_R <$       | 100    | 100  | 100  | 100  | 100  | 100  | 100 $\mu\text{A}$ |
| Reverse recovery time when switched from $I_F = 0,5\text{ A}$ to $I_R = 1\text{ A}$ ; measured at $I_R = 0,25\text{ A}$ | $t_{rr} <$    | 25     | 25   | 25   | 25   | 50   | 50   | 50 ns             |

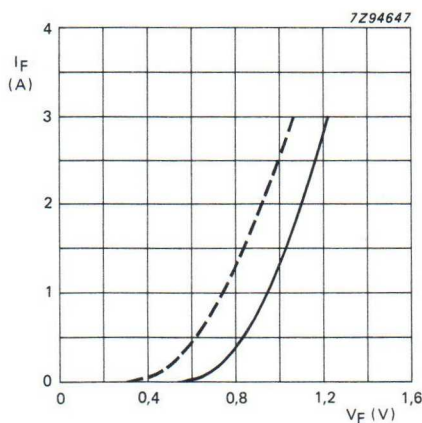


Fig. 3 BYD77A; B; C; D.  
Maximum forward voltage.  
—  $T_j = 25\text{ }^{\circ}\text{C}$ ; ---  $T_j = 175\text{ }^{\circ}\text{C}$ .

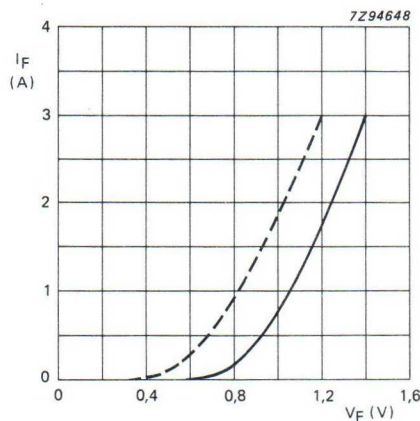


Fig. 4 BYD77E; F; G.  
Maximum forward voltage.  
—  $T_j = 25\text{ }^{\circ}\text{C}$ ; ---  $T_j = 175\text{ }^{\circ}\text{C}$ .

\* Measured under pulse conditions to avoid excessive dissipation.



## REGULATOR DIODES

Diodes in hermetically sealed leadless SMID\* glass envelopes.

They are intended for use as voltage regulator and transient suppressor diodes in medium power regulation and transient suppression circuits.

The series consists of BZD27-C7V5 to BZD27-C510 in the normalized E24 range.

## QUICK REFERENCE DATA

|                                                                                                                   |           |      | voltage<br>regulator |  | transient<br>suppressor |   |
|-------------------------------------------------------------------------------------------------------------------|-----------|------|----------------------|--|-------------------------|---|
|                                                                                                                   |           |      |                      |  |                         |   |
| Working voltage range                                                                                             | $V_Z$     | nom. | 7.5 to 270           |  | V                       |   |
| Stand-off voltage                                                                                                 | $V_R$     |      |                      |  | 6.2 to 430              | V |
| Total power dissipation                                                                                           | $P_{tot}$ | max. | 2.3                  |  | W                       |   |
| Non-repetitive peak reverse power dissipation<br>$T_J = 25\text{ }^{\circ}\text{C}; t_p = 100\text{ }\mu\text{s}$ | $P_{RSM}$ | max. | 300                  |  | W                       |   |

## MECHANICAL DATA

Dimensions in mm

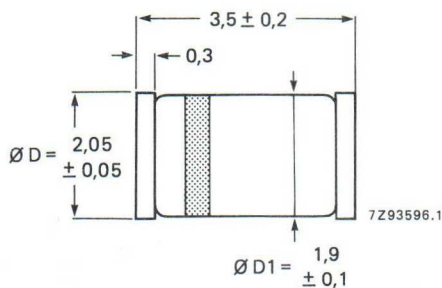


Fig. 1 SOD-87.

\* Surface mounted implosion diode.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Total power dissipation

$T_{tp} = 105\text{ }^{\circ}\text{C}$

$T_{amb} = 55\text{ }^{\circ}\text{C}$ ; PCB mounting (Fig. 2)

|           |      |       |
|-----------|------|-------|
| $P_{tot}$ | max. | 2.3 W |
| $P_{tot}$ | max. | 0.8 W |

Non-repetitive peak reverse power dissipation

$t_p = 100\text{ }\mu\text{s}$ , square pulse;

$T_j = 25\text{ }^{\circ}\text{C}$  (prior to surge) waveforms

waveform 10/1000 exponential pulse (Fig. 3);

$T_j = 25\text{ }^{\circ}\text{C}$  (prior to surge)

|           |      |       |
|-----------|------|-------|
| $P_{RSM}$ | max. | 300 W |
|-----------|------|-------|

|           |      |       |
|-----------|------|-------|
| $P_{RSM}$ | max. | 150 W |
|-----------|------|-------|

Storage temperature

|           |      |                                              |
|-----------|------|----------------------------------------------|
| $T_{stg}$ | max. | $-65\text{ to }+175\text{ }^{\circ}\text{C}$ |
|-----------|------|----------------------------------------------|

Junction temperature

|       |      |                               |
|-------|------|-------------------------------|
| $T_j$ | max. | $175\text{ }^{\circ}\text{C}$ |
|-------|------|-------------------------------|

## THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point

|              |   |        |
|--------------|---|--------|
| $R_{thj-tp}$ | = | 30 K/W |
|--------------|---|--------|

2. Thermal resistance from junction to ambient

when mounted on a 1.5 mm thick epoxy glass PCB;

Cu-thickness  $\geq 40\text{ }\mu\text{m}$ ; Fig. 2.

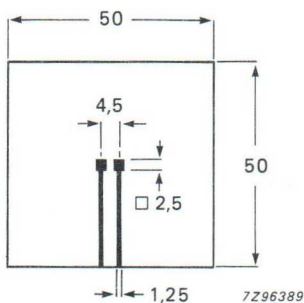


Fig. 2 Mounted on a printed-circuit board.

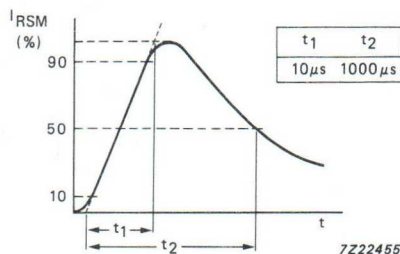


Fig. 3 Current pulse in accordance with IEC 60-2, Section 6.

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Forward voltage

$I_F = 0.2\text{ A}$

|       |   |       |
|-------|---|-------|
| $V_F$ | < | 1.2 V |
|-------|---|-------|

|      | temperature<br>coefficient $S_Z$ |      | test<br>current<br>$I_Z$<br>mA | reverse<br>current<br>$\mu A$ | at reverse<br>voltage<br>V | working voltage<br>$V_Z$<br>V |      |      | differential<br>resistance<br>$r_{diff}$<br>$\Omega$ |      |
|------|----------------------------------|------|--------------------------------|-------------------------------|----------------------------|-------------------------------|------|------|------------------------------------------------------|------|
|      | min.                             | max. |                                | max                           |                            | min.                          | nom. | max. | typ.                                                 | max. |
| C7V5 | 0                                | 0.07 | 100                            | 50                            | 3                          | 7.0                           | 7.5  | 7.9  | 1                                                    | 2    |
| C8V2 | 0.03                             | 0.08 | 100                            | 10                            | 3                          | 7.7                           | 8.2  | 8.7  | 1                                                    | 2    |
| C9V1 | 0.03                             | 0.08 | 50                             | 10                            | 5                          | 8.5                           | 9.1  | 9.6  | 2                                                    | 4    |
| C10  | 0.05                             | 0.09 | 50                             | 7                             | 7.5                        | 9.4                           | 10.0 | 10.6 | 2                                                    | 4    |
| C11  | 0.05                             | 0.10 | 50                             | 3                             | 8.2                        | 10.4                          | 11.0 | 11.6 | 4                                                    | 7    |
| C12  | 0.05                             | 0.10 | 50                             | 2                             | 9.1                        | 11.4                          | 12.0 | 12.7 | 4                                                    | 7    |
| C13  | 0.05                             | 0.10 | 50                             | 2                             | 10                         | 12.4                          | 13.0 | 14.1 | 5                                                    | 10   |
| C15  | 0.05                             | 0.10 | 50                             | 1                             | 11                         | 13.8                          | 15.0 | 15.6 | 5                                                    | 10   |
| C16  | 0.06                             | 0.11 | 25                             | 1                             | 12                         | 15.3                          | 16.0 | 17.1 | 6                                                    | 15   |
| C18  | 0.06                             | 0.11 | 25                             | 1                             | 13                         | 16.8                          | 18.0 | 19.1 | 6                                                    | 15   |
| C20  | 0.06                             | 0.11 | 25                             | 1                             | 15                         | 18.8                          | 20.0 | 21.2 | 6                                                    | 15   |
| C22  | 0.06                             | 0.11 | 25                             | 1                             | 16                         | 20.8                          | 22.0 | 23.3 | 6                                                    | 15   |
| C24  | 0.06                             | 0.11 | 25                             | 1                             | 18                         | 22.8                          | 24.0 | 25.6 | 7                                                    | 15   |
| C27  | 0.06                             | 0.11 | 25                             | 1                             | 20                         | 25.1                          | 27.0 | 28.9 | 7                                                    | 15   |
| C30  | 0.06                             | 0.11 | 25                             | 1                             | 22                         | 28                            | 30   | 32   | 8                                                    | 15   |
| C33  | 0.06                             | 0.11 | 25                             | 1                             | 24                         | 31                            | 33   | 35   | 8                                                    | 15   |
| C36  | 0.06                             | 0.11 | 10                             | 1                             | 27                         | 34                            | 36   | 38   | 21                                                   | 40   |
| C39  | 0.06                             | 0.11 | 10                             | 1                             | 30                         | 37                            | 39   | 41   | 21                                                   | 40   |
| C43  | 0.07                             | 0.12 | 10                             | 1                             | 33                         | 40                            | 43   | 46   | 24                                                   | 45   |
| C47  | 0.07                             | 0.12 | 10                             | 1                             | 36                         | 44                            | 47   | 50   | 24                                                   | 45   |
| C51  | 0.07                             | 0.12 | 10                             | 1                             | 39                         | 48                            | 51   | 54   | 25                                                   | 60   |
| C56  | 0.07                             | 0.12 | 10                             | 1                             | 43                         | 52                            | 56   | 60   | 25                                                   | 60   |
| C62  | 0.08                             | 0.13 | 10                             | 1                             | 47                         | 58                            | 62   | 66   | 25                                                   | 80   |
| C68  | 0.08                             | 0.13 | 10                             | 1                             | 51                         | 64                            | 68   | 72   | 25                                                   | 80   |
| C75  | 0.08                             | 0.13 | 10                             | 1                             | 56                         | 70                            | 75   | 79   | 30                                                   | 100  |
| C82  | 0.08                             | 0.13 | 10                             | 1                             | 62                         | 77                            | 82   | 87   | 30                                                   | 100  |
| C91  | 0.09                             | 0.13 | 5                              | 1                             | 68                         | 85                            | 91   | 96   | 60                                                   | 200  |
| C100 | 0.09                             | 0.13 | 5                              | 1                             | 75                         | 94                            | 100  | 106  | 60                                                   | 200  |
| C110 | 0.09                             | 0.13 | 5                              | 1                             | 82                         | 104                           | 110  | 116  | 80                                                   | 250  |
| C120 | 0.09                             | 0.13 | 5                              | 1                             | 91                         | 114                           | 120  | 127  | 80                                                   | 250  |
| C130 | 0.09                             | 0.13 | 5                              | 1                             | 100                        | 124                           | 130  | 141  | 110                                                  | 300  |
| C150 | 0.09                             | 0.13 | 5                              | 1                             | 110                        | 138                           | 150  | 156  | 130                                                  | 300  |
| C160 | 0.09                             | 0.13 | 5                              | 1                             | 120                        | 153                           | 160  | 171  | 150                                                  | 350  |
| C180 | 0.09                             | 0.13 | 5                              | 1                             | 130                        | 168                           | 180  | 191  | 180                                                  | 400  |
| C200 | 0.09                             | 0.13 | 5                              | 1                             | 150                        | 188                           | 200  | 212  | 200                                                  | 500  |
| C220 | 0.09                             | 0.13 | 2                              | 1                             | 160                        | 208                           | 220  | 233  | 350                                                  | 750  |
| C240 | 0.09                             | 0.13 | 2                              | 1                             | 180                        | 228                           | 240  | 256  | 400                                                  | 850  |
| C270 | 0.09                             | 0.13 | 2                              | 1                             | 200                        | 251                           | 270  | 289  | 450                                                  | 1000 |



# BZD27 SERIES

**CHARACTERISTICS** when used as transient suppressor diodes;  $T_j = 25\text{ }^{\circ}\text{C}$

| BZD27 | clamping voltage<br>(10/1000 pulse) | non-repetitive<br>at peak reverse | reverse current at recommended<br>stand-off voltage |            |
|-------|-------------------------------------|-----------------------------------|-----------------------------------------------------|------------|
|       | $V_{(CL)R}$<br>V                    | $I_{RSM}$<br>A                    | $I_R$<br>$\mu\text{A}$                              | $V_R$<br>V |
|       | max.                                |                                   | max.                                                |            |
| C7V5  | 11.3                                | 13.3                              | 1500                                                | 6.2        |
| C8V2  | 12.3                                | 12.2                              | 1200                                                | 6.8        |
| C9V1  | 13.3                                | 11.3                              | 100                                                 | 7.5        |
| C10   | 14.8                                | 10.1                              | 20                                                  | 8.2        |
| C11   | 15.7                                | 9.6                               | 5                                                   | 9.1        |
| C12   | 17.0                                | 8.8                               | 5                                                   | 10         |
| C13   | 18.9                                | 7.9                               | 5                                                   | 11         |
| C15   | 20.9                                | 7.2                               | 5                                                   | 12         |
| C16   | 22.9                                | 6.6                               | 5                                                   | 13         |
| C18   | 25.6                                | 5.9                               | 5                                                   | 15         |
| C20   | 28.4                                | 5.3                               | 5                                                   | 16         |
| C22   | 31.0                                | 4.8                               | 5                                                   | 18         |
| C24   | 33.8                                | 4.4                               | 5                                                   | 20         |
| C27   | 38.1                                | 3.9                               | 5                                                   | 22         |
| C30   | 42.2                                | 3.6                               | 5                                                   | 24         |
| C33   | 46.2                                | 3.2                               | 5                                                   | 27         |
| C36   | 50.1                                | 3.0                               | 5                                                   | 30         |
| C39   | 54.1                                | 2.8                               | 5                                                   | 33         |
| C43   | 60.7                                | 2.5                               | 5                                                   | 36         |
| C47   | 65.5                                | 2.3                               | 5                                                   | 39         |
| C51   | 70.8                                | 2.1                               | 5                                                   | 43         |
| C56   | 78.6                                | 1.9                               | 5                                                   | 47         |
| C62   | 86.5                                | 1.7                               | 5                                                   | 51         |
| C68   | 94.4                                | 1.6                               | 5                                                   | 56         |
| C75   | 103.5                               | 1.5                               | 5                                                   | 62         |
| C82   | 114.0                               | 1.3                               | 5                                                   | 68         |
| C91   | 126                                 | 1.2                               | 5                                                   | 75         |
| C100  | 139                                 | 1.1                               | 5                                                   | 82         |
| C110  | 152                                 | 1.0                               | 5                                                   | 91         |
| C120  | 167                                 | 0.90                              | 5                                                   | 100        |
| C130  | 185                                 | 0.81                              | 5                                                   | 110        |
| C150  | 204                                 | 0.73                              | 5                                                   | 120        |
| C160  | 224                                 | 0.67                              | 5                                                   | 130        |
| C180  | 249                                 | 0.60                              | 5                                                   | 150        |
| C200  | 276                                 | 0.54                              | 5                                                   | 160        |
| C220  | 305                                 | 0.50                              | 5                                                   | 180        |
| C240  | 336                                 | 0.45                              | 5                                                   | 200        |
| C270  | 380                                 | 0.40                              | 5                                                   | 220        |
| C300  | 419                                 | 0.36                              | 5                                                   | 240        |
| C330  | 459                                 | 0.33                              | 5                                                   | 270        |
| C360  | 498                                 | 0.30                              | 5                                                   | 300        |
| C390  | 537                                 | 0.28                              | 5                                                   | 330        |
| C430  | 603                                 | 0.25                              | 5                                                   | 360        |
| C470  | 655                                 | 0.23                              | 5                                                   | 390        |
| C510  | 707                                 | 0.21                              | 5                                                   | 430        |

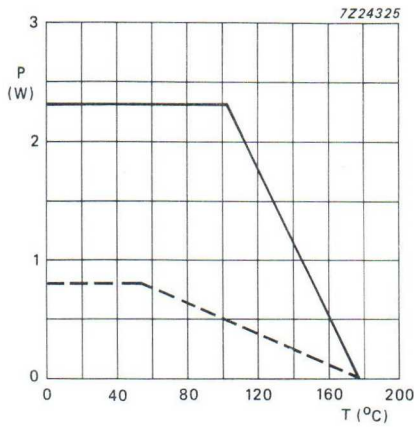


Fig. 4 Maximum total power dissipation as a function of temperature.

— = tie-point temperature  
 --- = ambient temperature and device mounted as shown in Fig. 2.

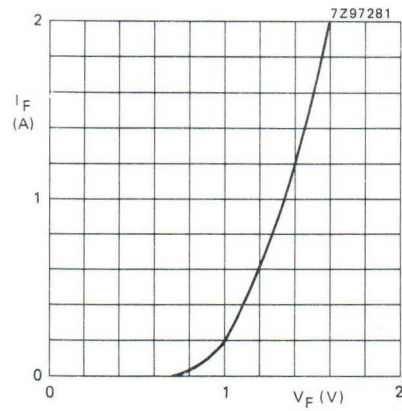


Fig. 5 Forward voltage;  $T_j = 25^{\circ}\text{C}$ ; typical values.

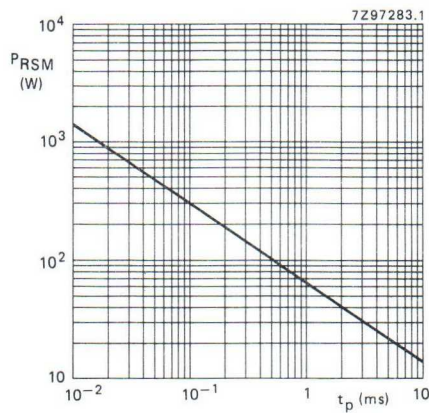


Fig. 6 Maximum non-repetitive peak reverse power dissipation (square pulse);  $T_j = 25^{\circ}\text{C}$  prior to surge.



## SILICON PLANAR VOLTAGE REGULATOR DIODES

Silicon planar voltage regulator diodes, in a SOT-89 plastic envelope, intended for stabilization applications in thick and thin-film circuits.

The series covers the normalized range of nominal working voltages from 2,4 V to 75 V with a tolerance of  $\pm 5\%$  (international standard E24 range).

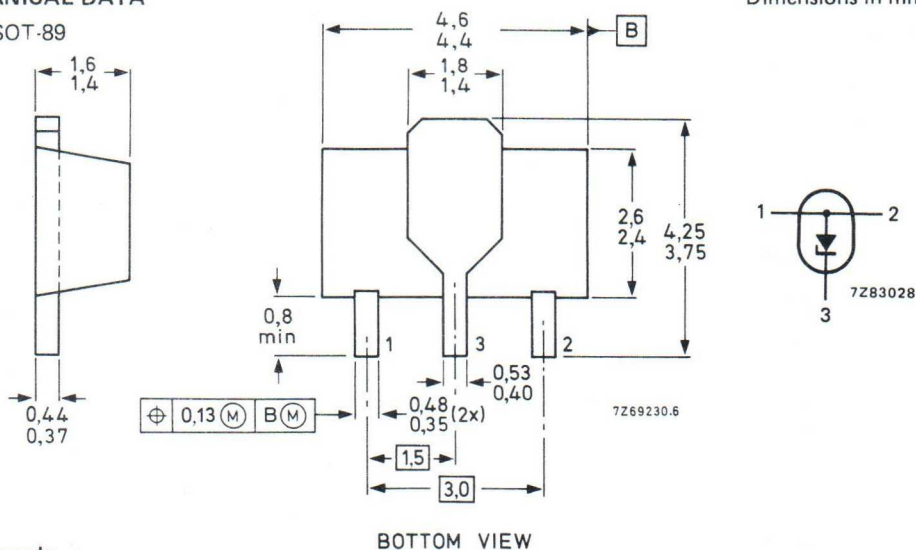
## QUICK REFERENCE DATA

|                                                                    |           |      |                      |
|--------------------------------------------------------------------|-----------|------|----------------------|
| Working voltage range                                              | $V_Z$     | nom. | 2,4 to 75 V          |
| Working voltage tolerance (E24 range)                              |           |      | $\pm 5\%$            |
| Total power dissipation up to $T_{amb} = 25\text{ }^\circ\text{C}$ | $P_{tot}$ | max. | 1 W                  |
| Junction temperature                                               | $T_j$     | max. | 150 $^\circ\text{C}$ |

## MECHANICAL DATA

Fig. 1 SOT-89

Dimensions in mm



BOTTOM VIEW

## Marking code

BZV49- C2V4 = 2Y4  
C2V7 = 2Y7  
C3V0 = 3Y0  
C3V3 = 3Y3  
C3V6 = 3Y6  
C3V9 = 3Y9  
C4V3 = 4Y3  
C4V7 = 4Y7

C5V1 = 5Y1  
C5V6 = 5Y6  
C6V2 = 6Y2  
C6V8 = 6Y8  
C7V5 = 7Y5  
C8V2 = 8Y2  
C9V1 = 9Y1  
C10 = 10Y  
C11 = 11Y

C12 = 12Y  
C13 = 13Y  
C15 = 15Y  
C16 = 16Y  
C18 = 18Y  
C20 = 20Y  
C22 = 22Y  
C24 = 24Y  
C27 = 27Y  
C30 = 30Y

C33 = 33Y  
C36 = 36Y  
C39 = 39Y  
C43 = 43Y  
C47 = 47Y  
C51 = 51Y  
C56 = 56Y  
C62 = 62Y  
C68 = 68Y  
C75 = 75Y

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                        |             |                          |                                |
|------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------|--------------------------------|
| Repetitive peak forward current                                                                                        | $I_{FRM}$   | max.                     | 250 mA                         |
| Average forward current<br>(averaged over any 20 ms period)                                                            | $I_{F(AV)}$ | max.                     | 250 mA                         |
| Working current (d.c.)                                                                                                 | $I_Z$       | limited by $P_{tot}$ max |                                |
| Total power dissipation *<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                                              | $P_{tot}$   | max.                     | 1 W                            |
| Non-repetitive peak reverse power dissipation *<br>$T_j = 25\text{ }^{\circ}\text{C}$ ; $t_p = 100\text{ }\mu\text{s}$ | $P_{ZSM}$   | max.                     | 40 W                           |
| Storage temperature                                                                                                    | $T_{stg}$   |                          | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                                                                   | $T_j$       | max.                     | 150 $^{\circ}\text{C}$         |

## THERMAL RESISTANCE

|                                        |                 |   |         |
|----------------------------------------|-----------------|---|---------|
| From junction to collector tab         | $R_{th\ j-tab}$ | = | 15 K/W  |
| From junction to ambient in free air * | $R_{th\ j-a}$   | = | 125 K/W |

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$

Forward voltage

$I_F = 50\text{ mA}$

|       |   |       |
|-------|---|-------|
| $V_F$ | < | 1,0 V |
|-------|---|-------|

Reverse current

BZV49- C2V4

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 50 $\mu\text{A}$ |
|-------|---|------------------|

C2V7

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 20 $\mu\text{A}$ |
|-------|---|------------------|

C3V0

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 10 $\mu\text{A}$ |
|-------|---|------------------|

C3V3

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 5 $\mu\text{A}$ |
|-------|---|-----------------|

C3V6

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 5 $\mu\text{A}$ |
|-------|---|-----------------|

C3V9

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

C4V3

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

C4V7

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

C5V1

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 2 $\mu\text{A}$ |
|-------|---|-----------------|

C5V6

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 1 $\mu\text{A}$ |
|-------|---|-----------------|

C6V2

$V_R = 4\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

C6V8

$V_R = 4\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 2 $\mu\text{A}$ |
|-------|---|-----------------|

C7V5

$V_R = 5\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 1 $\mu\text{A}$ |
|-------|---|-----------------|

C8V2

$V_R = 5\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 700 nA |
|-------|---|--------|

C9V1

$V_R = 6\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 500 nA |
|-------|---|--------|

C10

$V_R = 7\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 200 nA |
|-------|---|--------|

C11 to C13

$V_R = 8\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 100 nA |
|-------|---|--------|

C15 to C75

$V_R = 0,7\text{ V}_{Znom}$

|       |   |       |
|-------|---|-------|
| $I_R$ | < | 50 nA |
|-------|---|-------|

\* Device mounted on a ceramic substrate: area = 2,5 cm<sup>2</sup>; thickness = 0,7 mm.



$T_j = 25\text{ }^{\circ}\text{C}$ E24 logarithmic range (tolerance  $\pm 5\%$ )

| BZV49-... | working voltage                     |      | differential resistance             |      | temperature coefficient             |      |      | diode capacitance              |      |
|-----------|-------------------------------------|------|-------------------------------------|------|-------------------------------------|------|------|--------------------------------|------|
|           | $V_Z$ (V)                           |      | $r_{\text{diff}}$ ( $\Omega$ )      |      | $S_Z$ (mV/K)                        |      |      | $C_d$ (pF); $f = 1\text{ MHz}$ |      |
|           | at $I_{Z\text{test}} = 5\text{ mA}$ |      | at $I_{Z\text{test}} = 5\text{ mA}$ |      | at $I_{Z\text{test}} = 5\text{ mA}$ |      |      | $V_R = 0$                      |      |
|           | min.                                | max. | typ.                                | max. | min.                                | typ. | max. | typ.                           | max. |
| C2V4      | 2,2                                 | 2,6  | 70                                  | 100  | -3,5                                | -1,6 | 0    | 375                            | 450  |
| C2V7      | 2,5                                 | 2,9  | 75                                  | 100  | -3,5                                | -2,0 | 0    | 350                            | 450  |
| C3V0      | 2,8                                 | 3,2  | 80                                  | 95   | -3,5                                | -2,1 | 0    | 350                            | 450  |
| C3V3      | 3,1                                 | 3,5  | 85                                  | 95   | -3,5                                | -2,4 | 0    | 325                            | 450  |
| C3V6      | 3,4                                 | 3,8  | 85                                  | 90   | -3,5                                | -2,4 | 0    | 300                            | 450  |
| C3V9      | 3,7                                 | 4,1  | 85                                  | 90   | -3,5                                | -2,5 | 0    | 300                            | 450  |
| C4V3      | 4,0                                 | 4,6  | 80                                  | 90   | -3,5                                | -2,5 | 0    | 275                            | 450  |
| C4V7      | 4,4                                 | 5,0  | 50                                  | 80   | -3,5                                | -1,4 | 0,2  | 130                            | 180  |
| C5V1      | 4,8                                 | 5,4  | 40                                  | 60   | -2,7                                | -0,8 | 1,2  | 110                            | 160  |
| C5V6      | 5,2                                 | 6,0  | 15                                  | 40   | -2,0                                | 1,2  | 2,5  | 95                             | 140  |
| C6V2      | 5,8                                 | 6,6  | 6                                   | 10   | 0,4                                 | 2,3  | 3,7  | 90                             | 130  |
| C6V8      | 6,4                                 | 7,2  | 6                                   | 15   | 1,2                                 | 3,0  | 4,5  | 85                             | 110  |
| C7V5      | 7,0                                 | 7,9  | 6                                   | 15   | 2,5                                 | 4,0  | 5,3  | 80                             | 100  |
| C8V2      | 7,7                                 | 8,7  | 6                                   | 15   | 3,2                                 | 4,6  | 6,2  | 75                             | 95   |
| C9V1      | 8,5                                 | 9,6  | 6                                   | 15   | 3,8                                 | 5,5  | 7,0  | 70                             | 90   |
| C10       | 9,4                                 | 10,6 | 8                                   | 20   | 4,5                                 | 6,4  | 8,0  | 70                             | 90   |
| C11       | 10,4                                | 11,6 | 10                                  | 20   | 5,4                                 | 7,4  | 9,0  | 65                             | 85   |
| C12       | 11,4                                | 12,7 | 10                                  | 25   | 6,0                                 | 8,4  | 10,0 | 65                             | 85   |
| C13       | 12,4                                | 14,1 | 10                                  | 30   | 7,0                                 | 9,4  | 11,0 | 60                             | 80   |
| C15       | 13,8                                | 15,6 | 10                                  | 30   | 9,2                                 | 11,4 | 13,0 | 55                             | 75   |
| C16       | 15,3                                | 17,1 | 10                                  | 40   | 10,4                                | 12,4 | 14,0 | 52                             | 75   |
| C18       | 16,8                                | 19,1 | 10                                  | 45   | 12,4                                | 14,4 | 16,0 | 47                             | 70   |
| C20       | 18,8                                | 21,2 | 15                                  | 55   | 14,4                                | 16,4 | 18,0 | 36                             | 60   |
| C22       | 20,8                                | 23,3 | 20                                  | 55   | 16,4                                | 18,4 | 20,0 | 34                             | 60   |
| C24       | 22,8                                | 25,6 | 25                                  | 70   | 18,4                                | 20,4 | 22,0 | 33                             | 55   |
|           | at $I_{Z\text{test}} = 2\text{ mA}$ |      | at $I_{Z\text{test}} = 2\text{ mA}$ |      | at $I_{Z\text{test}} = 2\text{ mA}$ |      |      |                                |      |
|           | min.                                | max. | typ.                                | max. | min.                                | typ. | max. | typ.                           | max. |
| C27       | 25,1                                | 28,9 | 25                                  | 80   | 21,4                                | 23,4 | 25,3 | 30                             | 50   |
| C30       | 28,0                                | 32,0 | 30                                  | 80   | 24,4                                | 26,6 | 29,4 | 27                             | 50   |
| C33       | 31,0                                | 35,0 | 35                                  | 80   | 27,4                                | 29,7 | 33,4 | 25                             | 45   |
| C36       | 34,0                                | 38,0 | 35                                  | 90   | 30,4                                | 33,0 | 37,4 | 23                             | 45   |
| C39       | 37,0                                | 41,0 | 40                                  | 130  | 33,4                                | 36,4 | 41,2 | 21                             | 45   |
| C43       | 40,0                                | 46,0 | 45                                  | 150  | 37,6                                | 41,2 | 46,6 | 21                             | 40   |
| C47       | 44,0                                | 50,0 | 50                                  | 170  | 42,0                                | 46,1 | 51,8 | 19                             | 40   |
| C51       | 48,0                                | 54,0 | 60                                  | 180  | 46,6                                | 51,0 | 57,2 | 19                             | 40   |
| C56       | 52,0                                | 60,0 | 70                                  | 200  | 52,2                                | 57,0 | 63,8 | 18                             | 40   |
| C62       | 58,0                                | 66,0 | 80                                  | 215  | 58,8                                | 64,4 | 71,6 | 17                             | 35   |
| C68       | 64,0                                | 72,0 | 90                                  | 240  | 65,6                                | 71,7 | 79,8 | 17                             | 35   |
| C75       | 70,0                                | 79,0 | 95                                  | 255  | 73,4                                | 80,2 | 88,6 | 16,5                           | 35   |

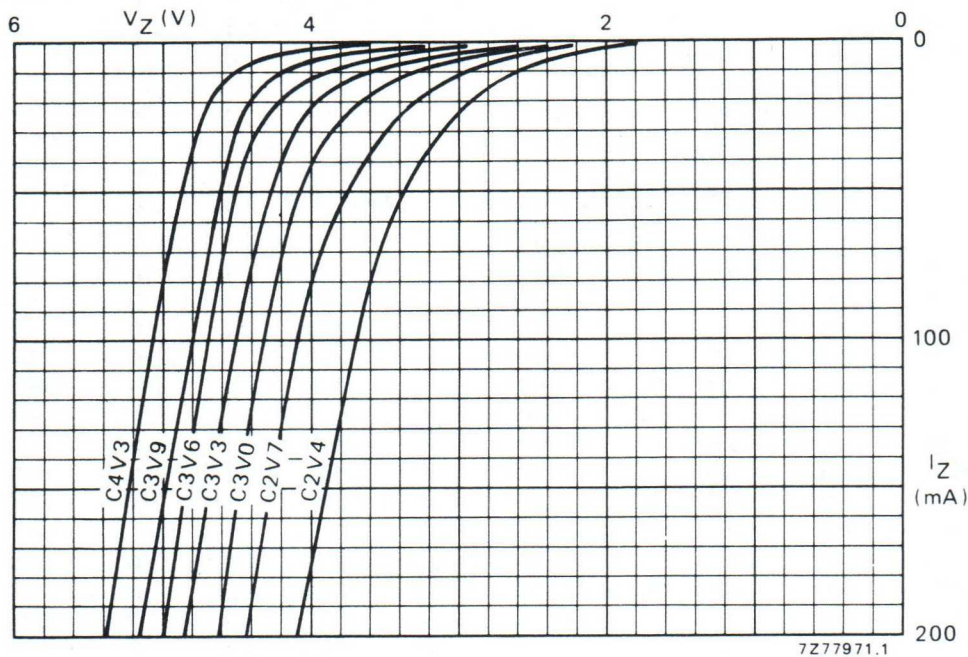


Fig. 2 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

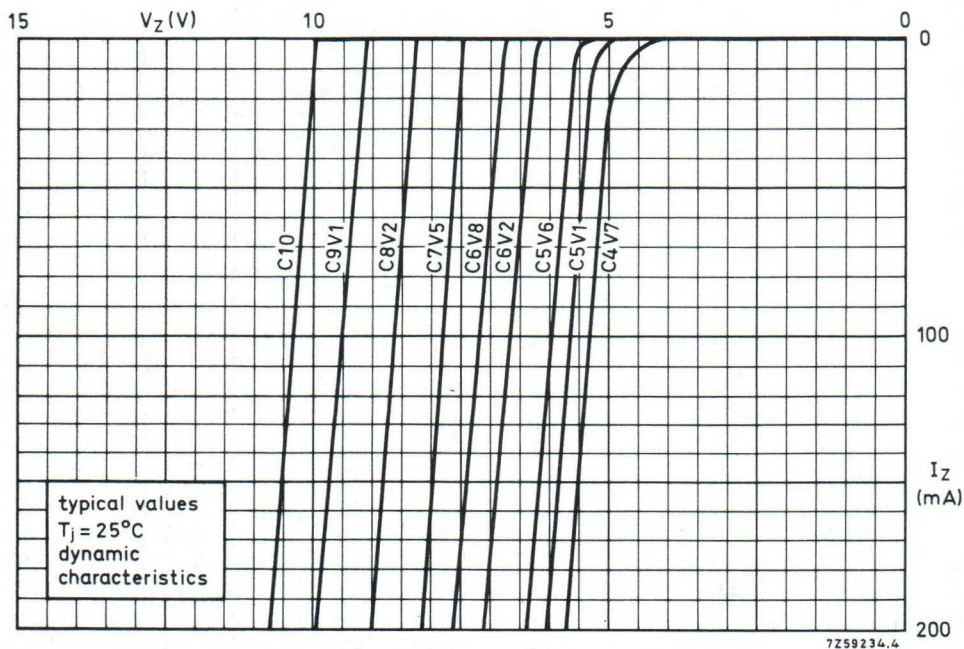
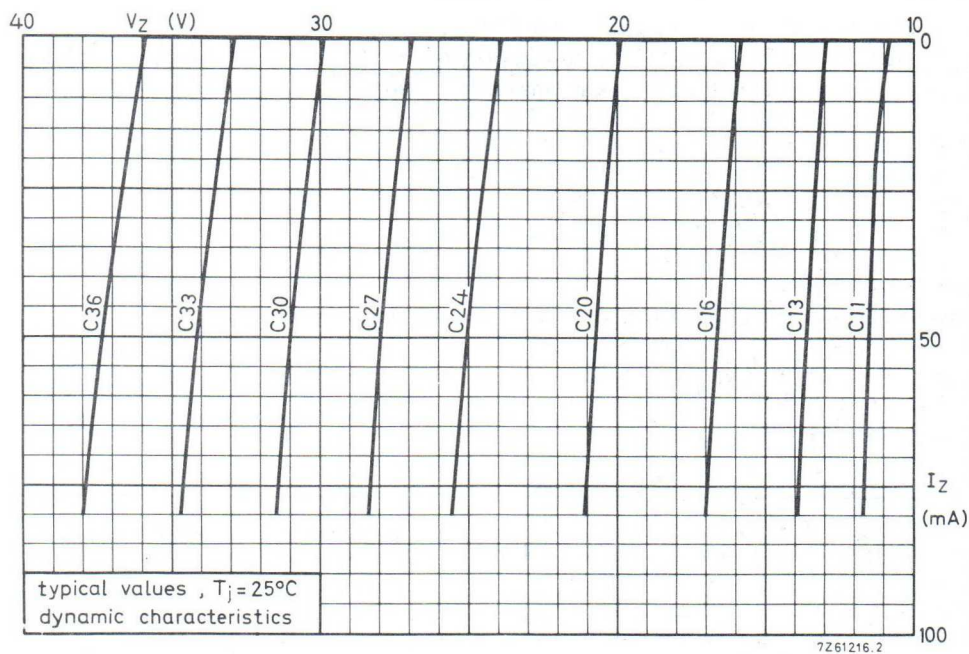
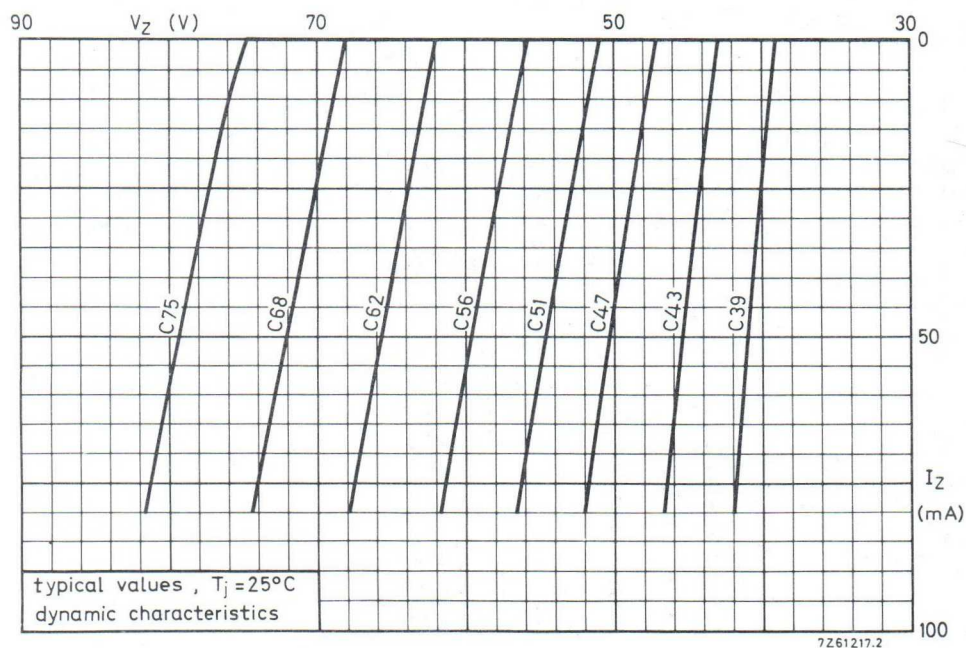


Fig. 3 Dynamic characteristics; typical values at  $T_j = 25^\circ\text{C}$ .

Fig. 4 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .Fig. 5 Dynamic characteristics; typical values at  $T_j = 25^\circ\text{C}$ .



## Model for calculating the static working voltage ( $V_Z \text{ stat}$ ).

This model can be derived from  $V_Z \text{ stat} = V_Z \text{ dyn} + \Delta V_Z$  of which  $V_Z \text{ dyn}$  is given in the preceding tables and can be derived from the typical dynamic characteristic curves (Figs 2, 3, 4 and 5)

$\Delta V_Z = \Delta T \times S_Z$ . For  $S_Z$  see tables and graphs  $S_Z$  versus  $T_j$ .

$\Delta T = P_{\text{tot}} \times R_{\text{th j-a}} = I_Z \times V_Z \text{ dyn} \times R_{\text{th j-a}}$ .

Following  $\Delta V_Z = I_Z \times V_Z \text{ dyn} \times R_{\text{th j-a}} \times S_Z$  and the model will be:

$$V_Z \text{ stat} = V_Z \text{ dyn} + I_Z \times V_Z \text{ dyn} \times R_{\text{th j-a}} \times S_Z$$

## Calculating example

BZV49-C24 mounted on a ceramic substrate of  $7 \times 5 \times 0,6 \text{ mm}$ ; at  $I_Z = 7 \text{ mA}$ .

$$\begin{aligned} V_Z \text{ stat} &= 24 + \left( \frac{7}{1000} \times 24 \times \frac{125}{1000} \times 20,3 \right) \\ &= 24 + 0,4 = 24,4 \text{ V.} \end{aligned}$$

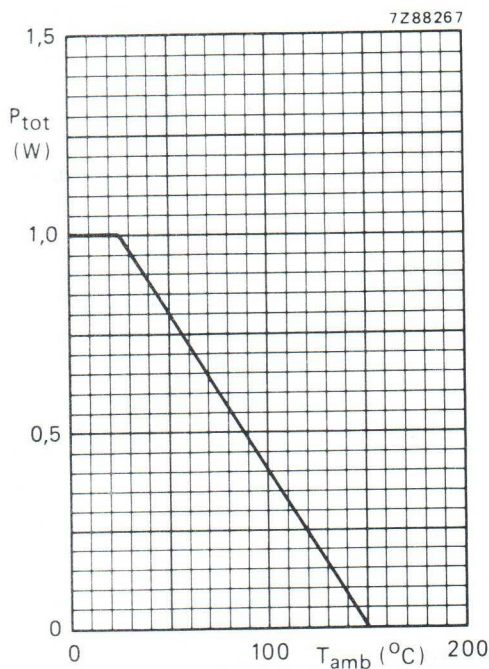


Fig. 6 Power derating curve.

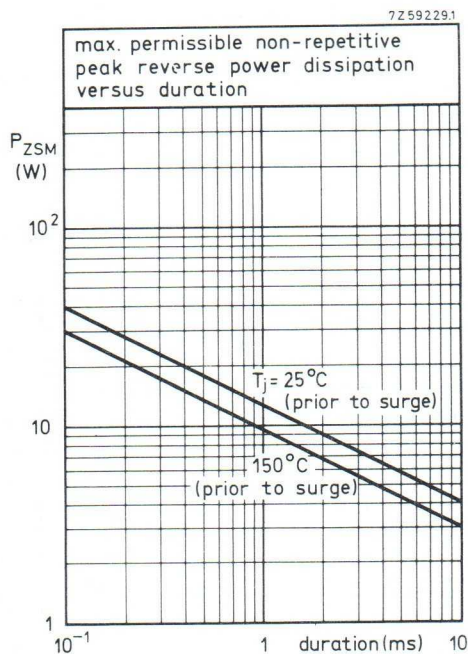


Fig. 7.

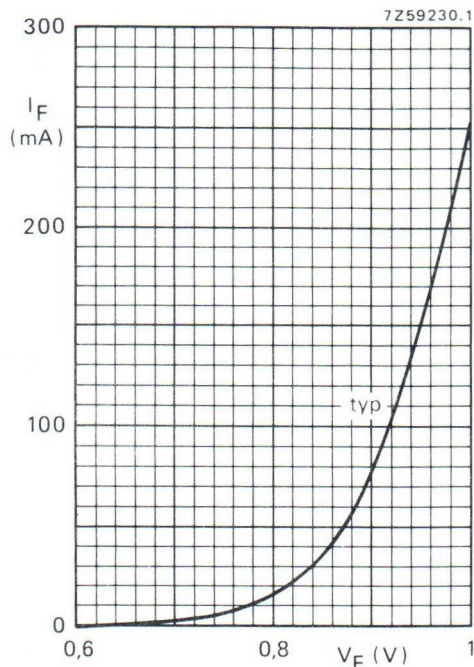
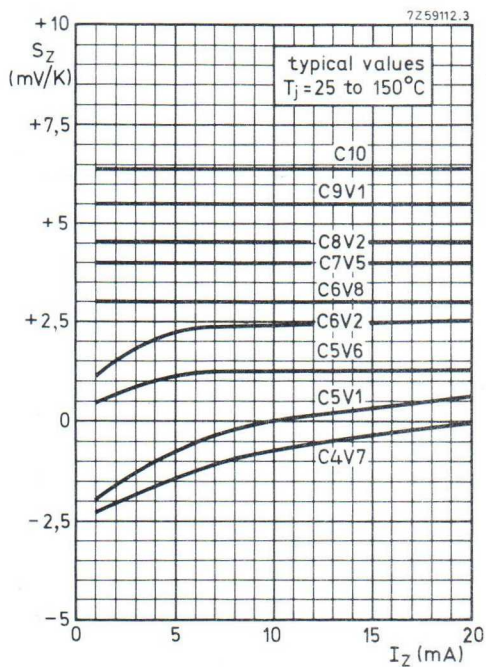
Fig. 8  $T_j = 25\text{ }^{\circ}\text{C}$ .

Fig. 9.

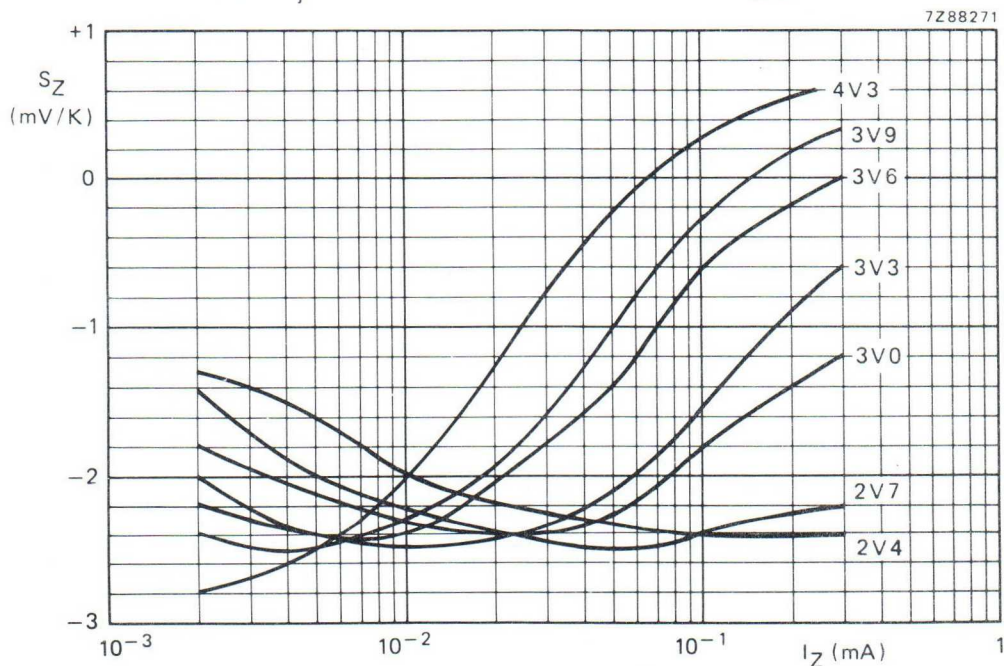


Fig. 10 Typical values temperature coefficient.



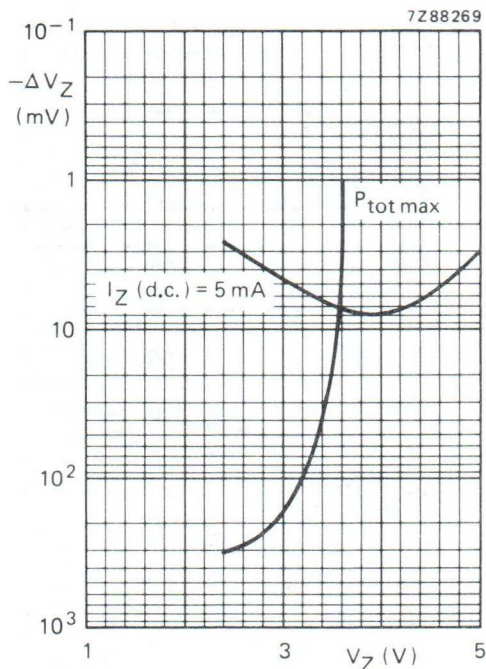


Fig. 11 Typical change of working voltage;  
 $T_j = 25^\circ\text{C}$ .

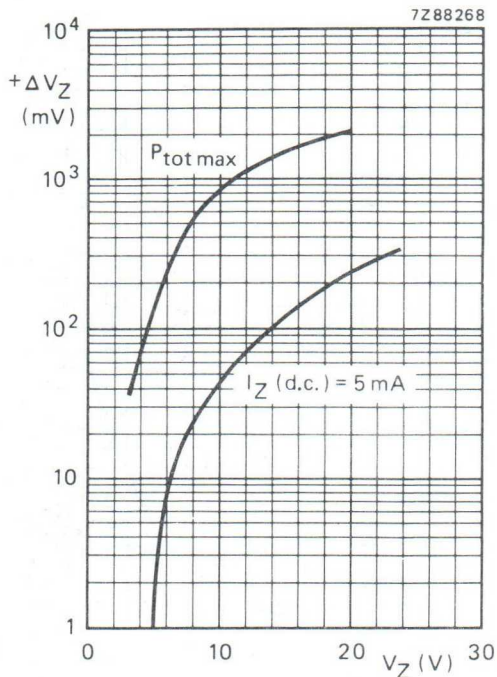


Fig. 12 Typical change of working voltage;  
 $T_{amb} = 25^\circ\text{C}$ .

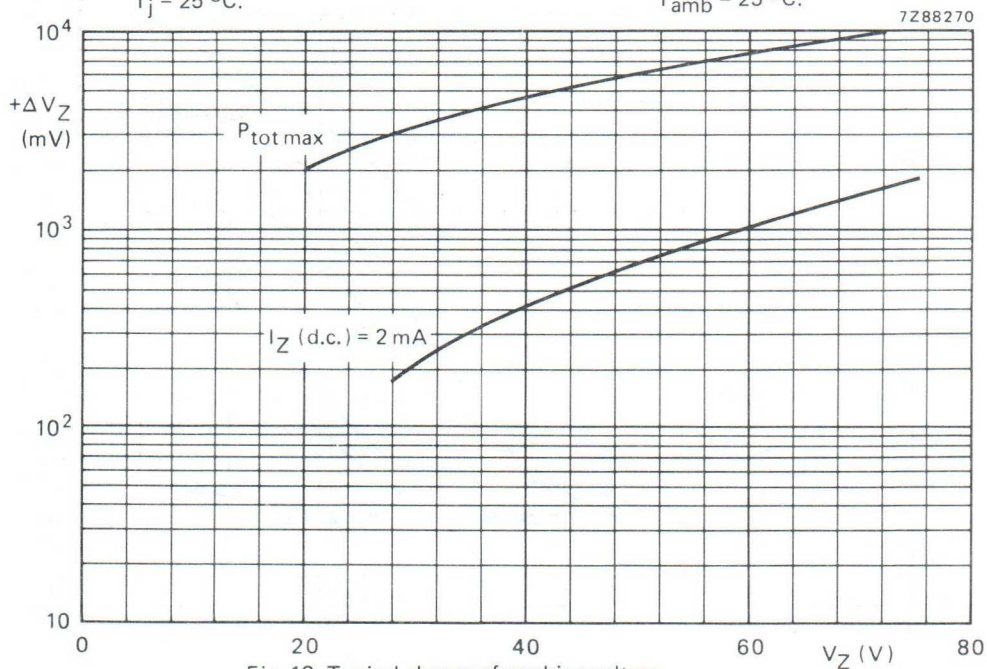


Fig. 13 Typical change of working voltage.

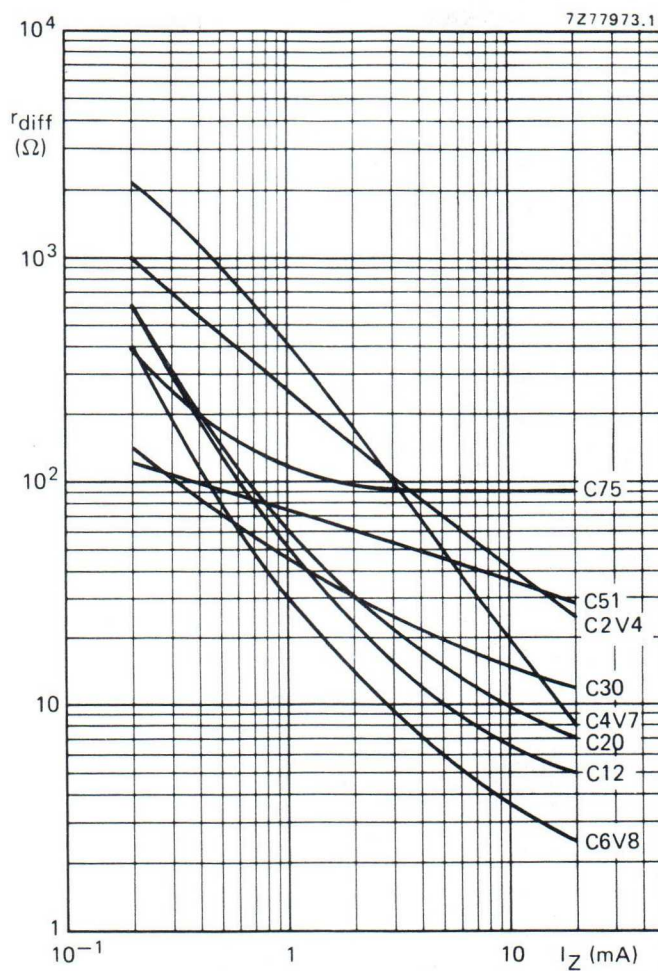
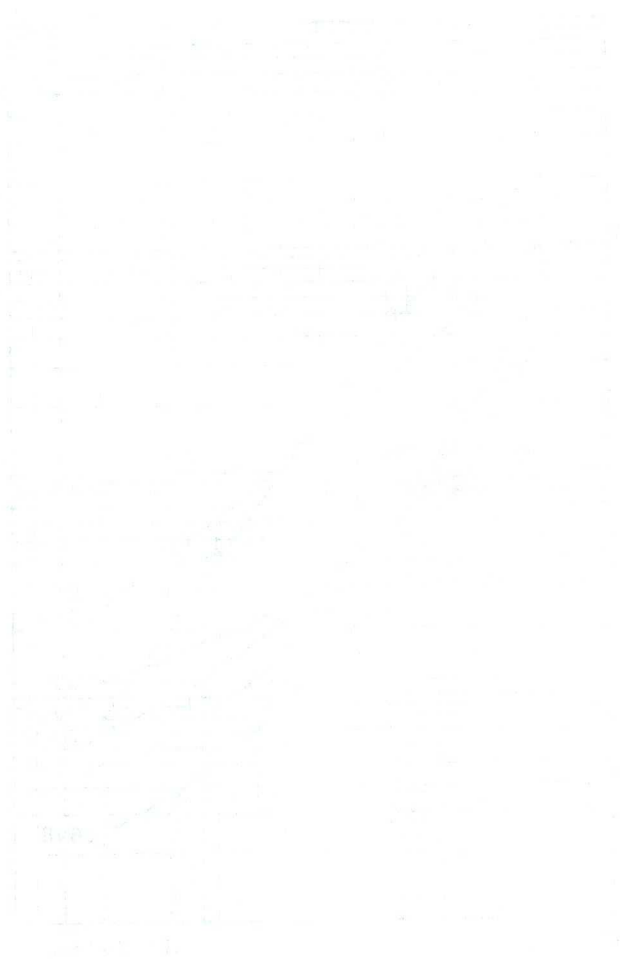


Fig. 14 Typical values;  $T_j = 25^\circ\text{C}$ ;  $f = 1\text{ kHz}$ .



## VOLTAGE REGULATOR DIODES FOR SURFACE MOUNTING

Silicon planar diodes designed for use as low-voltage stabilizers or voltage references. They are available in the international standardized E24 ( $\pm 5\%$ ) range, and also in tolerance ranges of 2% and 3%. The series consists of 37 types with nominal working voltages ranging from 2,4 V to 75 V.

The SM diode is a leadless diode in a hermetically sealed glass SOD-80 envelope with tin plated metal discs at each end. It is suitable for "automatic placement" and as such it can withstand immersion soldering.

The diodes are delivered in "super 8" tape.

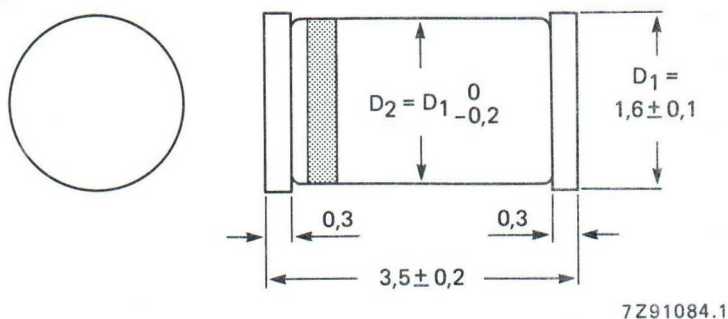
### QUICK REFERENCE DATA

|                                                              |                |                  |
|--------------------------------------------------------------|----------------|------------------|
| Working voltage range                                        | $V_Z$          | nom. 2,4 to 75 V |
| Total power dissipation up to<br>flange temperature of 50 °C | $P_{tot}$      | max. 500 mW      |
| Non-repetitive peak reverse power dissipation                | $P_{ZSM}$      | max. 30 W        |
| Junction temperature                                         | $T_j$          | max. 200 °C      |
| Thermal resistance from junction to tie-point                | $R_{th\ j-tp}$ | = 0,30 K/mW      |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-80.



The BZV55 cathode is indicated by a yellow band.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134).

Average forward current (averaged  
over any 20 ms period)

$I_F(AV)$  max. 250 mA

Repetitive peak forward current

$I_{FRM}$  max. 250 mA

Total power dissipation

up to  $T_{flange} = 50\text{ }^{\circ}\text{C}$

$P_{tot}$  max. 500 mW

up to  $T_{amb} = 50\text{ }^{\circ}\text{C}$  and mounted on a ceramic  
substrate of 10 mm x 10 mm x 0,6 mm

$P_{tot}$  max. 400 mW

Non-repetitive peak reverse power dissipation

$t = 100\text{ }\mu\text{s}$ ;  $T_j = 150\text{ }^{\circ}\text{C}$

$P_{ZSM}$  max. 30 W

Storage temperature

$T_{stg}$   $-65$  to  $+200\text{ }^{\circ}\text{C}$

Junction temperature

$T_j$  max.  $200\text{ }^{\circ}\text{C}$

## THERMAL RESISTANCE

From junction to tie-point (flanges)

$R_{th\ j-tp}$  = 0,30 K/mW

From junction to ambient when mounted on a ceramic  
substrate of 10 mm x 10 mm x 0,6 mm

$R_{th\ j-a}$  = 0,38 K/mW

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Forward voltage

$I_F = 10\text{ mA}$

$V_F$  < 0,9 V

Reverse current

BZV55- .2V4

$V_R = 1\text{ V}$

$I_R$  < 50  $\mu\text{A}$

.2V7

$V_R = 1\text{ V}$

$I_R$  < 20  $\mu\text{A}$

.3V0

$V_R = 1\text{ V}$

$I_R$  < 10  $\mu\text{A}$

.3V3

$V_R = 1\text{ V}$

$I_R$  < 5  $\mu\text{A}$

.3V6

$V_R = 1\text{ V}$

$I_R$  < 5  $\mu\text{A}$

.3V9

$V_R = 1\text{ V}$

$I_R$  < 3  $\mu\text{A}$

.4V3

$V_R = 1\text{ V}$

$I_R$  < 3  $\mu\text{A}$

.4V7

$V_R = 2\text{ V}$

$I_R$  < 3  $\mu\text{A}$

.5V1

$V_R = 2\text{ V}$

$I_R$  < 2  $\mu\text{A}$

.5V6

$V_R = 2\text{ V}$

$I_R$  < 1  $\mu\text{A}$

.6V2

$V_R = 4\text{ V}$

$I_R$  < 3  $\mu\text{A}$

.6V8

$V_R = 4\text{ V}$

$I_R$  < 2  $\mu\text{A}$

.7V5

$V_R = 5\text{ V}$

$I_R$  < 1  $\mu\text{A}$

.8V2

$V_R = 5\text{ V}$

$I_R$  < 700 nA

.9V1

$V_R = 6\text{ V}$

$I_R$  < 500 nA

.10

$V_R = 7\text{ V}$

$I_R$  < 200 nA

.11 to .13

$V_R = 8\text{ V}$

$I_R$  < 100 nA

.15 to .75

$V_R = 0,7\text{ }V_{Znom}$

$I_R$  < 50 nA

. = C for E24 ( $\pm 5\%$ ) tolerance

. = B for  $\pm 2\%$

. = F for  $\pm 3\%$



± 2% tolerance range

| BZV55B | working voltage       |       | differential resistance |      | temperature coefficient |       |      | differential resistance |      |
|--------|-----------------------|-------|-------------------------|------|-------------------------|-------|------|-------------------------|------|
|        | $V_Z$ (V)             |       | $r_{diff}$ ( $\Omega$ ) |      | $S_Z$ (mV/K)            |       |      | $r_{diff}$ ( $\Omega$ ) |      |
|        | at $I_{Ztest} = 5$ mA |       | at $I_{Ztest} = 5$ mA   |      | at $I_{Ztest} = 5$ mA   |       |      | at $I_Z = 1$ mA         |      |
|        | min.                  | max.  | typ.                    | max. | min.                    | typ.  | max. | typ.                    | max. |
| B2V4   | 2,35                  | 2,45  | 70                      | 100  | -3,5                    | -1,6  | 0    | 275                     | 600  |
| B2V7   | 2,65                  | 2,75  | 75                      | 100  | -3,5                    | -2,0  | 0    | 300                     | 600  |
| B3V0   | 2,94                  | 3,06  | 80                      | 95   | -3,5                    | -2,1  | 0    | 325                     | 600  |
| B3V3   | 3,23                  | 3,37  | 85                      | 95   | -3,5                    | -2,4  | 0    | 350                     | 600  |
| B3V6   | 3,53                  | 3,67  | 85                      | 90   | -3,5                    | -2,4  | 0    | 375                     | 600  |
| B3V9   | 3,82                  | 3,98  | 85                      | 90   | -3,5                    | -2,5  | 0    | 400                     | 600  |
| B4V3   | 4,21                  | 4,39  | 80                      | 90   | -3,5                    | -2,5  | 0    | 410                     | 600  |
| B4V7   | 4,61                  | 4,79  | 50                      | 80   | -3,5                    | -1,4  | 0,2  | 425                     | 500  |
| B5V1   | 5,00                  | 5,20  | 40                      | 60   | -2,7                    | -0,8  | 1,2  | 400                     | 480  |
| B5V6   | 5,49                  | 5,71  | 15                      | 40   | -2,0                    | 1,2   | 2,5  | 80                      | 400  |
| B6V2   | 6,08                  | 6,32  | 6                       | 10   | 0,4                     | 2,3   | 3,7  | 40                      | 150  |
| B6V8   | 6,66                  | 6,94  | 6                       | 15   | 1,2                     | 3,0   | 4,5  | 30                      | 80   |
| B7V5   | 7,35                  | 7,65  | 6                       | 15   | 2,5                     | 4,0   | 5,3  | 30                      | 80   |
| B8V2   | 8,04                  | 8,36  | 6                       | 15   | 3,2                     | 4,6   | 6,2  | 40                      | 80   |
| B9V1   | 8,92                  | 9,28  | 6                       | 15   | 3,8                     | 5,5   | 7,0  | 40                      | 100  |
| B10    | 9,80                  | 10,20 | 8                       | 20   | 4,5                     | 6,4   | 8,0  | 50                      | 150  |
| B11    | 10,80                 | 11,20 | 10                      | 20   | 5,4                     | 7,4   | 9,0  | 50                      | 150  |
| B12    | 11,80                 | 12,20 | 10                      | 25   | 6,0                     | 8,4   | 10,0 | 50                      | 150  |
| B13    | 12,70                 | 13,30 | 10                      | 30   | 7,0                     | 9,4   | 11,0 | 50                      | 170  |
| B15    | 14,70                 | 15,30 | 10                      | 30   | 9,2                     | 11,4  | 13,0 | 50                      | 200  |
| B16    | 15,70                 | 16,30 | 10                      | 40   | 10,4                    | 12,4  | 14,0 | 50                      | 200  |
| B18    | 17,60                 | 18,40 | 10                      | 45   | 12,4                    | 14,4  | 16,0 | 50                      | 225  |
| B20    | 19,60                 | 20,40 | 15                      | 55   | 14,4                    | 16,4  | 18,0 | 60                      | 225  |
| B22    | 21,60                 | 22,40 | 20                      | 55   | 16,4                    | 18,4  | 20,0 | 60                      | 250  |
| B24    | 23,50                 | 24,50 | 25                      | 70   | 18,4                    | 20,4  | 22,0 | 60                      | 250  |
|        | at $I_{Ztest} = 2$ mA |       | at $I_{Ztest} = 2$ mA   |      | at $I_{Ztest} = 2$ mA   |       |      | at $I_Z = 0,5$ mA       |      |
| B27    | 26,50                 | 27,50 | 25                      | 80   | 21,4                    | 23,4  | 25,3 | 65                      | 300  |
| B30    | 29,40                 | 30,60 | 30                      | 80   | 24,4                    | 26,6  | 29,4 | 70                      | 300  |
| B33    | 32,30                 | 33,70 | 35                      | 80   | 27,4                    | 29,7  | 33,4 | 75                      | 325  |
| B36    | 35,30                 | 36,70 | 35                      | 90   | 30,4                    | 33,0  | 37,4 | 80                      | 350  |
| B39    | 38,20                 | 39,80 | 40                      | 130  | 33,4                    | 36,4  | 41,2 | 80                      | 350  |
| B43    | 42,10                 | 43,90 | 45                      | 150  | 37,6                    | 41,2  | 46,6 | 85                      | 375  |
| B47    | 46,10                 | 47,90 | 50                      | 170  | 42,0                    | 46,1  | 51,8 | 85                      | 375  |
| B51    | 50,00                 | 51,00 | 60                      | 180  | 46,6                    | 51,0  | 57,2 | 90                      | 400  |
| B56    | 54,90                 | 57,10 | 70                      | 200  | 52,2                    | 57,0  | 63,8 | 100                     | 425  |
| B62    | 60,80                 | 63,20 | 80                      | 215  | 58,8                    | 64,4  | 71,6 | 120                     | 450  |
| B68    | 66,60                 | 69,40 | 90                      | 240  | 65,6                    | 71,7  | 79,8 | 150                     | 475  |
| B75    | 73,50                 | 76,50 | 95                      | 255  | 73,4                    | 80,02 | 88,6 | 170                     | 500  |

# BZV55 SERIES

$T_j = 25\text{ }^{\circ}\text{C}$   
 $\pm 3\%$  tolerance range

| ± 3% tolerance range |                              |       |                              |      |                              |                          |     |
|----------------------|------------------------------|-------|------------------------------|------|------------------------------|--------------------------|-----|
| BZV55F               | working voltage              |       | differential resistance      |      | temperature coefficient      | leakage current          |     |
|                      | $V_Z$ (V)                    |       | $r_{diff}$ (Ω)               |      | $S_Z$ (mV/K)                 | $I_R$ at $V_R$           |     |
|                      | at $I_{Ztest} = 5\text{ mA}$ |       | at $I_{Ztest} = 5\text{ mA}$ |      | at $I_{Ztest} = 5\text{ mA}$ | $\mu\text{A}$            | V   |
|                      | min.                         | max.  | typ.                         | max. | typ.                         |                          |     |
| F2V                  | 2,33                         | 2,47  | 70                           | 100  | -1,6                         | 50                       | 1   |
| F2V7                 | 2,62                         | 2,78  | 75                           | 100  | -2,0                         | 20                       | 1   |
| F3V0                 | 2,91                         | 3,09  | 80                           | 100  | -2,1                         | 10                       | 1   |
| F3V3                 | 3,20                         | 3,40  | 85                           | 100  | -2,4                         | 5                        | 1   |
| F3V6                 | 3,49                         | 3,71  | 85                           | 100  | -2,4                         | 5                        | 1   |
| F3V9                 | 3,78                         | 4,02  | 85                           | 100  | -2,5                         | 3                        | 1   |
| F4V3                 | 4,17                         | 4,43  | 80                           | 100  | -2,5                         | 3                        | 1   |
| F4V7                 | 4,56                         | 4,84  | 50                           | 100  | -1,4                         | 3                        | 2   |
| F5V1                 | 4,95                         | 5,25  | 40                           | 80   | -0,8                         | 2                        | 2   |
| F5V6                 | 5,43                         | 5,77  | 15                           | 40   | 1,2                          | 1                        | 2   |
| F6V2                 | 6,01                         | 6,39  | 6                            | 30   | 2,3                          | 3                        | 4   |
| F6V8                 | 6,60                         | 7,00  | 6                            | 20   | 3,0                          | 2                        | 4   |
| F7V5                 | 7,28                         | 7,72  | 6                            | 20   | 4,0                          | 1                        | 5   |
| F8V2                 | 7,95                         | 8,45  | 6                            | 20   | 4,6                          | 0,7                      | 5   |
| F9V1                 | 8,83                         | 9,37  | 6                            | 20   | 5,5                          | 0,5                      | 6   |
| F10                  | 9,7                          | 10,30 | 8                            | 25   | 6,4                          | 0,2                      | 7   |
| F11                  | 10,67                        | 11,33 | 10                           | 25   | 7,4                          | 0,1                      | 8   |
| F12                  | 11,64                        | 12,36 | 10                           | 25   | 8,4                          | 0,1                      | 8   |
| F13                  | 12,61                        | 13,39 | 10                           | 35   | 9,4                          | 0,1                      | 8   |
| F15                  | 14,55                        | 15,45 | 10                           | 40   | 11,4                         | 0,05                     | 10  |
| F16                  | 15,50                        | 16,50 | 10                           | 45   | 12,4                         | 0,05                     |     |
| F18                  | 17,50                        | 18,50 | 10                           | 50   | 14,4                         | 0,05                     |     |
| F20                  | 19,40                        | 20,60 | 15                           | 60   | 16,4                         | 0,05                     |     |
| F22                  | 21,30                        | 22,70 | 20                           | 70   | 18,4                         | 0,05                     |     |
| F24                  | 23,30                        | 24,70 | 25                           | 80   | 20,4                         | 0,05                     |     |
|                      | at $I_{Ztest} = 2\text{ mA}$ |       | at $I_{Ztest} = 2\text{ mA}$ |      | at $I_{Ztest} = 2\text{ mA}$ | at $I_Z = 0,5\text{ mA}$ |     |
| F27                  | 26,20                        | 27,80 | 25                           | 80   | 23,4                         | 0,05                     | 0,7 |
| F30                  | 29,10                        | 30,90 | 30                           | 100  | 26,6                         | 0,05                     | 0,7 |
| F33                  | 32,00                        | 34,00 | 35                           | 120  | 29,7                         | 0,05                     | 0,7 |
| F36                  | 34,90                        | 37,10 | 35                           | 140  | 33,0                         | 0,05                     | 0,7 |
| F39                  | 37,80                        | 40,20 | 40                           | 150  | 36,4                         | 0,05                     | 0,7 |
| F43                  | 41,70                        | 44,30 | 45                           | 160  | 41,2                         | 0,05                     | 0,7 |
| F47                  | 45,60                        | 48,40 | 50                           | 170  | 46,1                         | 0,05                     | 0,7 |
| F51                  | 49,50                        | 52,50 | 60                           | 180  | 51,0                         | 0,05                     | 0,7 |
| F56                  | 54,30                        | 57,70 | 70                           | 200  | 57,0                         | 0,05                     | 0,7 |
| F62                  | 60,10                        | 63,90 | 80                           | 220  | 64,4                         | 0,05                     | 0,7 |
| F68                  | 66,00                        | 70,00 | 90                           | 240  | 71,7                         | 0,05                     | 0,7 |
| F75                  | 72,80                        | 77,20 | 95                           | 255  | 80,02                        | 0,05                     | 0,7 |

$T_j = 25\text{ }^{\circ}\text{C}$

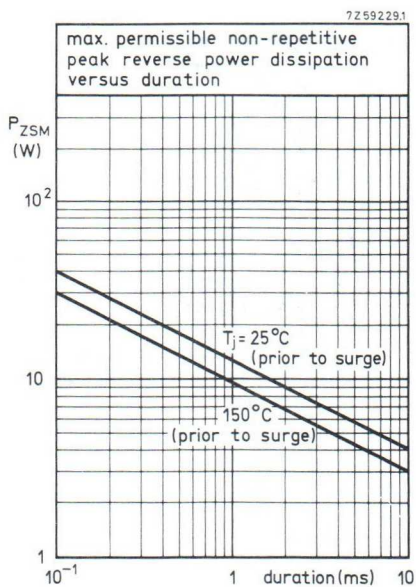


Fig. 2.

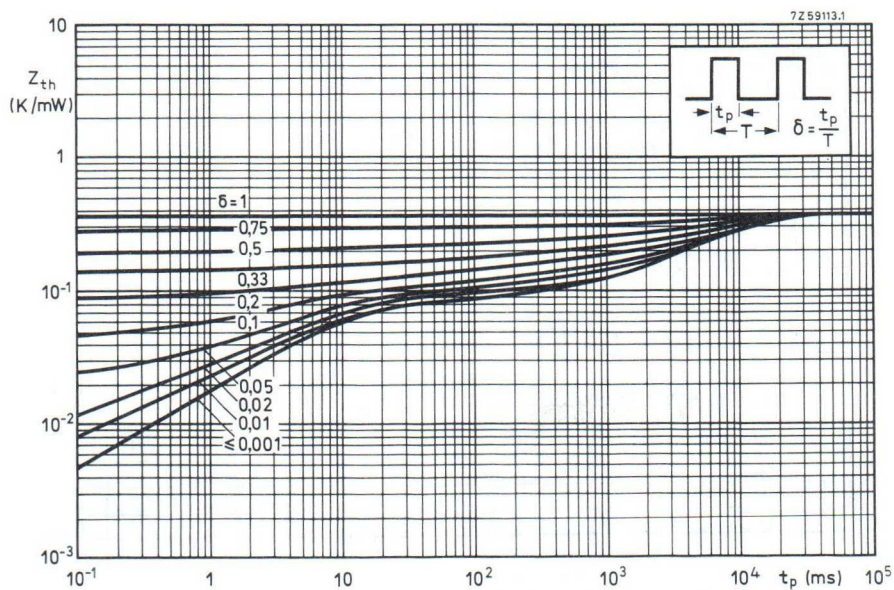


Fig. 3.



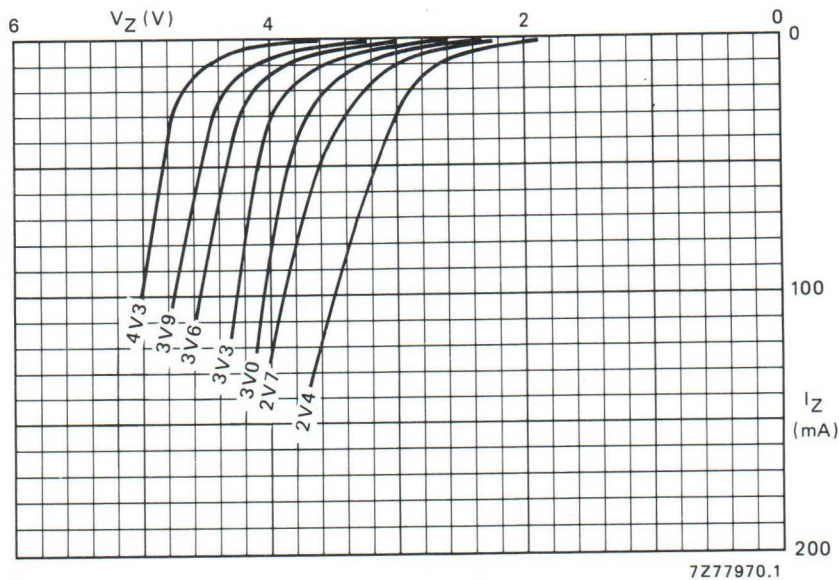


Fig. 4 Static characteristics; typical values;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

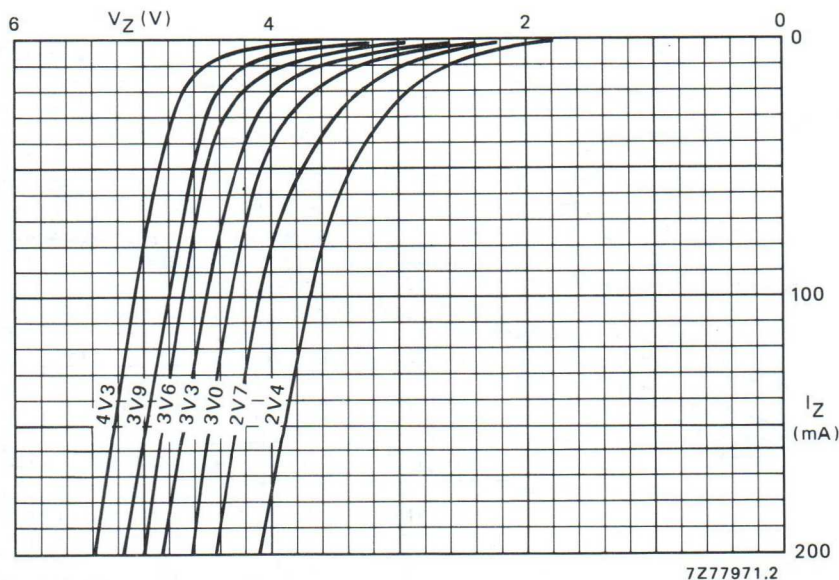


Fig. 5 Dynamic characteristics; typical values;  $T_j = 25\text{ }^{\circ}\text{C}$ .

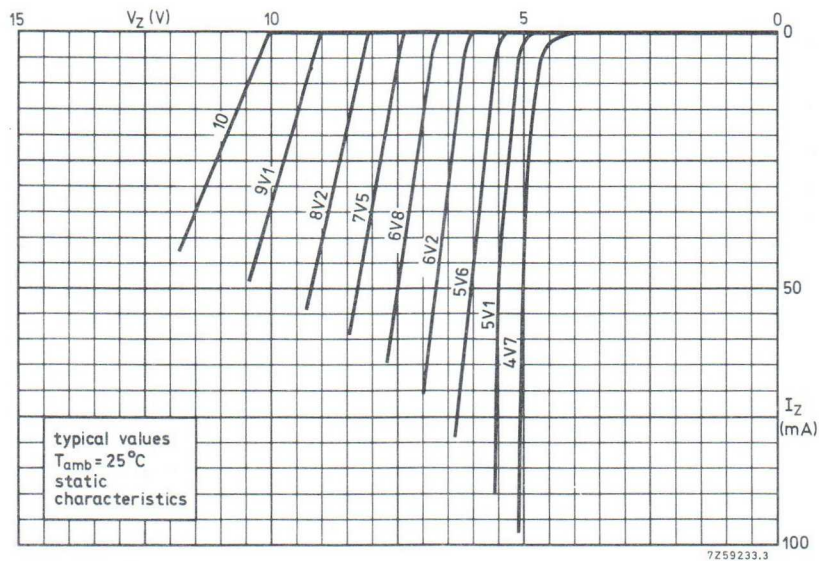


Fig. 6.

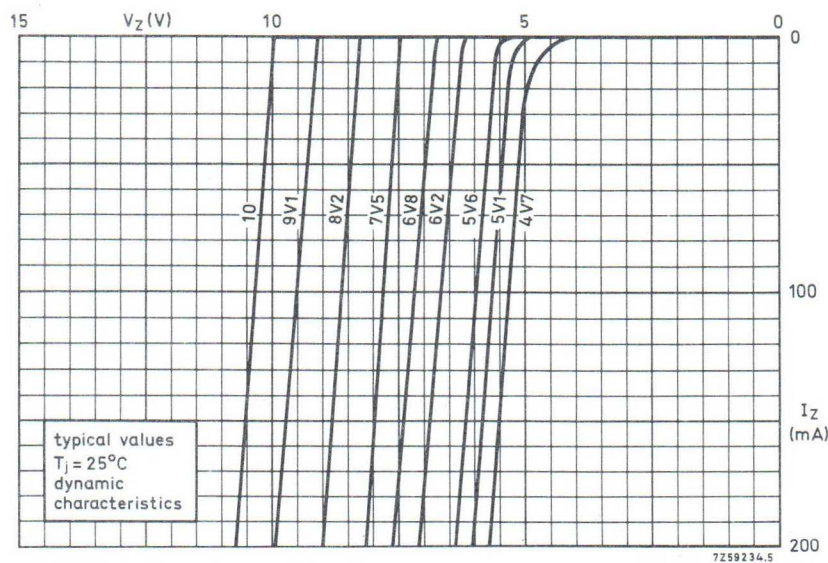


Fig. 7.



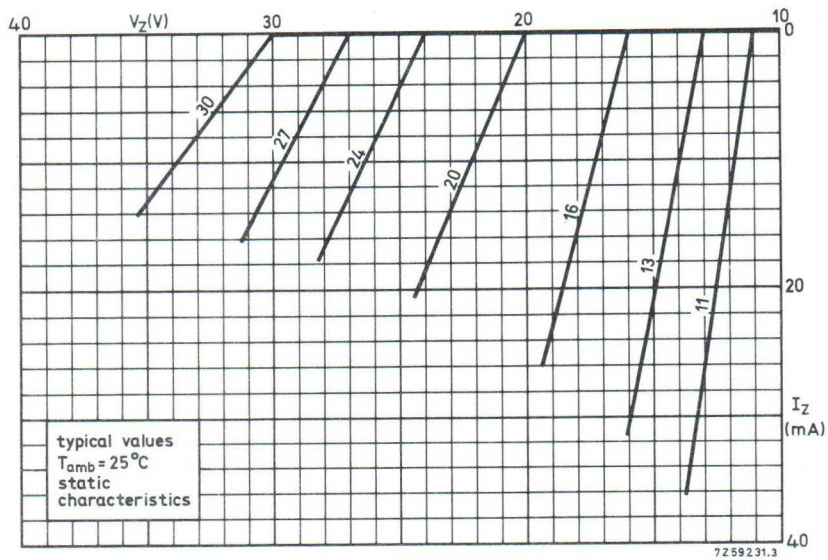


Fig. 8.

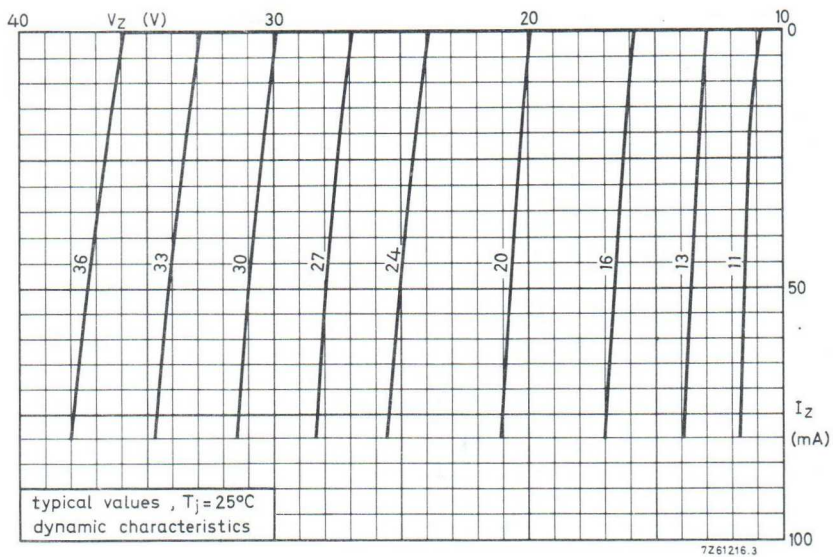


Fig. 9.

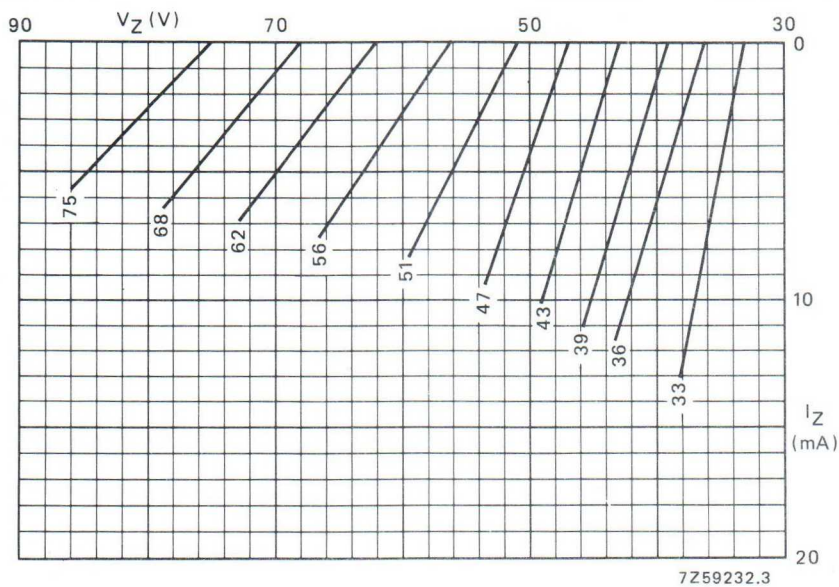
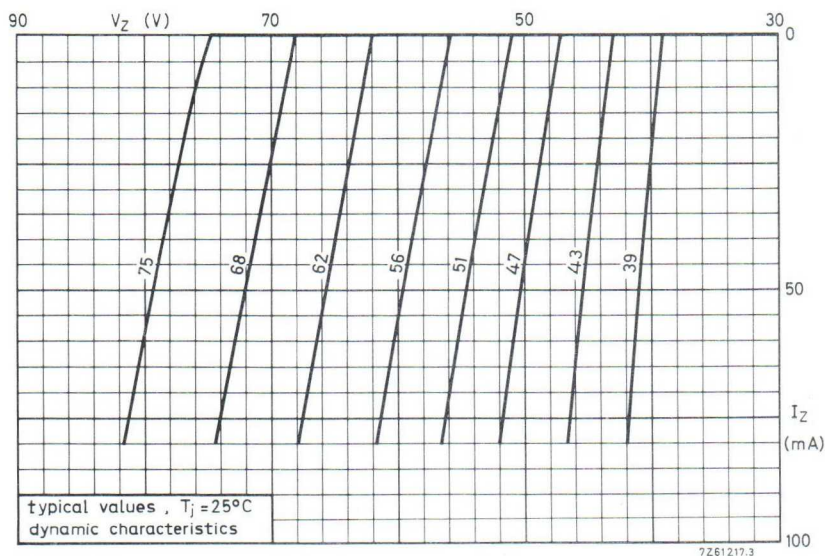
Fig. 10 Static characteristics; typical values;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig. 11.

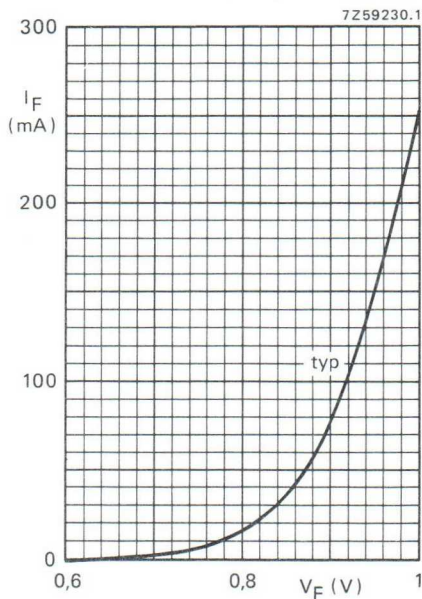


Fig. 12  $T_j = 25^\circ\text{C}$ .

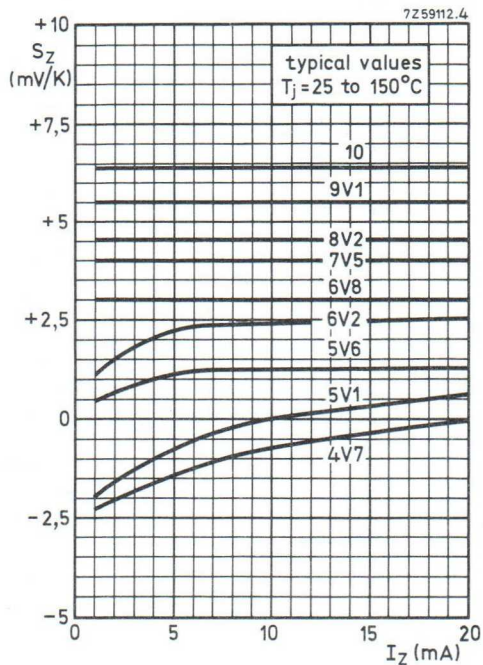


Fig. 13.

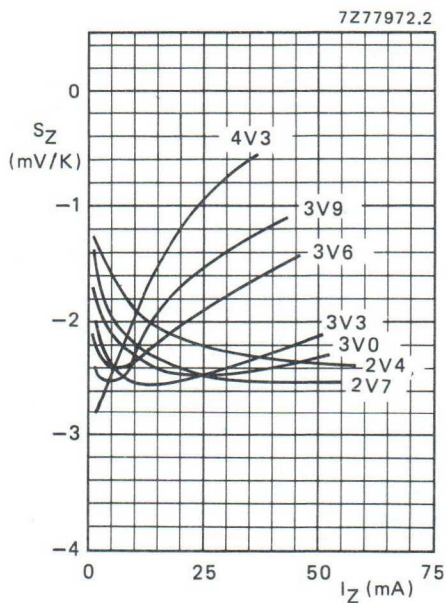


Fig. 14 Typical values;  $T_j = 25 \text{ to } 150^\circ\text{C}$ .

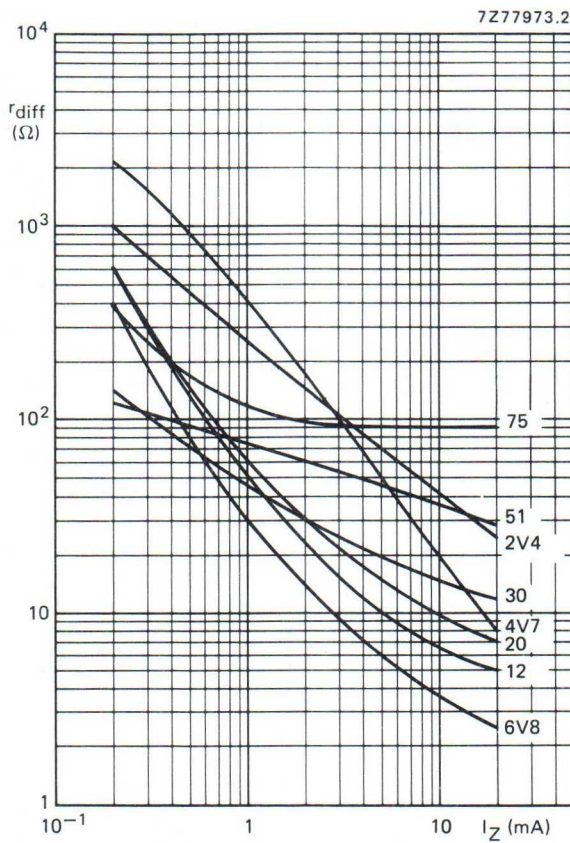


Fig. 15 Typical values;  $T_j = 25^\circ\text{C}$ ;  $f = 1\text{ kHz}$ .



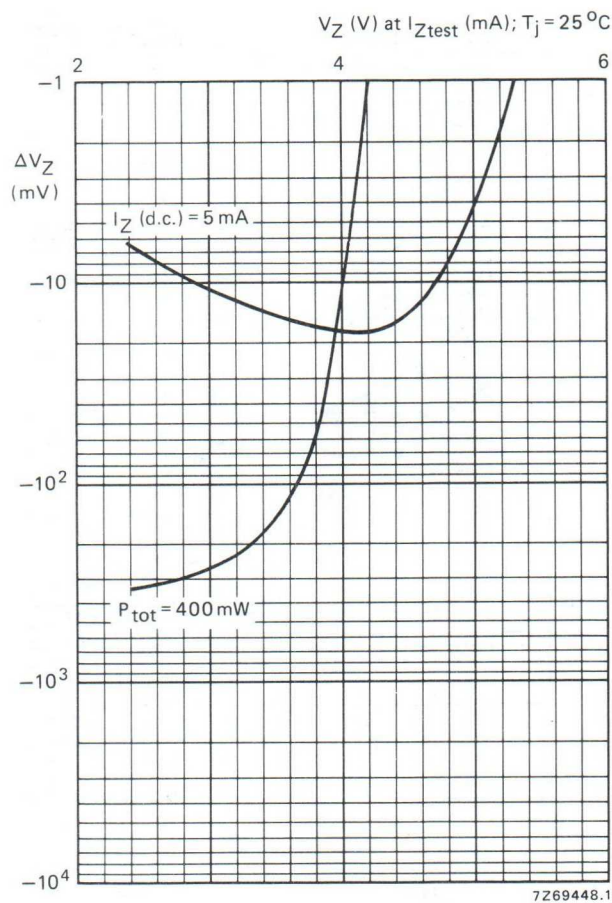


Fig. 16 Typical change of working voltage under operating conditions at  $T_{\text{amb}} = 25^\circ\text{C}$ .



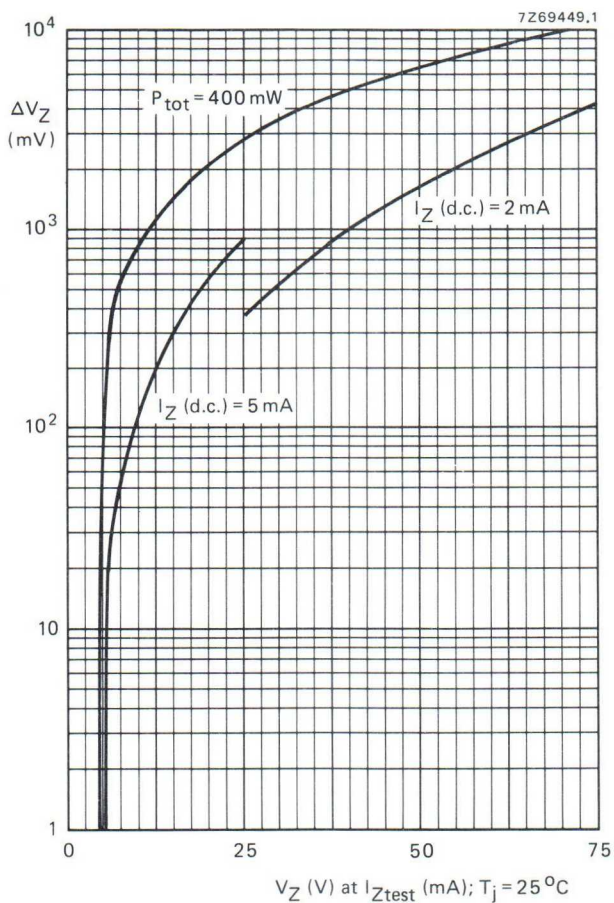


Fig. 17 Typical change of working voltage under operating conditions at  $T_{\text{amb}} = 25^\circ\text{C}$ .



## VOLTAGE REFERENCE DIODES FOR SURFACE MOUNTING

Voltage reference diodes in a SOD-80 envelope. They have a low temperature coefficient and are primarily intended for use as voltage reference sources.

The SM diode is a leadless diode in a hermetically sealed glass SOD-80 envelope with tinplated metal discs at each end. It is suitable for "automatic placement" and as such it can withstand immersion soldering.

The diodes are delivered in bulk or in "super 8" tape.

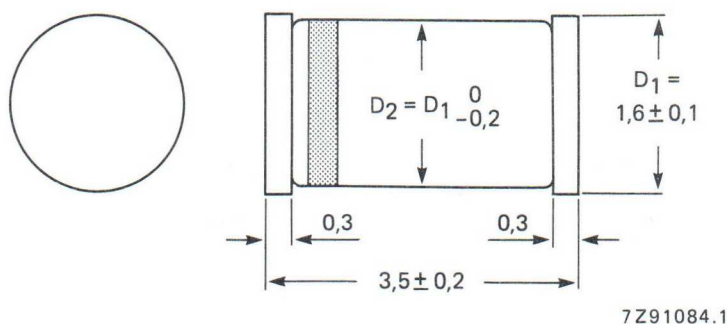
### QUICK REFERENCE DATA

|                                                      |                  |         |                |
|------------------------------------------------------|------------------|---------|----------------|
| Reference voltage at $I_Z = 7,5 \text{ mA}$          | $V_{\text{ref}}$ | >       | 5,89 V         |
|                                                      |                  | typ.    | 6,20 V         |
|                                                      |                  | <       | 6,51 V         |
| Temperature coefficient<br>at $I_Z = 7,5 \text{ mA}$ | BZV80            | $ S_Z $ | < 0,01 %/K     |
|                                                      | BZV81            | $ S_Z $ | < 0,005 %/K    |
| Operating temperature                                | $T_{\text{amb}}$ |         | -20 to + 80 °C |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-80



Cathode indicated by yellow band

BZV80 second band: black

BZV81 second band: brown

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |           |      |                                 |
|-------------------------------------------------------------------------|-----------|------|---------------------------------|
| Working current (d.c.)                                                  | $I_Z$     | max. | 50 mA                           |
| Working current (peak value)                                            | $I_{ZM}$  | max. | 50 mA                           |
| Total power dissipation<br>up to $T_{amb} = 50\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 400 mW                          |
| Storage temperature                                                     | $T_{stg}$ |      | -65 to + 200 $^{\circ}\text{C}$ |
| Operating ambient temperature                                           | $T_{amb}$ |      | -20 to + 80 $^{\circ}\text{C}$  |

## THERMAL RESISTANCE

From junction to ambient mounted on a  
ceramic substrate of 10 x 10 x 0,6 mm

$$R_{th\ j-a} = 380\text{ K/W}$$

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Reference voltage at  $I_Z = 7,5\text{ mA}$

|           |      |        |
|-----------|------|--------|
| $V_{ref}$ | >    | 5,89 V |
|           | typ. | 6,20 V |
|           | <    | 6,51 V |

Reference voltage excursion at  $I_Z = 7,5\text{ mA}$   
ambient temperature test points  
-20; + 25; + 55; + 80  $^{\circ}\text{C}$

|       |                    |   |       |
|-------|--------------------|---|-------|
| BZV80 | $ \Delta V_{ref} $ | < | 62 mV |
| BZV81 | $ \Delta V_{ref} $ | < | 31 mV |

Effective temperature coefficient at  $I_Z = 7,5\text{ mA}$

|       |         |   |           |
|-------|---------|---|-----------|
| BZV80 | $ S_Z $ | < | 0,01 %/K  |
| BZV81 | $ S_Z $ | < | 0,005 %/K |

Differential resistance at  $I_Z = 7,5\text{ mA}$

$$r_{diff} < 15\text{ }\Omega$$

## Notes

1. Tolerance and stability of  $I_Z$ .

The quoted values of  $\Delta V_{ref}$  are based on a constant current  $I_Z$ . Two factors can cause  $V_{ref}$  to change with  $I_Z$ , namely the differential resistance  $r_{diff}$  and the temperature coefficient  $S_Z$ .

a. Each change of  $I_Z$  can result in a maximum change of  $V_{ref}$  as follows:

$$\Delta V_{ref}\text{ (mV)} = \Delta I_Z\text{ (mA)} \times 15\text{ }\Omega$$

taking into account  $r_{diff}$  is max. 15  $\Omega$ .

b. The temperature coefficient of the reference voltage is also a function of  $I_Z$ . However, for these reference diodes  $S_Z$  varies max.  $\pm 0,05\text{ mV/K}$  or  $\pm 0,001\text{ %/K}$  when  $I_Z$  is between 6 and 10 mA, so this effect can be neglected in practice for these types.

2. The temperature coefficient of the reference voltage is obtained from the following equation.

$$S_Z = \frac{(V_{ref\ 1} - V_{ref\ 2})}{(T_{amb\ 2} - T_{amb\ 1})} \times \frac{100}{V_{ref\ nom}}\text{ %/K}$$

## LOW VOLTAGE STABISTORS FOR SURFACE MOUNTING

Silicon planar integrated voltage regulator diodes in hermetically sealed SOD80 glass envelopes, intended for low power clipping, level shifting, voltage regulation, temperature stabilization of transistor base-emitter biasing network and in many other applications where tight tolerances and low voltage levels are required.

The series consists of four types with nominal voltages ranging from 1.4 to 3.2 V.

The SM diode is a leadless diode in a hermetically sealed glass SOD80 envelope with tin plated metal discs at each end. It is suitable for "automatic placement" and as such it can withstand immersion soldering.

The diodes are delivered in bulk or in "super 8" tape.

### QUICK REFERENCE DATA

|                                                                        |            |              |          |          |            |          |                  |
|------------------------------------------------------------------------|------------|--------------|----------|----------|------------|----------|------------------|
| Regulation voltage range                                               | $V_F$      | nom.         | 1.4      | 2.0      | 2.6        | 3.2      | V                |
| Continuous reverse voltage                                             | $V_R$      | max.         |          |          | 10         |          | V                |
| Repetitive peak reverse voltage                                        | $V_{RRM}$  | max.         |          |          | 10         |          | V                |
| Total power dissipation<br>up to $T_{amb} = 25^\circ\text{C}$          | $P_{tot}$  | max.         |          |          | 350        |          | mW               |
| Junction temperature                                                   | $T_j$      | max.         |          |          | 150        |          | $^\circ\text{C}$ |
| Differential resistance<br>at $I_F = 5\text{ mA}$ ; $f = 1\text{ kHz}$ | $r_{diff}$ | typ.<br>max. | 10<br>20 | 15<br>30 | 18<br>32.5 | 20<br>35 | $\Omega$         |

### MECHANICAL DATA

Dimensions in mm

Fig.1 SOD80.

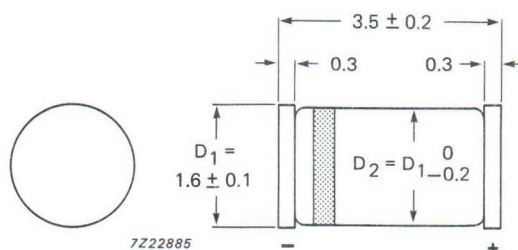
Marking code:

BZV87-1V4 = 1V4 Ph

BZV87-2V0 = 2V0 Ph

BZV87-2V6 = 2V6 Ph

BZV87-3V2 = 3V2 Ph



Cathode indicated by black band.



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |           |      | 1.4 | 2.0        | 2.6 | 3.2 | V                  |
|-------------------------------------------------------------------------|-----------|------|-----|------------|-----|-----|--------------------|
| Repetitive peak forward current                                         | $I_{FRM}$ | max. | 250 |            | 175 |     | mA                 |
| Continuous reverse voltage                                              | $V_R$     | max. |     | 10         |     |     | V                  |
| Repetitive peak reverse voltage                                         | $V_{RRM}$ | max. |     | 10         |     |     | V                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. |     | 350        |     |     | mW                 |
| Storage temperature range                                               | $T_{stg}$ |      |     | -65 to 150 |     |     | $^{\circ}\text{C}$ |
| Junction temperature                                                    | $T_j$     | max. |     | 150        |     |     | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                                      |               |   |  |     |  |  |     |
|--------------------------------------|---------------|---|--|-----|--|--|-----|
| From junction to ambient in free air | $R_{th\ j-a}$ | = |  | 350 |  |  | K/W |
|--------------------------------------|---------------|---|--|-----|--|--|-----|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                                                                               |            |      | 1.4 | 2.0  | 2.6  | 3.2  | V        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|-----|------|------|------|----------|
| Regulation voltage range<br>at $I_F = 5\text{ mA}$                                                                                                                            | $V_F$      | min. | 1.3 | 1.85 | 2.35 | 2.85 | V        |
|                                                                                                                                                                               |            | max. | 1.5 | 2.15 | 2.8  | 3.45 | V        |
| Differential resistance<br>at $I_F = 1\text{ mA}$ ; $f = 1\text{ kHz}$<br><br>at $I_F = 5\text{ mA}$ ; $f = 1\text{ kHz}$<br><br>at $I_F = 10\text{ mA}$ ; $f = 1\text{ kHz}$ | $r_{diff}$ | typ. | 55  | 80   | 90   | 100  | $\Omega$ |
|                                                                                                                                                                               |            | max. | 10  | 15   | 18   | 20   | $\Omega$ |
|                                                                                                                                                                               | $r_{diff}$ | typ. | 20  | 30   | 32.5 | 35   | $\Omega$ |
|                                                                                                                                                                               |            | max. | 6.0 | 8.0  | 9.0  | 10   | $\Omega$ |
|                                                                                                                                                                               | $r_{diff}$ | typ. | 10  | 15   | 17.5 | 20   | $\Omega$ |
|                                                                                                                                                                               |            | max. |     |      |      |      |          |
| Negative temperature coefficient<br>at $I_F = 5\text{ mA}$                                                                                                                    | $S_F$      | typ. | 3.8 | 6.0  | 8.5  | 11.5 | mV/K     |
| Reverse current<br>at $V_R = 5\text{ V}$                                                                                                                                      | $I_R$      | max. |     | 200  |      |      | nA       |
| Diode capacitance<br>at $V_R = 0$ ; $f = 1\text{ MHz}$                                                                                                                        | $C_d$      | typ. |     | 15   |      |      | pF       |
|                                                                                                                                                                               |            | max. |     | 25   |      |      | pF       |

**Note**

1. Mounted on an epoxy-glass printed-circuit board measuring 15 mm x 10 mm x 0.8 mm.

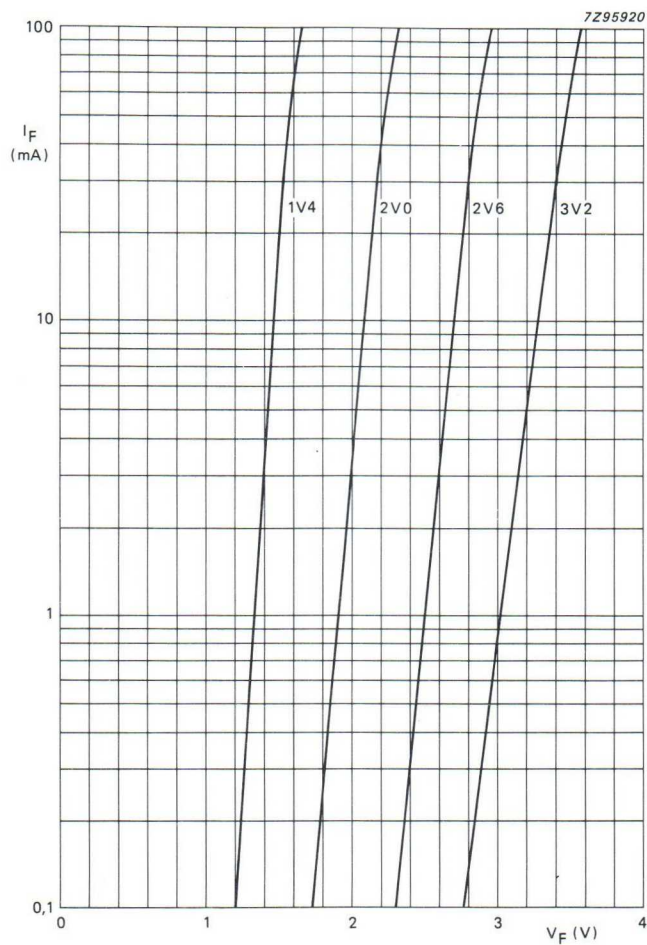


Fig. 2 Forward current as a function of forward voltage;  
 $T_j = 25\text{ }^{\circ}\text{C}$ ; typical values.



## SILICON PLANAR VOLTAGE REGULATOR DIODES

Low power general purpose voltage regulator diodes in a micro miniature plastic envelope. They are available in three series; one to the international standardized E24 ( $\pm 5\%$ ) range, one in a tolerance of  $\pm 2\%$  and the other in a tolerance of  $\pm 1\%$ .

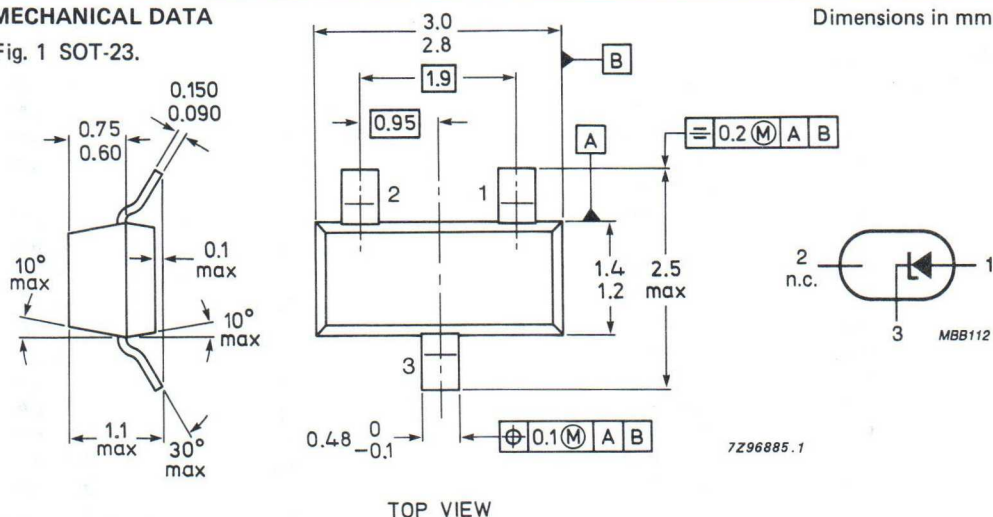
Each series consists of 37 types with nominal working voltages from 2.4 V to 75 V.

## QUICK REFERENCE DATA

|                                                            |                |                      |
|------------------------------------------------------------|----------------|----------------------|
| Working voltage range                                      | $V_Z$ nom.     | 2.4 to 75 V          |
| Working voltage tolerance                                  |                | $\pm 5\%$            |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ max. | 300 mW               |
| Junction temperature                                       | $T_j$ max.     | 175 $^\circ\text{C}$ |

## MECHANICAL DATA

Fig. 1 SOT-23.



See also *Soldering recommendations*.

## Marking code

BZX84-C2V4 = Z11

C2V7 = Z12

C3V0 = Z13

C3V3 = Z14

C3V6 = Z15

C3V9 = Z16

C4V3 = Z17

C4V7 = Z1

C5V1 = Z2

BZX84-C5V6 = Z3

C6V2 = Z4

C6V8 = Z5

C7V5 = Z6

C8V2 = Z7

C9V1 = Z8

C10 = Z9

C11 = Y1

C12 = Y2

BZX84-C13 = Y3

C15 = Y4

C16 = Y5

C18 = Y6

C20 = Y7

C22 = Y8

C24 = Y9

C27 = Y10

C30 = Y11

BZX84-C33 = Y12

C36 = Y13

C39 = Y14

C43 = Y15

C47 = Y16

C51 = Y17

C56 = Y18

C62 = Y19

C68 = Y20

C75 = Y21

Marking for B and A types available on request.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                |
|---------------------------------------------------------------------------|-----------|------|--------------------------------|
| Repetitive peak forward current                                           | $I_{FRM}$ | max. | 250 mA                         |
| Repetitive peak working current                                           | $I_{ZRM}$ | max. | 250 mA                         |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^{**}$ | $P_{tot}$ | max. | 300 mW                         |
| Storage temperature                                                       | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

## THERMAL CHARACTERISTICS\*

### Thermal resistance\*\*

|                          |               |   |         |
|--------------------------|---------------|---|---------|
| From junction to ambient | $R_{th\ j-t}$ | = | 420 K/W |
|--------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Forward voltage

$I_F = 10\text{ mA}$

|       |   |       |
|-------|---|-------|
| $V_F$ | < | 0.9 V |
|-------|---|-------|

Reverse current

BZX84—2V4

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 50 $\mu\text{A}$ |
|-------|---|------------------|

2V7

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 20 $\mu\text{A}$ |
|-------|---|------------------|

3V0

$V_R = 1\text{ V}$

|       |   |                  |
|-------|---|------------------|
| $I_R$ | < | 10 $\mu\text{A}$ |
|-------|---|------------------|

3V3

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 5 $\mu\text{A}$ |
|-------|---|-----------------|

3V6

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 5 $\mu\text{A}$ |
|-------|---|-----------------|

3V9

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

4V3

$V_R = 1\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

4V7

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

5V1

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 2 $\mu\text{A}$ |
|-------|---|-----------------|

5V6

$V_R = 2\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 1 $\mu\text{A}$ |
|-------|---|-----------------|

6V2

$V_R = 4\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 3 $\mu\text{A}$ |
|-------|---|-----------------|

6V8

$V_R = 4\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 2 $\mu\text{A}$ |
|-------|---|-----------------|

7V5

$V_R = 5\text{ V}$

|       |   |                 |
|-------|---|-----------------|
| $I_R$ | < | 1 $\mu\text{A}$ |
|-------|---|-----------------|

8V2

$V_R = 5\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 700 nA |
|-------|---|--------|

9V1

$V_R = 6\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 500 nA |
|-------|---|--------|

10

$V_R = 7\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 200 nA |
|-------|---|--------|

11

$V_R = 8\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 100 nA |
|-------|---|--------|

12

$V_R = 8\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 100 nA |
|-------|---|--------|

13

$V_R = 8\text{ V}$

|       |   |        |
|-------|---|--------|
| $I_R$ | < | 100 nA |
|-------|---|--------|

15 to 75

$V_R = 0.7\text{ }V_{Znom}$

|       |   |       |
|-------|---|-------|
| $I_R$ | < | 50 nA |
|-------|---|-------|

. = A for 1%

. = B for 2%

.. = C for (E24), 5%

\* See *Thermal characteristics* in chapter GENERAL.

\*\* Device mounted on a ceramic substrate of 7 mm x 5 mm x 0.6 mm.



$T_j = 25\text{ }^{\circ}\text{C}$  $\pm 5\%$  tolerance range

| BZX84 | working voltage              |       | differential resistance      |      | temperature coefficient      |       |      | differential resistance  |      |
|-------|------------------------------|-------|------------------------------|------|------------------------------|-------|------|--------------------------|------|
|       | $V_Z$ (V)                    |       | $r_{diff}$ ( $\Omega$ )      |      | $S_Z$ (mV/K)                 |       |      | $r_{diff}$ ( $\Omega$ )  |      |
|       | at $I_{Ztest} = 5\text{ mA}$ |       | at $I_{Ztest} = 5\text{ mA}$ |      | at $I_{Ztest} = 5\text{ mA}$ |       |      | at $I_Z = 1\text{ mA}$   |      |
|       | min.                         | max.  | typ.                         | max. | min.                         | typ.  | max. | typ.                     | max. |
| C2V4  | 2.20                         | 2.60  | 70                           | 100  | -3.5                         | -1.6  | 0    | 275                      | 600  |
| C2V7  | 2.50                         | 2.90  | 75                           | 100  | -3.5                         | -2.0  | 0    | 300                      | 600  |
| C3V0  | 2.80                         | 3.20  | 80                           | 95   | -3.5                         | -2.1  | 0    | 325                      | 600  |
| C3V3  | 3.10                         | 3.50  | 85                           | 95   | -3.5                         | -2.4  | 0    | 350                      | 600  |
| C3V6  | 3.40                         | 3.80  | 85                           | 90   | -3.5                         | -2.4  | 0    | 375                      | 600  |
| C3V9  | 3.70                         | 4.10  | 85                           | 90   | -3.5                         | -2.5  | 0    | 400                      | 600  |
| C4V3  | 4.00                         | 4.60  | 80                           | 90   | -3.5                         | -2.5  | 0    | 410                      | 600  |
| C4V7  | 4.40                         | 5.00  | 50                           | 80   | -3.5                         | -1.4  | 0.2  | 425                      | 500  |
| C5V1  | 4.80                         | 5.40  | 40                           | 60   | -2.7                         | -0.8  | 1.2  | 400                      | 480  |
| C5V6  | 5.20                         | 6.00  | 15                           | 40   | -2.0                         | 1.2   | 2.5  | 80                       | 400  |
| C6V2  | 5.80                         | 6.60  | 6                            | 10   | 0.4                          | 2.3   | 3.7  | 40                       | 150  |
| C6V8  | 6.40                         | 7.20  | 6                            | 15   | 1.2                          | 3.0   | 4.5  | 30                       | 80   |
| C7V5  | 7.00                         | 7.90  | 6                            | 15   | 2.5                          | 4.0   | 5.3  | 30                       | 80   |
| C8V2  | 7.70                         | 8.90  | 6                            | 15   | 3.2                          | 4.6   | 6.2  | 40                       | 80   |
| C9V1  | 9.50                         | 9.60  | 6                            | 15   | 3.8                          | 5.5   | 7.0  | 40                       | 100  |
| C10   | 9.40                         | 10.60 | 8                            | 20   | 4.5                          | 6.4   | 8.0  | 50                       | 150  |
| C11   | 10.40                        | 11.60 | 10                           | 20   | 5.4                          | 7.4   | 9.0  | 50                       | 150  |
| C12   | 11.40                        | 12.70 | 10                           | 25   | 6.0                          | 8.4   | 10.0 | 50                       | 150  |
| C13   | 12.40                        | 14.10 | 10                           | 30   | 7.0                          | 9.4   | 11.0 | 50                       | 170  |
| C15   | 13.80                        | 15.60 | 10                           | 30   | 9.2                          | 11.4  | 13.0 | 50                       | 200  |
| C16   | 15.30                        | 17.10 | 10                           | 40   | 10.4                         | 12.4  | 14.0 | 50                       | 200  |
| C18   | 16.80                        | 19.10 | 10                           | 45   | 12.4                         | 14.4  | 16.0 | 50                       | 225  |
| C20   | 18.80                        | 21.20 | 15                           | 55   | 14.4                         | 16.4  | 18.0 | 60                       | 225  |
| C22   | 20.80                        | 23.30 | 20                           | 55   | 16.4                         | 18.4  | 20.0 | 60                       | 250  |
| C24   | 22.80                        | 25.60 | 25                           | 70   | 18.4                         | 20.4  | 22.0 | 60                       | 250  |
|       | at $I_{Ztest} = 2\text{ mA}$ |       | at $I_{Ztest} = 2\text{ mA}$ |      | at $I_{Ztest} = 2\text{ mA}$ |       |      | at $I_Z = 0.5\text{ mA}$ |      |
| C27   | 25.10                        | 28.90 | 25                           | 80   | 21.4                         | 23.4  | 25.3 | 65                       | 300  |
| C30   | 28.00                        | 32.00 | 30                           | 80   | 24.4                         | 26.6  | 29.4 | 70                       | 300  |
| C33   | 31.00                        | 35.00 | 35                           | 80   | 27.4                         | 29.7  | 33.4 | 75                       | 325  |
| C36   | 34.00                        | 38.00 | 35                           | 90   | 30.4                         | 33.0  | 37.4 | 80                       | 350  |
| C39   | 37.00                        | 41.00 | 40                           | 130  | 33.4                         | 36.4  | 41.2 | 80                       | 350  |
| C43   | 40.00                        | 46.00 | 45                           | 150  | 37.6                         | 41.2  | 46.6 | 85                       | 375  |
| C47   | 44.00                        | 50.00 | 50                           | 170  | 42.0                         | 46.1  | 51.8 | 85                       | 375  |
| C51   | 48.00                        | 54.00 | 60                           | 180  | 46.6                         | 51.0  | 57.2 | 90                       | 400  |
| C56   | 52.00                        | 60.00 | 70                           | 200  | 52.2                         | 57.0  | 63.8 | 100                      | 425  |
| C62   | 58.00                        | 66.00 | 80                           | 215  | 58.8                         | 64.4  | 71.6 | 120                      | 450  |
| C68   | 64.00                        | 72.00 | 90                           | 240  | 65.6                         | 71.7  | 79.8 | 150                      | 475  |
| C75   | 70.00                        | 79.00 | 95                           | 255  | 73.4                         | 80.02 | 88.6 | 170                      | 500  |

# BZX84 SERIES

± 2% tolerance range

| BZX84 | working voltage              |       | differential resistance      |      | temperature coefficient      |       |      | differential resistance    |      |
|-------|------------------------------|-------|------------------------------|------|------------------------------|-------|------|----------------------------|------|
|       | V <sub>Z</sub> (V)           |       | r <sub>diff</sub> (Ω)        |      | S <sub>Z</sub> (mV/K)        |       |      | r <sub>diff</sub> (Ω)      |      |
|       | at I <sub>Ztest</sub> = 5 mA |       | at I <sub>Ztest</sub> = 5 mA |      | at I <sub>Ztest</sub> = 5 mA |       |      | at I <sub>Z</sub> = 1 mA   |      |
|       | min.                         | max.  | typ.                         | max. | min.                         | typ.  | max. | typ.                       | max. |
| B2V4  | 2.35                         | 2.45  | 70                           | 100  | -3.5                         | -1.6  | 0    | 275                        | 600  |
| B2V7  | 2.65                         | 2.75  | 75                           | 100  | -3.5                         | -2.0  | 0    | 300                        | 600  |
| B3V0  | 2.94                         | 3.06  | 80                           | 95   | -3.5                         | -2.1  | 0    | 325                        | 600  |
| B3V3  | 3.23                         | 3.37  | 85                           | 95   | -3.5                         | -2.4  | 0    | 350                        | 600  |
| B3V6  | 3.53                         | 3.67  | 85                           | 90   | -3.5                         | -2.4  | 0    | 375                        | 600  |
| B3V9  | 3.82                         | 3.98  | 85                           | 90   | -3.5                         | -2.5  | 0    | 400                        | 600  |
| B4V3  | 4.21                         | 4.39  | 80                           | 90   | -3.5                         | -2.5  | 0    | 410                        | 600  |
| B4V7  | 4.61                         | 4.79  | 50                           | 80   | -3.5                         | -1.4  | 0.2  | 425                        | 500  |
| B5V1  | 5.00                         | 5.20  | 40                           | 60   | -2.7                         | -0.8  | 1.2  | 400                        | 480  |
| B5V6  | 5.49                         | 5.71  | 15                           | 40   | -2.0                         | 1.2   | 2.5  | 80                         | 400  |
| B6V2  | 6.08                         | 6.32  | 6                            | 10   | 0.4                          | 2.3   | 3.7  | 40                         | 150  |
| B6V8  | 6.66                         | 6.94  | 6                            | 15   | 1.2                          | 3.0   | 4.5  | 30                         | 80   |
| B7V5  | 7.35                         | 7.65  | 6                            | 15   | 2.5                          | 4.0   | 5.3  | 30                         | 80   |
| B8V2  | 8.04                         | 8.36  | 6                            | 15   | 3.2                          | 4.6   | 6.2  | 40                         | 80   |
| B9V1  | 8.92                         | 9.28  | 6                            | 15   | 3.8                          | 5.5   | 7.0  | 40                         | 100  |
| B10   | 9.80                         | 10.20 | 8                            | 20   | 4.5                          | 6.4   | 8.0  | 50                         | 150  |
| B11   | 10.80                        | 11.20 | 10                           | 20   | 5.4                          | 7.4   | 9.0  | 50                         | 150  |
| B12   | 11.80                        | 12.20 | 10                           | 25   | 6.0                          | 8.4   | 10.0 | 50                         | 150  |
| B13   | 12.70                        | 13.30 | 10                           | 30   | 7.0                          | 9.4   | 11.0 | 50                         | 170  |
| B15   | 14.70                        | 15.30 | 10                           | 30   | 9.2                          | 11.4  | 13.0 | 50                         | 200  |
| B16   | 15.70                        | 16.30 | 10                           | 40   | 10.4                         | 12.4  | 14.0 | 50                         | 200  |
| B18   | 17.60                        | 18.40 | 10                           | 45   | 12.4                         | 14.4  | 16.0 | 50                         | 225  |
| B20   | 19.60                        | 20.40 | 15                           | 55   | 14.4                         | 16.4  | 18.0 | 60                         | 225  |
| B22   | 21.60                        | 22.40 | 20                           | 55   | 16.4                         | 18.4  | 20.0 | 60                         | 250  |
| B24   | 23.50                        | 24.50 | 25                           | 70   | 18.4                         | 20.4  | 22.0 | 60                         | 250  |
|       | at I <sub>Ztest</sub> = 2 mA |       | at I <sub>Ztest</sub> = 2 mA |      | at I <sub>Ztest</sub> = 2 mA |       |      | at I <sub>Z</sub> = 0.5 mA |      |
|       |                              |       |                              |      |                              |       |      |                            |      |
| B27   | 26.50                        | 27.50 | 25                           | 80   | 21.4                         | 23.4  | 25.3 | 65                         | 300  |
| B30   | 29.40                        | 30.60 | 30                           | 80   | 24.4                         | 26.6  | 29.4 | 70                         | 300  |
| B33   | 32.30                        | 33.70 | 35                           | 80   | 27.4                         | 29.7  | 33.4 | 75                         | 325  |
| B36   | 35.30                        | 36.70 | 35                           | 90   | 30.4                         | 33.0  | 37.4 | 80                         | 350  |
| B39   | 38.20                        | 39.80 | 40                           | 130  | 33.4                         | 36.4  | 41.2 | 80                         | 350  |
| B43   | 42.10                        | 43.90 | 45                           | 150  | 37.6                         | 41.2  | 46.6 | 85                         | 375  |
| B47   | 46.10                        | 47.90 | 50                           | 170  | 42.0                         | 46.1  | 51.8 | 85                         | 375  |
| B51   | 50.00                        | 51.00 | 60                           | 180  | 46.6                         | 51.0  | 57.2 | 90                         | 400  |
| B56   | 54.90                        | 57.10 | 70                           | 200  | 52.2                         | 57.0  | 63.8 | 100                        | 425  |
| B62   | 60.80                        | 63.20 | 80                           | 215  | 58.8                         | 64.4  | 71.6 | 120                        | 450  |
| B68   | 66.60                        | 69.40 | 90                           | 240  | 65.6                         | 71.7  | 79.8 | 150                        | 475  |
| B75   | 73.50                        | 76.50 | 95                           | 255  | 73.4                         | 80.02 | 88.6 | 170                        | 500  |

$T_j = 25\text{ }^{\circ}\text{C}$  $\pm 1\%$  tolerance range

| BZX84 | working voltage                     |       | differential resistance             |      | temperature coefficient             |       |      | differential resistance        |      |
|-------|-------------------------------------|-------|-------------------------------------|------|-------------------------------------|-------|------|--------------------------------|------|
|       | $V_Z$ (V)                           |       | $r_{\text{diff}}$ ( $\Omega$ )      |      | $S_Z$ (mV/K)                        |       |      | $r_{\text{diff}}$ ( $\Omega$ ) |      |
|       | at $I_{Z\text{test}} = 5\text{ mA}$ |       | at $I_{Z\text{test}} = 5\text{ mA}$ |      | at $I_{Z\text{test}} = 5\text{ mA}$ |       |      | at $I_Z = 1\text{ mA}$         |      |
|       | min.                                | max.  | typ.                                | max. | min.                                | typ.  | max. | typ.                           | max. |
| A2V4  | 2.37                                | 2.43  | 70                                  | 100  | -3.5                                | -1.6  | 0    | 275                            | 600  |
| A2V7  | 2.67                                | 2.73  | 75                                  | 100  | -3.5                                | -2.0  | 0    | 300                            | 600  |
| A3V0  | 2.97                                | 3.03  | 80                                  | 95   | -3.5                                | -2.1  | 0    | 325                            | 600  |
| A3V3  | 3.26                                | 3.34  | 85                                  | 95   | -3.5                                | -2.4  | 0    | 350                            | 600  |
| A3V6  | 3.56                                | 3.64  | 85                                  | 90   | -3.5                                | -2.4  | 0    | 375                            | 600  |
| A3V9  | 3.86                                | 3.94  | 85                                  | 90   | -3.5                                | -2.5  | 0    | 400                            | 600  |
| A4V3  | 4.25                                | 4.35  | 80                                  | 90   | -3.5                                | -2.5  | 0    | 410                            | 600  |
| A4V7  | 4.65                                | 4.75  | 50                                  | 80   | -3.5                                | -1.4  | 0.2  | 425                            | 500  |
| A5V1  | 5.04                                | 5.16  | 40                                  | 60   | -2.7                                | -0.8  | 1.2  | 400                            | 480  |
| A5V6  | 5.54                                | 5.66  | 15                                  | 40   | -2.0                                | 1.2   | 2.5  | 80                             | 400  |
| A6V2  | 6.13                                | 6.27  | 6                                   | 10   | 0.4                                 | 2.3   | 3.7  | 40                             | 150  |
| A6V8  | 6.73                                | 6.87  | 6                                   | 15   | 1.2                                 | 3.0   | 4.5  | 30                             | 80   |
| A7V5  | 7.42                                | 7.58  | 6                                   | 15   | 2.5                                 | 4.0   | 5.3  | 30                             | 80   |
| A8V2  | 8.11                                | 8.29  | 6                                   | 15   | 3.2                                 | 4.6   | 6.2  | 40                             | 80   |
| A9V1  | 9.0                                 | 9.2   | 6                                   | 15   | 3.8                                 | 5.5   | 7.0  | 40                             | 100  |
| A10   | 9.9                                 | 10.10 | 8                                   | 20   | 4.5                                 | 6.4   | 8.0  | 50                             | 150  |
| A11   | 10.8                                | 11.11 | 10                                  | 20   | 5.4                                 | 7.4   | 9.0  | 50                             | 150  |
| A12   | 11.88                               | 12.12 | 10                                  | 25   | 6.0                                 | 8.4   | 10.0 | 50                             | 150  |
| A13   | 12.87                               | 13.13 | 10                                  | 30   | 7.0                                 | 9.4   | 11.0 | 50                             | 170  |
| A15   | 14.85                               | 15.15 | 10                                  | 30   | 9.2                                 | 11.4  | 13.0 | 50                             | 200  |
| A16   | 15.84                               | 16.16 | 10                                  | 40   | 10.4                                | 12.4  | 14.0 | 50                             | 200  |
| A18   | 17.82                               | 18.18 | 10                                  | 45   | 12.4                                | 14.4  | 16.0 | 50                             | 225  |
| A20   | 19.80                               | 20.20 | 15                                  | 55   | 14.4                                | 16.4  | 18.0 | 60                             | 225  |
| A22   | 21.78                               | 22.22 | 20                                  | 55   | 16.4                                | 18.4  | 20.0 | 60                             | 250  |
| A24   | 23.76                               | 24.24 | 25                                  | 70   | 18.4                                | 20.4  | 22.0 | 60                             | 250  |
|       | at $I_{Z\text{test}} = 2\text{ mA}$ |       | at $I_{Z\text{test}} = 2\text{ mA}$ |      | at $I_{Z\text{test}} = 2\text{ mA}$ |       |      | at $I_Z = 0.5\text{ mA}$       |      |
| A27   | 26.73                               | 27.27 | 25                                  | 80   | 21.4                                | 23.4  | 25.3 | 65                             | 300  |
| A30   | 29.70                               | 30.30 | 30                                  | 80   | 24.4                                | 26.6  | 29.4 | 70                             | 300  |
| A33   | 32.67                               | 33.33 | 35                                  | 80   | 27.4                                | 29.7  | 33.4 | 75                             | 325  |
| A36   | 35.64                               | 36.36 | 35                                  | 90   | 30.4                                | 33.0  | 37.4 | 80                             | 350  |
| A39   | 38.61                               | 39.39 | 40                                  | 130  | 33.4                                | 36.4  | 41.2 | 80                             | 350  |
| A43   | 42.57                               | 43.43 | 45                                  | 150  | 37.6                                | 41.2  | 46.6 | 85                             | 375  |
| A47   | 46.53                               | 47.47 | 50                                  | 170  | 42.0                                | 46.1  | 51.8 | 85                             | 375  |
| A51   | 50.49                               | 51.51 | 60                                  | 180  | 46.6                                | 51.0  | 57.2 | 90                             | 400  |
| A56   | 55.44                               | 56.56 | 70                                  | 200  | 52.2                                | 57.0  | 63.8 | 100                            | 425  |
| A62   | 61.38                               | 62.62 | 80                                  | 215  | 58.8                                | 64.4  | 71.6 | 120                            | 450  |
| A68   | 74.25                               | 75.75 | 90                                  | 240  | 65.6                                | 71.7  | 79.8 | 150                            | 475  |
| A75   | 90.09                               | 91.91 | 95                                  | 255  | 73.4                                | 80.02 | 88.6 | 170                            | 500  |

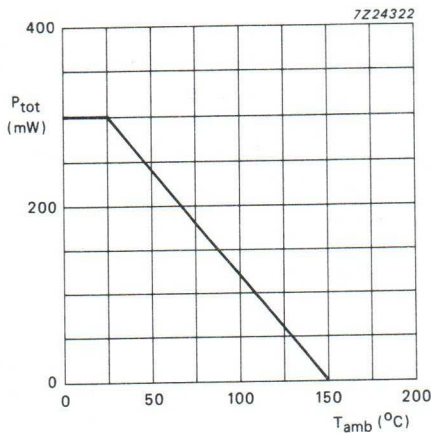


Fig. 2 Power derating curve.

**Model for calculating the static working voltage ( $V_{Z \text{ stat}}$ ).**

This model can be derived from  $V_{Z \text{ stat}} = V_{Z \text{ dyn}} + \Delta V_Z$  of which  $V_{Z \text{ dyn}}$  is given in the preceding tables and can be derived from the typical dynamic characteristic curves in Figs 3 to 6.

$\Delta V_Z = \Delta T \times S_Z$ . For  $S_Z$  see tables and graphs  $S_Z$  versus  $T_j$ .

$\Delta T = P_{\text{tot}} \times R_{\text{th j-a}} = I_Z \times V_{Z \text{ dyn}} \times R_{\text{th j-a}}$ .

Following  $\Delta V_Z = I_Z \times V_{Z \text{ dyn}} \times R_{\text{th j-a}} \times S_Z$  and the model will be:

$$V_{Z \text{ stat}} = V_{Z \text{ dyn}} + I_Z \times V_{Z \text{ dyn}} \times R_{\text{th j-a}} \times S_Z$$

**Calculating example**

BZX84-C24 mounted on a ceramic substrate of 7 x 5 x 0.6 mm; at  $I_Z = 7 \text{ mA}$ .

$$V_{Z \text{ stat}} = 24 + \left( \frac{7}{1000} \times 24 \times \frac{430}{1000} \times 20.3 \right)$$

$$= 24 + 1.47 = 25.47 \text{ V.}$$



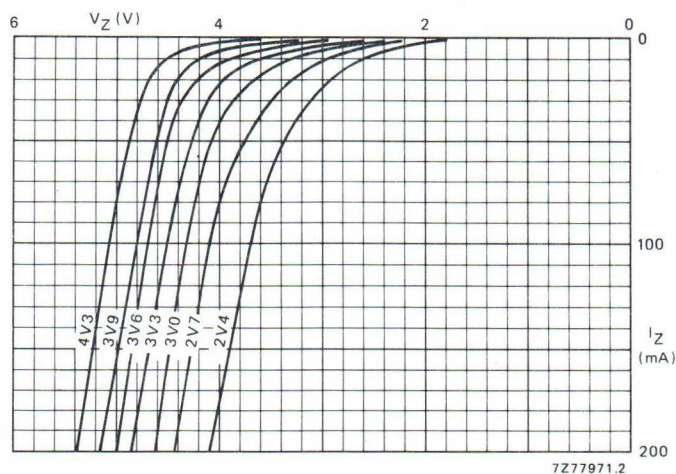


Fig. 3 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

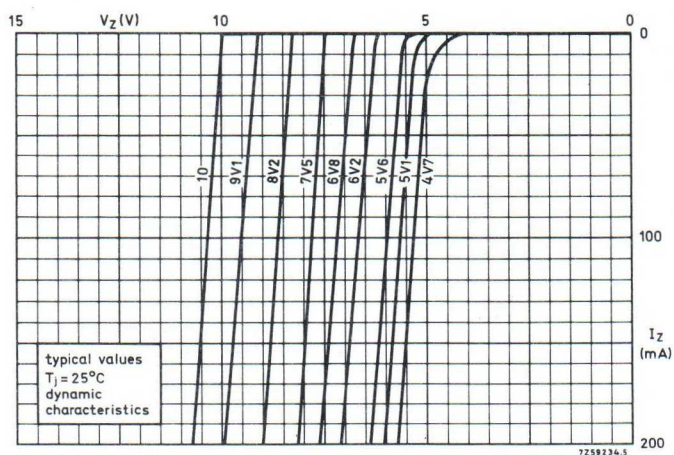


Fig. 4 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .



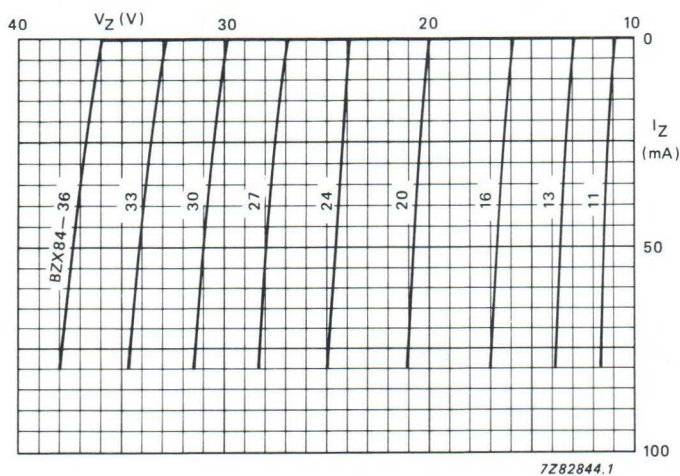


Fig. 5 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

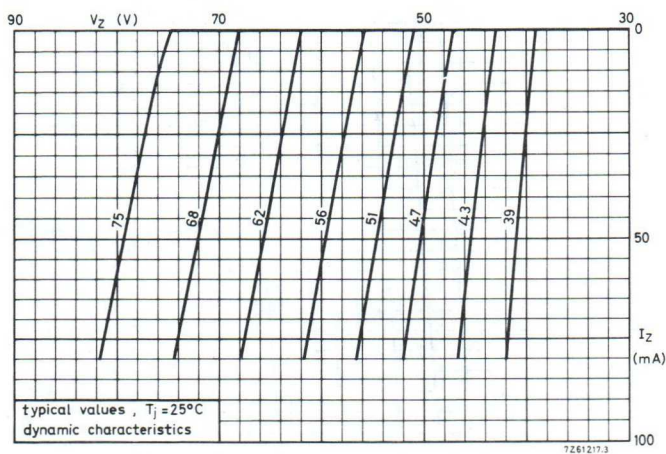
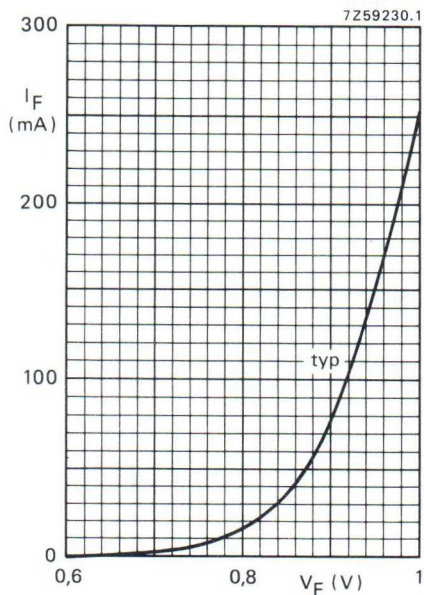
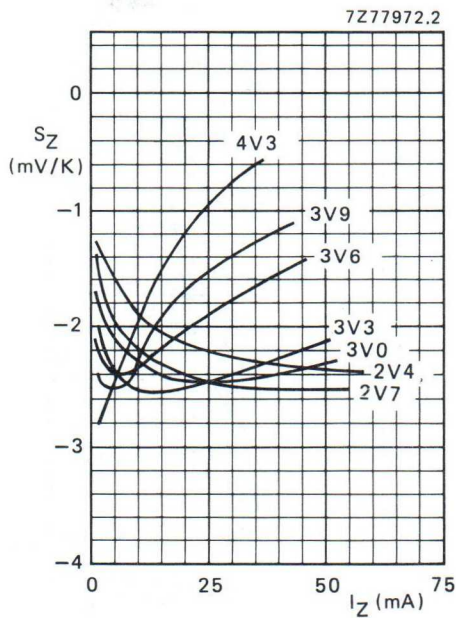
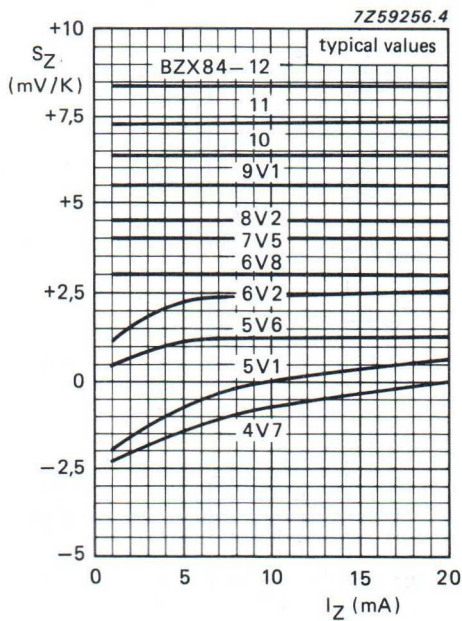


Fig. 6 Dynamic characteristics; typical values;  $T_j = 25^\circ\text{C}$ .

Fig. 7 Typical values at  $T_j = 25^\circ\text{C}$ .Fig. 8 Typical values;  $T_j = 25$  to  $175^\circ\text{C}$ .Fig. 9 Typical values;  $T_j = 25$  to  $175^\circ\text{C}$ .

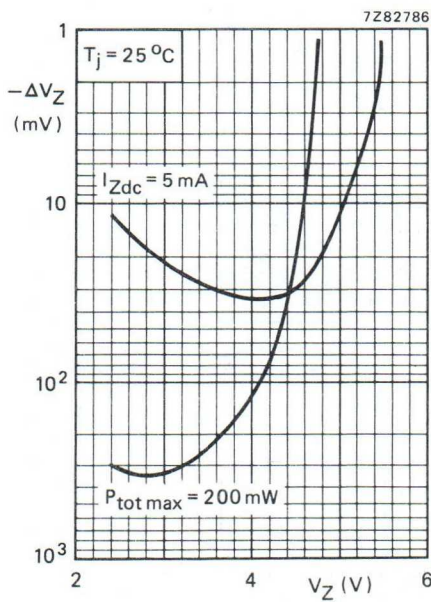


Fig. 10 Typical values;  $T_j = 25^\circ\text{C}$ .

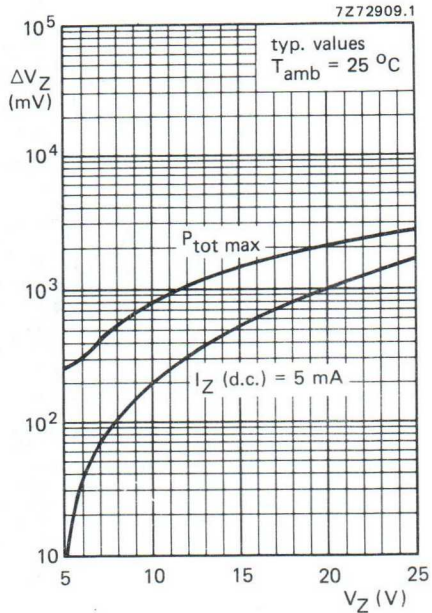


Fig. 11 Typical values;  $T_{amb} = 25^\circ\text{C}$ .

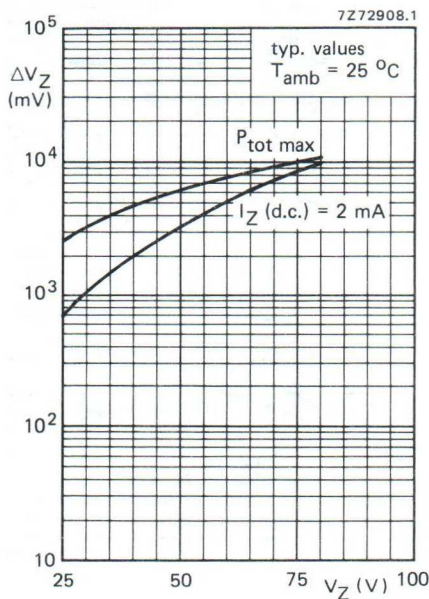


Fig. 12 Typical values;  $T_{amb} = 25^\circ\text{C}$ .

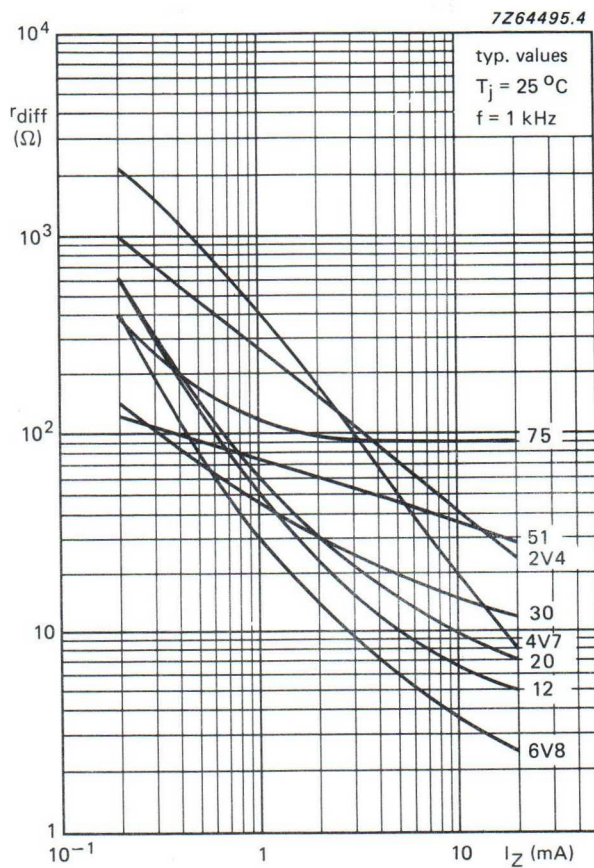


Fig. 13.





## SILICON TEMPERATURE SENSORS

These sensors have a positive temperature coefficient of resistance and are for use in measurement and control.

### QUICK REFERENCE DATA

Resistance at  $T_{amb} = 25\text{ }^{\circ}\text{C}$

Type tape  
(identification colour)

$I_C = 1\text{ mA}$

|           |                                                      |
|-----------|------------------------------------------------------|
| KTY85-110 | $R_{25} = 990 - 1010\text{ }\Omega$ ; yellow         |
| KTY85-120 | $R_{25} = 980 - 1020\text{ }\Omega$ ; white or green |
| KTY85-121 | $R_{25} = 980 - 1000\text{ }\Omega$ ; white          |
| KTY85-122 | $R_{25} = 1000 - 1020\text{ }\Omega$ ; green         |
| KTY85-150 | $R_{25} = 950 - 1050\text{ }\Omega$ ; black or blue  |
| KTY85-151 | $R_{25} = 950 - 1000\text{ }\Omega$ ; black          |
| KTY85-152 | $R_{25} = 1000 - 1050\text{ }\Omega$ ; blue          |

**KTY85-120** is composed of groups -121 and -122, and is correspondingly designated.

**KTY85-150** is composed of groups -151 and -152, and is correspondingly designated.

Operating ambient temperature range  $T_{amb}$

$-40\text{ to }+125\text{ }^{\circ}\text{C}$

### MECHANICAL DATA

Dimensions in mm

Indication of polarity and type tape

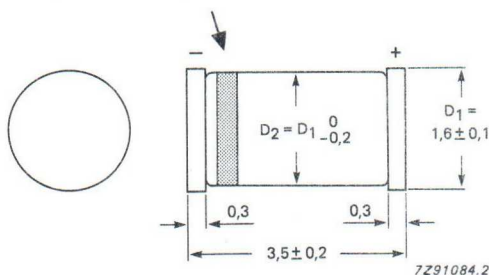


Fig. 1 SOD-80.

### Note

The sensor has to be operated with the lower potential at the marked connection.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air

|                                         |       |      |        |
|-----------------------------------------|-------|------|--------|
| $T_{amb} = 25\text{ }^{\circ}\text{C}$  | $I_C$ | max. | 10 mA  |
| $T_{amb} = 125\text{ }^{\circ}\text{C}$ | $I_C$ | max. | 2.0 mA |

**CHARACTERISTICS**

(Based on the measurements in liquid at  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
unless otherwise specified)

Resistance

 $I_C = 1\text{ mA}$ 

|           |                                |
|-----------|--------------------------------|
| KTY85-110 | $R_{25} = 990 - 1010\ \Omega$  |
| KTY85-120 | $R_{25} = 980 - 1020\ \Omega$  |
| KTY85-121 | $R_{25} = 980 - 1000\ \Omega$  |
| KTY85-122 | $R_{25} = 1000 - 1020\ \Omega$ |
| KTY85-150 | $R_{25} = 950 - 1050\ \Omega$  |
| KTY85-151 | $R_{25} = 950 - 1000\ \Omega$  |
| KTY85-152 | $R_{25} = 1000 - 1050\ \Omega$ |

Temperature coefficient

typ. 0.76 %/K

Resistance ratio

|                  |                   |
|------------------|-------------------|
| $R_{100}/R_{25}$ | $1.670 \pm 0.020$ |
| $R_{-40}/R_{25}$ | $0.577 \pm 0.008$ |

Thermal time constant\*

|                     |      |       |
|---------------------|------|-------|
| in still air        | typ. | 20 s  |
| in still liquid**   | typ. | 1.0 s |
| in flowing liquid** | typ. | 0.5 s |

Measuring temperature range

-40 to +125  $^{\circ}\text{C}$ 

\* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4  $^{\circ}\text{C}$ , when a sensor with an initial temperature of 25  $^{\circ}\text{C}$  is put into an ambient with a temperature of 100  $^{\circ}\text{C}$ .

\*\* Inert liquid FC43 of 3M company.

| $T_{amb}$<br>°C | Resistance<br>$\Omega$ |
|-----------------|------------------------|
| -40             | 577                    |
| -30             | 632                    |
| -20             | 691                    |
| -10             | 754                    |
| 0               | 820                    |
| 10              | 889                    |
| 20              | 962                    |
| 25              | 1000                   |
| 30              | 1039                   |
| 40              | 1118                   |
| 50              | 1202                   |
| 60              | 1288                   |
| 70              | 1379                   |
| 80              | 1472                   |
| 90              | 1569                   |
| 100             | 1670                   |
| 110             | 1774                   |
| 120             | 1882                   |
| 125             | 1937                   |

Ambient temperatures and corresponding resistance values of sensor ( $I_C = 1\text{ mA}$ ).

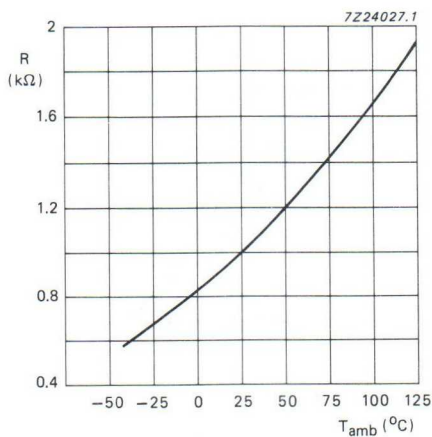


Fig. 2 Average resistance value of sensor at  $I_C = 1\text{ mA}$  as a function of ambient temperature.

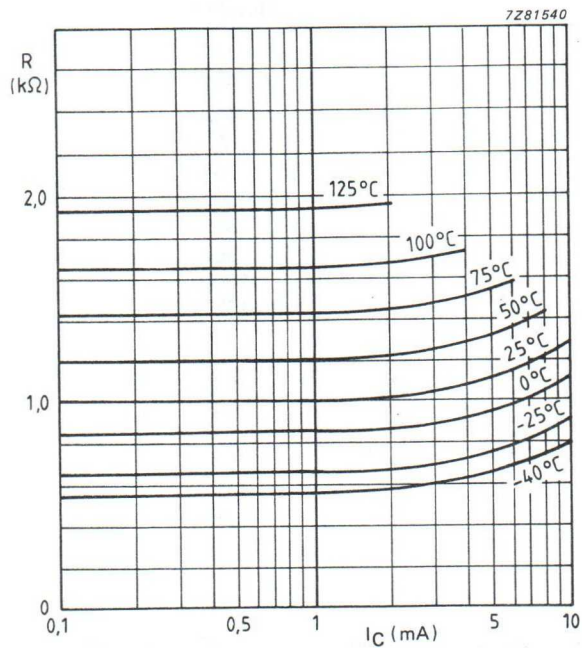


Fig. 3 Sensor resistance as a function of operating current.

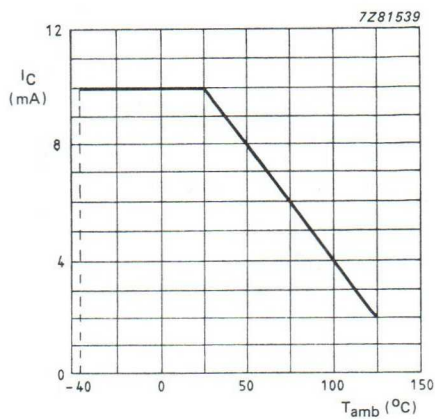


Fig. 4 Maximum operating current for safe operation.

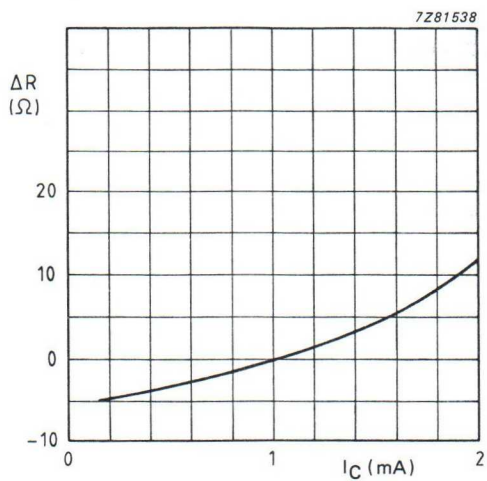


Fig. 5 Deviation of sensor resistance  $R$  as a function of operating current  $I_C$  in still liquid;  $T_{amb} = 25^\circ\text{C}$ .

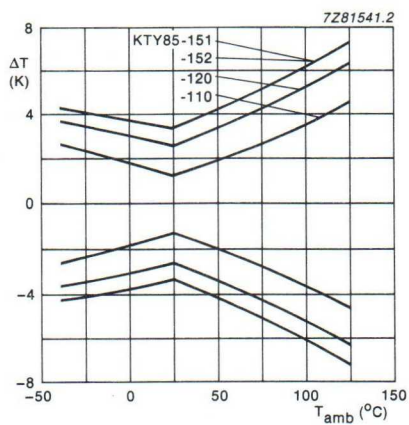


Fig. 6 Maximum expected temperature error  $\Delta T$ .





# DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PMBD 914

SUPESEDES DATA OF NOVEMBER 1988

## SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

Silicon epitaxial high speed diodes in a microminiature plastic envelope. It is intended for high-speed switching in thick and thin-film circuits.

### QUICK REFERENCE DATA

|                                                                                                          |           |      |                        |
|----------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Continuous reverse voltage                                                                               | $V_R$     | max. | 70 V                   |
| Forward current (DC)                                                                                     | $I_F$     | max. | 200 mA                 |
| Non-repetitive peak forward current                                                                      | $I_{FSM}$ | max. | 500 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$                                        | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                                     | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| Forward voltage at $I_F = 10\text{ mA}$                                                                  | $V_F$     | max. | 1 V                    |
| Reverse recovery time<br>$I_F = 10\text{ mA}$ to $I_R = 10\text{ mA}$<br>measured at $I_R = 1\text{ mA}$ | $t_{rr}$  | max. | 15 ns                  |

### MECHANICAL DATA

Dimensions in mm

Marking code:

PMBD914: 5D

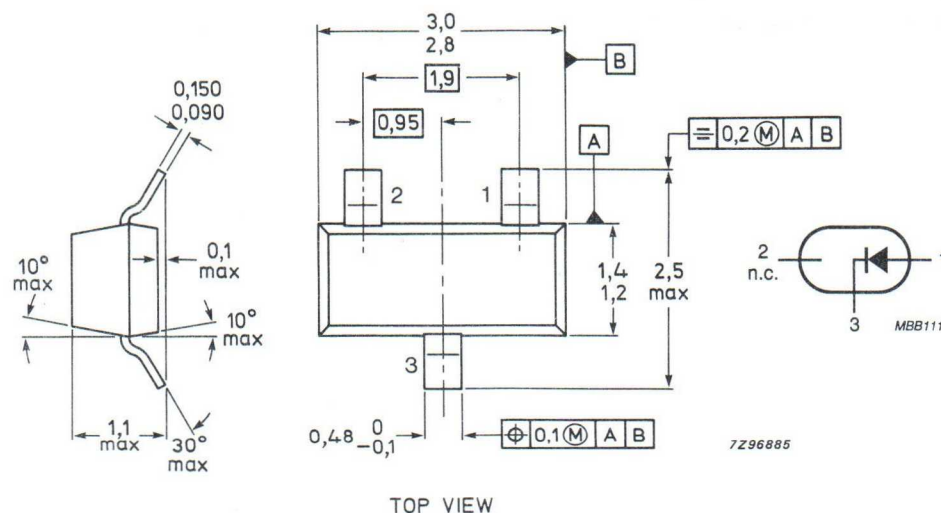


Fig. 1 SOT-23.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |      |                                         |
|---------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Continuous reverse voltage                                          | $V_R$     | max. | 70 V                                    |
| Forward current (DC)                                                | $I_F$     | max. | 200 mA                                  |
| Non-repetitive peak forward current                                 | $I_{FSM}$ | max. | 500 mA                                  |
| Total power dissipated up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                                  |
| Storage temperature                                                 | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$     | max. | $150\text{ }^{\circ}\text{C}$           |

# THERMAL RESISTANCE

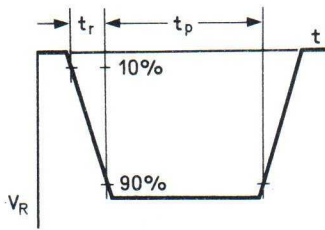
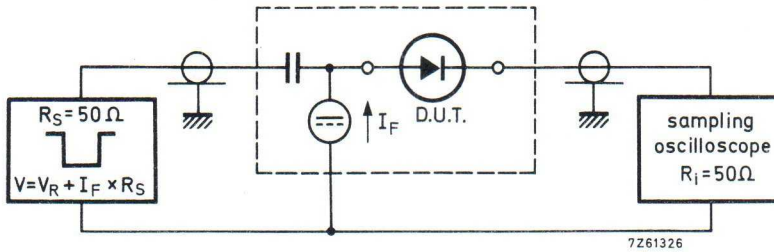
|                           |               |  |         |
|---------------------------|---------------|--|---------|
| From junction to ambient* | $R_{th\ j-a}$ |  | 430 K/W |
|---------------------------|---------------|--|---------|

# CHARACTERISTICS

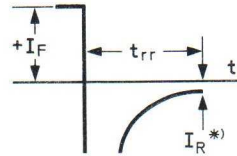
$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                                       |             |      |                          |
|---------------------------------------------------------------------------------------------------------------------------------------|-------------|------|--------------------------|
| Forward voltage<br>$I_F = 10\text{ mA}$                                                                                               | $V_F$       | max. | 1.0 V                    |
| Reverse breakdown voltage<br>$I_R = 100\text{ }\mu\text{A}$                                                                           | $V_{(br)r}$ | min. | 100 V                    |
| Reverse current<br>$V_R = 25\text{ V}$<br>$V_R = 75\text{ V}$                                                                         | $I_R$       | max. | 25 nA<br>5 $\mu\text{A}$ |
| Diode capacitance<br>$V_R = 0\text{ V}$ ; $f = 1\text{ MHz}$                                                                          | $C_d$       | max. | 4.0 pF                   |
| Reverse recovery time switched<br>from $I_F = 10\text{ mA}$ to $I_R = 10\text{ mA}$ ;<br>measured at $I_R = 1\text{ mA}$ (see Fig. 2) | $t_{rr}$    | max. | 15 ns                    |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



input signal



7Z61328.1

output signal

Fig. 2 Test circuit and waveforms; reverse recovery time.

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000

1000



# DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PMBD 6050

SUPERSEDES DATA OF NOVEMBER 1988

## SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

Silicon epitaxial high speed diodes in a microminiature plastic envelope. It is intended for high-speed switching in thick and thin-film circuits.

### QUICK REFERENCE DATA

|                                                                                     |           |      |                |
|-------------------------------------------------------------------------------------|-----------|------|----------------|
| Continuous reverse voltage                                                          | $V_R$     | max. | 70 V           |
| Forward current (DC)                                                                | $I_F$     | max. | 200 mA         |
| Non-repetitive peak forward current                                                 | $I_{FSM}$ | max. | 500 mA         |
| Total power dissipation at $T_{amb} = 25^\circ C$                                   | $P_{tot}$ | max. | 300 mW         |
| Junction temperature                                                                | $T_j$     | max. | 150 $^\circ C$ |
| Forward voltage at $I_F = 100$ mA                                                   | $V_F$     | min. | 0.85 V         |
|                                                                                     |           | max. | 1.1 V          |
| Reverse recovery time<br>$I_F = 10$ mA to $I_R = 10$ mA<br>measured at $I_R = 1$ mA | $t_{rr}$  | max. | 15 ns          |

### MECHANICAL DATA

Dimensions in mm

Marking code:

PMBD6050: 5A

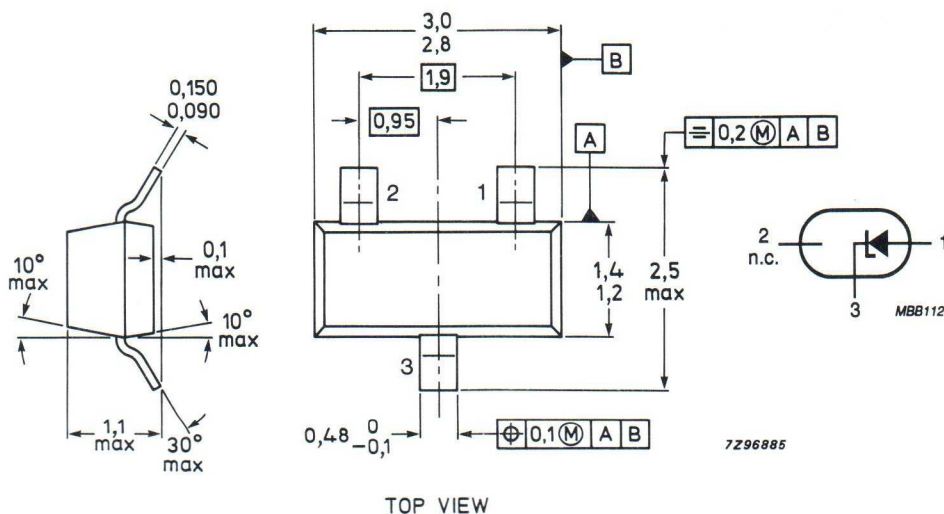


Fig. 1 SOT-23.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |      |                                              |
|---------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Continuous reverse voltage                                          | $V_R$     | max. | 70 V                                         |
| Forward current (DC)                                                | $I_F$     | max. | 200 mA                                       |
| Non-repetitive peak forward current                                 | $I_{FSM}$ | max. | 500 mA                                       |
| Total power dissipated up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                                       |
| Storage temperature                                                 | $T_{stg}$ |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$     | max. | 150 $^{\circ}\text{C}$                       |

# THERMAL RESISTANCE

|                           |               |  |         |
|---------------------------|---------------|--|---------|
| From junction to ambient* | $R_{th\ j-a}$ |  | 430 K/W |
|---------------------------|---------------|--|---------|

# CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                     |             |      |        |
|-----------------------------------------------------|-------------|------|--------|
| Forward voltage                                     |             |      |        |
| $I_F = 1\text{ mA}$                                 | $V_F$       | min. | 0.55 V |
|                                                     |             | max. | 0.70 V |
| $I_F = 100\text{ mA}$                               | $V_F$       | min. | 0.85 V |
|                                                     |             | max. | 1.10 V |
| Reverse breakdown voltage                           |             |      |        |
| $I_R = 100\text{ }\mu\text{A}$                      | $V_{(br)r}$ | min. | 70 V   |
| Reverse current $V_R = 50\text{ V}$                 | $I_R$       | max. | 100 nA |
| Diode capacitance                                   |             |      |        |
| $V_R = 0\text{ V}; f = 1\text{ MHz}$                | $C_d$       | max. | 2.5 pF |
| Reverse recovery time switched                      |             |      |        |
| from $I_F = 10\text{ mA}$ to $I_R = 10\text{ mA}$ ; |             |      |        |
| measured at $I_R = 1\text{ mA}$ (see Fig. 2)        | $t_{rr}$    | max. | 15 ns  |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

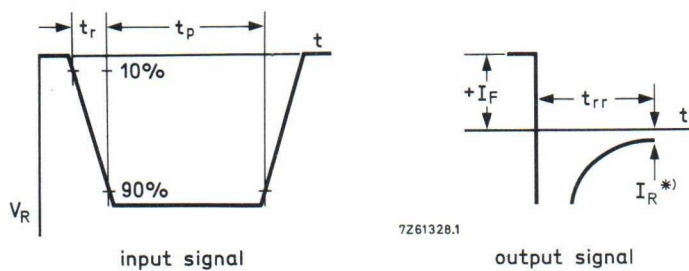
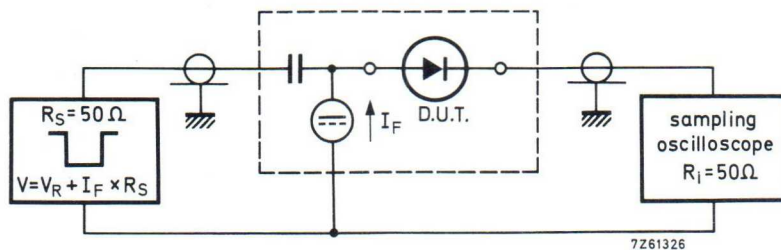
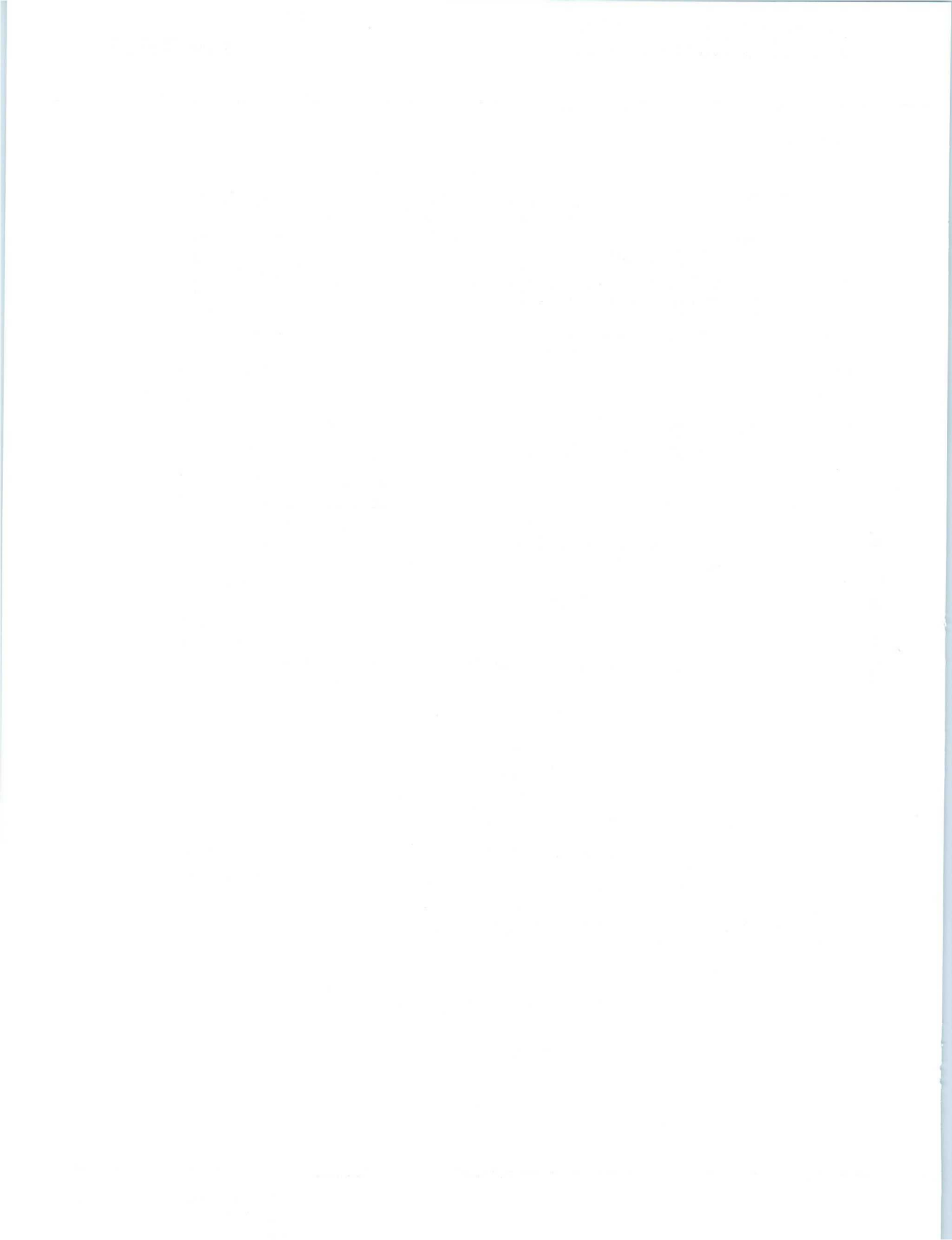


Fig. 2 Test circuit and waveforms; reverse recovery time.



# DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PMBD 7000

SUPERSEDES DATA OF MAY 1988

## SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

The PMBD7000 consists of two diodes in a microminiature plastic envelope. The diodes are connected in series and the unit is intended for high speed switching.

### QUICK REFERENCE DATA

|                                                                                                       |           |      |                        |
|-------------------------------------------------------------------------------------------------------|-----------|------|------------------------|
| Continuous reverse voltage                                                                            | $V_R$     | max. | 100 V                  |
| Forward current (DC)                                                                                  | $I_F$     | max. | 200 mA                 |
| Non-repetitive peak forward current                                                                   | $I_{FSM}$ | max. | 500 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$                                     | $P_{tot}$ | max. | 300 mW                 |
| Junction temperature                                                                                  | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| Forward voltage at $I_F = 100\text{ mA}$                                                              | $V_F$     | max. | 1.10 V                 |
| Reverse recovery time<br>$I_F = 10\text{ mA}$ to $I_R = 10\text{ mA}$ measured at $I_R = 1\text{ mA}$ | $t_{rr}$  | max. | 15 ns                  |

### MECHANICAL DATA

Dimensions in mm

Marking code:

PMBD7000: 5C

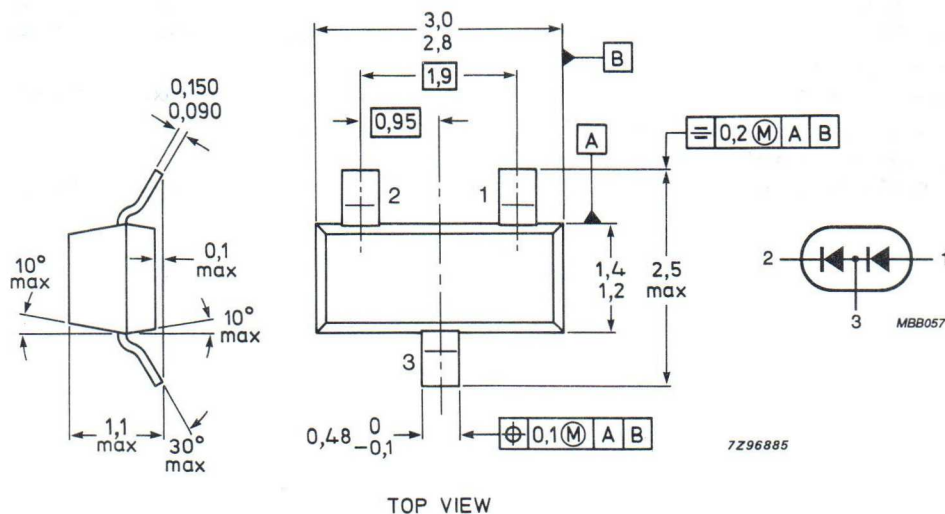


Fig. 1 SOT-23.



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |      |                                              |
|---------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Continuous reverse voltage                                          | $V_R$     | max. | 100 V                                        |
| Forward current (DC)                                                | $I_F$     | max. | 200 mA                                       |
| Non-repetitive peak forward current                                 | $I_{FSM}$ | max. | 500 mA                                       |
| Total power dissipated up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 300 mW                                       |
| Storage temperature                                                 | $T_{stg}$ |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$     | max. | 150 $^{\circ}\text{C}$                       |

# THERMAL RESISTANCE

|                           |               |  |         |
|---------------------------|---------------|--|---------|
| From junction to ambient* | $R_{th\ j-a}$ |  | 430 K/W |
|---------------------------|---------------|--|---------|

# CHARACTERISTICS (per diode)

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Forward voltage

|                       |       |      |        |
|-----------------------|-------|------|--------|
| $I_F = 1\text{ mA}$   | $V_F$ | min. | 0.55 V |
|                       |       | max. | 0.70 V |
| $I_F = 10\text{ mA}$  | $V_F$ | min. | 0.67 V |
|                       |       | max. | 0.82 V |
| $I_F = 100\text{ mA}$ | $V_F$ | min. | 0.75 V |
|                       |       | max. | 1.10 V |

Reverse breakdown voltage

|                                |             |      |       |
|--------------------------------|-------------|------|-------|
| $I_R = 100\text{ }\mu\text{A}$ | $V_{(br)r}$ | min. | 100 V |
|--------------------------------|-------------|------|-------|

Reverse current

|                                                            |       |      |                   |
|------------------------------------------------------------|-------|------|-------------------|
| $V_R = 50\text{ V}$                                        | $I_R$ | max. | 300 nA            |
| $V_R = 100\text{ V}$                                       | $I_R$ | max. | 500 nA            |
| $V_R = 50\text{ V}; T_{amb} = 125\text{ }^{\circ}\text{C}$ | $I_R$ | max. | 100 $\mu\text{A}$ |

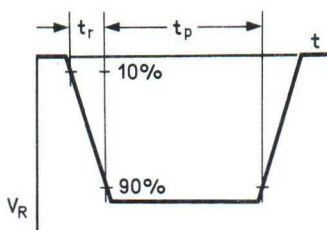
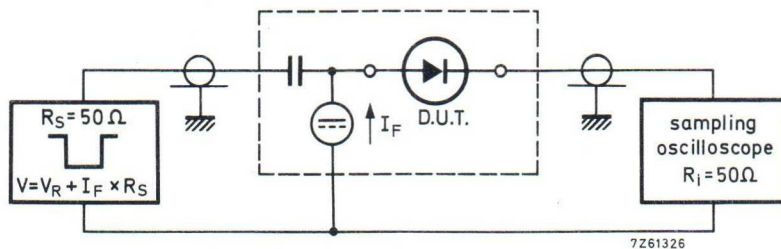
Diode capacitance

|                                      |       |      |        |
|--------------------------------------|-------|------|--------|
| $V_R = 0\text{ V}; f = 1\text{ MHz}$ | $C_d$ | max. | 1.5 pF |
|--------------------------------------|-------|------|--------|

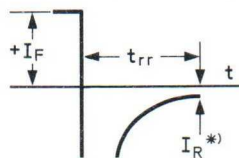
Reverse recovery time switched from

|                                                                                             |          |      |       |
|---------------------------------------------------------------------------------------------|----------|------|-------|
| $I_F = 10\text{ mA}$ to $I_R = 10\text{ mA}$ ; measured at $I_R = 1\text{ mA}$ (see Fig. 2) | $t_{rr}$ | max. | 15 ns |
|---------------------------------------------------------------------------------------------|----------|------|-------|

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



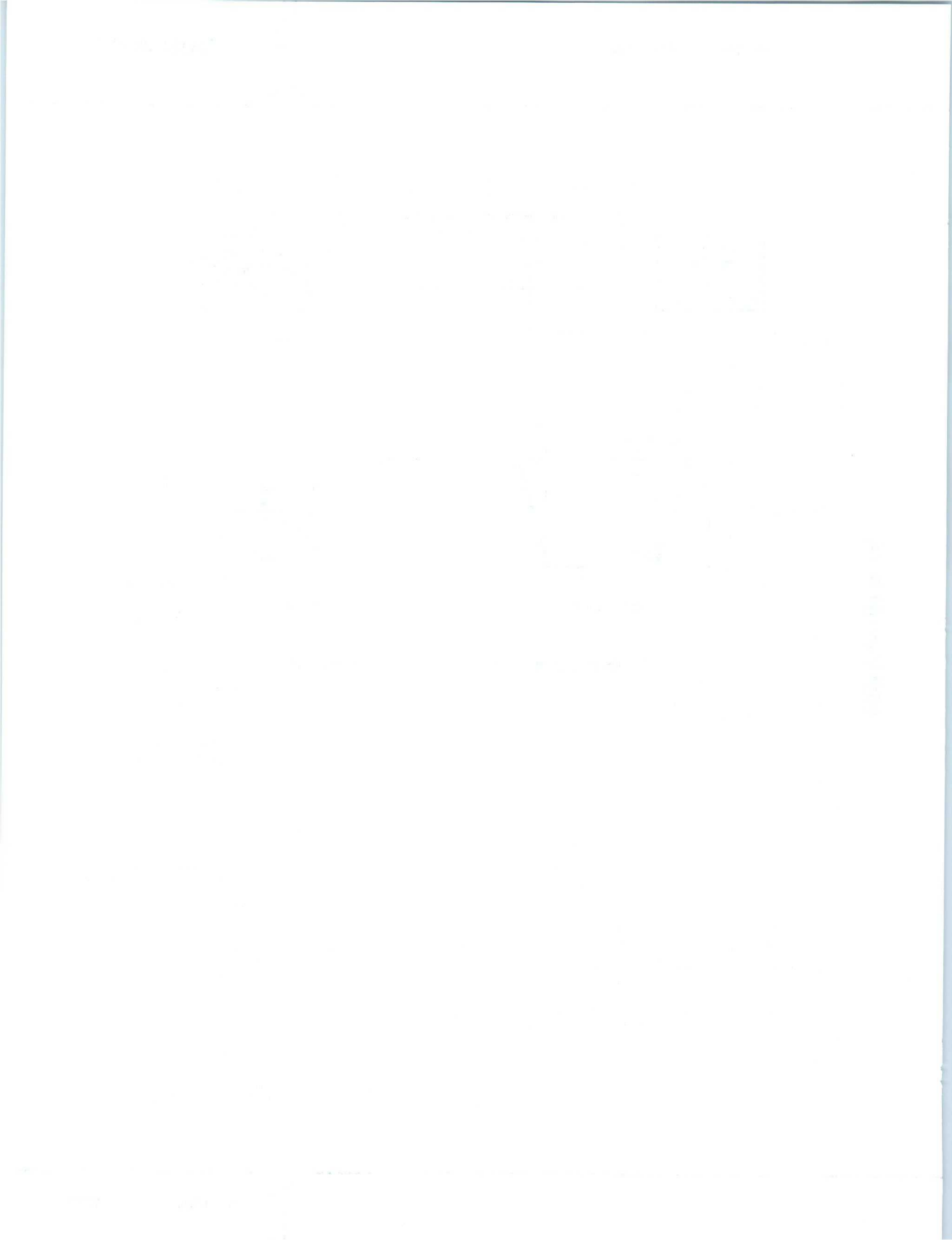
input signal



7Z61328.1

output signal

Fig. 2 Test circuit and waveforms; reverse recovery time.



## N-CHANNEL ENHANCEMENT MODE VERTICAL D-MOS TRANSISTOR

N-channel enhancement mode vertical D-MOS transistor in a SOT23 envelope. Designed for use as a Surface Mounted Device (SMD) in thin and thick-film circuits with applications in relay, high-speed and line transformer drivers.

### Features

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown

### QUICK REFERENCE DATA

|                                                                           |               |              |                              |
|---------------------------------------------------------------------------|---------------|--------------|------------------------------|
| Drain-source voltage                                                      | $V_{DS}$      | max.         | 60 V                         |
| Gate-source voltage (open drain)                                          | $\pm V_{GSO}$ | max.         | 20 V                         |
| Drain current (DC)                                                        | $I_D$         | max.         | 250 mA                       |
| Total power dissipation up to<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$   | $P_{tot}$     | max.         | 300 mW                       |
| Drain-source on-resistance<br>$I_D = 200\text{ mA}; V_{GS} = 10\text{ V}$ | $R_{DS\ on}$  | typ.<br>max. | 2.5 $\Omega$<br>5.0 $\Omega$ |
| Transfer admittance<br>$I_D = 200\text{ mA}; V_{DS} = 10\text{ V}$        | $ y_{fs} $    | min.<br>typ. | 100 mS<br>200 mS             |

### MECHANICAL DATA

Fig.1 SOT23.

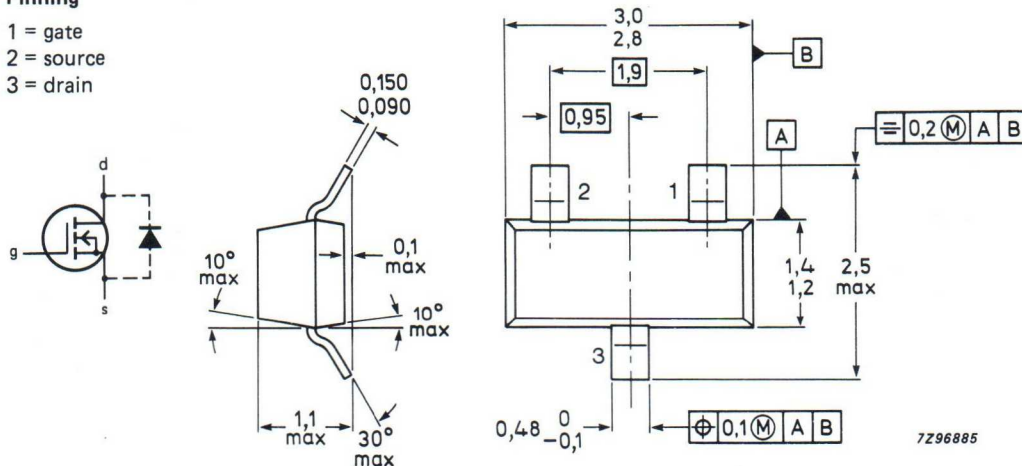
Dimensions in mm

Marking code:

PMBF170 = pKX

### Pinning

- 1 = gate  
2 = source  
3 = drain



7296885

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                               |               |      |                                         |
|-------------------------------------------------------------------------------|---------------|------|-----------------------------------------|
| Drain-source voltage                                                          | $V_{DS}$      | max. | 60 V                                    |
| Gate-source voltage (open drain)                                              | $\pm V_{GSO}$ | max. | 20 V                                    |
| Drain current (DC)                                                            | $I_D$         | max. | 250 mA                                  |
| Drain current (peak)                                                          | $I_{DM}$      | max. | 500 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ (note 1) | $P_{tot}$     | max. | 300 mW (note 1)                         |
|                                                                               |               | max. | 250 mW (note 2)                         |
| Storage temperature range                                                     | $T_{stg}$     |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                          | $T_j$         | max. | $150\text{ }^{\circ}\text{C}$           |

**THERMAL RESISTANCE**

|                                   |               |   |         |
|-----------------------------------|---------------|---|---------|
| From junction to ambient (note 1) | $R_{th\ j-a}$ | = | 430 K/W |
| From junction to ambient (note 2) | $R_{th\ j-a}$ | = | 500 K/W |

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                             |               |              |                              |
|---------------------------------------------------------------------------------------------|---------------|--------------|------------------------------|
| Drain-source breakdown voltage<br>$I_D = 10\text{ }\mu\text{A}$ ; $V_{GS} = 0$              | $V_{(BR)DSS}$ | min.<br>typ. | 60 V<br>90 V                 |
| Drain-source leakage current<br>$V_{DS} = 25\text{ V}$ ; $V_{GS} = 0$                       | $I_{DSS}$     | max.         | 500 nA                       |
| $V_{DS} = 48\text{ V}$ ; $V_{GS} = 0$                                                       | $I_{DSS}$     | max.         | 1 $\mu\text{A}$              |
| Gate-source leakage current<br>$V_{GS} = 15\text{ V}$ ; $V_{DS} = 0$                        | $I_{GSS}$     | max.         | 10 nA                        |
| Gate-source cut-off voltage<br>$I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$                      | $V_{GS(th)}$  | min.<br>max. | 0.8 V<br>3.0 V               |
| Drain-source on-resistance<br>$I_D = 200\text{ mA}$ ; $V_{GS} = 10\text{ V}$                | $R_{DSon}$    | typ.<br>max. | 2.5 $\Omega$<br>5.0 $\Omega$ |
| Transfer admittance<br>$I_D = 200\text{ mA}$ ; $V_{DS} = 10\text{ V}$                       | $ y_{fs} $    | min.<br>typ. | 100 mS<br>200 mS             |
| Input capacitance<br>$V_{DS} = 10\text{ V}$ ; $V_{GS} = 0\text{ V}$ ; $f = 1\text{ MHz}$    | $C_{iss}$     | typ.<br>max. | 25 pF<br>40 pF               |
| Output capacitance<br>$V_{DS} = 10\text{ V}$ ; $V_{GS} = 0\text{ V}$ ; $f = 1\text{ MHz}$   | $C_{oss}$     | typ.<br>max. | 22 pF<br>30 pF               |
| Feedback capacitance<br>$V_{DS} = 10\text{ V}$ ; $V_{GS} = 0\text{ V}$ ; $f = 1\text{ MHz}$ | $C_{rss}$     | typ.<br>max. | 6 pF<br>10 pF                |

**Notes**

1. Mounted on ceramic substrate measuring 10 mm x 8 mm x 0.7 mm.
2. Mounted on printed-circuit board.



## Switching times

 $V_{GS} = 0 \text{ to } 10 \text{ V}; I_D = 200 \text{ mA}; V_{DD} = 50 \text{ V}$ 
 $t_{on}$   
 $t_{off}$ 

|      |       |
|------|-------|
| max. | 10 ns |
| max. | 15 ns |

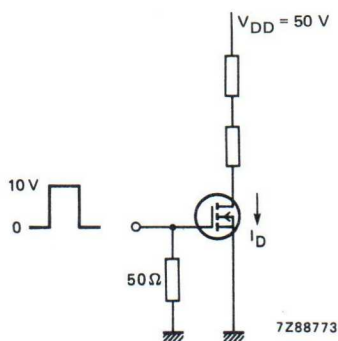


Fig.2 Switching times test circuit.

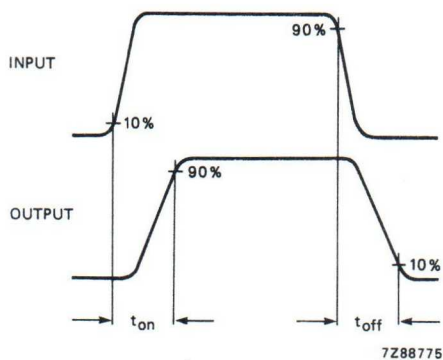


Fig.3 Input and output waveforms.



## N-CHANNEL FETS

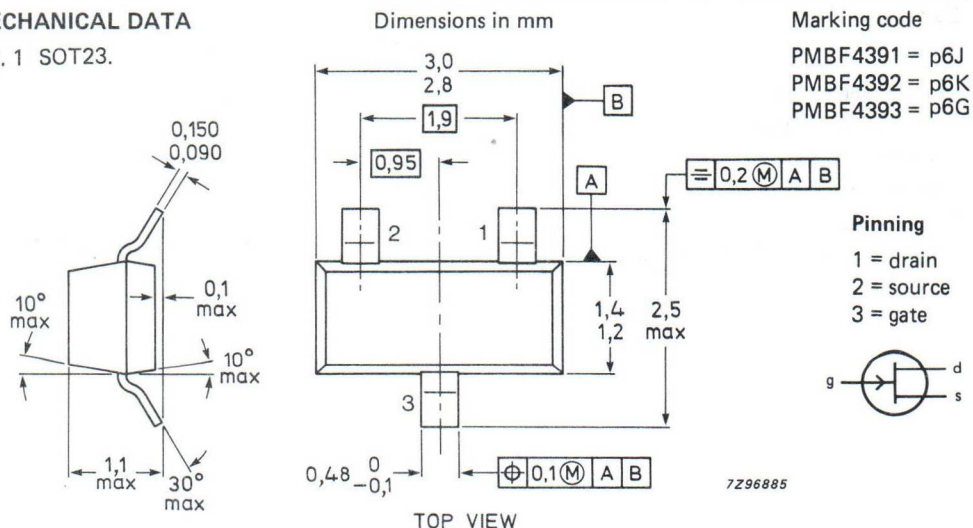
Symmetrical silicon n-channel depletion type junction field-effect transistors on a plastic microminiature envelope intended for application in thick and thin-film circuits. The transistors are intended for low-power chopper or switching applications in industry.

### QUICK REFERENCE DATA

|                                                     |                     | PMBF4391    | PMBF4392 | PMBF4393     |
|-----------------------------------------------------|---------------------|-------------|----------|--------------|
| Drain-source voltage                                | $\pm V_{DS}$ max.   | 40          | 40       | 40 V         |
| Drain current                                       |                     |             |          |              |
| $V_{DS} = 20 \text{ V}; V_{GS} = 0$                 | $I_{DSS}$           | > 50        | 25       | 5 mA         |
| Gate-source cut-off voltage                         |                     |             |          |              |
| $V_{DS} = 20 \text{ V}; I_D = 1 \text{ nA}$         | $-V_{(P)GS}$        | > 4<br>< 10 | 2<br>5   | 0.5 V<br>3 V |
| Drain-source resistance (on) at $f = 1 \text{ kHz}$ |                     |             |          |              |
| $I_D = 0; V_{GS} = 0$                               | $R_{ds \text{ on}}$ | < 30        | 60       | 100 $\Omega$ |
| Feedback capacitance at $f = 1 \text{ MHz}$         |                     |             |          |              |
| $-V_{GS} = 12 \text{ V}; V_{DS} = 0$                | $C_{rs}$            | < 3.5       | 3.5      | 3.5 pF       |
| Turn-off time                                       |                     |             |          |              |
| $V_{DD} = 10 \text{ V}; V_{GS} = 0$                 |                     |             |          |              |
| $I_D = 12 \text{ mA}; -V_{GSM} = 12 \text{ V}$      | $t_{off}$           | < 20        | —        | — ns         |
| $I_D = 6 \text{ mA}; -V_{GSM} = 7 \text{ V}$        | $t_{off}$           | < —         | 35       | — ns         |
| $I_D = 3 \text{ mA}; -V_{GSM} = 5 \text{ V}$        | $t_{off}$           | < —         | —        | 50 ns        |

### MECHANICAL DATA

Fig. 1 SOT23.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |              |      |                                              |
|------------------------------------------------------------------------|--------------|------|----------------------------------------------|
| Drain-source voltage                                                   | $\pm V_{DS}$ | max. | 40 V                                         |
| Drain-gate voltage                                                     | $V_{DGO}$    | max. | 40 V                                         |
| Gate-source voltage                                                    | $-V_{GSO}$   | max. | 40 V                                         |
| Gate current (DC)                                                      | $I_G$        | max. | 50 mA                                        |
| Total power dissipation up to $T_{amb} = 40\text{ }^{\circ}\text{C}^*$ | $P_{tot}$    | max. | 250 mW                                       |
| Storage temperature range                                              | $T_{stg}$    | max. | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$        | max. | 150 $^{\circ}\text{C}$                       |

## THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 430 K/W |
|---------------------------|---------------|---|---------|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Gate-source voltage

$$I_G = 1\text{ mA}; V_{DS} = 0$$

$$V_{GSON} < 1\text{ V}$$

Gate-source cut-off current

$$V_{DS} = 0\text{ V}; -V_{GS} = 20\text{ V}$$

$$-I_{GSS} < 0.1\text{ nA}$$

$$V_{DS} = 0\text{ V}; -V_{GS} = 20\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$$

$$-I_{GSS} < 0.2\text{ }\mu\text{A}$$

|                                                                                                                                     |                | PMBF4391 | PMBF4392 | PMBF4393     |
|-------------------------------------------------------------------------------------------------------------------------------------|----------------|----------|----------|--------------|
| Drain current<br>$V_{DS} = 20\text{ V}; V_{GS} = 0$                                                                                 | $I_{DSS}$      | $> 50$   | 25       | 5 mA         |
|                                                                                                                                     |                | $< 150$  | 75       | 30 mA        |
| Gate-source breakdown voltage<br>$-I_G = 1\text{ }\mu\text{A}; V_{DS} = 0$                                                          | $-V_{(BR)GSS}$ | $> 40$   | 40       | 40 V         |
| Gate-source cut-off voltage<br>$I_D = 1\text{ nA}; V_{DS} = 20\text{ V}$                                                            | $-V_{(P)GS}$   | $> 4$    | 2        | 0.5 V        |
|                                                                                                                                     |                | $< 10$   | 5        | 3 V          |
| Drain-source voltage (on)<br>$I_D = 12\text{ mA}; V_{GS} = 0$<br>$I_D = 6\text{ mA}; V_{GS} = 0$<br>$I_D = 3\text{ mA}; V_{GS} = 0$ | $V_{DSON}$     | $< 0.4$  | —        | — V          |
|                                                                                                                                     | $V_{DSON}$     | $< 0.4$  | 0.4      | — V          |
|                                                                                                                                     | $V_{DSON}$     | $< 0.4$  | —        | 0.4 V        |
| Drain-source resistance (on)<br>$I_D = 0; V_{GS} = 0; f = 1\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$                       | $r_{ds\ on}$   | $< 30$   | 60       | 100 $\Omega$ |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

|                                                                                            |                                                               | PMBF4391  | PMBF4392 | PMBF4393      |                   |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------|-----------|----------|---------------|-------------------|
| Drain cut-off current                                                                      |                                                               |           |          |               |                   |
| $-V_{GS} = 12\text{ V}$                                                                    | $V_{DS} = 20\text{ V}$                                        | $I_{DSX}$ | $< 0.1$  | —             | — nA              |
| $-V_{GS} = 7\text{ V}$                                                                     |                                                               | $I_{DSX}$ | $< —$    | 0.1           | — nA              |
| $-V_{GS} = 5\text{ V}$                                                                     |                                                               | $I_{DSX}$ | $< —$    | —             | 0.1 nA            |
| $-V_{GS} = 12\text{ V}$                                                                    | $V_{DS} = 20\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$ | $I_{DSX}$ | $< 0.2$  | —             | — $\mu\text{A}$   |
| $-V_{GS} = 7\text{ V}$                                                                     |                                                               | $I_{DSX}$ | $< —$    | 0.2           | — $\mu\text{A}$   |
| $-V_{GS} = 5\text{ V}$                                                                     |                                                               | $I_{DSX}$ | $< —$    | —             | 0.2 $\mu\text{A}$ |
| y-parameters (common source)                                                               |                                                               |           |          |               |                   |
| $V_{DS} = 20\text{ V}; V_{GS} = 0; f = 1\text{ MHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ |                                                               |           |          |               |                   |
| Input capacitance                                                                          | $C_{is}$                                                      | $< 14$    | 14       | 14 pF         |                   |
| Feedback capacitance                                                                       |                                                               |           |          |               |                   |
| $-V_{GS} = 12\text{ V}$                                                                    | $C_{rs}$                                                      | $< 3.5$   | —        | — pF          |                   |
| $-V_{GS} = 7\text{ V}$                                                                     | $C_{rs}$                                                      | $< —$     | 3.5      | — pF          |                   |
| $-V_{GS} = 5\text{ V}$                                                                     | $C_{rs}$                                                      | $< —$     | —        | 3.5 pF        |                   |
| Switching times                                                                            |                                                               |           |          |               |                   |
| $V_{DD} = 10\text{ V}; V_{GS} = 0$                                                         |                                                               |           |          |               |                   |
| Conditions $I_D$ and $-V_{GSoff}$                                                          |                                                               |           |          |               |                   |
|                                                                                            | $I_D$                                                         | $= 12$    | 6        | 3 mA          |                   |
|                                                                                            | $-V_{GSoff}$                                                  | $= 12$    | 7        | 5 V           |                   |
|                                                                                            | $R_L$                                                         | $= 750$   | 1550     | 3150 $\Omega$ |                   |
| Rise time                                                                                  | $t_r$                                                         | $< 5$     | 5        | 5 ns          |                   |
| Turn on time                                                                               | $t_{on}$                                                      | $< 15$    | 15       | 15 ns         |                   |
| Fall time                                                                                  | $t_f$                                                         | $< 15$    | 20       | 30 ns         |                   |
| Turn off time                                                                              | $t_{off}$                                                     | $< 20$    | 35       | 50 ns         |                   |

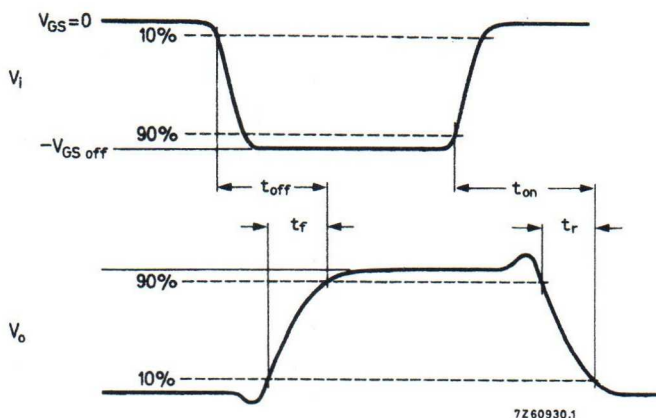
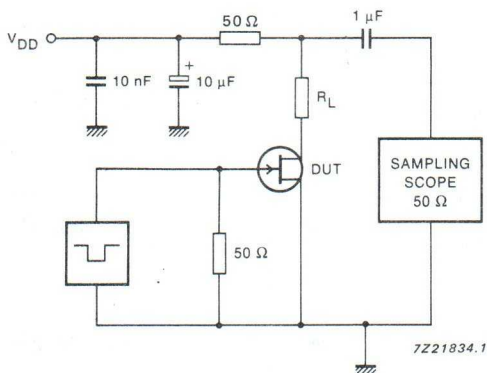


Fig.2 Switching times waveforms.





Pulse generator:

$$t_r < 0.5 \text{ ns}$$

$$t_f < 0.5 \text{ ns}$$

$$t_p = 100 \mu\text{s}$$

$$\delta = 0.01$$

Oscilloscope:

$$R_i = 50 \Omega$$

Fig. 3 Test circuit.

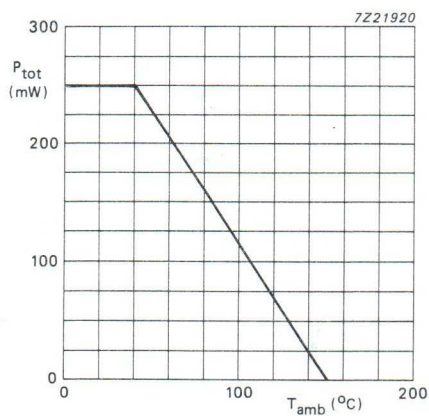


Fig.4 Power derating curve.

| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# PMBFJ108/PMBFJ109/ PMBFJ110

## N-channel junction FETs

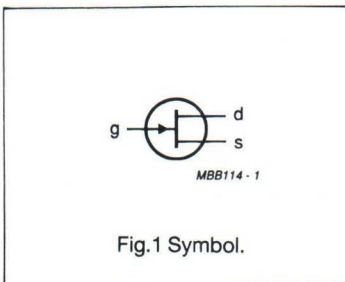
### FEATURES

- High speed switching
- Interchangeability of drain and source connections
- Low  $R_{DS(on)}$  at zero gate voltage ( $< 8 \Omega$  for PMBFJ108)

### DESCRIPTION

Silicon symmetrical n-channel junction FETs in a SOT23 envelope. They are intended for use in applications such as analog switches, choppers and commutators, and in audio amplifiers.

### PIN CONFIGURATION



### PINNING - SOT23

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | drain       |
| 2   | source      |
| 3   | gate        |

### Note

1. Drain and source are interchangeable.

### LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL       | PARAMETER                      | CONDITIONS                               | MIN. | MAX. | UNIT             |
|--------------|--------------------------------|------------------------------------------|------|------|------------------|
| $\pm V_{DS}$ | drain-source voltage           |                                          | -    | 25   | V                |
| $-V_{GSO}$   | gate-source voltage            |                                          | -    | 25   | V                |
| $-V_{GDO}$   | gate-drain voltage             |                                          | -    | 25   | V                |
| $I_G$        | forward gate current           | DC                                       | -    | 50   | mA               |
| $P_{tot}$    | total power dissipation        | $T_{amb} = 25^\circ\text{C}$<br>(note 1) | -    | 250  | mW               |
| $T_{stg}$    | storage temperature range      |                                          | -65  | 150  | $^\circ\text{C}$ |
| $T_j$        | operating junction temperature |                                          | -    | 150  | $^\circ\text{C}$ |

**N-channel junction FETs****PMBFJ108/PMBFJ109/PMBFJ110****THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                         | VALUE | UNIT |
|---------------|-----------------------------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient (note 1) | 500   | K/W  |

**Notes**

1. Mounted on an FR-4 printboard.

**STATIC CHARACTERISTICS**

$T_j = 25\ ^\circ\text{C}$ .

| SYMBOL         | PARAMETER                     | CONDITIONS                                         | MIN.           | MAX.          | UNIT     |
|----------------|-------------------------------|----------------------------------------------------|----------------|---------------|----------|
| $-I_{GSS}$     | reverse gate current          | $-V_{GS} = 15\ \text{V}$<br>$V_{DS} = 0$           | -              | 3             | nA       |
| $I_{DSX}$      | drain-source cut-off current  | $V_{GS} = -10\ \text{V}$<br>$V_{DS} = 5\ \text{V}$ | -              | 3             | nA       |
| $I_{DSS}$      | drain current                 | $V_{GS} = 0$<br>$V_{DS} = 15\ \text{V}$            | 80<br>40<br>10 | -<br>-<br>-   | mA       |
| $-V_{(BR)GSS}$ | gate-source breakdown voltage | $-I_G = 1\ \mu\text{A}$<br>$V_{DS} = 0$            | -              | 25            | V        |
| $-V_{GS(off)}$ | gate-source cut-off voltage   | $I_D = 1\ \mu\text{A}$<br>$V_{DS} = 5\ \text{V}$   | 3<br>2<br>0.5  | 10<br>6<br>4  | V        |
| $R_{DS(on)}$   | drain-source on-resistance    | $V_{GS} = 0\ \text{V}$<br>$V_{DS} = 0.1\ \text{V}$ | -<br>-<br>-    | 8<br>12<br>18 | $\Omega$ |

N-channel junction FETs

PMBFJ108/PMBFJ109/PMBFJ110

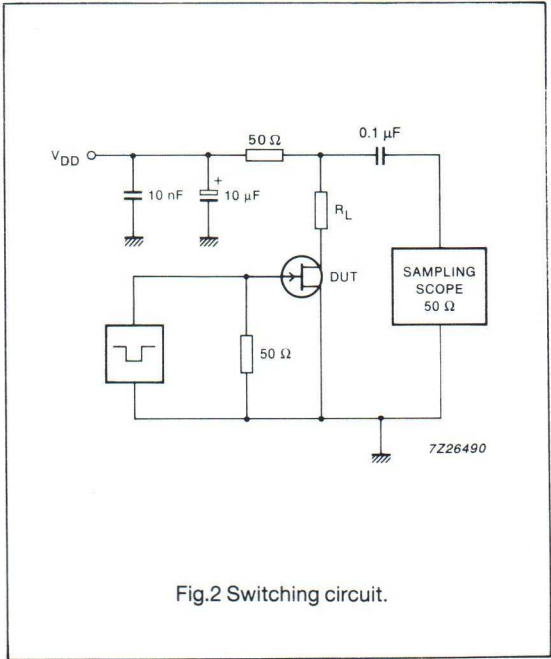
DYNAMIC CHARACTERISTICS

T<sub>j</sub> = 25 °C unless otherwise specified.

| SYMBOL                      | PARAMETER            | CONDITIONS                                                                           | TYP. | MAX. | UNIT |
|-----------------------------|----------------------|--------------------------------------------------------------------------------------|------|------|------|
| C <sub>is</sub>             | input capacitance    | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 10 V<br>f = 1 MHz                          | 15   | 30   | pF   |
| C <sub>is</sub>             | input capacitance    | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 0<br>f = 1 MHz<br>T <sub>amb</sub> = 25 °C | 50   | 85   | pF   |
| C <sub>rs</sub>             | feedback capacitance | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 10 V<br>f = 1 MHz                          | 8    | 15   | pF   |
| Switching times (see Fig.2) |                      |                                                                                      |      |      |      |
| t <sub>d</sub>              | delay time           | note 1                                                                               | 2    | -    | ns   |
| t <sub>on</sub>             | turn-on time         | note 1                                                                               | 4    | -    | ns   |
| t <sub>s</sub>              | storage time         | note 1                                                                               | 4    | -    | ns   |
| t <sub>off</sub>            | turn-off time        | note 1                                                                               | 6    | -    | ns   |

Notes

1. Test conditions for switching times are as follows:  
V<sub>DD</sub> = 1.5 V, V<sub>GS</sub> = 0 to -V<sub>GS(off)</sub> (all types);  
-V<sub>GS(off)</sub> = 12 V, R<sub>L</sub> = 100 Ω (PMBFJ108);  
-V<sub>GS(off)</sub> = 7 V, R<sub>L</sub> = 100 Ω (PMBFJ109);  
-V<sub>GS(off)</sub> = 5 V, R<sub>L</sub> = 100 Ω (PMBFJ110).



## N-channel junction FETs

## PMBFJ108/PMBFJ109/PMBFJ110

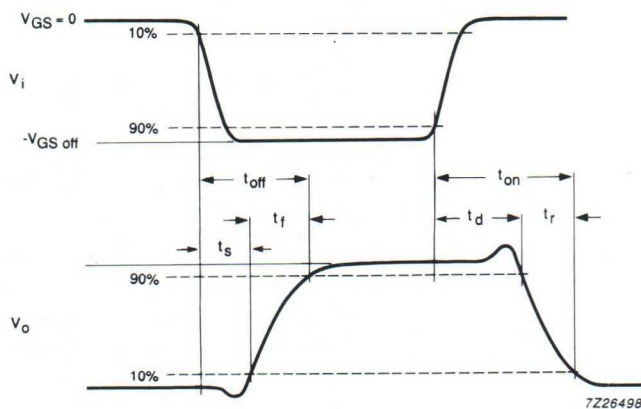


Fig.3 Input and output waveforms.

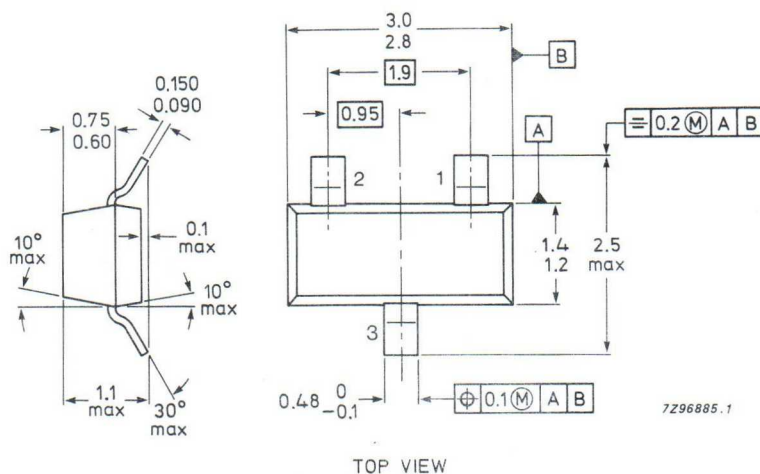


## N-channel junction FETs

**PMBFJ108/PMBFJ109/PMBFJ110**

## PACKAGE OUTLINE

Dimensions in mm

**Marking code:**

PMBFJ108 = p08

PMBFJ109 = p09

PMBFJ110 = p10

Fig.4 SOT23.



| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# PMBFJ111/PMBFJ112/ PMBFJ113

## N-channel junction FETs

### FEATURES

- High-speed switching
- Low  $R_{DS(on)}$  at zero gate voltage ( $< 30 \Omega$  for PMBFJ111)
- Interchangeability of drain and source connections.

### DESCRIPTION

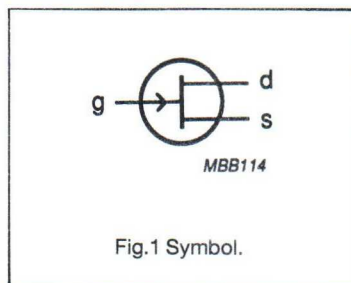
Silicon n-channel junction field-effect transistors in a surface-mount SOT23 envelope. They are intended for use in applications such as analog switches, choppers, commutators, multiplexers and thin and thick film hybrids.

### LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL       | PARAMETER                      | CONDITIONS                             | MIN. | MAX. | UNIT             |
|--------------|--------------------------------|----------------------------------------|------|------|------------------|
| $\pm V_{DS}$ | drain-source voltage           |                                        | -    | 40   | V                |
| $-V_{GSO}$   | gate-source voltage            |                                        | -    | 40   | V                |
| $-V_{GDO}$   | gate-drain voltage             |                                        | -    | 40   | V                |
| $I_G$        | forward gate current           | DC                                     | -    | 50   | mA               |
| $P_{tot}$    | total power dissipation        | $T_{amb} = 25^\circ\text{C}$<br>note 1 | -    | 300  | mW               |
| $T_{stg}$    | storage temperature range      |                                        | -65  | 150  | $^\circ\text{C}$ |
| $T_j$        | operating junction temperature |                                        | -    | 150  | $^\circ\text{C}$ |

### PIN CONFIGURATION



### PINNING - SOT23

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | drain       |
| 2   | source      |
| 3   | gate        |

### Note

1. Drain and source are interchangeable.

**N-channel junction FETs****PMBFJ111/PMBFJ112/PMBFJ113****THERMAL CHARACTERISTICS**

$$T_j = P(R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

| SYMBOL        | PARAMETER                         | MAX. | UNIT |
|---------------|-----------------------------------|------|------|
| $R_{th\ j-a}$ | from junction to ambient (note 1) | 430  | K/W  |
| $R_{th\ j-a}$ | from junction to ambient (note 2) | 500  | K/W  |

**Notes**

1. Mounted on a ceramic substrate, 8 mm x 10 mm x 0.7 mm.
2. Mounted on printed circuit board.

**STATIC CHARACTERISTICS**

$$T_j = 25\ ^\circ\text{C}.$$

| SYMBOL         | PARAMETER                     | CONDITIONS                                       | MIN.          | MAX.            | UNIT     |
|----------------|-------------------------------|--------------------------------------------------|---------------|-----------------|----------|
| $-I_{GSS}$     | reverse gate current          | $-V_{GS} = 15\text{ V}$<br>$V_{DS} = 0$          | -             | 1               | nA       |
| $I_{DSS}$      | drain current                 | $V_{GS} = 0$<br>$V_{DS} = 15\text{ V}$           | 20<br>5<br>2  | -<br>-<br>-     | mA       |
| $-V_{(BR)GSS}$ | gate-source breakdown voltage | $-I_G = 1\ \mu\text{A}$<br>$V_{DS} = 0$          | 40            | -               | V        |
| $-V_{GS(off)}$ | gate-source cut-off voltage   | $I_D = 1\ \mu\text{A}$<br>$V_{DS} = 5\text{ V}$  | 3<br>1<br>0.5 | 10<br>5<br>3    | V        |
| $R_{DS(on)}$   | drain-source on-resistance    | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 0.1\text{ V}$ | -<br>-<br>-   | 30<br>50<br>100 | $\Omega$ |

N-channel junction FETs

PMBFJ111/PMBFJ112/PMBFJ113

DYNAMIC CHARACTERISTICS

T<sub>j</sub> = 25 °C.

| SYMBOL                      | PARAMETER            | CONDITIONS                                                                           | TYP. | MAX. | UNIT |
|-----------------------------|----------------------|--------------------------------------------------------------------------------------|------|------|------|
| C <sub>iss</sub>            | input capacitance    | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 10 V<br>f = 1 MHz                          | 6    | -    | pF   |
|                             |                      | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 0<br>f = 1 MHz<br>T <sub>amb</sub> = 25 °C | 22   | 28   | pF   |
| C <sub>rss</sub>            | feedback capacitance | V <sub>DS</sub> = 0<br>-V <sub>GS</sub> = 10 V<br>f = 1 MHz                          | 3    | -    | pF   |
| Switching times (see Fig.2) |                      |                                                                                      |      |      |      |
| t <sub>r</sub>              | rise time            | note 1                                                                               | 6    | -    | ns   |
| t <sub>on</sub>             | turn-on time         | note 1                                                                               | 13   | -    | ns   |
| t <sub>f</sub>              | fall time            | note 1                                                                               | 15   | -    | ns   |
| t <sub>off</sub>            | turn-off time        | note 1                                                                               | 35   | -    | ns   |

Notes

1. Test conditions for switching times are as follows:  
V<sub>DD</sub> = 10 V, V<sub>GS</sub> = 0 to -V<sub>GS(off)</sub> (all types);  
-V<sub>GS(off)</sub> = 12 V, R<sub>L</sub> = 750 Ω (PMBFJ111);  
-V<sub>GS(off)</sub> = 7 V, R<sub>L</sub> = 1550 Ω (PMBFJ112);  
-V<sub>GS(off)</sub> = 5 V, R<sub>L</sub> = 3150 Ω (PMBFJ113).

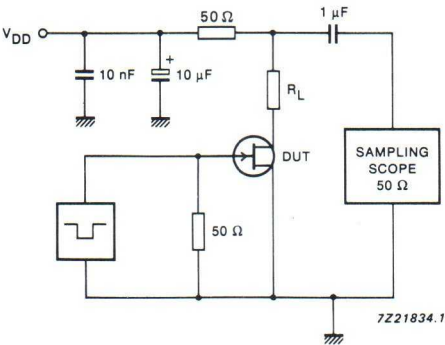


Fig.2 Switching circuit.



## N-channel junction FETs

## PMBFJ111/PMBFJ112/PMBFJ113

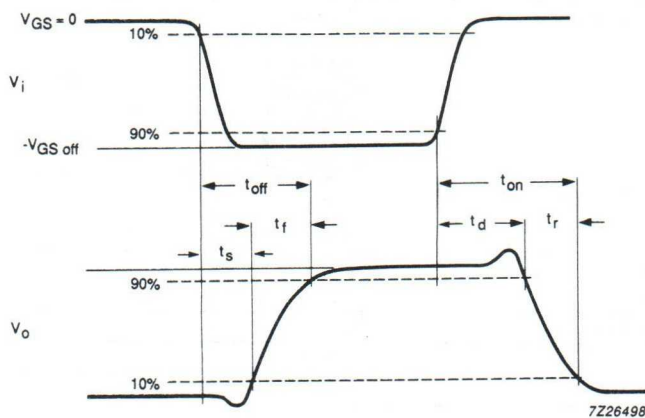


Fig.3 Input and output waveforms.

## N-channel junction FETs

## PMBFJ111/PMBFJ112/PMBFJ113

## PACKAGE OUTLINE

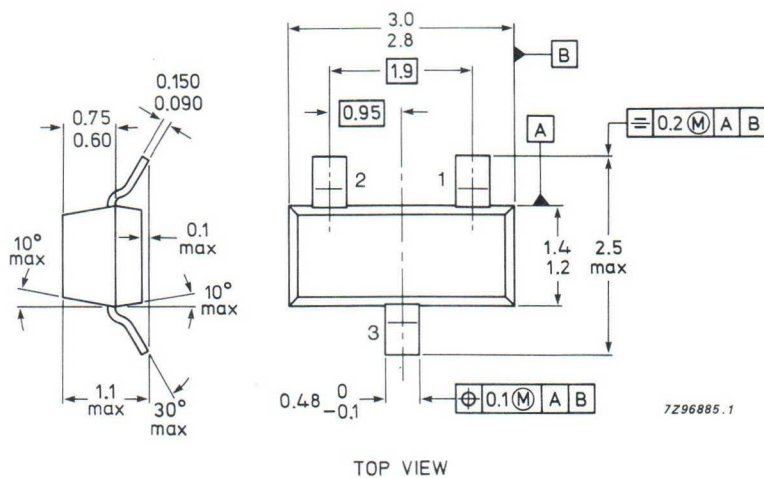
Dimensions in mm

## Marking code:

PMBFJ111 = p11

PMBFJ112 = p12

PMBFJ113 = p13



See also soldering recommendations

Fig.4 SOT23.

1. Introduction

2. Methodology

3. Results

4. Discussion

5. Conclusion

6. References

7. Appendix

8. Acknowledgements

9. Author Biographies

10. Contact Information

11. Declaration of Interest

12. Funding Sources

13. Data Availability Statement

14. Ethics Approval

15. Supplementary Materials

16. Correspondence

17. Copyright

18. Publisher's Note

19. Additional Information

## P-CHANNEL SILICON FIELD-EFFECT TRANSISTORS

Silicon symmetrical p-channel junction FETs in plastic microminiature SOT-23 envelopes.

They are intended for application with analogue switches, choppers, commutators etc. using SMD technology.

A special feature is the interchangeability of the drain and source connections.

### QUICK REFERENCE DATA

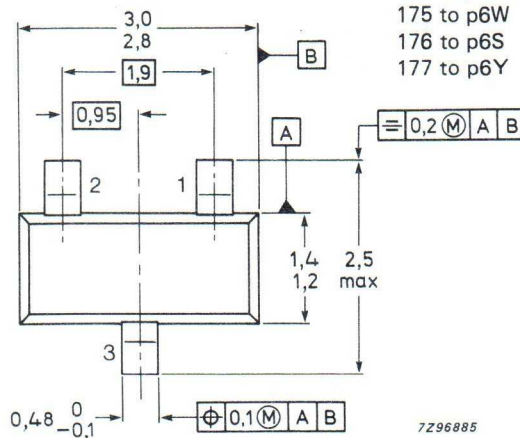
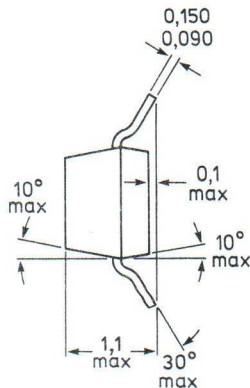
|                                                                    |                    |         |     |     |
|--------------------------------------------------------------------|--------------------|---------|-----|-----|
| Drain-source voltage                                               | $\pm V_{DS}$       | max.    | 30  | V   |
| Gate-source voltage                                                | $V_{GSO}$          | max.    | 30  | V   |
| Gate current                                                       | $-I_G$             | max.    | 50  | mA  |
| Total power dissipation<br>up to $T_{amb} = 25^\circ\text{C}$      | $P_{tot}$          | max.    | 300 | mW  |
| <b>PMBFJ174</b>                                                    |                    |         |     |     |
| Drain current<br>$-V_{DS} = 15\text{ V}; V_{GS} = 0$               | $-I_{DSS}$         | $> 20$  | 7   | 2   |
|                                                                    |                    | $< 135$ | 70  | 35  |
| Drain-source ON-resistance<br>$-V_{DS} = 0,1\text{ V}; V_{GS} = 0$ | $R_{DS\text{ on}}$ | $< 85$  | 125 | 250 |
|                                                                    |                    |         |     | 300 |

### MECHANICAL DATA

Fig. 1 SOT-23.

Pinning:

- 1 = Drain
- 2 = Source
- 3 = Gate



TOP VIEW

Note: Drain and source are interchangeable.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |              |      |              |                    |
|---------------------------------------------------------------------------|--------------|------|--------------|--------------------|
| Drain-source voltage                                                      | $\pm V_{DS}$ | max. | 30           | V                  |
| Gate-source voltage                                                       | $V_{GSO}$    | max. | 30           | V                  |
| Gate-drain voltage                                                        | $V_{GDO}$    | max. | 30           | V                  |
| Gate current (DC)                                                         | $-I_G$       | max. | 50           | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$    | max. | 300          | mW                 |
| Storage temperature range                                                 | $T_{stg}$    |      | -65 to + 150 | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$        | max. | 150          | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                                        |               |   |     |     |
|----------------------------------------|---------------|---|-----|-----|
| From junction to ambient in free air * | $R_{th\ j-a}$ | = | 430 | K/W |
|----------------------------------------|---------------|---|-----|-----|

**STATIC CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                            |               | PMBFJ174      | 175     | 176     | 177         |          |
|----------------------------------------------------------------------------|---------------|---------------|---------|---------|-------------|----------|
| Gate cut-off current<br>$-V_{GS} = 20\text{ V}; V_{DS} = 0$                | $I_{GSS}$     | < 1           | 1       | 1       | 1           | nA       |
| Drain cut-off current<br>$-V_{DS} = 15\text{ V}; -V_{GS} = 10\text{ V}$    | $-I_{DSX}$    | < 1           | 1       | 1       | 1           | nA       |
| Drain current<br>$-V_{DS} = 15\text{ V}; V_{GS} = 0$                       | $-I_{DSS}$    | > 20<br>< 135 | 7<br>70 | 2<br>35 | 1,5<br>20   | mA<br>mA |
| Gate-source breakdown voltage<br>$I_G = 1\text{ }\mu\text{A}; V_{DS} = 0$  | $V_{(BR)GSS}$ | > 30          | 30      | 30      | 30          | V        |
| Gate-source cut-off voltage<br>$-I_D = 10\text{ nA}; V_{DS} = 15\text{ V}$ | $V_{GS\ off}$ | > 5<br>< 10   | 3<br>6  | 1<br>4  | 0,8<br>2,25 | V<br>V   |
| Drain-source ON-resistance<br>$-V_{DS} = 0,1\text{ V}; V_{GS} = 0$         | $R_{DS\ on}$  | < 85          | 125     | 250     | 300         | $\Omega$ |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.



**DYNAMIC CHARACTERISTICS**

$T_j = 25^\circ\text{C}$  unless otherwise specified

Input capacitance,  $f = 1\text{ MHz}$

$-V_{GS} = 10\text{ V}; V_{DS} = 0\text{ V}$

$-V_{GS} = V_{DS} = 0$

|          |      |    |    |
|----------|------|----|----|
| $C_{is}$ | typ. | 8  | pF |
| $C_{is}$ | typ. | 30 | pF |

Feedback capacitance,  $f = 1\text{ MHz}$

$-V_{GS} = 10\text{ V}; V_{DS} = 0\text{ V}$

|          |      |   |    |
|----------|------|---|----|
| $C_{rs}$ | typ. | 4 | pF |
|----------|------|---|----|

Switching times (see Fig. 2 + 3)

Delay time

|       | PMBFJ174 | 175 | 176 | 177   |
|-------|----------|-----|-----|-------|
| $t_d$ | typ. 2   | 5   | 15  | 20 ns |

Rise time

|       |        |    |    |       |
|-------|--------|----|----|-------|
| $t_r$ | typ. 5 | 10 | 20 | 25 ns |
|-------|--------|----|----|-------|

Turn-on time

|          |        |    |    |       |
|----------|--------|----|----|-------|
| $t_{on}$ | typ. 7 | 15 | 35 | 45 ns |
|----------|--------|----|----|-------|

Storage time

|       |        |    |    |       |
|-------|--------|----|----|-------|
| $t_s$ | typ. 5 | 10 | 15 | 20 ns |
|-------|--------|----|----|-------|

Fall time

|       |         |    |    |       |
|-------|---------|----|----|-------|
| $t_f$ | typ. 10 | 20 | 20 | 25 ns |
|-------|---------|----|----|-------|

Turn-off time

|           |         |    |    |       |
|-----------|---------|----|----|-------|
| $t_{off}$ | typ. 15 | 30 | 35 | 45 ns |
|-----------|---------|----|----|-------|

Test conditions:

|                    |     |      |      |               |
|--------------------|-----|------|------|---------------|
| $-V_{DD}$          | 10  | 6    | 6    | 6 V           |
| $V_{GS\text{off}}$ | 12  | 8    | 6    | 3 V           |
| $R_L$              | 560 | 1200 | 2000 | 2900 $\Omega$ |
| $V_{GS\text{on}}$  | 0   | 0    | 0    | 0 V           |

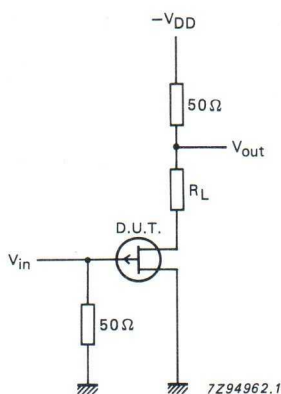


Fig. 2 Switching times test circuit.

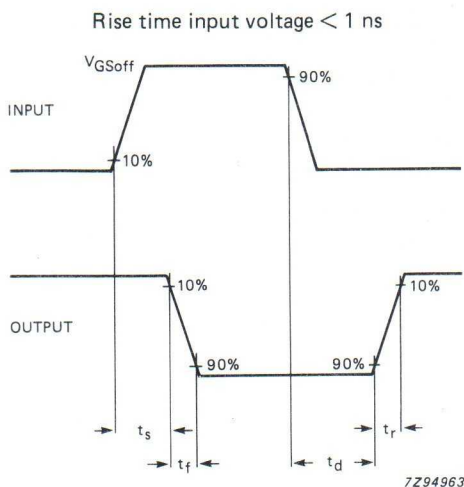


Fig. 3 Input and output waveforms;

$$t_d + t_r = t_{on}$$

$$t_s + t_f = t_{off}$$



# SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N silicon transistors, in a microminiature plastic envelope intended for switching and linear applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                                      |           |      | PMBT2222   | PMBT2222A |
|----------------------------------------------------------------------|-----------|------|------------|-----------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 60         | 75 V      |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 30         | 40 V      |
| Emitter-base voltage (open collector)                                | $V_{EBO}$ | max. | 5,0        | 6,0 V     |
| Collector current (d.c.)                                             | $I_C$     | max. | 600        | mA        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250        | mW        |
| D.C. current gain                                                    |           |      |            |           |
| $I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$                          | $h_{FE}$  |      | 100 to 300 |           |
| $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}$                          | $h_{FE}$  | >    | 30         | 40        |
| Transition frequency at $f = 100\text{ MHz}$                         |           |      |            |           |
| $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$                           | $f_T$     | >    | 250        | 300 MHz   |

## MECHANICAL DATA

Dimensions in mm

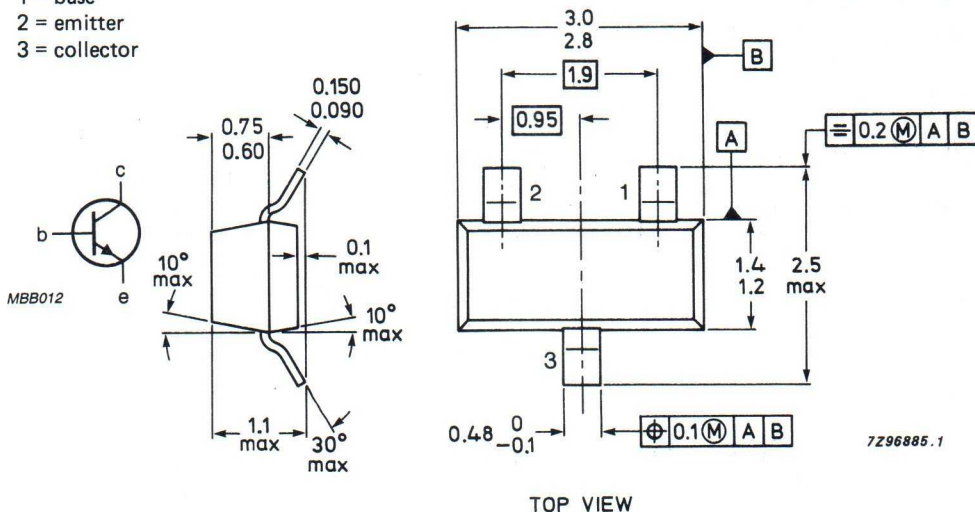
Fig. 1 SOT-23.

### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector

### Marking code

PMBT2222 = p1B  
PMBT2222A = p1P



TOP VIEW

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |           | PMBT2222   | PMBT2222A          |
|--------------------------------------------------------------------------|-----------|------------|--------------------|
| Collector-base voltage (open emitter)                                    | $V_{CBO}$ | max. 60    | 75 V               |
| Collector-emitter voltage (open base)                                    | $V_{CEO}$ | max. 30    | 40 V               |
| Emitter-base voltage (open collector)                                    | $V_{EBO}$ | max. 5,0   | 6,0 V              |
| Collector current (d.c.)                                                 | $I_C$     | max. 600   | mA                 |
| Total power dissipation*<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. 250   | mW                 |
| Storage temperature range                                                | $T_{stg}$ | -65 to 150 | $^{\circ}\text{C}$ |
| Junction temperature                                                     | $T_j$     | max. 150   | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE \*

|                          |               |   |     |     |
|--------------------------|---------------|---|-----|-----|
| From junction to ambient | $R_{th\ j-a}$ | = | 500 | K/W |
|--------------------------|---------------|---|-----|-----|

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                    |               | PMBT2222 | PMBT2222A          |
|--------------------------------------------------------------------|---------------|----------|--------------------|
| Collector cut-off current                                          |               |          |                    |
| $I_E = 0; V_{CB} = 50\text{ V}$                                    | $I_{CBO}$     | < 0,01   | — $\mu\text{A}$    |
| $I_E = 0; V_{CB} = 60\text{ V}$                                    | $I_{CBO}$     | < —      | 0,01 $\mu\text{A}$ |
| $I_E = 0; V_{CB} = 50\text{ V}; T_j = 125\text{ }^{\circ}\text{C}$ | $I_{CBO}$     | < 10     | — $\mu\text{A}$    |
| $I_E = 0; V_{CB} = 60\text{ V}; T_j = 125\text{ }^{\circ}\text{C}$ | $I_{CBO}$     | < —      | 10 $\mu\text{A}$   |
| $V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$                        | $I_{CEX}$     | < —      | 10 nA              |
| Base current                                                       |               |          |                    |
| with reverse biased emitter junction                               |               |          |                    |
| $V_{EB} = 3\text{ V}; V_{CE} = 60\text{ V}$                        | $I_{BEX}$     | < —      | 20 nA              |
| Emitter cut-off current                                            |               |          |                    |
| $I_C = 0; V_{EB} = 3\text{ V}$                                     | $I_{EBO}$     | < —      | 10 nA              |
| Saturation voltages**                                              |               |          |                    |
| $I_C = 150\text{ mA}; I_B = 15\text{ mA}$                          | $V_{CEsat}$   | < 400    | 300 mV             |
|                                                                    | $V_{BEsat}$   | < 1300   | — mV               |
|                                                                    | $V_{BEsat}$   | —        | 0,6 to 1,2 V       |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$                          | $V_{CEsat}$   | < 1600   | 1000 mV            |
|                                                                    | $V_{BEsat}$   | < 2600   | 2000 mV            |
| Breakdown voltages                                                 |               |          |                    |
| $I_C = 1,0\text{ mA}; I_B = 0$                                     | $V_{(BR)CEO}$ | > 30     | 40 V               |
| $I_C = 100\text{ }\mu\text{A}; I_E = 0$                            | $V_{(BR)CBO}$ | > 60     | 75 V               |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$                             | $V_{(BR)EBO}$ | > 5,0    | 6,0 V              |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

\*\* Measured under pulsed conditions to avoid excessive dissipation;  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0,02$ .

|                                                                           |          |     | PMBT2222               | PMBT2222A     |
|---------------------------------------------------------------------------|----------|-----|------------------------|---------------|
| D.C. current gain                                                         |          |     |                        |               |
| $I_C = 0,1 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | $>$ | 35                     |               |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                               | $h_{FE}$ | $>$ | 50                     |               |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$                              | $h_{FE}$ | $>$ | 75                     |               |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = -55^\circ\text{C}$ | $h_{FE}$ | $>$ | 35                     |               |
| $I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ |     | 100 to 300             |               |
| $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$                              | $h_{FE}$ | $>$ | 50                     |               |
| $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | $>$ | 30                     | 40            |
| Transition frequency at $f = 100 \text{ MHz}^*$                           |          |     |                        |               |
| $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}$                              | $f_T$    | $>$ | 250                    | 300 MHz       |
| Output capacitance at $f = 1 \text{ MHz}$                                 |          |     |                        |               |
| $I_E = 0; V_{CB} = 10 \text{ V}$                                          | $C_o$    | $<$ | 8,0                    | pF            |
| Input capacitance at $f = 1 \text{ MHz}$                                  |          |     |                        |               |
| $I_C = 0; V_{EB} = 0,5 \text{ V}$                                         | $C_i$    | $<$ | 30                     | 25            |
| h-parameters (common emitter) at $f = 1 \text{ kHz}$                      |          |     |                        |               |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                               |          |     |                        |               |
| input impedance                                                           | $h_{ie}$ |     | 2,0 to 8,0             | k $\Omega$    |
| reverse voltage transfer ratio                                            | $h_{re}$ |     | $< 8,0 \times 10^{-4}$ |               |
| small signal current gain                                                 | $h_{fe}$ |     | 50 to 300              |               |
| output admittance                                                         | $h_{oe}$ |     | 5,0 to 35              | $\mu\text{S}$ |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$                              |          |     |                        |               |
| input impedance                                                           | $h_{ie}$ |     | 0,25 to 1,25           | k $\Omega$    |
| reverse voltage transfer ratio                                            | $h_{re}$ |     | $< 4,0 \times 10^{-4}$ |               |
| small signal current gain                                                 | $h_{fe}$ |     | 75 to 375              |               |
| output admittance                                                         | $h_{oe}$ |     | 25 to 200              | $\mu\text{S}$ |
| Noise figure at $R_S = 1 \text{ k}\Omega$                                 |          |     |                        |               |
| $I_C = 100 \mu\text{A}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$         | F        | $<$ | 4,0                    | dB            |
| Switching times (between 10% and 90% levels)                              |          |     |                        |               |
| Turn-on time switched to $I_C = 150 \text{ mA}$                           |          |     |                        |               |
| delay time                                                                | $t_d$    | $<$ | 10                     | ns            |
| rise time                                                                 | $t_r$    | $<$ | 25                     | ns            |
| Turn-off time switched from $I_C = 150 \text{ mA}$                        |          |     |                        |               |
| storage time                                                              | $t_s$    | $<$ | 225                    | ns            |
| fall time                                                                 | $t_f$    | $<$ | 60                     | ns            |

\*  $f_T$  is defined as the frequency at which  $h_{fe}$  extrapolates to unity.



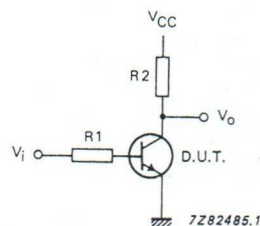
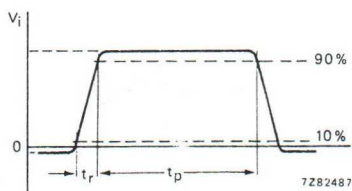


Fig. 2 Waveform and test circuit delay and rise time.

$V_i = -0,5$  to  $+9,9$  V;  $V_{CC} = 30$  V;  $R1 = 619 \Omega$ ;  $R2 = 200 \Omega$ .

Pulse generator:

|                |                   |
|----------------|-------------------|
| pulse duration | $t_p \leq 200$ ns |
| rise time      | $t_r \leq 2$ ns   |
| duty factor    | $\delta = 2$ %    |

Oscilloscope:

|                   |                        |
|-------------------|------------------------|
| input impedance   | $Z_i > 100$ k $\Omega$ |
| input capacitance | $C_i < 12$ pF          |
| rise time         | $t_r < 5$ ns           |

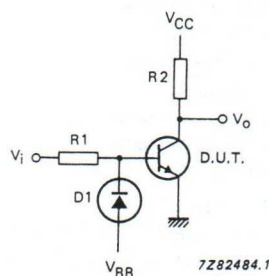
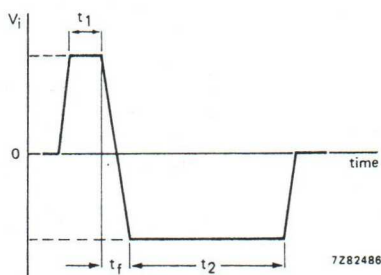


Fig. 3 Waveform and test circuit storage and fall time.

$V_i = -13,8$  to  $+16,2$  V;  $V_{CC} = 30$  V;  $-V_{BB} = 3$  V;  $R1 = 1$  k $\Omega$ ;  $R2 = 200 \Omega$ .

Pulse generator:

|            |                     |
|------------|---------------------|
| fall time  | $t_f < 5$ ns        |
| pulse time | $t_1 = 100$ $\mu$ s |
|            | $t_2 = 500$ $\mu$ s |

Oscilloscope:

|                   |                        |
|-------------------|------------------------|
| input impedance   | $Z_i > 100$ k $\Omega$ |
| input capacitance | $C_i < 12$ pF          |
| rise time         | $t_r < 5$ ns           |

## SILICON PLANAR EPITAXIAL SWITCHING TRANSISTOR

N-P-N transistor in a plastic SOT-23 envelope intended for high-speed switching applications.

## QUICK REFERENCE DATA

|                                                                      |           |      |           |
|----------------------------------------------------------------------|-----------|------|-----------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. | 40 V      |
| Collector-emitter voltage ( $V_{BE} = 0$ )                           | $V_{CES}$ | max. | 40 V      |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 15 V      |
| Collector current (d.c. value)                                       | $I_C$     | max. | 500 mA    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW    |
| D.C. current gain                                                    |           |      |           |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                            | $h_{FE}$  |      | 40 to 120 |
| $I_C = 100\text{ mA}; V_{CE} = 2\text{ V}$                           | $h_{FE}$  | >    | 20        |
| Storage time                                                         |           |      |           |
| $I_{Con} = I_{Bon} = I_{Boff} = 10\text{ mA}$                        | $t_s$     | <    | 13 ns     |

## MECHANICAL DATA

Dimensions in mm

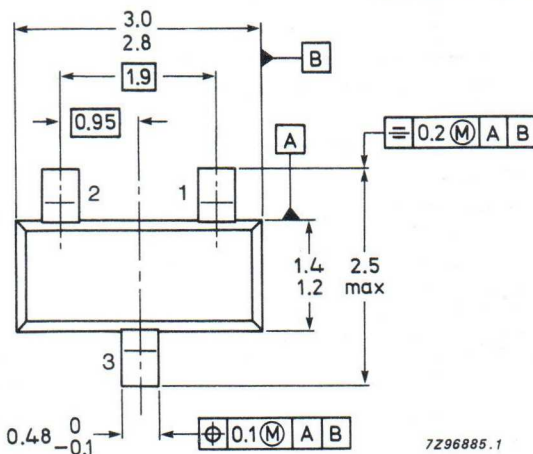
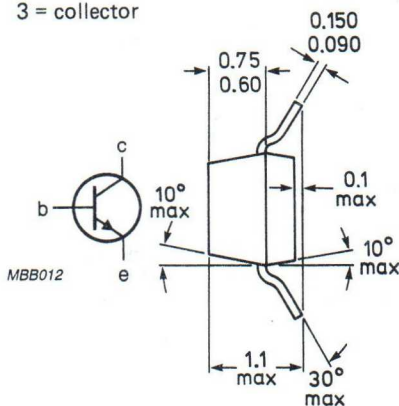
Fig. 1 SOT-23.

Marking code

PMBT2369 = p1J

## Pinning:

- 1 = base  
2 = emitter  
3 = collector



7296885.1

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                               |
|------------------------------------------------------------------------|-----------|------|-------------------------------|
| Collector-base voltage (open emitter)                                  | $V_{CBO}$ | max. | 40 V                          |
| Collector-emitter voltage ( $V_{BE} = 0$ )                             | $V_{CES}$ | max. | 40 V                          |
| Collector-emitter voltage (open base)                                  | $V_{CEO}$ | max. | 15 V                          |
| Emitter-base voltage (open collector)                                  | $V_{EBO}$ | max. | 4,5 V                         |
| Collector current (d.c. value)                                         | $I_C$     | max. | 500 mA                        |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$ | max. | 250 mW                        |
| Storage temperature                                                    | $T_{stg}$ |      | -65 to 150 $^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | 150 $^{\circ}\text{C}$        |

## THERMAL RESISTANCE

|                                       |               |   |         |
|---------------------------------------|---------------|---|---------|
| From junction to ambient in free air* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------------------|---------------|---|---------|

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

 $I_E = 0; V_{CB} = 20\text{ V}$  $I_{CBO} < 400\text{ nA}$  $I_E = 0; V_{CB} = 20\text{ V}; T_j = 125\text{ }^{\circ}\text{C}$  $I_{CBO} < 30\text{ }\mu\text{A}$ 

Saturation voltages

 $I_C = 10\text{ mA}; I_B = 1\text{ mA}$  $V_{CEsat} < 0,25\text{ V}$  $V_{BEsat} 0,70\text{ to }0,85\text{ V}$ 

D.C. current gain

 $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$  $h_{FE} 40\text{ to }120$  $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}; T_{amb} = -55\text{ }^{\circ}\text{C}$  $h_{FE} > 20$  $I_C = 100\text{ mA}; V_{CE} = 2\text{ V}$  $h_{FE} > 20$ Output capacitance at  $f = 1\text{ MHz}$  $I_E = 0; V_{CB} = 5\text{ V}$  $C_o < 4,0\text{ pF}$ 

Small-signal current gain

 $I_C = 1,0\text{ mA}; V_{CE} = 10\text{ V}; f = 100\text{ MHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$  $h_{fe} > 5,0\text{ pF}$ 

Breakdown voltages

 $I_C = 10\text{ mA}; I_B = 0$  $V_{(BR)CEO} \text{ min. } 15\text{ V}$  $I_C = 10\text{ }\mu\text{A}; I_E = 0$  $V_{(BR)CBO} \text{ min. } 40\text{ V}$  $I_C = 0; I_E = 10\text{ }\mu\text{A}$  $V_{(BR)EBO} \text{ min. } 4,5\text{ V}$  $I_C = 10\text{ }\mu\text{A}; V_{BE} = 0$  $V_{(BR)CES} \text{ min. } 40\text{ V}$ Switching times at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ 

Storage time (see Fig. 2)

 $I_{Con} = I_{Bon} = -I_{Boff} = 10\text{ mA}$ 

|       |      |        |
|-------|------|--------|
| $t_s$ | typ. | 5,0 ns |
|       | <    | 13 ns  |

Turn-on time (see Fig. 3)

 $I_C = 10\text{ mA}; I_{Bon} = 3\text{ mA}; V_{CC} = 3\text{ V}$ 

|          |      |        |
|----------|------|--------|
| $t_{on}$ | typ. | 8,0 ns |
|          | <    | 12 ns  |

Turn-off time (see Fig. 3)

 $I_C = 10\text{ mA}; I_{Bon} = 3\text{ mA}; I_{Boff} = 1,5\text{ mA}; V_{CC} = 3\text{ V}$ 

|           |      |       |
|-----------|------|-------|
| $t_{off}$ | typ. | 10 ns |
|           | <    | 18 ns |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

# SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P silicon transistors, in a microminiature plastic envelope, intended for medium power switching and general purpose amplifier applications in thick and thin-film circuits.

## QUICK REFERENCE DATA

|                                                                |            |      | PMBT2907 | PMBT2907A        |
|----------------------------------------------------------------|------------|------|----------|------------------|
| Collector-base voltage (open emitter)                          | $-V_{CBO}$ | max. | 60       | 60 V             |
| Collector-emitter voltage (open base)                          | $-V_{CEO}$ | max. | 40       | 60 V             |
| Emitter-base voltage (open collector)                          | $-V_{EBO}$ | max. | 5.0      | V                |
| Collector current (d.c.)                                       | $-I_C$     | max. | 600      | mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$     | $P_{tot}$  | max. | 250      | mW               |
| Junction temperature                                           | $T_j$      | max. | 150      | $^\circ\text{C}$ |
| D.C. current gain                                              |            |      |          |                  |
| $-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}$                  | $h_{FE}$   | $>$  | 30       | 50               |
| Turn-off switching time                                        |            |      |          |                  |
| $-I_{Con} = 150\text{ mA}; -I_{Bon} = I_{Boff} = 15\text{ mA}$ | $t_{off}$  | $<$  | 100      | ns               |
| Transition frequency at $f = 100\text{ MHz}$                   |            |      |          |                  |
| $-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}$                   | $f_T$      | $>$  | 200      | MHz              |

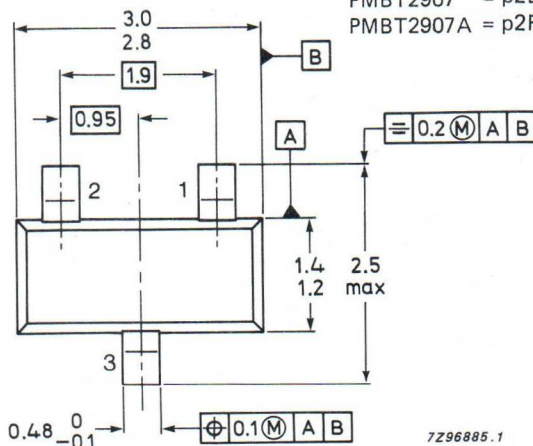
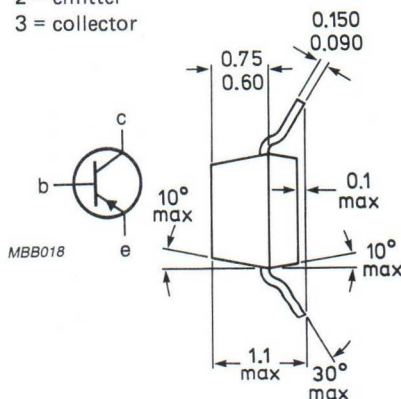
## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |            | PMBT2907    | PMBT2907A          |
|----------------------------------------------------------------|------------|-------------|--------------------|
| Collector-base voltage (open emitter)                          | $-V_{CBO}$ | max. 60     | 60 V               |
| Collector-emitter voltage (open base)                          | $-V_{CEO}$ | max. 40     | 60 V               |
| Emitter-base voltage (open collector)                          | $-V_{EBO}$ | max. 5,0    | V                  |
| Collector current (d.c.)                                       | $-I_C$     | max. 600    | mA                 |
| Power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. 250    | mW                 |
| Storage temperature range                                      | $T_{stg}$  | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                           | $T_j$      | max. 150    | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE \*

From junction to ambient in free air  $R_{th\ j-a} = 500\text{ K/W}$

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                     |                | PMBT2907 | PMBT2907A        |
|---------------------------------------------------------------------|----------------|----------|------------------|
| Collector cut-off current                                           |                |          |                  |
| $I_E = 0; -V_{CB} = 50\text{ V}$                                    | $-I_{CBO}$     | < 20     | 10 nA            |
| $I_E = 0; -V_{CB} = 50\text{ V}; T_j = 125\text{ }^{\circ}\text{C}$ | $-I_{CBO}$     | < 20     | 10 $\mu\text{A}$ |
| $-V_{EB} = 0,5\text{ V}; -V_{CE} = 30\text{ V}$                     | $-I_{CEX}$     | < 50     | nA               |
| Base current                                                        |                |          |                  |
| with reverse biased emitter junction                                |                |          |                  |
| $-V_{EB} = 3\text{ V}; -V_{CE} = 30\text{ V}$                       | $-I_{BEX}$     | < 50     | nA               |
| Saturation voltages**                                               |                |          |                  |
| $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$                         | $-V_{CEsat}$   | < 0,4    | V                |
|                                                                     | $-V_{BEsat}$   | < 1,3    | V                |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$                         | $-V_{CEsat}$   | < 1,6    | V                |
|                                                                     | $-V_{BEsat}$   | < 2,6    | V                |
| Collector-base breakdown voltage                                    |                |          |                  |
| open emitter; $-I_C = 10\text{ }\mu\text{A}; I_E = 0$               | $-V_{(BR)CBO}$ | 60       | V                |
| Collector-emitter breakdown voltage                                 |                |          |                  |
| open base; $-I_C = 10\text{ mA}; I_B = 0$                           | $-V_{(BR)CEO}$ | > 40     | 60 V             |
| Emitter-base breakdown voltage                                      |                |          |                  |
| open collector; $-I_E = 10\text{ }\mu\text{A}; I_C = 0$             | $-V_{(BR)EBO}$ | 5,0      | V                |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



|                                                                            |           |     | PMBT2907   | PMBT2907A |
|----------------------------------------------------------------------------|-----------|-----|------------|-----------|
| D.C. current gain                                                          |           |     |            |           |
| $-I_C = 0,1 \text{ mA}; -V_{CE} = 10 \text{ V}$                            | $h_{FE}$  | $>$ | 35         | 75        |
| $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$                              | $h_{FE}$  | $>$ | 50         | 100       |
| $-I_C = 10 \text{ mA}; -V_{CE} = 10 \text{ V}$                             | $h_{FE}$  | $>$ | 75         | 100       |
| $-I_C = 150 \text{ mA}; -V_{CE} = 10 \text{ V}$                            | $h_{FE}$  |     | 100 to 300 |           |
| $-I_C = 500 \text{ mA}; -V_{CE} = 10 \text{ V}$                            | $h_{FE}$  | $>$ | 30         | 50        |
| Transition frequency at $f = 100 \text{ MHz}$                              |           |     |            |           |
| $-I_C = 50 \text{ mA}; -V_{CE} = 20 \text{ V}; T_{amb} = 25^\circ\text{C}$ | $f_T$     | $>$ | 200        | MHz       |
| Output capacitance at $f = 1 \text{ MHz}$                                  |           |     |            |           |
| $I_E = I_e = 0; -V_{CB} = 10 \text{ V}$                                    | $C_o$     | $<$ | 8,0        | pF        |
| Input capacitance at $f = 1 \text{ MHz}$                                   |           |     |            |           |
| $I_C = I_c = 0; -V_{EB} = 2 \text{ V}$                                     | $C_i$     | $<$ | 30         | pF        |
| Switching times (between 10% and 90% levels)                               |           |     |            |           |
| Turn-on time when switched to                                              |           |     |            |           |
| $-I_C = 150 \text{ mA}; -I_B = 15 \text{ mA}; V_{CC} = 30 \text{ V}$       |           |     |            |           |
| delay time                                                                 | $t_d$     | $<$ | 10         | ns        |
| rise time                                                                  | $t_r$     | $<$ | 40         | ns        |
| turn-on time ( $t_d + t_r$ )                                               | $t_{on}$  | $<$ | 45         | ns        |
| Turn-off time when switched from                                           |           |     |            |           |
| $-I_C = 150 \text{ mA}; -I_B = 15 \text{ mA}; V_{CC} = 6 \text{ V}$        |           |     |            |           |
| to cut-off with $+I_{BM} = 15 \text{ mA}$ (see Fig. 3)                     |           |     |            |           |
| storage time                                                               | $t_s$     | $<$ | 80         | ns        |
| fall time                                                                  | $t_f$     | $<$ | 30         | ns        |
| turn-off time ( $t_s + t_f$ )                                              | $t_{off}$ | $<$ | 100        | ns        |

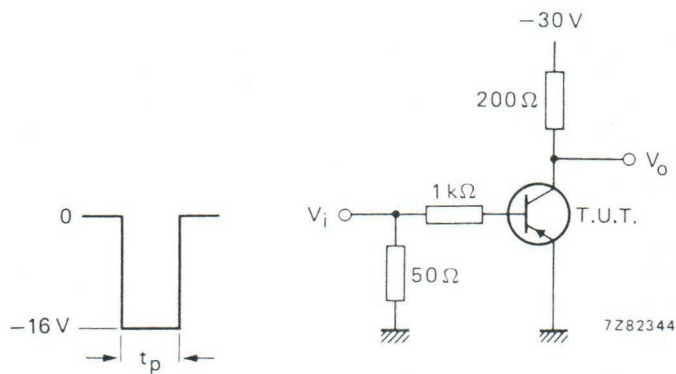


Fig. 2 Turn-on switching time test circuit.

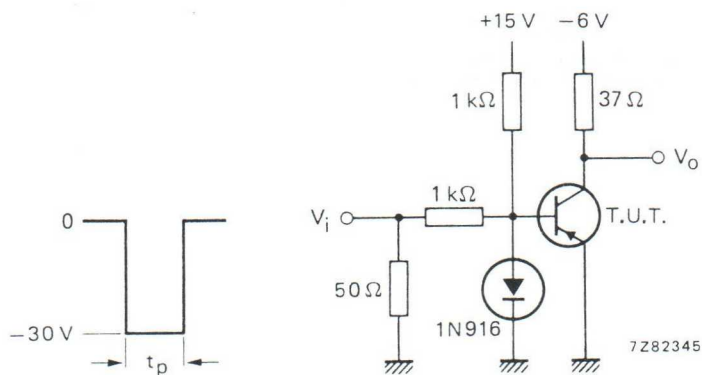


Fig. 3 Turn-off switching time test circuit.

|                                             |                  |       |        |     |            |
|---------------------------------------------|------------------|-------|--------|-----|------------|
| Input pulse generator:<br>Fig. 2 and Fig. 3 | frequency        | $f$   | =      | 150 | Hz         |
|                                             | pulse duration   | $t_p$ | =      | 200 | ns         |
|                                             | rise time        | $t_r$ | $\leq$ | 2   | ns         |
| Output oscilloscope:<br>Fig. 2 and Fig. 3   | output impedance | $Z_o$ | =      | 50  | $\Omega$   |
|                                             | rise time        | $t_r$ | $\leq$ | 5   | ns         |
|                                             | input impedance  | $Z_i$ | =      | 10  | M $\Omega$ |

## SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature (SMD) plastic envelope intended for surface mounted applications. They are primarily intended for use in telephony and professional communication equipment.

## QUICK REFERENCE DATA

|                                                            |           |      |         |
|------------------------------------------------------------|-----------|------|---------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ | max. | 60 V    |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. | 40 V    |
| Emitter-base voltage (open collector)                      | $V_{EBO}$ | max. | 6 V     |
| Collector current (DC)                                     | $I_C$     | max. | 200 mA  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. | 250 mW  |
| DC current gain                                            | $h_{FE}$  |      |         |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                  |           | $>$  | 100     |
|                                                            |           | $<$  | 300     |
| Transition frequency at $f = 35\text{ MHz}$                | $f_T$     | $>$  | 300 MHz |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                 |           |      |         |

## MECHANICAL DATA

Fig.1 SOT-23.

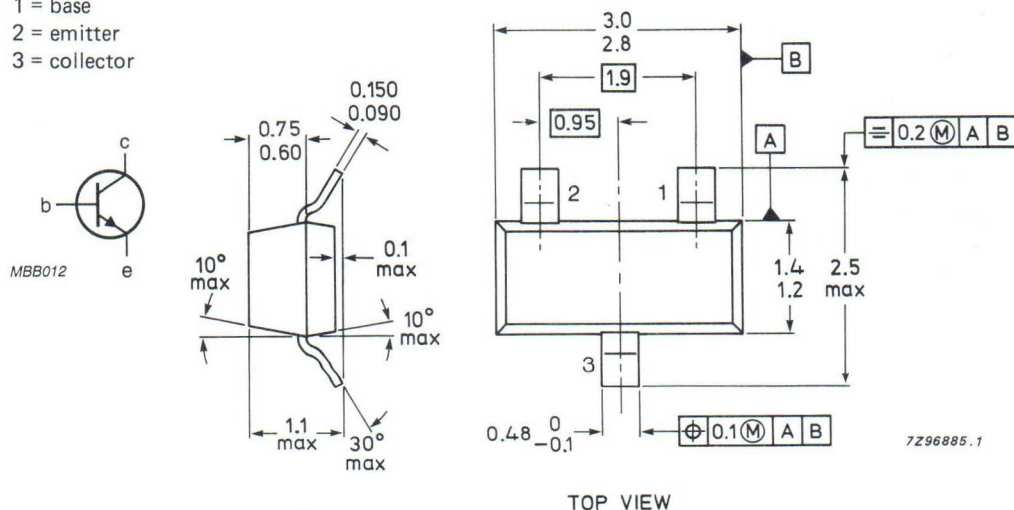
Dimensions in mm

Marking code

PMBT3904: p1A

## Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



See also Soldering recommendations.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |           |      |             |                    |
|--------------------------------------------------------------------------|-----------|------|-------------|--------------------|
| Collector-base voltage (open emitter)                                    | $V_{CBO}$ | max. | 60          | V                  |
| Collector-emitter voltage (open base)                                    | $V_{CEO}$ | max. | 40          | V                  |
| Emitter-base voltage (open collector)                                    | $V_{EBO}$ | max. | 6           | V                  |
| Collector current (d.c.)                                                 | $I_C$     | max. | 200         | mA                 |
| Total power dissipation*<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250         | mW                 |
| Storage temperature                                                      | $T_{stg}$ |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                     | $T_j$     | max. | 150         | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient\*

$$R_{th\ j-a} = 500\text{ K/W}$$

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                     |               |      |    |    |
|-----------------------------------------------------------------------------------------------------|---------------|------|----|----|
| Collector-emitter breakdown voltage▲<br>$I_C = 1\text{ mA}; I_B = 0$                                | $V_{(BR)CEO}$ | min. | 40 | V  |
| Collector-base breakdown voltage<br>$I_C = 10\text{ }\mu\text{A}; I_E = 0$                          | $V_{(BR)CBO}$ | min. | 60 | V  |
| Emitter-base breakdown voltage<br>$I_E = 10\text{ }\mu\text{A}; I_C = 0$                            | $V_{(BR)EBO}$ | min. | 6  | V  |
| Collector cut-off current<br>$V_{CE} = 30\text{ V}; V_{EB} = 3\text{ V}$                            | $I_{CEX}$     | max. | 50 | nA |
| Output capacitance at $f = 1\text{ MHz}$<br>$I_E = 0; V_{CB} = 5\text{ V}$                          | $C_c$         | max. | 4  | pF |
| Input capacitance at $f = 1\text{ MHz}$<br>$I_C = 0; V_{BE} = 0,5\text{ V}$                         | $C_e$         | max. | 8  | pF |
| Base current<br>with reverse biased emitter junction<br>$V_{EB} = 3\text{ V}; V_{CE} = 30\text{ V}$ | $I_{BEX}$     | max. | 50 | nA |

\* Mounted on a ceramic substrate: area =  $10 \times 8\text{ mm}^2$ ; thickness =  $0,7\text{ mm}$ .▲ Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

## Saturation voltages

 $I_C = 10 \text{ mA}; I_B = 1 \text{ mA}$  $I_C = 50 \text{ mA}; I_B = 5 \text{ mA}$  $I_C = 10 \text{ mA}; I_B = 1 \text{ mA}$  $I_C = 50 \text{ mA}; I_B = 5 \text{ mA}$ 

## D.C. current gain \*

 $I_C = 0,1 \text{ mA}; V_{CE} = 1 \text{ V}$  $I_C = 1 \text{ mA}; V_{CE} = 1 \text{ V}$  $I_C = 10 \text{ mA}; V_{CE} = 1 \text{ V}$  $I_C = 50 \text{ mA}; V_{CE} = 1 \text{ V}$  $I_C = 100 \text{ mA}; V_{CE} = 1 \text{ V}$ Transition frequency at  $f = 100 \text{ MHz}$  $I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V}$ Noise figure at  $R_S = 1 \text{ k}\Omega$  $I_C = 100 \mu\text{A}; V_{CE} = 5 \text{ V}$  $f = 10 \text{ Hz to } 15,7 \text{ kHz}$ 

## h-parameters (common emitter)

 $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

## Input impedance

## Reverse voltage transfer ratio

## Small-signal current gain

## Output admittance

## Switching times

Turn-on time when  $V_{CC} = 3 \text{ V}; V_{BE} = 0,5 \text{ V}$  $I_C = 10 \text{ mA}; I_{B\text{on}} = 1 \text{ mA}$ 

## Delay time

## Rise time

Turn-off time when  $V_{CC} = 3 \text{ V}; I_C = 10 \text{ mA}$  $I_{B\text{on}} = I_{B\text{off}} = 1 \text{ mA}$ 

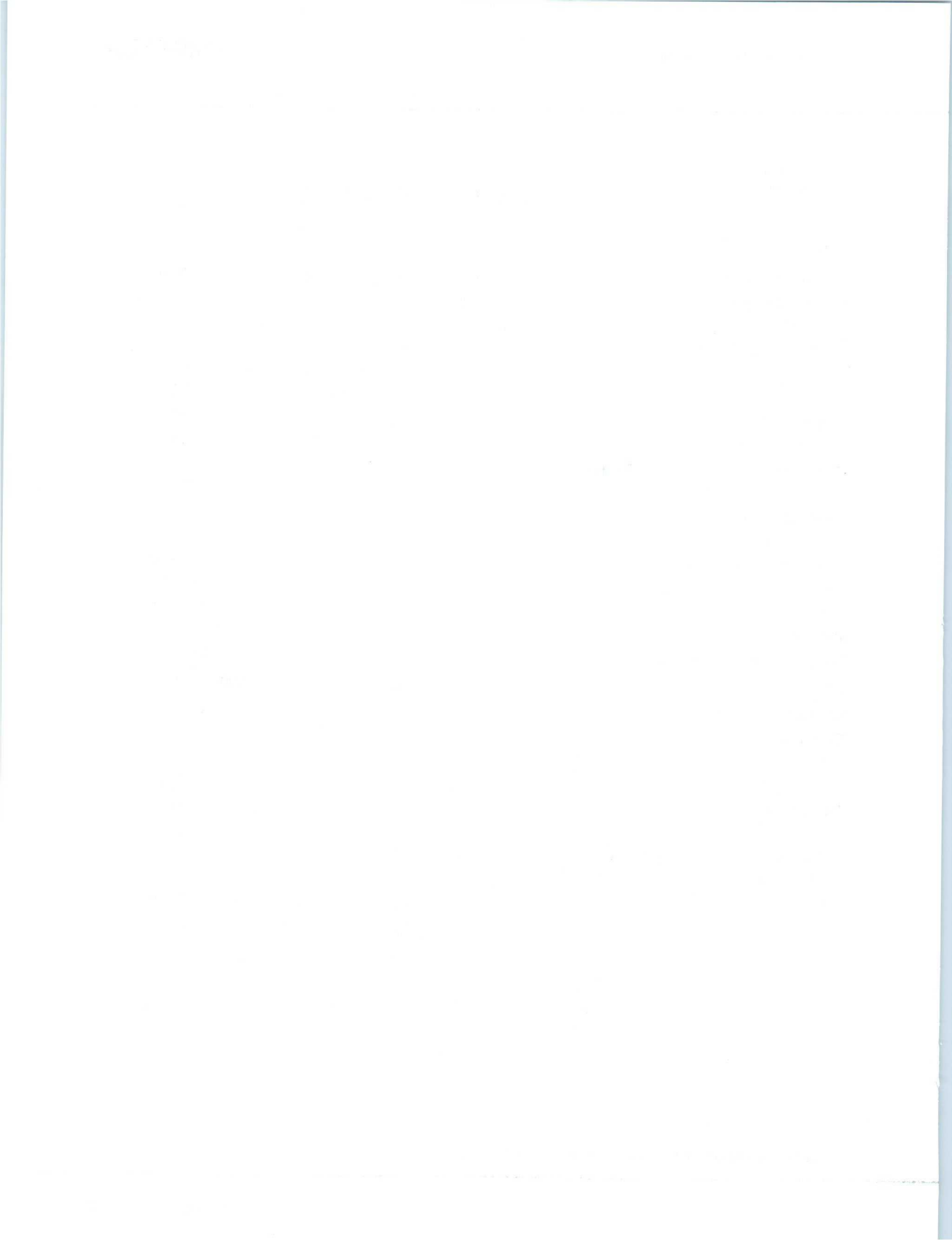
## Storage time

## Fall time

|                    |      |                       |
|--------------------|------|-----------------------|
| $V_{CE\text{sat}}$ | max. | 0.2 V                 |
|                    | max. | 0.3 V                 |
| $V_{BE\text{sat}}$ | min. | 0.65 V                |
|                    | max. | 0.85 V                |
| $V_{BE\text{sat}}$ | max. | 0.95 V                |
| $h_{FE}$           | >    | 40                    |
| $h_{FE}$           | >    | 70                    |
| $h_{FE}$           | >    | 100                   |
|                    | <    | 300                   |
| $h_{FE}$           | >    | 60                    |
| $h_{FE}$           | >    | 30                    |
| $f_T$              | min. | 300 MHz               |
| F                  | max. | 5 dB                  |
| $h_{ie}$           |      | 1 to 10 k $\Omega$    |
| $h_{re}$           |      | 0.5 to 8 $10^{-4}$    |
| $h_{fe}$           |      | 100 to 400            |
| $h_{oe}$           |      | 1 to 40 $\mu\text{S}$ |
| $t_d$              | <    | 35 ns                 |
| $t_r$              | <    | 35 ns                 |
| $t_s$              | <    | 200 ns                |
| $t_f$              | <    | 50 ns                 |

\* Pulse test conditions:  $t_p = 300 \mu\text{s}$ ; duty cycle  $\leq 2\%$ .





## SILICON EPITAXIAL TRANSISTOR

P-N-P transistor in a microminiature (SMD) plastic envelope intended for surface mounted applications. The PMBT3906 is primarily intended for use in telephony and professional communication equipment.

## QUICK REFERENCE DATA

|                                                                      |            |      |            |
|----------------------------------------------------------------------|------------|------|------------|
| Collector-base voltage (open emitter)                                | $-V_{CBO}$ | max. | 40 V       |
| Collector-emitter voltage (open base)                                | $-V_{CEO}$ | max. | 40 V       |
| Emitter-base voltage (open collector)                                | $-V_{EBO}$ | max. | 5 V        |
| Collector current (d.c.)                                             | $-I_C$     | max. | 200 mA     |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW     |
| D.C. current gain                                                    | $h_{FE}$   |      | 100 to 300 |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                          |            |      |            |
| Transition frequency at $f = 100\text{ MHz}$                         | $f_T$      | min. | 250 MHz    |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$                         |            |      |            |

## MECHANICAL DATA

Dimensions in mm

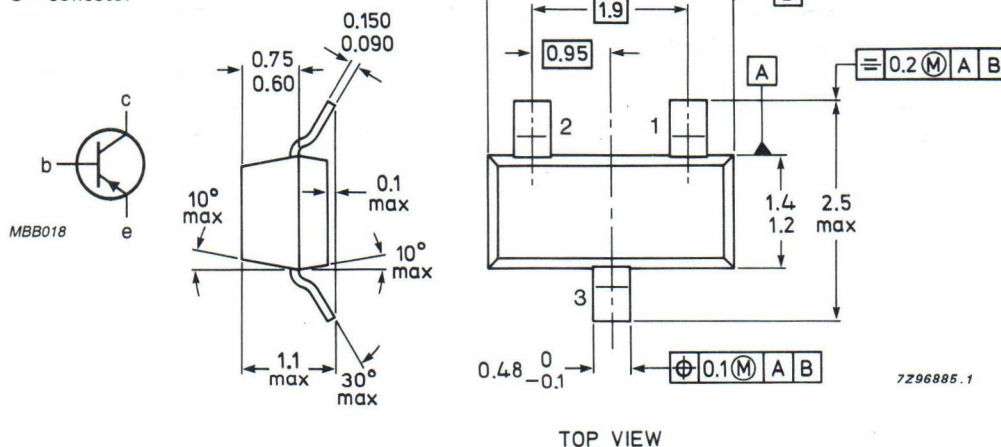
Fig. 1 SOT-23.

## Pinning:

- 1 = base  
2 = emitter  
3 = collector

Marking code

PMBT3906 : p2A



See also Soldering recommendations.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |            |      |                                         |
|--------------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                    | $-V_{CBO}$ | max. | 40 V                                    |
| Collector-emitter voltage (open base)                                    | $-V_{CEO}$ | max. | 40 V                                    |
| Emitter-base voltage (open collector)                                    | $-V_{EBO}$ | max. | 5 V                                     |
| Collector current (d.c.)                                                 | $-I_C$     | max. | 200 mA                                  |
| Total power dissipation*<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW                                  |
| Storage temperature                                                      | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |

**THERMAL CHARACTERISTICS\*\***

$$T_j = P(R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient

$$R_{th\ j-a} = 500\text{ K/W}$$

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector-emitter breakdown voltage▲

$$-I_C = 1\text{ mA}; I_B = 0$$

$$-V_{(BR)CEO} \text{ min. } 40\text{ V}$$

Collector-base breakdown voltage

$$-I_C = 10\text{ }\mu\text{A}; I_E = 0$$

$$-V_{(BR)CBO} \text{ min. } 40\text{ V}$$

Emitter-base breakdown voltage

$$-I_E = 10\text{ }\mu\text{A}; I_C = 0$$

$$-V_{(BR)EBO} \text{ min. } 5\text{ V}$$

Collector cut-off current

$$-V_{CE} = 30\text{ V}; -V_{EB} = 3\text{ V}$$

$$-I_{CE} \text{ max. } 50\text{ nA}$$

Base current

with reverse biased emitter junction

$$-I_{BEX} \text{ max. } 50\text{ nA}$$

Output capacitance at  $f = 100\text{ kHz}$ 

$$I_E = 0; -V_{CB} = 5\text{ V}$$

$$C_C \text{ max. } 4,5\text{ pF}$$

Input capacitance at  $f = 100\text{ kHz}$ 

$$I_C = 0; -V_{BE} = 0,5\text{ V}$$

$$C_e \text{ max. } 10\text{ pF}$$

\* Mounted on a ceramic substrate: area =  $10 \times 8\text{ mm}$ ; thickness =  $0,7\text{ mm}$ .

\*\* See Thermal characteristics.

▲ Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

## Saturation voltages

 $-I_C = 10 \text{ mA}; -I_B = 1 \text{ mA}$  $-V_{CEsat}$  max. 0,25 V $-I_C = 50 \text{ mA}; -I_B = 5 \text{ mA}$  $-V_{CEsat}$  max. 0,4 V  
min. 0,65 V $-I_C = 10 \text{ mA}; -I_B = 1 \text{ mA}$  $-V_{BEsat}$  max. 0,85 V $-I_C = 50 \text{ mA}; -I_B = 5 \text{ mA}$  $-V_{BBSat}$  max. 0,95 V

## D.C. current gain

 $-I_C = 0,1 \text{ mA}; -V_{CE} = 1 \text{ V}$  $h_{FE}$  min. 60 $-I_C = 1 \text{ mA}; -V_{CE} = 1 \text{ V}$  $h_{FE}$  min. 80 $-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$  $h_{FE}$  min. 100  
max. 300 $-I_C = 50 \text{ mA}; -V_{CE} = 1 \text{ V}$  $h_{FE}$  min. 60 $-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$  $h_{FE}$  min. 30Transition frequency at  $f = 100 \text{ MHz}$  $-I_C = 10 \text{ mA}; -V_{CE} = 20 \text{ V}$  $f_T$  min. 250 MHzNoise figure at  $R_S = 1 \text{ k}\Omega$  $-I_C = 100 \mu\text{A}; -V_{CE} = 5 \text{ V}$  $f = 10 \text{ Hz to } 15,7 \text{ kHz}$  $F$  max. 4 dB

## h-parameters (common emitter)

 $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

## Input impedance

 $h_{ie}$  min. 2,0  $\text{k}\Omega$   
max. 12  $\text{k}\Omega$ 

## Reverse voltage transfer ratio

 $h_{re}$  min.  $1,0 \cdot 10^{-4}$   
max.  $10 \cdot 10^{-4}$ 

## Small signal current gain

 $h_{fe}$  min. 100  
max. 400

## Output admittance

 $h_{oe}$  min. 30  $\mu\text{S}$   
max. 60  $\mu\text{S}$ 

## Switching times

Turn-on time when  $-V_{CC} = 3 \text{ V}; -V_{BE} = 0,5 \text{ V}$  $-I_C = 10 \text{ mA}; -I_{Bon} = 1 \text{ mA}$ 

## Delay time

 $t_d$  max. 35 ns

## Rise time

 $t_r$  max. 35 nsTurn-off time when  $-V_{CC} = 3 \text{ V}; -I_C = 10 \text{ mA}$  $-I_{Bon} = -I_{Boff} = 1 \text{ mA}$ 

## Storage time

 $t_s$  max. 225 ns

## Fall time

 $t_f$  max. 75 ns





## SILICON PLANAR EPITAXIAL TRANSISTOR

NPN silicon planar epitaxial transistor, housed in a SOT-23 envelope.

It is intended for use in linear, switching, and general purpose applications.

The complementary type is the PMBT4403.

## QUICK REFERENCE DATA

|                                                                          |           |      |        |
|--------------------------------------------------------------------------|-----------|------|--------|
| Collector-emitter voltage                                                | $V_{CEO}$ | max. | 40 V   |
| Collector current (DC)                                                   | $I_C$     | max. | 600 mA |
| DC current gain                                                          | $h_{FE}$  | min. | 100    |
| $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$                             |           | max. | 300    |
| Total power dissipation<br>up to $T_{amb} = 25 \text{ }^\circ\text{C}^*$ | $P_{tot}$ | max. | 250 mW |

## MECHANICAL DATA

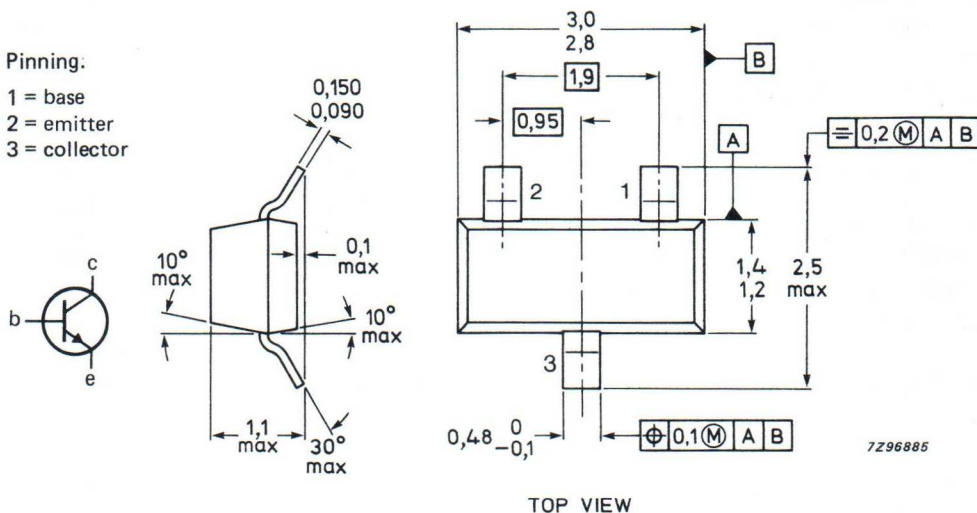
Dimensions in mm

Fig. 1 SOT-23

Marking code = p2X

Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                |
|---------------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-emitter voltage                                                 | $V_{CEO}$ | max. | 40 V                           |
| Collector-base voltage                                                    | $V_{CBO}$ | max. | 60 V                           |
| Emitter-base voltage                                                      | $V_{EBO}$ | max. | 6.0 V                          |
| Collector current (DC)                                                    | $I_C$     | max. | 600 mA                         |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 250 mW                         |
| Storage temperature range                                                 | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                |               |   |                   |
|--------------------------------------------------------------------------------|---------------|---|-------------------|
| Collector-emitter breakdown voltage<br>$I_C = 1.0\text{ mA}$ ; $I_B = 0$       | $V_{(BR)CEO}$ | > | 40 V              |
| Collector-base breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}$ ; $I_E = 0$ | $V_{(BR)CBO}$ | > | 60 V              |
| Emitter-base breakdown voltage<br>$I_E = 100\text{ }\mu\text{A}$ ; $I_C = 0$   | $V_{(BR)EBO}$ | > | 6.0 V             |
| Base cut-off current<br>$V_{CE} = 35\text{ V}$ ; $V_{EB} = 0.4\text{ V}$       | $I_{BEX}$     | < | 0.1 $\mu\text{A}$ |
| Collector cut-off current<br>$V_{CE} = 35\text{ V}$ ; $V_{EB} = 0.4\text{ V}$  | $I_{CEX}$     | < | 0.1 $\mu\text{A}$ |
| DC current gain<br>$I_C = 0.1\text{ mA}$ ; $V_{CE} = 1\text{ V}$               | $h_{FE}$      | > | 20                |
| $I_C = 1.0\text{ mA}$ ; $V_{CE} = 1\text{ V}$                                  | $h_{FE}$      | > | 40                |
| $I_C = 10\text{ mA}$ ; $V_{CE} = 1\text{ V}$                                   | $h_{FE}$      | > | 80                |
| $I_C = 150\text{ mA}$ ; $V_{CE} = 1\text{ V}$                                  | $h_{FE}$      |   | 100 to 300        |
| $I_C = 500\text{ mA}$ ; $V_{CE} = 2\text{ V}$                                  | $h_{FE}$      | > | 40                |
| Saturation voltage<br>$I_C = 150\text{ mA}$ ; $I_B = 15\text{ mA}$             | $V_{CE\ sat}$ | < | 0.4 V             |
|                                                                                | $V_{BE\ sat}$ |   | 0.75 to 0.95 V    |
| $I_C = 500\text{ mA}$ ; $I_B = 50\text{ mA}$                                   | $V_{CE\ sat}$ | < | 0.75 V            |
|                                                                                | $V_{BE\ sat}$ | < | 1.2 V             |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

Transition frequency;  $f = 100 \text{ MHz}$ ; $I_C = 20 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$  $f_T > 250 \text{ MHz}$ 

Collector-base capacitance

 $I_E = 0$ ;  $V_{CB} = 5 \text{ V}$ ;  $f = 100 \text{ kHz}$  $C_{cb} < 8.0 \text{ pF}$ 

Emitter-base capacitance

 $I_C = 0$ ;  $V_{BE} = 0.5 \text{ V}$ ;  $f = 100 \text{ kHz}$  $C_{eb} < 30 \text{ pF}$ Input impedance;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$  $h_{ie}$  min.  $1.0 \text{ k}\Omega$   
max.  $8.0 \text{ k}\Omega$ 

Voltage feed-back ratio

 $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ ;  $f = 1 \text{ kHz}$  $h_{re}$  min.  $0.1 \times 10^{-4}$   
max.  $30 \times 10^{-4}$ Small-signal current gain;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$  $h_{fe}$  min. 40  
max. 500Output admittance;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$  $h_{oe}$  min.  $1.0 \text{ }\mu\text{S}$   
max.  $30 \text{ }\mu\text{S}$ 

Switching times (resistive load)

Turn-on time

 $I_C = 150 \text{ mA}$ ;  $I_{B1} = 15 \text{ mA}$ ; $V_{CC} = 30 \text{ V}$ ;  $V_{EB} = 2 \text{ V}$ 

delay time

rise time

 $t_d$  max. 15 ns  
 $t_r$  max. 20 ns

Turn-off time

 $I_C = 150 \text{ mA}$ ;  $V_{CC} = 30 \text{ V}$ ; $I_{B1} = I_{B2} = 15 \text{ mA}$ 

storage time

fall time

 $t_s$  max. 225 ns  
 $t_f$  max. 30 ns

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

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100

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100

100

100

100

100

# SILICON PLANAR EPITAXIAL TRANSISTOR

PNP silicon planar epitaxial transistor, housed in a SOT-23 envelope.

It is intended for use in linear, switching and general purpose applications.

The complementary type is the PMBT4401.

### QUICK REFERENCE DATA

|                                              |            |      |        |
|----------------------------------------------|------------|------|--------|
| Collector-emitter voltage                    | $-V_{CE0}$ | max. | 40 V   |
| Collector current (DC)                       | $-I_C$     | max. | 600 mA |
| DC current gain                              |            |      |        |
| $I_C = 150 \text{ mA}; V_{CE} = 2 \text{ V}$ | $h_{FE}$   | min. | 100    |
|                                              |            | max. | 300    |
| Total power dissipation                      |            |      |        |
| up to $T_{amb} = 25^\circ\text{C}$           | $P_{tot}$  | max. | 250 mW |

## MECHANICAL DATA

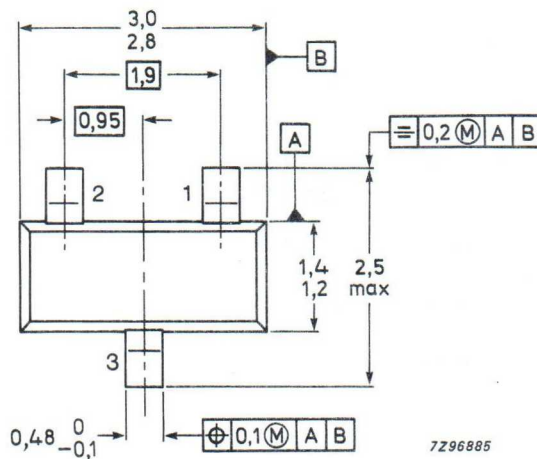
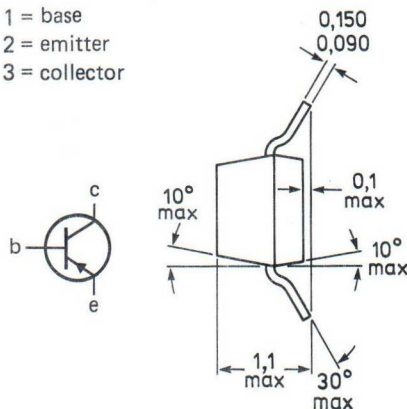
Dimensions in mm

Fig. 1 SOT-23

Marking code = p2T

### Pinning:

1 = base  
2 = emitter  
3 = collector



TOP VIEW

7296885

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                         |
|---------------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-emitter voltage                                                 | $-V_{CEO}$ | max. | 40 V                                    |
| Collector-base voltage                                                    | $-V_{CBO}$ | max. | 40 V                                    |
| Emitter-base voltage                                                      | $-V_{EBO}$ | max. | 5.0 V                                   |
| Collector current (DC)                                                    | $-I_C$     | max. | 600 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 250 mW                                  |
| Storage temperature range                                                 | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | 150 $^{\circ}\text{C}$                  |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                              |                |   |                   |
|------------------------------------------------------------------------------|----------------|---|-------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 1.0\text{ mA}; I_B = 0$       | $-V_{(BR)CEO}$ | > | 40 V              |
| Collector-base breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}; I_E = 0$ | $-V_{(BR)CBO}$ | > | 40 V              |
| Emitter-base breakdown voltage<br>$-I_E = 100\text{ }\mu\text{A}; I_C = 0$   | $-V_{(BR)EBO}$ | > | 5.0 V             |
| Base cut-off current<br>$-V_{CE} = 35\text{ V}; -V_{EB} = 0.4\text{ V}$      | $-I_{BEX}$     | < | 0.1 $\mu\text{A}$ |
| Collector cut-off current<br>$-V_{CE} = 35\text{ V}; -V_{EB} = 0.4\text{ V}$ | $-I_{CEX}$     | < | 0.1 $\mu\text{A}$ |
| DC current gain<br>$-I_C = 0.1\text{ mA}; -V_{CE} = 1\text{ V}$              | $h_{FE}$       | > | 30                |
| $-I_C = 1.0\text{ mA}; -V_{CE} = 1\text{ V}$                                 | $h_{FE}$       | > | 60                |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                                  | $h_{FE}$       | > | 100               |
| $-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$                                 | $h_{FE}$       |   | 100 to 300        |
| $-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$                                 | $h_{FE}$       | > | 20                |
| Saturation voltage<br>$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$            | $-V_{CE\ sat}$ | < | 0.4 V             |
|                                                                              | $-V_{BE\ sat}$ |   | 0.75 to 0.95 V    |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$                                  | $-V_{CE\ sat}$ | < | 0.75 V            |
|                                                                              | $-V_{BE\ sat}$ | < | 1.3 V             |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

Transition frequency at  $f = 100 \text{ MHz}$ ; $-I_C = 20 \text{ mA}$ ;  $-V_{CE} = 10 \text{ V}$  $f_T > 200 \text{ MHz}$ 

Collector-base capacitance

 $I_E = 0$ ;  $-V_{CB} = 10 \text{ V}$ ;  $f = 100 \text{ kHz}$  $C_{cb} < 8.5 \text{ pF}$ Emitter-base capacitance at  $f = 100 \text{ kHz}$ ; $I_C = 0$ ;  $-V_{BE} = 0.5 \text{ V}$  $C_{eb} < 35 \text{ pF}$ Input impedance at  $f = 1 \text{ kHz}$ ; $-I_C = 1 \text{ mA}$ ;  $-V_{CE} = 10 \text{ V}$  $h_{ie} \begin{matrix} \text{min.} \\ \text{max.} \end{matrix} \begin{matrix} 1.5 \text{ k}\Omega \\ 15 \text{ k}\Omega \end{matrix}$ Voltage feed-back ratio at  $f = 1 \text{ kHz}$ ; $-I_C = 1 \text{ mA}$ ;  $-V_{CE} = 10 \text{ V}$  $h_{re} \begin{matrix} \text{min.} \\ \text{max.} \end{matrix} \begin{matrix} 0.1 \times 10^{-4} \\ 8.0 \times 10^{-4} \end{matrix}$ Small-signal current gain at  $f = 1 \text{ kHz}$ ; $-I_C = 1 \text{ mA}$ ;  $-V_{CE} = 10 \text{ V}$  $h_{fe} \begin{matrix} \text{min.} \\ \text{max.} \end{matrix} \begin{matrix} 60 \\ 500 \end{matrix}$ Output admittance at  $f = 1 \text{ kHz}$ ; $-I_C = 1 \text{ mA}$ ;  $-V_{CE} = 10 \text{ V}$  $h_{oe} \begin{matrix} \text{min.} \\ \text{max.} \end{matrix} \begin{matrix} 1.0 \text{ }\mu\text{S} \\ 100 \text{ }\mu\text{S} \end{matrix}$ 

Switching times (resistive load)

Turn-on time

 $-I_C = 150 \text{ mA}$ ;  $-I_{B1} = 15 \text{ mA}$ ; $-V_{CC} = 30 \text{ V}$ ;  $-V_{EB} = 2 \text{ V}$ 

delay time

 $t_d \text{ max. } 15 \text{ ns}$ 

rise time

 $t_r \text{ max. } 20 \text{ ns}$ 

Turn-off time

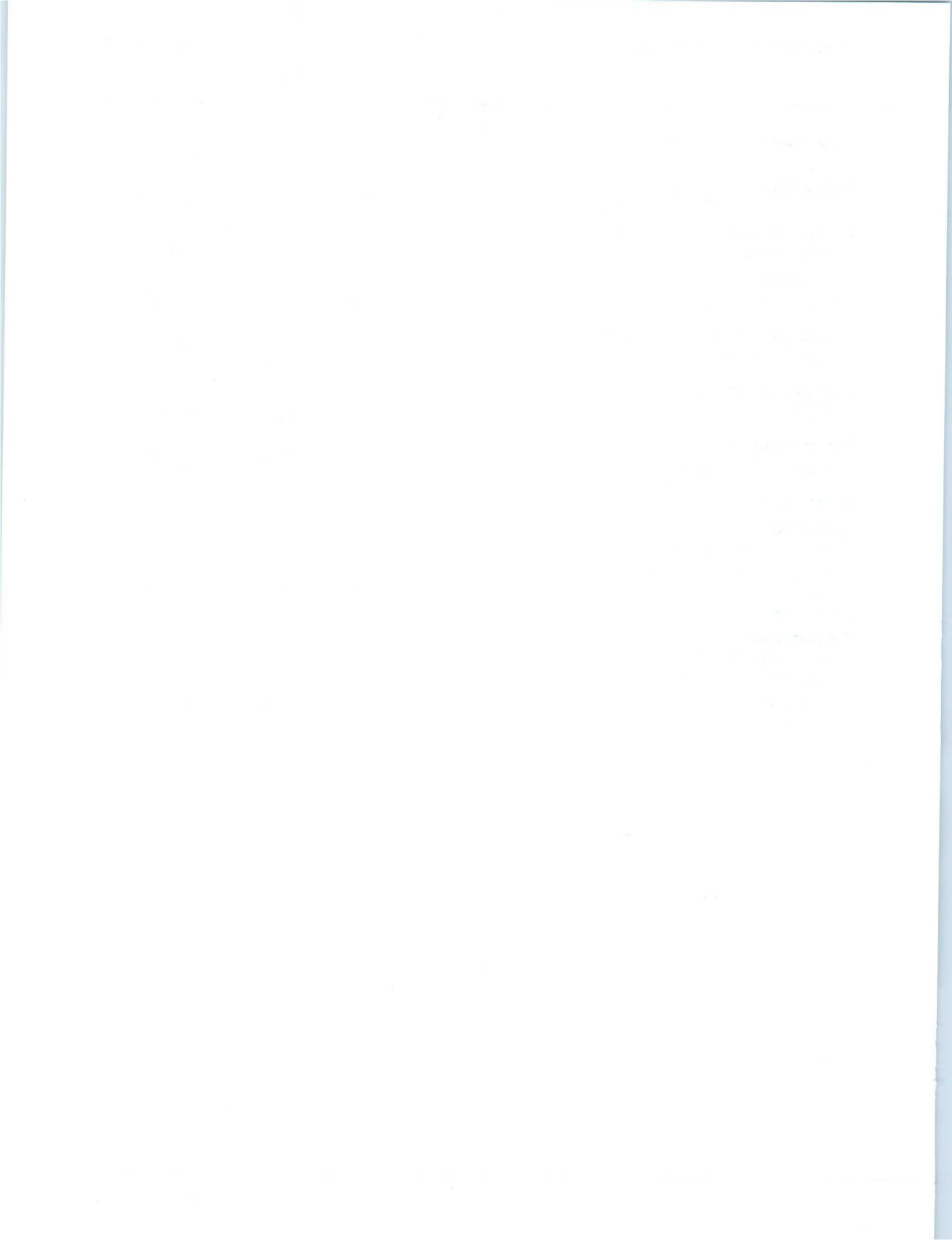
 $-I_C = 150 \text{ mA}$ ;  $-V_{CC} = 30 \text{ V}$ ; $-I_{B1} = +I_{B2} = 15 \text{ mA}$ 

storage time

 $t_s \text{ max. } 225 \text{ ns}$ 

fall time

 $t_f \text{ max. } 30 \text{ ns}$



## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N small-signal transistor in plastic SOT-23 envelope intended for low-noise input stages in audio equipment, when using SMD technology.

## QUICK REFERENCE DATA

|                                                                                 |             |      |        |
|---------------------------------------------------------------------------------|-------------|------|--------|
| Collector-emitter voltage<br>(open base)                                        | $V_{CEO}$   | max. | 30 V   |
| Collector-base voltage<br>(open emitter)                                        | $V_{CBO}$   | max. | 35 V   |
| Collector current (d.c.)                                                        | $I_C$       | max. | 50 mA  |
| Total device dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$        | $P_{tot}$   | max. | 250 mW |
| Collector-emitter saturation voltage<br>$I_C = 10\text{ mA}; I_B = 1\text{ mA}$ | $V_{CEsat}$ | max. | 0,5 V  |
| D.C. current gain<br>$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$                   | $h_{FE}$    | min. | 350    |

## MECHANICAL DATA

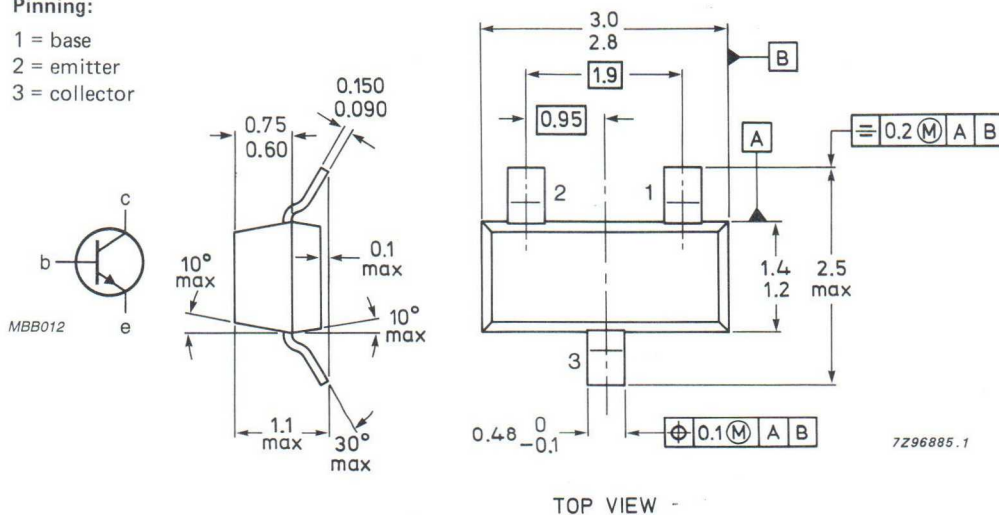
Dimensions in mm

Fig. 1 SOT-23.

Marking code: p1Q

### Pinning:

- 1 = base  
2 = emitter  
3 = collector



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                |
|---------------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-emitter voltage<br>(open base)                                  | $V_{CEO}$ | max. | 30 V                           |
| Collector-base voltage<br>(open emitter)                                  | $V_{CBO}$ | max. | 35 V                           |
| Emitter-base voltage<br>(open collector)                                  | $V_{EBO}$ | max. | 4,5 V                          |
| Collector current (d.c.)                                                  | $I_C$     | max. | 50 mA                          |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 250 mW                         |
| Storage temperature                                                       | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector-emitter breakdown voltage

 $I_B = 0; I_C = 1\text{ mA}$  $V_{(BR)CEO}$  min. 30 V

Collector-base breakdown voltage

 $I_E = 0; I_C = 100\text{ }\mu\text{A}$  $V_{(BR)CBO}$  min. 35 V

Collector cut-off current

 $V_{CB} = 20\text{ V}; I_E = 0$  $I_{CBO}$  max. 50 nA

Emitter cut-off current

 $V_{EBoff} = 3\text{ V}; I_C = 0$  $I_{EBO}$  max. 50 nA

Saturation voltages

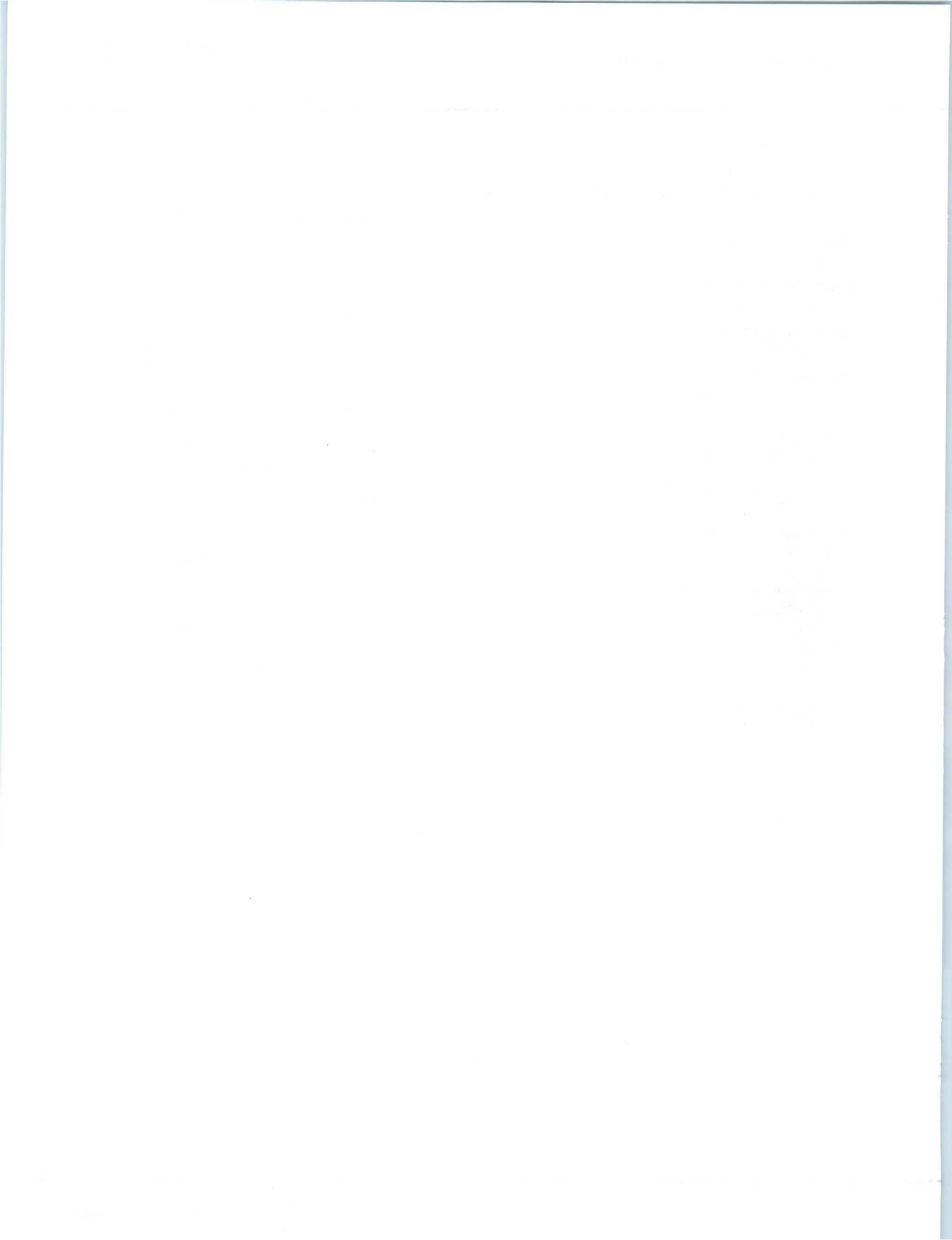
 $I_C = 10\text{ mA}; I_B = 1\text{ mA}$  $V_{CEsat}$  max. 0,5 V $V_{BEsat}$  max. 0,8 V

D.C. current gain

 $I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$  $h_{FE}$  min. 300  
max. 900 $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$  $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$  $h_{FE}$  min. 350  
min. 300

Small-signal current gain

 $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}; f = 1\text{ kHz}$  $h_{fe}$  min. 350  
max. 1400Noise figure at  $R_S = 10\text{ k}\Omega; T_{amb} = 25\text{ }^{\circ}\text{C}$  $I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V};$  $f = 10\text{ Hz to } 15,7\text{ kHz}$  $F$  max. 3,0 dBCollector capacitance at  $f = 100\text{ kHz}$  $V_{CB} = 5\text{ V}; I_E = 0$  $C_c$  max. 4,0 pFEmitter capacitance at  $f = 100\text{ kHz}$  $V_{BE} = 0,5\text{ V}; I_C = 0$  $C_e$  max. 10 pF



## SILICON P-N-P HIGH-VOLTAGE TRANSISTOR

P-N-P high-voltage small-signal transistor for general purposes and especially in telephony applications and encapsulated in a SOT-23 envelope.

## QUICK REFERENCE DATA

|                                                                                    |             |      |           |
|------------------------------------------------------------------------------------|-------------|------|-----------|
| Collector-base voltage (open emitter)                                              | $-V_{CBO}$  | max. | 160 V     |
| Collector-emitter voltage (open base)                                              | $-V_{CEO}$  | max. | 150 V     |
| Collector current                                                                  | $-I_C$      | max. | 500 mA    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$               | $P_{tot}$   | max. | 250 mW    |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ | $V_{CEsat}$ | max. | 0,5 V     |
| D.C. current gain<br>$I_C = 10\text{ mA}$ ; $V_{CE} = -5\text{ V}$                 | $h_{FE}$    |      | 60 to 240 |

## MECHANICAL DATA

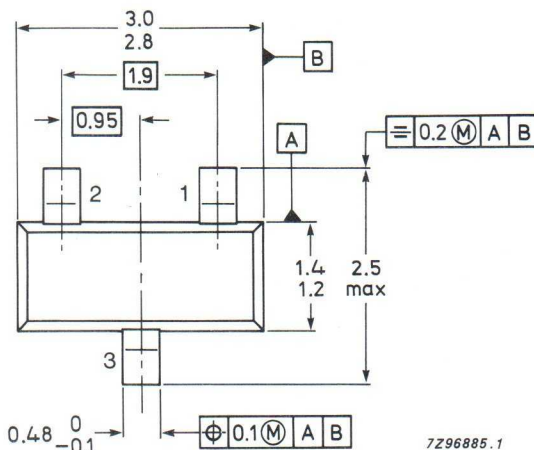
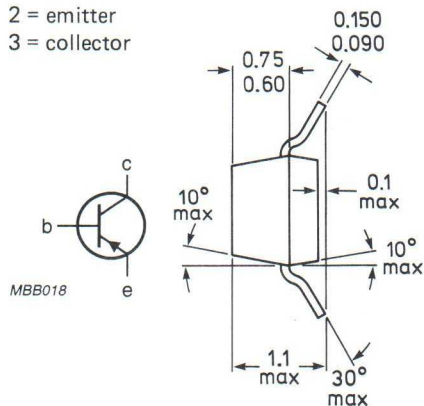
Dimensions in mm

Fig. 1 SOT-23.

Marking code: p2L

## Pinning:

- 1 = base  
2 = emitter  
3 = collector



TOP VIEW

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                |
|---------------------------------------------------------------------------|------------|------|--------------------------------|
| Collector-base voltage (open emitter)                                     | $-V_{CB0}$ | max. | 160 V                          |
| Collector-emitter voltage (open base)                                     | $-V_{CEO}$ | max. | 150 V                          |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 5,0 V                          |
| Collector current                                                         | $-I_C$     | max. | 500 mA                         |
| Total power dissipation *<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250 mW                         |
| Junction temperature                                                      | $T_j$      | max. | 150 $^{\circ}\text{C}$         |
| Storage temperature                                                       | $T_{stg}$  |      | -65 to +150 $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                            |               |  |         |
|----------------------------|---------------|--|---------|
| From junction to ambient * | $R_{th\ j-a}$ |  | 500 K/W |
|----------------------------|---------------|--|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

 $I_E = 0; -V_{CB} = 120\text{ V}$  $-I_{CBO}$  max. 50 nA $I_E = 0; -V_{CB} = 120\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$  $-I_{CBO}$  max. 50  $\mu\text{A}$ 

Breakdown voltages

 $I_C = 1,0\text{ mA}; I_B = 0$  $-V_{(BR)CEO}$  min. 150 V $I_C = 100\text{ }\mu\text{A}; I_E = 0$  $-V_{(BR)CBO}$  min. 160 V $I_C = 0; I_E = 10\text{ }\mu\text{A}$  $-V_{(BR)EBO}$  min. 5,0 V

Saturation voltages

 $-I_C = 10\text{ mA}; -I_B = 1,0\text{ mA}$  $-V_{CEsat}$  max. 0,2 V $-V_{BEsat}$  max. 1,0 V $-I_C = 50\text{ mA}; -I_B = 5,0\text{ mA}$  $-V_{CEsat}$  max. 0,5 V $-V_{BEsat}$  max. 1,0 V

D.C. current gain

 $I_C = 1,0\text{ mA}; -V_{CE} = 5\text{ V}$  $h_{FE}$  min. 50 $I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$  $h_{FE}$  min. 60 $I_C = 50\text{ mA}; -V_{CE} = 5\text{ V}$  $h_{FE}$  max. 240 $h_{FE}$  min. 50

Small-signal current gain

 $I_C = 1,0\text{ mA}; -V_{CE} = 10\text{ V}; f = 1\text{ kHz}$  $h_{fe}$  min. 40 $h_{fe}$  max. 200Output capacitance at  $f = 1\text{ MHz}$  $I_E = 0; -V_{CB} = 10\text{ V}$  $C_o$  max. 6,0 pFTransition frequency at  $f = 100\text{ MHz}$  $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$  $f_T$  min. 100 MHz $f_T$  max. 300 MHzNoise figure at  $R_S = 10\text{ }\Omega$  $I_C = 200\text{ }\mu\text{A}; -V_{CE} = 5\text{ V};$  $f = 10\text{ Hz to }15,7\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$  $F$  max. 8,0 dB

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

## SILICON N-P-N HIGH-VOLTAGE TRANSISTOR

N-P-N high-voltage small-signal transistor for general purposes and especially telephony applications and encapsulated in a SOT-23 envelope.

### QUICK REFERENCE DATA

|                                                                                    |             |      |           |
|------------------------------------------------------------------------------------|-------------|------|-----------|
| Collector-base voltage (open emitter)                                              | $V_{CB0}$   | max. | 160 V     |
| Collector-emitter voltage (open base)                                              | $V_{CEO}$   | max. | 140 V     |
| Collector current                                                                  | $I_C$       | max. | 600 mA    |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$               | $P_{tot}$   | max. | 250 mW    |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ | $V_{CEsat}$ | max. | 0,25 V    |
| D.C. current gain<br>$I_C = 10\text{ mA}$ ; $V_{CE} = 5\text{ V}$                  | $h_{FE}$    |      | 60 to 250 |

### MECHANICAL DATA

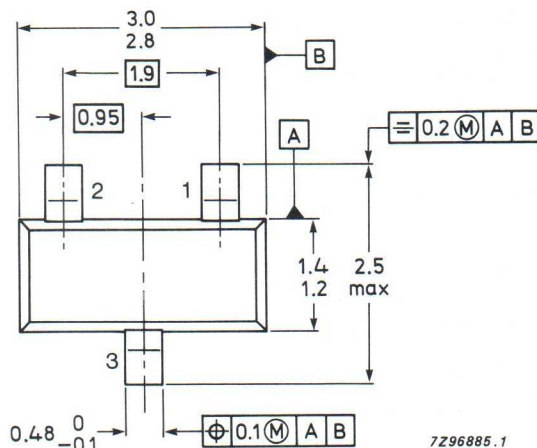
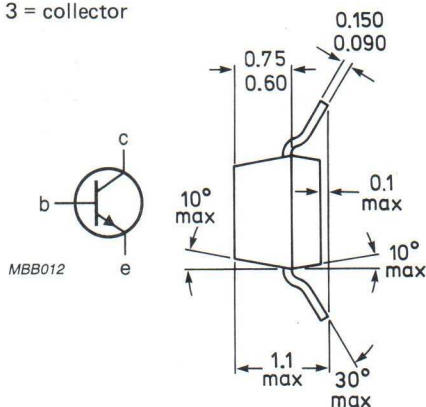
Dimensions in mm

Fig. 1 SOT-23.

Marking code: p1F

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                              |
|---------------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Collector-base voltage (open emitter)                                     | $V_{CBO}$ | max. | 160                                          |
| Collector-emitter voltage (open base)                                     | $V_{CEO}$ | max. | 140                                          |
| Emitter-base voltage (open collector)                                     | $V_{EB0}$ | max. | 6 V                                          |
| Collector current                                                         | $I_C$     | max. | 600 mA                                       |
| Total power dissipation *<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW                                       |
| Storage temperature                                                       | $T_{stg}$ |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$                       |

**THERMAL RESISTANCE \***

|                          |                     |  |         |
|--------------------------|---------------------|--|---------|
| From junction to ambient | $R_{th\text{ }t-a}$ |  | 500 K/W |
|--------------------------|---------------------|--|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                  |               |      |                   |
|----------------------------------------------------------------------------------|---------------|------|-------------------|
| Collector cut-off current                                                        |               |      |                   |
| $I_E = 0; V_{CB} = 100\text{ V}$                                                 | $I_{CBO}$     | max. | 100 nA            |
| $I_E = 0; V_{CB} = 100\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$          | $I_{CBO}$     | max. | 100 $\mu\text{A}$ |
| Emitter cut-off current                                                          |               |      |                   |
| $I_C = 0; V_{EB} = 4,0\text{ V}$                                                 | $I_{EBO}$     | max. | 50 nA             |
| Breakdown voltages                                                               |               |      |                   |
| $I_C = 1,0\text{ mA}; I_B = 0$                                                   | $V_{(BR)CEO}$ | min. | 140 V             |
| $I_C = 10\text{ }\mu\text{A}; I_E = 0$                                           | $V_{(BR)CBO}$ | min. | 160 V             |
| $I_C = 0; I_E = 10\text{ }\mu\text{A}$                                           | $V_{(BR)EBO}$ | min. | 6 V               |
| Saturation voltages                                                              |               |      |                   |
| $I_C = 10\text{ mA}; I_B = 1,0\text{ mA}$                                        | $V_{CEsat}$   | max. | 0,15 V            |
|                                                                                  | $V_{BEsat}$   | max. | 1,0 V             |
| $I_C = 50\text{ mA}; I_B = 5,0\text{ mA}$                                        | $V_{CEsat}$   | max. | 0,25 V            |
|                                                                                  | $V_{BEsat}$   | max. | 1,2 V             |
| D.C. current gain                                                                |               |      |                   |
| $I_C = 1,0\text{ mA}; V_{CE} = 5\text{ V}$                                       | $h_{FE}$      | min. | 60                |
| $I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$                                        | $h_{FE}$      | min. | 60                |
| $I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$                                        | $h_{FE}$      | max. | 250               |
|                                                                                  | $h_{FE}$      | min. | 20                |
| Output capacitance at $f = 1\text{ MHz}$                                         |               |      |                   |
| $I_E = 0; V_{CB} = 10\text{ V}$                                                  | $C_o$         | max. | 6 pF              |
| Input capacitance at $f = 1\text{ MHz}$                                          |               |      |                   |
| $I_C = 0; V_{EB} = 0,5\text{ V}$                                                 | $C_i$         | max. | 30 pF             |
| Transition frequency at $f = 100\text{ MHz}$                                     |               |      |                   |
| $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $f_T$         | min. | 100 MHz           |
|                                                                                  |               | max. | 300 MHz           |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

## SILICON NPN HIGH-VOLTAGE TRANSISTOR

NPN high-voltage small-signal transistor for general purposes and especially telephony applications and encapsulated in a SOT23 envelope.

## QUICK REFERENCE DATA

|                                                                                 |             |      |                        |
|---------------------------------------------------------------------------------|-------------|------|------------------------|
| Collector-base voltage (open emitter)                                           | $V_{CB0}$   | max. | 180 V                  |
| Collector-emitter voltage (open base)                                           | $V_{CEO}$   | max. | 160 V                  |
| Collector current                                                               | $I_C$       | max. | 600 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$            | $P_{tot}$   | max. | 250 mW                 |
| Junction temperature                                                            | $T_j$       | max. | 150 $^{\circ}\text{C}$ |
| Collector-emitter saturation voltage<br>$I_C = 50\text{ mA}; I_B = 5\text{ mA}$ | $V_{CEsat}$ | max. | 0.20 V                 |
| DC current gain<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$                    | $h_{FE}$    | min. | 80                     |

## MECHANICAL DATA

Dimensions in mm

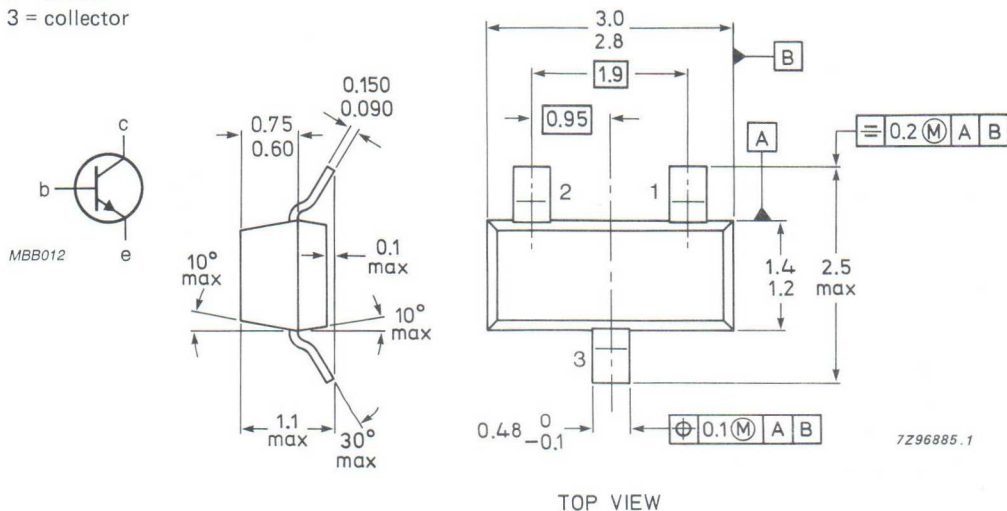
Fig.1 SOT23.

## Pinning:

- 1 = base  
2 = emitter  
3 = collector

## Marking code

PMBT5551 = pGI



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |           |      |                                |
|----------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                                | $V_{CB0}$ | max. | 180 V                          |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. | 160 V                          |
| Emitter-base voltage (open collector)                                | $V_{EB0}$ | max. | 6 V                            |
| Collector current                                                    | $I_C$     | max. | 600 mA                         |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250 mW                         |
| Junction temperature                                                 | $T_j$     | max. | 150 $^{\circ}\text{C}$         |
| Storage temperature range                                            | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 500 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

$I_E = 0; V_{CB} = 120\text{ V}$

|           |      |       |
|-----------|------|-------|
| $I_{CBO}$ | max. | 50 nA |
|-----------|------|-------|

$I_E = 0; V_{CB} = 120\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$

|           |      |                  |
|-----------|------|------------------|
| $I_{CBO}$ | max. | 50 $\mu\text{A}$ |
|-----------|------|------------------|

Emitter cut-off current

$I_C = 0; V_{EB} = 4.0\text{ V}$

|           |      |       |
|-----------|------|-------|
| $I_{EBO}$ | max. | 50 nA |
|-----------|------|-------|

Breakdown voltages

$I_C = 1.0\text{ mA}; I_B = 0$

|               |      |       |
|---------------|------|-------|
| $V_{(BR)CEO}$ | min. | 160 V |
|---------------|------|-------|

$I_C = 100\text{ }\mu\text{A}; I_E = 0$

|               |      |       |
|---------------|------|-------|
| $V_{(BR)CBO}$ | min. | 180 V |
|---------------|------|-------|

$I_C = 0; I_E = 10\text{ }\mu\text{A}$

|               |      |       |
|---------------|------|-------|
| $V_{(BR)EBO}$ | min. | 6.0 V |
|---------------|------|-------|

Saturation voltages

$I_C = 10\text{ mA}; I_B = 1.0\text{ mA}$

|             |      |        |
|-------------|------|--------|
| $V_{CEsat}$ | max. | 0.15 V |
|-------------|------|--------|

|             |      |       |
|-------------|------|-------|
| $V_{BEsat}$ | max. | 1.0 V |
|-------------|------|-------|

$I_C = 50\text{ mA}; I_B = 5.0\text{ mA}$

|             |      |        |
|-------------|------|--------|
| $V_{CEsat}$ | max. | 0.20 V |
|-------------|------|--------|

|             |      |       |
|-------------|------|-------|
| $V_{BEsat}$ | max. | 1.0 V |
|-------------|------|-------|

DC current gain

$I_C = 1.0\text{ mA}; V_{CE} = 5\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 80 |
|----------|------|----|

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 80 |
|----------|------|----|

|  |      |     |
|--|------|-----|
|  | max. | 250 |
|--|------|-----|

$I_C = 50\text{ mA}; V_{CE} = 5\text{ V}$

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 30 |
|----------|------|----|

Small-signal current gain

$I_C = 1.0\text{ mA}; V_{CE} = 10\text{ V}; f = 1\text{ kHz}$

|          |      |    |
|----------|------|----|
| $h_{fe}$ | min. | 50 |
|----------|------|----|

|  |      |     |
|--|------|-----|
|  | max. | 200 |
|--|------|-----|

Output capacitance at  $f = 1\text{ MHz}$ 

$I_E = 0; V_{CB} = 10\text{ V}$

|       |      |      |
|-------|------|------|
| $C_o$ | max. | 6 pF |
|-------|------|------|

Input capacitance at  $f = 1\text{ MHz}$ 

$I_C = 0; V_{EB} = 0.5\text{ V}$

|       |      |       |
|-------|------|-------|
| $C_i$ | max. | 30 pF |
|-------|------|-------|

Transition frequency at  $f = 100\text{ MHz}$ 

$I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$

|       |      |         |
|-------|------|---------|
| $f_T$ | min. | 100 MHz |
|-------|------|---------|

|  |      |         |
|--|------|---------|
|  | max. | 300 MHz |
|--|------|---------|

Noise figure at  $R_S = 1\text{ k}\Omega$ 

$I_C = 250\text{ }\mu\text{A}; V_{CE} = 5\text{ V}; f = 10\text{ Hz to }15.7\text{ kHz}$

|     |      |      |
|-----|------|------|
| $F$ | max. | 8 dB |
|-----|------|------|

\* Substrate size 8 mm x 10 mm x 0.7 mm.

## SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature (SMD) plastic envelope intended for application in thick and thin-film circuits (Surface Mounted Device).

They are primarily intended for use in telephony and professional communication equipment.

### QUICK REFERENCE DATA

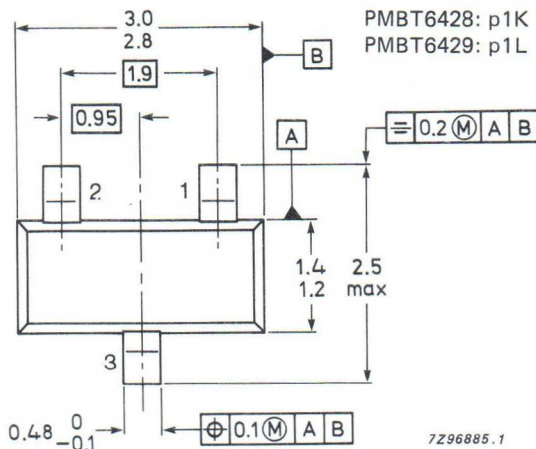
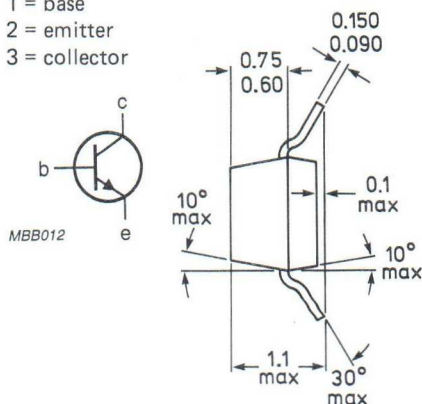
|                                                                      |           | PMBT6428 | PMBT6429 |
|----------------------------------------------------------------------|-----------|----------|----------|
| Collector-base voltage (open emitter)                                | $V_{CBO}$ | max. 60  | 55 V     |
| Collector-emitter voltage (open base)                                | $V_{CEO}$ | max. 50  | 45 V     |
| Collector current (d.c.)                                             | $I_C$     | max. 200 | mA       |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. 250 | mW       |
| D.C. current gain                                                    | $h_{FE}$  | min. 250 | 500      |
| $I_C = 0,1\text{ mA}; V_{CE} = 5\text{ V}$                           |           | max. 650 | 1250     |
| $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$                             | $h_{FE}$  | min. 250 | 500      |
| Transition frequency at $f = 100\text{ MHz}$                         | $f_T$     | min. 100 | MHz      |
| $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$                             |           | max. 700 | MHz      |
| Input capacitance at $f = 1\text{ MHz}$                              | $C_e$     | max. 8,0 | pF       |
| $I_C = 0; V_{EB} = 0,5\text{ V}$                                     |           |          |          |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

See also Soldering recommendations.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                          |           |      | PMBT6428    | PMBT6429           |
|--------------------------------------------------------------------------|-----------|------|-------------|--------------------|
| Collector-base voltage (open emitter)                                    | $V_{CBO}$ | max. | 60          | 55 V               |
| Collector-emitter voltage (open base)                                    | $V_{CEO}$ | max. | 50          | 45 V               |
| Emitter-base voltage (open collector)                                    | $V_{EBO}$ | max. | 6,0         | V                  |
| Collector current (d.c.)                                                 | $I_C$     | max. | 200         | mA                 |
| Total power dissipation*<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ |      | 250         | mW                 |
| Storage temperature                                                      | $T_{stg}$ |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                     | $T_j$     | max. | 150         | $^{\circ}\text{C}$ |

## THERMAL CHARACTERISTICS

Thermal resistance

from junction to ambient\*

|               |   |     |     |
|---------------|---|-----|-----|
| $R_{th\ j-a}$ | = | 500 | K/W |
|---------------|---|-----|-----|

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                        |               |      | PMBT6428 | PMBT6429 |
|----------------------------------------------------------------------------------------|---------------|------|----------|----------|
| Collector-emitter breakdown voltage<br>$I_C = 1\text{ mA}; I_B = 0$                    | $V_{(BR)CEO}$ | min. | 50       | 45 V     |
| Collector-base breakdown voltage<br>$I_C = 0,1\text{ mA}; I_E = 0$                     | $V_{(BR)CBO}$ | min. | 60       | 55 V     |
| Collector cut-off current<br>$V_{CE} = 30\text{ V}$<br>$I_E = 0; V_{CB} = 30\text{ V}$ | $I_{CEO}$     | max. | 100      | nA       |
|                                                                                        | $I_{CBO}$     | max. | 10       | nA       |
| Emitter cut-off current<br>$I_C = 0; V_{EB} = 5\text{ V}$                              | $I_{EBO}$     | max. | 10       | nA       |
| Base-emitter On-voltage<br>$I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$                    | $V_{BE(on)}$  | min. | 560      | mV       |
|                                                                                        |               | max. | 660      | mV       |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.



|                                               |             |      | PMBT6428 | PMBT6429 |
|-----------------------------------------------|-------------|------|----------|----------|
| Collector-emitter saturation voltage          |             |      |          |          |
| $I_C = 10 \text{ mA}; I_B = 0,5 \text{ mA}$   | $V_{CEsat}$ | max. | 0,2      | V        |
| $I_C = 100 \text{ mA}; I_B = 5 \text{ mA}$    | $V_{CEsat}$ | max. | 0,6      | V        |
| D.C. current gain                             |             |      |          |          |
| $I_C = 0,1 \text{ mA}; V_{CE} = 5 \text{ V}$  | $h_{FE}$    | min. | 250      | 500      |
|                                               |             | min. | 250      | 500      |
| $I_C = 0,1 \text{ mA}; V_{CE} = 5 \text{ V}$  | $h_{FE}$    | max. | 650      | 1250     |
| $I_C = 1 \text{ mA}; V_{CE} = 5 \text{ V}$    | $h_{FE}$    | min. | 250      | 500      |
| $I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$   | $h_{FE}$    | min. | 250      | 500      |
| Transition frequency at $f = 100 \text{ MHz}$ |             |      |          |          |
| $I_C = 1 \text{ mA}; V_{CE} = 5 \text{ V}$    | $f_T$       | min. | 100      | MHz      |
|                                               |             | max. | 700      | MHz      |
| Output capacitance at $f = 1 \text{ MHz}$     |             |      |          |          |
| $I_E = 0; V_{CB} = 10 \text{ V}$              | $C_c$       | max. | 3,0      | pF       |
| Input capacitance at $f = 1 \text{ MHz}$      |             |      |          |          |
| $I_C = 0; V_{EB} = 0,5 \text{ V}$             | $C_e$       | max. | 8,0      | pF       |



## SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature (SMD) plastic envelope intended for surface mounted applications. They are primarily intended for use in telephony and professional communication equipment.

### QUICK REFERENCE DATA

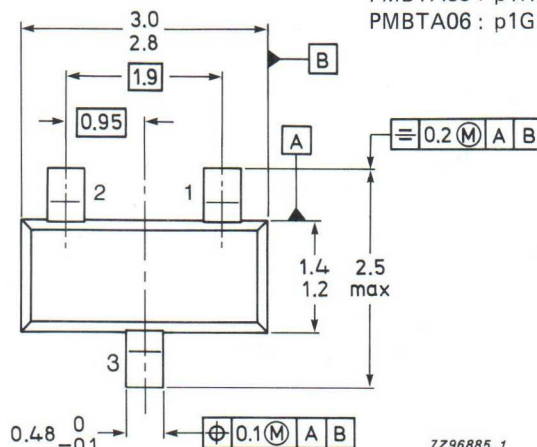
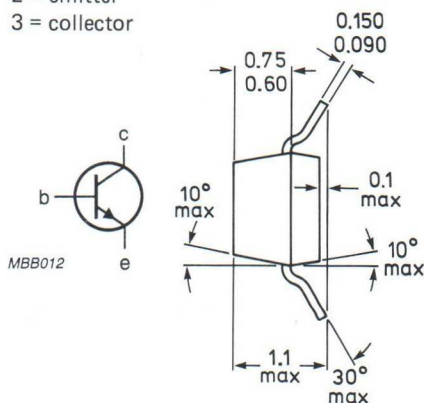
|                                                                                           |             |      | PMBTA05 | PMBTA06 |
|-------------------------------------------------------------------------------------------|-------------|------|---------|---------|
| Collector-base voltage (open emitter)                                                     | $V_{CBO}$   | max. | 60      | 80 V    |
| Collector-emitter voltage (open base)                                                     | $V_{CEO}$   | max. | 60      | 80 V    |
| Emitter-base voltage (open collector)                                                     | $V_{EBO}$   | max. | 4       | V       |
| Collector current (d.c.)                                                                  | $I_C$       | max. | 500     | mA      |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                      | $P_{tot}$   | max. | 250     | mW      |
| D.C. current gain<br>$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$                           | $h_{FE}$    | min. | 50      |         |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$ | $f_T$       | min. | 100     | MHz     |
| Collector-emitter saturation voltage<br>$I_C = 100\text{ mA}; I_B = 10\text{ mA}$         | $V_{CEsat}$ | max. | 0,25    | V       |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

See also Soldering recommendations.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      | PMBTA05     | PMBTA06            |
|---------------------------------------------------------------------------|-----------|------|-------------|--------------------|
| Collector-base voltage                                                    | $V_{CBO}$ | max. | 60          | 80 V               |
| Collector-emitter voltage (open base)                                     | $V_{CEO}$ | max. | 60          | 80 V               |
| Emitter-base voltage (open collector)                                     | $V_{EBO}$ | max. | 4           | V                  |
| Collector current (d.c.)                                                  | $I_C$     | max. | 500         | mA                 |
| Total power dissipation *<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250         | mW                 |
| Storage temperature                                                       | $T_{stg}$ |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150         | $^{\circ}\text{C}$ |

# THERMAL CHARACTERISTICS \*\*

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient

$$R_{th\ j-a} = 500\text{ K/W}$$

# CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                 |               |              | PMBTA05    | PMBTA06                        |
|-------------------------------------------------------------------------------------------------|---------------|--------------|------------|--------------------------------|
| Collector-emitter breakdown voltage ▲<br>$I_C = 1\text{ mA}; I_B = 0$                           | $V_{(BR)CEO}$ | min.         | 60         | 80 V                           |
| Emitter-base breakdown voltage<br>$I_C = 0; I_E = 100\text{ }\mu\text{A}$                       | $V_{(BR)EBO}$ | min.         | 4          | V                              |
| Collector cut-off current<br>$V_{CE} = 60\text{ V}; I_B = 0$                                    | $I_{CEO}$     | max.         | 0,1        | $\mu\text{A}$                  |
| Collector cut-off current<br>$V_{CB} = 60\text{ V}; I_E = 0$<br>$V_{CB} = 80\text{ V}; I_E = 0$ | $I_{CBO}$     | max.<br>max. | 0,1<br>0,1 | $\mu\text{A}$<br>$\mu\text{A}$ |
| Saturation voltages<br>$I_C = 100\text{ mA}; I_B = 10\text{ mA}$                                | $V_{CEsat}$   | max.         | 0,25       | V                              |
| Base-emitter on voltage<br>$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$                           | $V_{BE(on)}$  | max.         | 1,2        | V                              |
| D.C. current gain<br>$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                                  | $h_{FE}$      | min.         | 50         |                                |
| $I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$                                                      | $h_{FE}$      | min.         | 50         |                                |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}$       | $f_T$         | min.         | 100        | MHz                            |

\* Mounted on a ceramic substrate: area = 10 x 8 mm; thickness = 0,7 mm.

\*\* See Thermal characteristics.

▲ Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

## N-P-N SMALL-SIGNAL DARLINGTON TRANSISTORS

N-P-N small-signal darlington transistors in a microminiature SMD envelope (SOT-23).

Designed primarily for preamplifier input applications requiring high input impedance.

P-N-P complement is the PMBTA63/64.

### QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

$V_{CES}$  max. 30 V

Collector current (d.c.)

$I_C$  max. 300 mA

Total power dissipation

up to  $T_{amb} = 25^\circ\text{C}$

$P_{tot}$  max. 250 mW

Junction temperature

$T_j$  max.  $150^\circ\text{C}$

D.C. current gain

$$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$$

PMBTA13

$h_{FE}$  min. 5000

PMBTA14

$h_{FE}$  min. 10 000

Transition frequency at  $f = 100 \text{ MHz}$

$$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$$

$f_T$  min. 125 MHz

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

#### Pinning:

1 = base

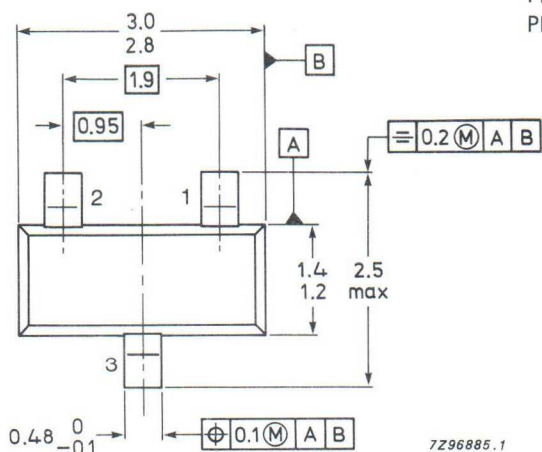
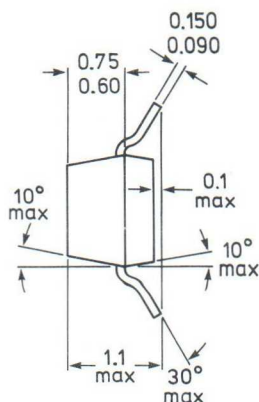
2 = emitter

3 = collector

#### Marking code

PMBTA13: p1M

PMBTA14: p1N



TOP VIEW

See also Soldering recommendations.



# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                         |
|---------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                     | $V_{CBO}$ | max. | 30 V                                    |
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $V_{CES}$ | max. | 30 V                                    |
| Emitter-base voltage (open collector)                                     | $V_{EBO}$ | max. | 10 V                                    |
| Collector current (d.c.)                                                  | $I_C$     | max. | 300 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 250 mW                                  |
| Storage temperature                                                       | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$                  |

# **THERMAL RESISTANCE**

|                           |               |  |         |
|---------------------------|---------------|--|---------|
| From junction to ambient* | $R_{th\ j-a}$ |  | 500 K/W |
|---------------------------|---------------|--|---------|

# **CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                           |                     |      |                   |
|-------------------------------------------------------------------------------------------|---------------------|------|-------------------|
| Collector-emitter breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}$                     | $V_{(BR)CES}$       | min. | 30 V              |
| Emitter-base cut-off current<br>$V_{BE} = 10\text{ V}$                                    | $I_{EBO}$           | max. | 0,1 $\mu\text{A}$ |
| Collector-base cut-off current<br>$V_{CB} = 30\text{ V}$                                  | $I_{CBO}$           | max. | 0,1 $\mu\text{A}$ |
| D.C. current gain<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$                            | PMBTA13<br>$h_{FE}$ | min. | 5000              |
|                                                                                           | PMBTA14<br>$h_{FE}$ | min. | 10 000            |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                                                | PMBTA13<br>$h_{FE}$ | min. | 10 000            |
|                                                                                           | PMBTA14<br>$h_{FE}$ | min. | 20 000            |
| Collector-emitter saturation voltage<br>$I_C = 100\text{ mA}; I_B = 0,1\text{ mA}$        | $V_{CEsat}$         | max. | 1,5 V             |
| Base-emitter ON-voltage<br>$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                     | $V_{BE(on)}$        | max. | 2,0 V             |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$ | $f_T$               | min. | 125 MHz           |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

# SILICON EPITAXIAL TRANSISTORS

N-P-N transistors in a microminiature (SMD) plastic envelope intended for surface mounted applications. They are primarily intended for use in telephony and professional communication equipment.

## QUICK REFERENCE DATA

|                                                            |           |      | PMBTA42 | PMBTA43          |
|------------------------------------------------------------|-----------|------|---------|------------------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ | max. | 300     | 200 V            |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. | 300     | 200 V            |
| Emitter-base voltage (open collector)                      | $V_{EBO}$ | max. |         | 6 V              |
| Collector current (DC)                                     | $I_C$     | max. | 500     | mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. | 250     | mW               |
| Junction temperature                                       | $T_j$     | max. | 150     | $^\circ\text{C}$ |
| D.C. current gain                                          |           |      |         |                  |
| $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$                 | $h_{FE}$  | min. | 40      |                  |
| Transition frequency at $f = 35\text{ MHz}$                |           |      |         |                  |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                 | $f_T$     | min. | 50      | MHz              |
| Feedback capacitance at $f = 1\text{ MHz}$                 |           |      |         |                  |
| $I_C = 0; V_{CE} = 20\text{ V}$                            | $C_{re}$  | max. | 3       | 4 pF             |

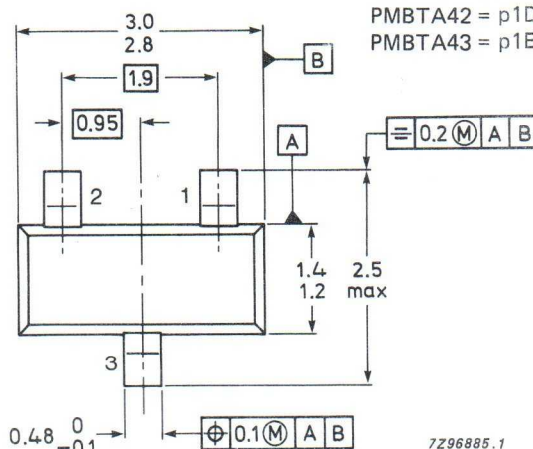
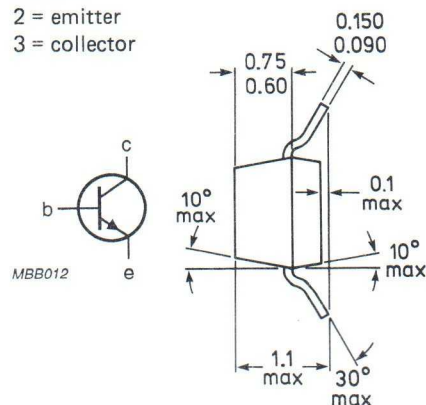
## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-23.

### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



TOP VIEW

See also Soldering recommendations.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                  |           |      | PMBTA42     | PMBTA43            |
|----------------------------------------------------------------------------------|-----------|------|-------------|--------------------|
| Collector-base voltage (open emitter)                                            | $V_{CBO}$ | max. | 300         | 200 V              |
| Collector-emitter voltage (open base)                                            | $V_{CEO}$ | max. | 300         | 200 V              |
| Emitter-base voltage (open collector)                                            | $V_{EBO}$ | max. | 6           | V                  |
| Collector current (DC)                                                           | $I_C$     | max. | 500         | mA                 |
| Total power dissipation (note 1)<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 250         | mW                 |
| Storage temperature                                                              | $T_{stg}$ |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                             | $T_j$     | max. | 150         | $^{\circ}\text{C}$ |

## THERMAL CHARACTERISTICS

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient

$$R_{th\ j-a} = 500 \text{ K/W}$$

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                   |               |              | PMBTA42  | PMBTA43                |
|---------------------------------------------------------------------------------------------------|---------------|--------------|----------|------------------------|
| Collector-emitter breakdown voltage (note 2)<br>$I_C = 1\text{ mA}; I_B = 0$                      | $V_{(BR)CEO}$ | min.         | 300      | 200 V                  |
| Collector-base breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}; I_E = 0$                       | $V_{(BR)CBO}$ | min.         | 300      | 200 V                  |
| Emitter-base breakdown voltage<br>$I_E = 100\text{ }\mu\text{A}; I_C = 0$                         | $V_{(BR)EBO}$ | min.         | 6        | 6 V                    |
| Collector cut-off current<br>$I_E = 0; V_{CB} = 200\text{ V}$<br>$I_E = 0; V_{CB} = 160\text{ V}$ | $I_{CBO}$     | max.<br>max. | 0,1<br>— | —<br>0,1 $\mu\text{A}$ |
| Emitter cut-off current<br>$I_C = 0; V_{BE} = 6\text{ V}$<br>$I_C = 0; V_{BE} = 4\text{ V}$       | $I_{EBO}$     | max.<br>max. | 0,1<br>— | —<br>0,1 $\mu\text{A}$ |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_E = 0; V_{CB} = 20\text{ V}$                     | $C_{re}$      | max.         | 3        | 4 pF                   |

## Notes

1. Mounted on a ceramic substrate: area = 2,5 cm<sup>2</sup>; thickness 0,7 mm.
2. Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ;  $\delta = 0,02$ .

## Saturation voltages

 $I_C = 20 \text{ mA}; I_B = 2 \text{ mA}$ 

|             |      |     |   |
|-------------|------|-----|---|
| $V_{CEsat}$ | max. | 0,5 | V |
| $V_{BEsat}$ | max. | 0,9 | V |

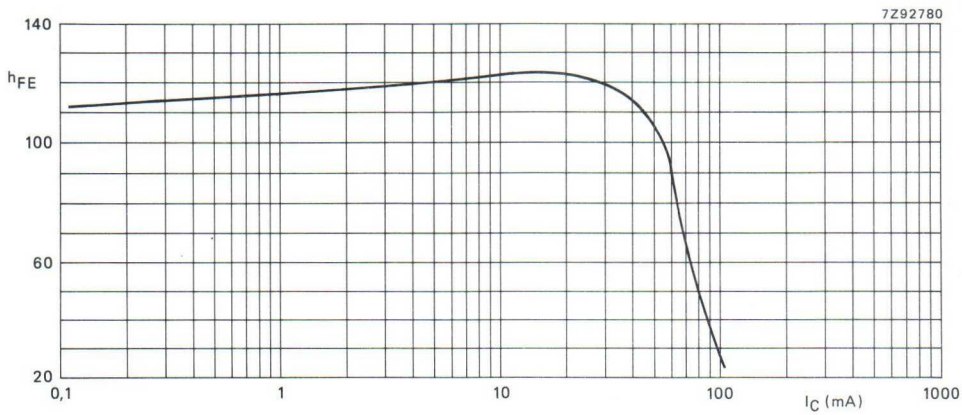
## D.C. current gain

 $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 30 \text{ mA}; V_{CE} = 10 \text{ V}$ 

|          |      |    |
|----------|------|----|
|          | min. | 25 |
| $h_{FE}$ | min. | 40 |
|          | min. | 40 |

Transition frequency at  $f = 100 \text{ MHz}$  $I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V}$ 

|       |      |    |     |
|-------|------|----|-----|
| $f_T$ | min. | 50 | MHz |
|-------|------|----|-----|

Fig. 2  $T_j = 25^\circ\text{C}; V_{CE} = 20 \text{ V}$ ; typical values.







## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                 |            |      | PMBTA55     | PMBTA56          |
|-----------------------------------------------------------------|------------|------|-------------|------------------|
| Collector-base voltage (open emitter)                           | $-V_{CBO}$ | max. | 60          | 80 V             |
| Collector-emitter voltage (open base)                           | $-V_{CEO}$ | max. | 60          | 80 V             |
| Emitter-base voltage (open collector)                           | $-V_{EBO}$ | max. | 4           | V                |
| Collector current (d.c.)                                        | $-I_C$     | max. | 500         | mA               |
| Total power dissipation *<br>up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 250         | mW               |
| Storage temperature                                             | $T_{stg}$  |      | -65 to +150 | $^\circ\text{C}$ |
| Junction temperature                                            | $T_j$      | max. | 150         | $^\circ\text{C}$ |

## THERMAL CHARACTERISTICS\*\*

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient

$$R_{th\ j-a} = 500 \text{ K/W}$$

## CHARACTERISTICS

$T_{amb} = 25^\circ\text{C}$  unless otherwise specified

|                                                                                                                      |                |              | PMBTA55    | PMBTA56                        |
|----------------------------------------------------------------------------------------------------------------------|----------------|--------------|------------|--------------------------------|
| Collector-emitter breakdown voltage▲<br>$-I_C = 1 \text{ mA}; I_B = 0$                                               | $-V_{(BR)CEO}$ | min.         | 60         | 80 V                           |
| Emitter-base breakdown voltage<br>$-I_C = 0; I_E = 100 \mu\text{A}$                                                  | $-V_{(BR)EBO}$ | min.         | 4          | V                              |
| Collector cut-off current<br>$-V_{CE} = 60 \text{ V}; I_B = 0$                                                       | $-I_{CEO}$     | max.         | 0,1        | $\mu\text{A}$                  |
| Collector cut-off current<br>$-V_{CB} = 60 \text{ V}; I_E = 0$<br>$-V_{CB} = 80 \text{ V}; I_E = 0$                  | $-I_{CBO}$     | max.<br>max. | 0,1<br>0,1 | $\mu\text{A}$<br>$\mu\text{A}$ |
| Saturation voltages<br>$-I_C = 100 \text{ mA}; -I_B = 10 \text{ mA}$                                                 | $-V_{CEsat}$   | max.         | 0,25       | V                              |
| Base-emitter on voltage<br>$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$                                            | $-V_{BE(on)}$  | max.         | 1,2        | V                              |
| D.C. current gain<br>$-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$<br>$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$ | $h_{FE}$       | min.<br>min. | 50<br>50   |                                |
| Transition frequency at $f = 100 \text{ MHz}$<br>$-I_C = 100 \text{ mA}; -V_{CE} = 1 \text{ V}$                      | $f_T$          | min.         | 50         | MHz                            |

\* Mounted on a ceramic substrate: area =  $10 \times 8 \text{ mm}$ ; thickness =  $0,7 \text{ mm}$ .

\*\* See Thermal characteristics.

▲ Pulse test conditions:  $t_p = 300 \mu\text{s}$ ; duty cycle  $\leq 2\%$ .

## P-N-P SMALL-SIGNAL DARLINGTON TRANSISTORS

P-N-P small-signal darlington transistors in a microminiature SMD envelope (SOT-23).  
Designed primarily for preamplifier input applications requiring high input impedance.  
N-P-N complement is the PMBTA13/14.

### QUICK REFERENCE DATA

|                                                                                              |                    |          |                          |
|----------------------------------------------------------------------------------------------|--------------------|----------|--------------------------|
| Collector-emitter voltage<br>$V_{BE} = 0$                                                    | $-V_{CES}$         | max.     | 30 V                     |
| Collector current (d.c.)                                                                     | $-I_C$             | max.     | 500 mA                   |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                      | $P_{tot}$          | max.     | 250 mW                   |
| Junction temperature                                                                         | $T_j$              | max.     | 150 $^{\circ}\text{C}$   |
| D.C. current gain<br>$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$                             | PMBTA63<br>PMBTA64 | $h_{FE}$ | min. 5000<br>min. 10 000 |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 50\text{ V}$ |                    | $f_T$    | min. 125 MHz             |

### MECHANICAL DATA

Dimensions in mm

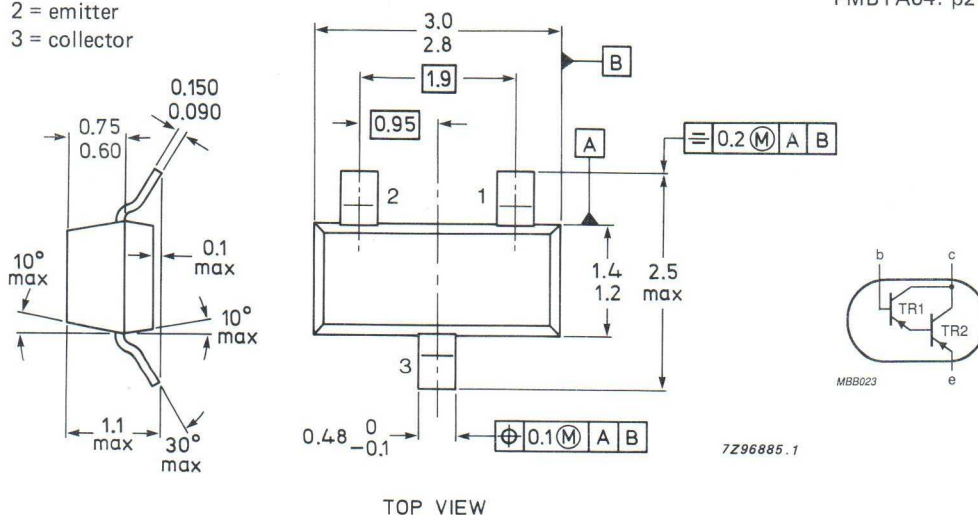
Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector

#### Marking code

PMBTA63: p2U  
PMBTA64: p2V



See also Soldering recommendations.

# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                         |
|---------------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                     | $-V_{CBO}$ | max. | 30 V                                    |
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $-V_{CES}$ | max. | 30 V                                    |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 10 V                                    |
| Collector current (d.c.)                                                  | $-I_C$     | max. | 500 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$  | max. | 250 mW                                  |
| Storage temperature                                                       | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | 150 $^{\circ}\text{C}$                  |

# **THERMAL RESISTANCE**

|                           |               |  |         |
|---------------------------|---------------|--|---------|
| From junction to ambient* | $R_{th\ j-a}$ |  | 500 K/W |
|---------------------------|---------------|--|---------|

# **CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                                    |                     |      |                   |
|------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|-------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}$                                                             | $-V_{(BR)CES}$      | min. | 30 V              |
| Emitter-base cut-off current<br>$-V_{BE} = 10\text{ V}$                                                                            | $-I_{EBO}$          | max. | 0,1 $\mu\text{A}$ |
| Collector-base cut-off current<br>$-V_{CB} = 30\text{ V}$                                                                          | $-I_{CBO}$          | max. | 0,1 $\mu\text{A}$ |
| D.C. current gain<br>$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$                                                                   | PMBTA63<br>$h_{FE}$ | min. | 5000              |
|                                                                                                                                    | PMBTA64<br>$h_{FE}$ | min. | 10 000            |
| $-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                                                                       | PMBTA63<br>$h_{FE}$ | min. | 10 000            |
|                                                                                                                                    | PMBTA64<br>$h_{FE}$ | min. | 20 000            |
| Collector-emitter saturation voltage<br>$-I_C = 100\text{ mA}; -I_B = 0,1\text{ mA}$                                               | $-V_{CEsat}$        | max. | 1,5 V             |
| Base-emitter ON-voltage<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                                            | $-V_{BE(on)}$       | max. | 2,0 V             |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 50\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $f_T$               | min. | 125 MHz           |

\* Mounted on a ceramic substrate of 8 mm x 10 mm x 0,7 mm.

## SILICON EPITAXIAL TRANSISTORS

P-N-P transistors in a microminiature (SMD) plastic envelope intended for surface mounted applications. They are primarily intended for use in telephony and professional communication equipment.

### QUICK REFERENCE DATA

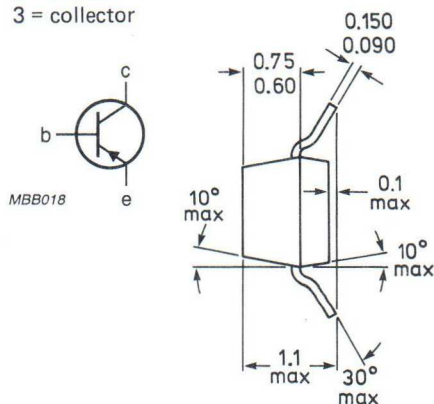
|                                                            |            |      | PMBTA92 | PMBTA93 |
|------------------------------------------------------------|------------|------|---------|---------|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ | max. | 300     | 200 V   |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ | max. | 300     | 200 V   |
| Emitter-base voltage (open collector)                      | $-V_{EBO}$ | max. | 5       | V       |
| Collector current (d.c.)                                   | $-I_C$     | max. | 500     | mA      |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 250     | mW      |
| D.C. current gain                                          |            |      |         |         |
| $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$               | $h_{FE}$   | min. | 40      |         |
| Transition frequency at $f = 100\text{ MHz}$               |            |      |         |         |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$               | $f_T$      | min. | 50      | MHz     |
| Collector-base capacitance at $f = 1\text{ MHz}$           |            |      |         |         |
| $I_E = 0; -V_{CB} = 20\text{ V}$                           | $C_{cb}$   | max. | 6       | 8 pF    |

### MECHANICAL DATA

Fig. 1 SOT-23.

#### Pinning:

- 1 = base
- 2 = emitter
- 3 = collector



Dimensions in mm

Marking code

PMBTA92 : p2D

PMBTA93 : p2E

TOP VIEW

See also Soldering recommendations.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      | PMBTA92     | PMBTA93            |
|---------------------------------------------------------------------------|------------|------|-------------|--------------------|
| Collector-base voltage (open emitter)                                     | $-V_{CBO}$ | max. | 300         | 200 V              |
| Collector-emitter voltage (open base)                                     | $-V_{CEO}$ | max. | 300         | 200 V              |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 5           | V                  |
| Collector current (d.c.)                                                  | $-I_C$     | max. | 500         | mA                 |
| Total power dissipation *<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 250         | mW                 |
| Storage temperature                                                       | $T_{stg}$  |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | 150         | $^{\circ}\text{C}$ |

## THERMAL CHARACTERISTICS \*\*

$$T_j = P (R_{th\ j-t} + R_{th\ t-s} + R_{th\ s-a}) + T_{amb}$$

Thermal resistance

from junction to ambient\*

|               |   |     |     |
|---------------|---|-----|-----|
| $R_{th\ j-a}$ | = | 500 | K/W |
|---------------|---|-----|-----|

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                                                                    |                                  |                      | PMBTA92        | PMBTA93                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------|----------------|---------------------------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 1\text{ mA}; I_B = 0$                                                                                               | $-V_{(BR)CEO}$                   | min.                 | 300            | 200 V                                 |
| Collector-base breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}; I_E = 0$                                                                                       | $-V_{(BR)CBO}$                   | min.                 | 300            | 200 V                                 |
| Collector cut-off current<br>$-V_{CB} = 200\text{ V}; I_E = 0$<br>$-V_{CB} = 160\text{ V}; I_E = 0$                                                                | $-I_{CBO}$                       | max.<br>max.         | 0,25<br>—      | — $\mu\text{A}$<br>0,25 $\mu\text{A}$ |
| Emitter-base breakdown voltage<br>$-I_E = 100\text{ }\mu\text{A}; I_C = 0$                                                                                         | $-V_{(BR)EBO}$                   | min.                 | 5              | V                                     |
| Emitter cut-off current<br>$I_C = 0; -V_{BE} = 3\text{ V}$                                                                                                         | $-I_{EBO}$                       | max.                 | 0,1            | $\mu\text{A}$                         |
| Collector-base capacitance<br>at $f = 1\text{ MHz};$<br>$I_E = 0; -V_{CB} = 20\text{ V}$                                                                           | $C_{cb}$                         | max.                 | 6              | 8 pF                                  |
| Saturation voltages<br>$-I_C = 20\text{ mA}; -I_B = 2\text{ mA}$<br>$-I_C = 20\text{ mA}; -I_B = 2\text{ mA}$                                                      | $-V_{CEsat}$<br>$-V_{BEsat}$     | max.<br>max.         | 0,5<br>0,9     | V<br>V                                |
| D.C. current gain ▲<br>$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$<br>$-I_C = 30\text{ mA}; -V_{CE} = 10\text{ V}$ | $h_{FE}$<br>$h_{FE}$<br>$h_{FE}$ | min.<br>min.<br>min. | 25<br>40<br>25 |                                       |

\* Mounted on a ceramic substrate: area =  $10 \times 8\text{ mm}$ ; thickness =  $0,7\text{ mm}$ .

\*\* See Thermal characteristics.

▲ Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

# DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PMBZ 5226B  
to  
PMBZ 5257B

SUPERSEDES DATA OF NOVEMBER 1988

## SILICON PLANAR VOLTAGE REGULATOR DIODES

Low power general purpose voltage regulator diodes in a microminiature plastic envelope intended for application in thick and thin film circuits. The series covers the range of nominal working voltages from 3.3 to 33 V with a working voltage tolerance of  $\pm 5\%$ .

### QUICK REFERENCE DATA

|                                                            |           |                           |
|------------------------------------------------------------|-----------|---------------------------|
| Working voltage range                                      | $V_Z$     | nom. 3.3 to 33 V          |
| Working voltage tolerance                                  |           | $\pm 5\%$                 |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. 300 mW               |
| Junction temperature                                       | $T_j$     | max. 150 $^\circ\text{C}$ |

### MECHANICAL DATA

Dimensions in mm

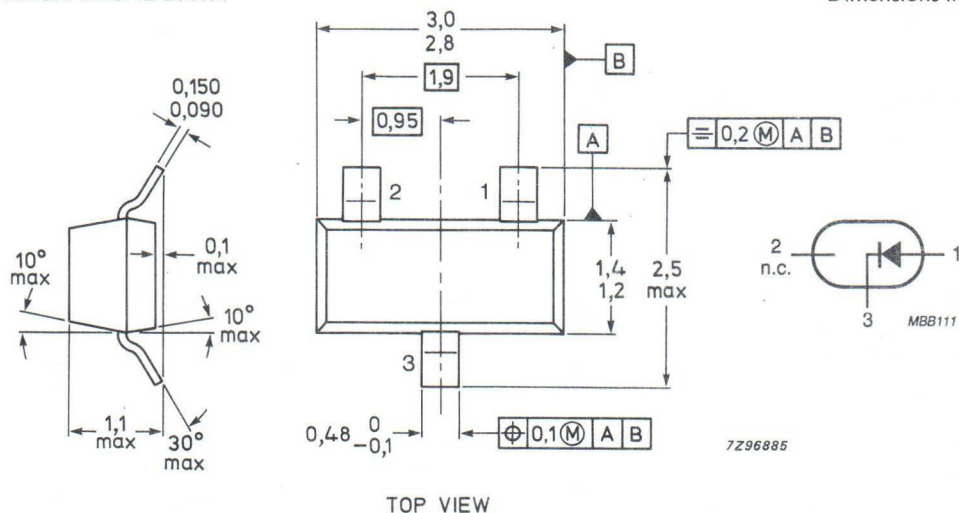


Fig.1 SOT23.

### Marking code

PMBZ 5226B = 8A  
PMBZ 5227B = 8B  
PMBZ 5228B = 8C  
PMBZ 5229B = 8D  
PMBZ 5230B = 8E  
PMBZ 5231B = 8F  
PMBZ 5232B = 8G  
PMBZ 5233B = 8H  
PMBZ 5234B = 8J  
PMBZ 5235B = 8K  
PMBZ 5236B = 8L  
PMBZ 5237B = 8M

PMBZ 5238B = 8N  
PMBZ 5239B = 8P  
PMBZ 5240B = 8Q  
PMBZ 5241B = 8R  
PMBZ 5242B = 8S  
PMBZ 5243B = 8T  
PMBZ 5244B = 8U  
PMBZ 5245B = 8V  
PMBZ 5246B = 8W  
PMBZ 5247B = 8X  
PMBZ 5248B = 8Y  
PMBZ 5249B = 8Z

PMBZ 5250B = 81A  
PMBZ 5251B = 81B  
PMBZ 5252B = 81C  
PMBZ 5253B = 81D  
PMBZ 5254B = 81E  
PMBZ 5255B = 81F  
PMBZ 5256B = 81G  
PMBZ 5257B = 81H

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                        |           |      |                                         |
|------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Repetitive peak forward current                                        | $I_{FRM}$ | max. | 250 mA                                  |
| Repetitive peak working current                                        | $I_{ZRM}$ | max. | 250 mA                                  |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 300 mW                                  |
| Storage temperature                                                    | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                   | $T_j$     | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL CHARACTERISTICS

Thermal resistance

from junction to ambient

$$R_{th\ j-a} = 420\text{ K/W}$$

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise stated

Forward voltage

$I_F = 200\text{ mA}$

$$V_F \text{ max. } 1.1\text{ V}$$

| type<br>number | working<br>voltage<br>$V_Z$<br>(V)<br>at $I_{Ztest}$<br>(note 1)<br>nom. | test<br>current<br>$I_{Ztest}$<br>(mA) | max. Zener<br>impedance<br>$Z_{ZT}$<br>( $\Omega$ )<br>at $I_{Ztest}$<br>(note 2) | differential<br>resistance<br>$r_{diff}$<br>( $\Omega$ )<br>at $I_{ZK} =$<br>$0.25\text{ mA}$<br>(note 2)<br>max. | reverse<br>current<br>$I_R$<br>( $\mu\text{A}$ )<br>at $V_R$<br>max. | test<br>voltage<br>$V_R$<br>(V) | temp.<br>coeff.<br>$S_Z$<br>(%/K)<br>(note 3)<br>typ. |
|----------------|--------------------------------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------|-------------------------------------------------------|
| PMBZ 5226B     | 3.3                                                                      | 20                                     | 28                                                                                | 1600                                                                                                              | 25                                                                   | 1.0                             | -0.064                                                |
| PMBZ 5227B     | 3.6                                                                      | 20                                     | 26                                                                                | 1700                                                                                                              | 15                                                                   | 1.0                             | -0.065                                                |
| PMBZ 5228B     | 3.9                                                                      | 20                                     | 25                                                                                | 1900                                                                                                              | 10                                                                   | 1.0                             | -0.063                                                |
| PMBZ 5229B     | 4.3                                                                      | 20                                     | 22                                                                                | 2000                                                                                                              | 5                                                                    | 1.0                             | -0.058                                                |
| PMBZ 5230B     | 4.7                                                                      | 20                                     | 19                                                                                | 2000                                                                                                              | 5                                                                    | 1.0                             | -0.047                                                |
| PMBZ 5231B     | 5.1                                                                      | 20                                     | 17                                                                                | 2000                                                                                                              | 5                                                                    | 2.0                             | -0.013                                                |
| PMBZ 5232B     | 5.6                                                                      | 20                                     | 11                                                                                | 1600                                                                                                              | 5                                                                    | 3.0                             | +0.023                                                |
| PMBZ 5233B     | 6.0                                                                      | 20                                     | 7                                                                                 | 1600                                                                                                              | 5                                                                    | 3.5                             | +0.023                                                |
| PMBZ 5234B     | 6.2                                                                      | 20                                     | 7                                                                                 | 1000                                                                                                              | 5                                                                    | 4.0                             | +0.039                                                |
| PMBZ 5235B     | 6.8                                                                      | 20                                     | 5                                                                                 | 750                                                                                                               | 3                                                                    | 5.0                             | +0.040                                                |
| PMBZ 5236B     | 7.5                                                                      | 20                                     | 6                                                                                 | 500                                                                                                               | 3                                                                    | 6.0                             | +0.047                                                |
| PMBZ 5237B     | 8.2                                                                      | 20                                     | 8                                                                                 | 500                                                                                                               | 3                                                                    | 6.5                             | +0.052                                                |
| PMBZ 5238B     | 8.7                                                                      | 20                                     | 8                                                                                 | 600                                                                                                               | 3                                                                    | 6.5                             | +0.053                                                |
| PMBZ 5239B     | 9.1                                                                      | 20                                     | 10                                                                                | 600                                                                                                               | 3                                                                    | 7.0                             | +0.055                                                |
| PMBZ 5240B     | 10                                                                       | 20                                     | 17                                                                                | 600                                                                                                               | 3                                                                    | 8.0                             | +0.055                                                |
| PMBZ 5241B     | 11                                                                       | 20                                     | 22                                                                                | 600                                                                                                               | 2                                                                    | 8.4                             | +0.058                                                |
| PMBZ 5242B     | 12                                                                       | 20                                     | 30                                                                                | 600                                                                                                               | 1                                                                    | 9.1                             | +0.062                                                |
| PMBZ 5243B     | 13                                                                       | 9.5                                    | 13                                                                                | 600                                                                                                               | 0.5                                                                  | 9.9                             | +0.065                                                |
| PMBZ 5244B     | 14                                                                       | 9.0                                    | 15                                                                                | 600                                                                                                               | 0.1                                                                  | 10                              | +0.067                                                |

\* Device mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.

| type<br>number | working<br>voltage<br>$V_Z$<br>(V)<br>at $I_{Ztest}$<br><br>(note 1)<br>nom. | test<br>current<br>$I_{Ztest}$<br>(mA) | max. Zener<br>impedance<br>$Z_{ZT}$<br>( $\Omega$ )<br>at $I_{Ztest}$<br><br>(note 2) | differential<br>resistance<br>$r_{diff}$<br>( $\Omega$ )<br>at $I_{ZK} =$<br>0.25 mA<br>(note 2)<br>max. | reverse<br>current<br>$I_R$<br>( $\mu A$ )<br>at $V_R$<br><br>max. | test<br>voltage<br>$V_R$<br>(V) | temp.<br>coeff.<br>$S_Z$<br>(%/K)<br><br>(note 3)<br>(typ.) |
|----------------|------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------------------------|-------------------------------------------------------------|
| PMBZ 5245B     | 15                                                                           | 8.5                                    | 16                                                                                    | 600                                                                                                      | 0.1                                                                | 11                              | +0.073                                                      |
| PMBZ 5246B     | 16                                                                           | 7.8                                    | 17                                                                                    | 600                                                                                                      | 0.1                                                                | 12                              | +0.073                                                      |
| PMBZ 5247B     | 17                                                                           | 7.4                                    | 19                                                                                    | 600                                                                                                      | 0.1                                                                | 13                              | +0.073                                                      |
| PMBZ 5248B     | 18                                                                           | 7.0                                    | 21                                                                                    | 600                                                                                                      | 0.1                                                                | 14                              | +0.078                                                      |
| PMBZ 5249B     | 19                                                                           | 6.6                                    | 23                                                                                    | 600                                                                                                      | 0.1                                                                | 14                              | +0.078                                                      |
| PMBZ 5250B     | 20                                                                           | 6.2                                    | 25                                                                                    | 600                                                                                                      | 0.1                                                                | 15                              | +0.080                                                      |
| PMBZ 5251B     | 22                                                                           | 5.6                                    | 29                                                                                    | 600                                                                                                      | 0.1                                                                | 17                              | +0.080                                                      |
| PMBZ 5252B     | 24                                                                           | 5.2                                    | 33                                                                                    | 600                                                                                                      | 0.1                                                                | 18                              | +0.081                                                      |
| PMBZ 5253B     | 25                                                                           | 5.0                                    | 35                                                                                    | 600                                                                                                      | 0.1                                                                | 19                              | +0.082                                                      |
| PMBZ 5254B     | 27                                                                           | 4.6                                    | 41                                                                                    | 600                                                                                                      | 0.1                                                                | 21                              | +0.085                                                      |
| PMBZ 5255B     | 28                                                                           | 4.5                                    | 44                                                                                    | 600                                                                                                      | 0.1                                                                | 21                              | +0.085                                                      |
| PMBZ 5256B     | 30                                                                           | 4.2                                    | 49                                                                                    | 600                                                                                                      | 0.1                                                                | 23                              | +0.085                                                      |
| PMBZ 5257B     | 33                                                                           | 3.8                                    | 58                                                                                    | 700                                                                                                      | 0.1                                                                | 25                              | +0.085                                                      |

## Notes

- $V_Z$  is measured with device at thermal equilibrium while mounted on a ceramic substrate of 8 mm x 10 mm x 0.7 mm.
- $I_{(ac\ rms)}$  = 10% of  $I_{Ztest}$  resp.  $I_{ZK}$ ; 1 kHz superimposed; thermal equilibrium see note 1.
- For types PMBZ 5226B to PMBZ 5242B the current  $I_Z = 7.5$  mA; for PMBZ 5243B and higher  $I_Z = I_{Ztest}$ . Testpoints at  $T_1 = 25^\circ C$ ,  $T_2 = 125^\circ C$ .



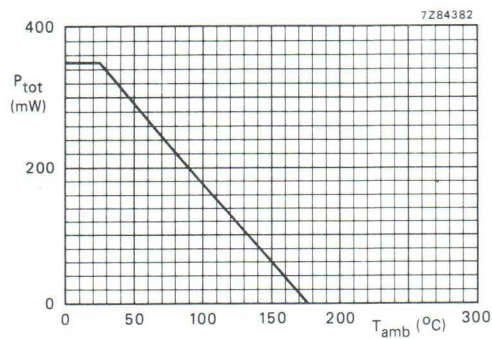


Fig. 2 Power derating curve.

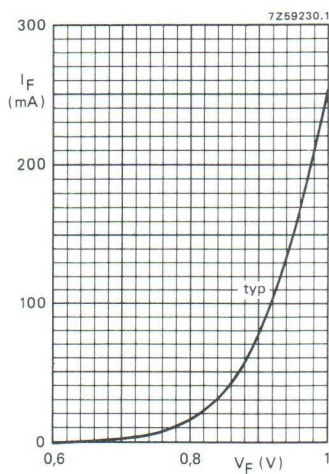


Fig. 3 Typical values at  $T_j = 25^{\circ}C$ .  
Forward current as a function of forward voltage.



## HIGH-SPEED SILICON DIODES FOR SURFACE MOUNTING

These diodes are primarily designed for fast logic applications.

These SM diodes are leadless diodes in a hermetically sealed SOD-80 envelope with tin-plated metal discs at each end. They are suitable for "automatic placement" and as such it can withstand immersion soldering.

The diodes can be delivered in "super 8" tape.

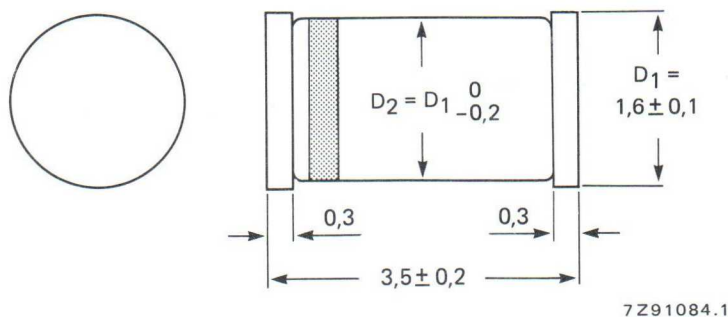
### QUICK REFERENCE DATA

|                                                                                                                                                       |           |      |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|--------|
| Continuous reverse voltage                                                                                                                            | $V_R$     | max. | 75 V   |
| Repetitive peak reverse voltage                                                                                                                       | $V_{RRM}$ | max. | 75 V   |
| Repetitive peak forward current                                                                                                                       | $I_{FRM}$ | max. | 450 mA |
| Forward voltage                                                                                                                                       | $V_F$     | <    | 1 V    |
| PMLL4148: $I_F = 10 \text{ mA}$<br>PMLL4446: $I_F = 20 \text{ mA}$<br>PMLL4448: $I_F = 100 \text{ mA}$                                                |           |      |        |
| Reverse recovery time when switched<br>from $I_F = 10 \text{ mA}$ to $I_R = 60 \text{ mA}$ ;<br>$R_L = 100 \Omega$ ; measured at $I_R = 1 \text{ mA}$ | $t_{rr}$  | <    | 4 ns   |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-80.



Cathode indicated by black band.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                      |             |      |                         |
|------------------------------------------------------|-------------|------|-------------------------|
| Continuous reverse voltage                           | $V_R$       | max. | 75 V                    |
| Repetitive peak reverse voltage                      | $V_{RRM}$   | max. | 75 V                    |
| Average rectified forward current                    | $I_{F(AV)}$ | max. | 150 mA                  |
| Forward current (d.c.)                               | $I_F$       | max. | 200 mA                  |
| Repetitive peak forward current                      | $I_{FRM}$   | max. | 450 mA                  |
| Non-repetitive peak forward current                  |             |      |                         |
| $t = 1 \mu s$                                        | $I_{FSM}$   | max. | 2000 mA                 |
| $t = 1 s$                                            | $I_{FSM}$   | max. | 500 mA                  |
| Total power dissipation up to $T_{amb} = 25^\circ C$ | $P_{tot}$   | max. | 500 mW                  |
| Derating factor                                      |             |      | 2,85 mW/K               |
| Storage temperature                                  | $T_{stg}$   |      | $-65$ to $+200^\circ C$ |
| Junction temperature                                 | $T_j$       | max. | $200^\circ C$           |

## CHARACTERISTICS

$T_j = 25^\circ C$  unless otherwise specified

Forward voltages

PMLL4148:  $I_F = 10$  mA  
PMLL4446:  $I_F = 20$  mA  
PMLL4448:  $I_F = 100$  mA  
PMLL4448:  $I_F = 5$  mA

|       |   |                |
|-------|---|----------------|
| $V_F$ | < | 1 V            |
| $V_F$ |   | 0,62 to 0,72 V |

Reverse avalanche breakdown voltage

$I_R = 100 \mu A$   
 $I_R = 5 \mu A$

|             |   |       |
|-------------|---|-------|
| $V_{(BR)R}$ | > | 100 V |
| $V_{(BR)R}$ | > | 75 V  |

Reverse currents

$V_R = 20$  V  
 $V_R = 20$  V;  $T_j = 100^\circ C$   
 $V_R = 20$  V;  $T_j = 150^\circ C$

PMLL4448

|       |   |            |
|-------|---|------------|
| $I_R$ | < | 25 nA      |
| $I_R$ | < | 3 $\mu A$  |
| $I_R$ | < | 50 $\mu A$ |

Diode capacitance

$V_R = 0$ ;  $f = 1$  MHz

|       |   |      |
|-------|---|------|
| $C_d$ | < | 4 pF |
|-------|---|------|

Forward recovery voltage when switched

to  $I_F = 50$  mA;  $t_r = 20$  ns

|          |   |       |
|----------|---|-------|
| $V_{fr}$ | < | 2,5 V |
|----------|---|-------|

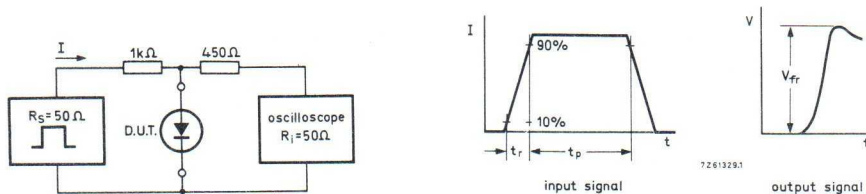


Fig. 2 Forward recovery voltage test circuit and waveforms.

Input signal: Rise time of the forward pulse  $t_r = 20 \text{ ns}$   
 Forward current pulse duration  $t_p = 120 \text{ ns}$   
 Duty factor  $\delta = 0,01$

Oscilloscope: Rise time  $t_r = 0,35 \text{ ns}$

Circuit capacitance  $C \leq 1 \text{ pF}$  ( $C = \text{oscilloscope input capacitance} + \text{parasitic capacitance}$ )

Reverse recovery time when switched from  
 $I_F = 10 \text{ mA}$  to  $I_R = 10 \text{ mA}$ ;  $R_L = 100 \Omega$ ;  
 measured at  $I_R = 1 \text{ mA}$

$$t_{rr} < 4 \text{ ns}$$

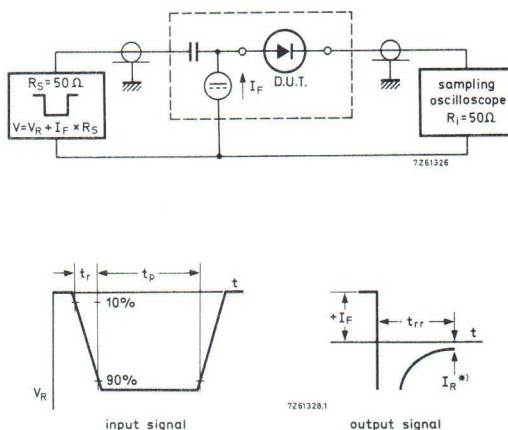


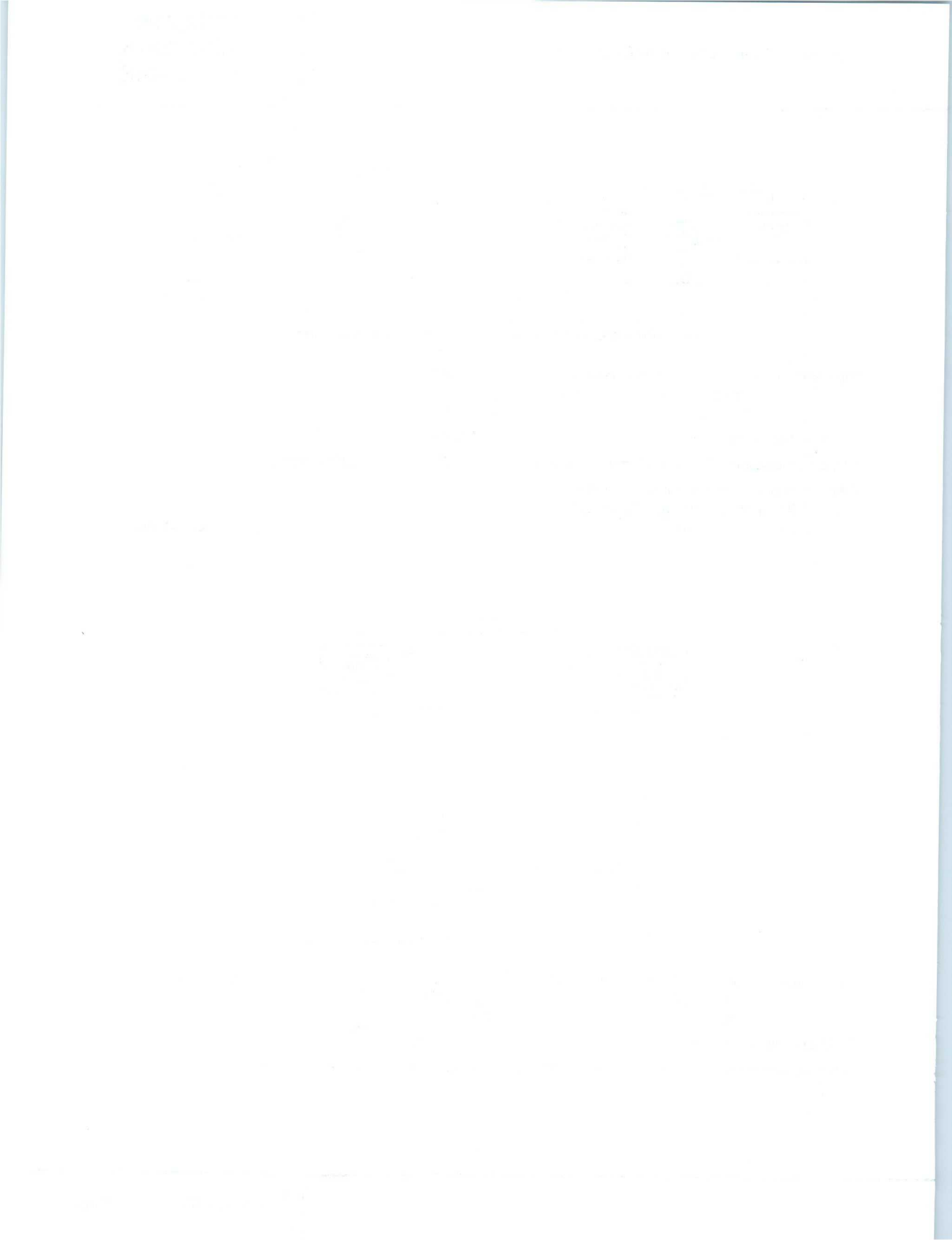
Fig. 3 Reverse recovery time test circuit and waveforms.

Input signal: Rise time of the reverse pulse  $t_r = 0,6 \text{ ns}$   
 Reverse pulse duration  $t_p = 100 \text{ ns}$   
 Duty factor  $\delta = 0,05$

\*  $I_R = 1 \text{ mA}$

Oscilloscope: Rise time  $t_r = 0,35 \text{ ns}$

Circuit capacitance  $C \leq 1 \text{ pF}$  ( $C = \text{oscilloscope input capacitance} + \text{parasitic capacitance}$ )



# ULTRA-HIGH-SPEED SILICON DIODES FOR SURFACE MOUNTING

Whiskerless diodes in SOD-80 envelopes.

The PMLL4150 is primarily intended for general purpose use in computer and industrial applications.  
 The PMLL4151 and PMLL4153 are intended for military and industrial applications.

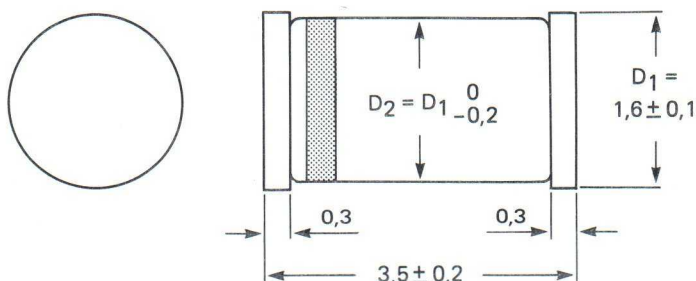
## QUICK REFERENCE DATA

|                                                                         |           |      | PMLL4150 | 4151 | 4153   |
|-------------------------------------------------------------------------|-----------|------|----------|------|--------|
| Continuous reverse voltage                                              | $V_R$     | max. | 50       | 50   | 50 V   |
| Repetitive peak reverse voltage                                         | $V_{RRM}$ | max. | —        | 75   | 75 V   |
| Repetitive peak forward current                                         | $I_{FRM}$ | max. | 0,60     | 0,45 | 0,45 A |
| Non-repetitive peak forward current                                     |           |      |          |      |        |
| $t = 1 \mu s$                                                           | $I_{FSM}$ | max. | 4,0      | —    | — A    |
| $t = 1 s$                                                               | $I_{FSM}$ | max. | 0,5      | —    | — A    |
| Forward voltage                                                         |           |      |          |      |        |
| $I_F = 20 \text{ mA}$                                                   | $V_F$     | <    | —        | —    | 0,88 V |
| $I_F = 50 \text{ mA}$                                                   | $V_F$     | <    | —        | 1    | — V    |
| $I_F = 200 \text{ mA}$                                                  | $V_F$     | <    | 1        | —    | — V    |
| Reverse recovery time when switched from                                |           |      |          |      |        |
| $I_F = 400 \text{ mA}$ to $I_R = 400 \text{ mA}$ ; $R_L = 100 \Omega$ ; |           |      |          |      |        |
| measured at $I_R = 40 \text{ mA}$                                       | $t_{rr}$  | <    | 6        | —    | — ns   |
| $I_F = 10 \text{ mA}$ to $I_R = 10 \text{ mA}$ ; $R_L = 100 \Omega$ ;   |           |      |          |      |        |
| measured at $I_R = 1 \text{ mA}$                                        | $t_{rr}$  | <    | —        | 4    | 4 ns   |

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-80.



7Z91084.1

Cathode indicated by black band.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                       |           | PMLL4150     | 4151 | 4153       |
|-------------------------------------------------------|-----------|--------------|------|------------|
| Continuous reverse voltage                            | $V_R$     | max. 50      | 50   | 50 V       |
| Repetitive peak reverse voltage                       | $V_{RRM}$ | max. —       | 75   | 75 V       |
| Forward current (d.c.)                                | $I_F$     | max. 0,30    | 0,20 | 0,20 A     |
| Repetitive peak forward current                       | $I_{FRM}$ | max. 0,60    | 0,45 | 0,45 A     |
| Non-repetitive peak forward current                   |           |              |      |            |
| $t = 1 \mu s$                                         | $I_{FSM}$ | max. 4,0     | —    | — A        |
| $t = 1 s$                                             | $I_{FSM}$ | max. 0,5     | —    | — A        |
| Total power dissipation up to $T_{amb} = 25 ^\circ C$ | $P_{tot}$ | max.         | 500  | mW         |
| Derating factor                                       |           |              | 2,85 | mW/K       |
| Storage temperature                                   | $T_{stg}$ | —65 to + 200 |      | $^\circ C$ |
| Junction temperature                                  | $T_j$     | max.         | 200  | $^\circ C$ |

## CHARACTERISTICS

$T_j = 25 ^\circ C$  unless otherwise specified

|                                              |             | PMLL4150                       | 4151   | 4153             |
|----------------------------------------------|-------------|--------------------------------|--------|------------------|
| Forward voltage                              |             |                                |        |                  |
| $I_F = 0,1 \text{ mA}$                       | $V_F$       | $> \text{ —}$<br>$< \text{ —}$ | —      | 0,49 V<br>0,55 V |
| $I_F = 0,25 \text{ mA}$                      | $V_F$       | $> \text{ —}$<br>$< \text{ —}$ | —      | 0,53 V<br>0,59 V |
| $I_F = 1 \text{ mA}$                         | $V_F$       | $> 0,54$<br>$< 0,62$           | —      | 0,59 V<br>0,67 V |
| $I_F = 2 \text{ mA}$                         | $V_F$       | $> \text{ —}$<br>$< \text{ —}$ | —      | 0,62 V<br>0,70 V |
| $I_F = 10 \text{ mA}$                        | $V_F$       | $> 0,66$<br>$< 0,74$           | —      | 0,70 V<br>0,81 V |
| $I_F = 20 \text{ mA}$                        | $V_F$       | $> \text{ —}$<br>$< \text{ —}$ | —      | 0,74 V<br>0,88 V |
| $I_F = 50 \text{ mA}$                        | $V_F$       | $> 0,76$<br>$< 0,86$           | —<br>1 | — V<br>— V       |
| $I_F = 100 \text{ mA}$                       | $V_F$       | $> 0,82$<br>$< 0,92$           | —      | — V<br>— V       |
| $I_F = 200 \text{ mA}$                       | $V_F$       | $> 0,87$<br>$< 1,00$           | —      | — V<br>— V       |
| Reverse avalanche breakdown voltage          |             |                                |        |                  |
| $I_R = 5 \mu A$                              | $V_{(BR)R}$ | $> \text{ —}$                  | 75     | 75 V             |
| Reverse current                              |             |                                |        |                  |
| $V_R = 50 \text{ V}$                         | $I_R$       | $< 0,1$                        | 0,05   | 0,05 $\mu A$     |
| $V_R = 50 \text{ V}; T_{amb} = 150 ^\circ C$ | $I_R$       | $< 100$                        | 50     | 50 $\mu A$       |

Diode capacitance

$$V_R = 0; f = 1 \text{ MHz}$$

|                                                                                                                                                                                         | PMLL4150     | 4151 | 4153 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------|------|
| $C_D$                                                                                                                                                                                   | < 2,5        | 2    | 2 pF |
| Reverse recovery time when switched from<br>$I_F = 10 \text{ to } 200 \text{ mA}$ to $I_R = 10 \text{ to } 200 \text{ mA}$ ;<br>$R_L = 100 \Omega$ ; measured at $I_R = 0,1 \times I_F$ | $t_{rr} < 4$ | —    | — ns |
| $I_F = 200 \text{ to } 400 \text{ mA}$ to $I_R = 200 \text{ to } 400 \text{ mA}$ ;<br>$R_L = 100 \Omega$ ; measured at $I_R = 0,1 \times I_F$                                           | $t_{rr} < 6$ | —    | — ns |
| $I_F = 10 \text{ mA}$ to $I_R = 1 \text{ mA}$ ; $R_L = 100 \Omega$ ;<br>measured at $I_R = 0,1 \text{ mA}$                                                                              | $t_{rr} < 6$ | —    | — ns |
| $I_F = 10 \text{ mA}$ to $I_R = 10 \text{ mA}$ ; $R_L = 100 \Omega$ ;<br>measured at $I_R = 1 \text{ mA}$                                                                               | $t_{rr} < —$ | 4    | 4 ns |
| $I_F = 10 \text{ mA}$ to $I_R = 60 \text{ mA}$ ; $R_L = 100 \Omega$ ;<br>measured at $I_R = 1 \text{ mA}$                                                                               | $t_{rr} < —$ | 2    | 2 ns |

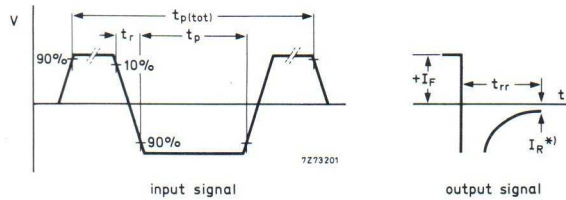
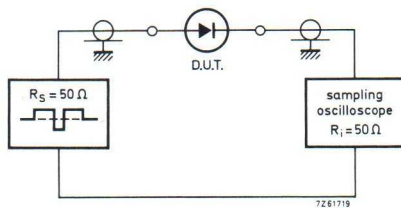
\*) value at which  $t_{rr}$  is measured

Fig. 2 Test circuit and waveforms.

Input signal: Total pulse duration  $t_p(\text{tot}) = 0,2 \mu\text{s}$   
 Duty factor  $\delta = 0,0025$   
 Rise time of the reverse pulse  $t_r = 0,6 \text{ ns}$   
 Reverse pulse duration  $t_p = 30 \text{ ns}$   
 Oscilloscope: Rise time  $t_r = 0,35 \text{ ns}$

Circuit capacitance  $C \leq 1 \text{ pF}$  ( $C$  = oscilloscope input capacitance + parasitic capacitance)

Forward recovery time when switched from

$I = 0$  to  $I_F = 200 \text{ mA}$ ;  $t_r = 0,4 \text{ ns}$ ;  $t_p = 100 \text{ ns}$ ;  $\delta < 0,01$ ;  
 measured at  $V_F = 1 \text{ V}$   $t_{fr} < 10 \text{ ns}$

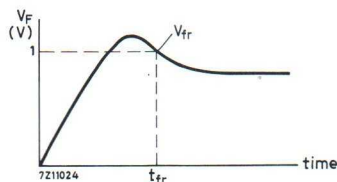


Fig. 3 PMLL4150.



## VOLTAGE REGULATOR DIODES FOR SURFACE MOUNTING

Silicon planar diodes in a SOD-80 envelope intended for use as low-power voltage stabilizers or voltage references.

The series consists of 43 types with nominal working voltages in the range 3,0 V to 75 V with a tolerance of  $\pm 5\%$ . The SM diode is a leadless diode in a hermetically sealed glass SOD-80 envelope with tin plated metal discs at each end. It is suitable for "automatic placement" and as such can withstand immersion soldering.

The diodes are delivered on "super 8" tape.

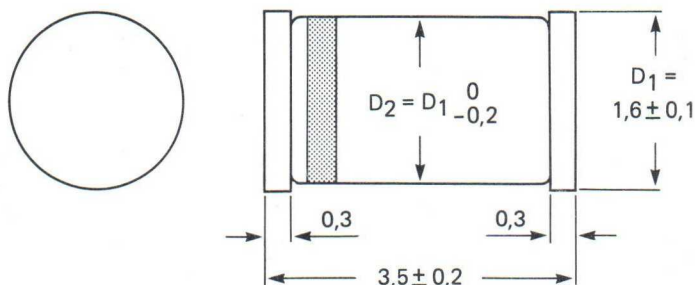
### QUICK REFERENCE DATA

|                                                                                                                     |           |      |                                            |
|---------------------------------------------------------------------------------------------------------------------|-----------|------|--------------------------------------------|
| Working voltage range                                                                                               | $V_Z$     | nom. | 3,0 to 75 V                                |
| Working voltage tolerance                                                                                           |           |      | $\pm 5\%$                                  |
| Total power dissipation                                                                                             | $P_{tot}$ | max. | 500 mW                                     |
| Non-repetitive peak reverse power dissipation<br>$T_j = 55\text{ }^\circ\text{C}; t_p = 8,3\text{ ms, square wave}$ | $P_{ZSM}$ | max. | 10 W                                       |
| Junction temperature                                                                                                | $T_j$     |      | $-65\text{ to }+200\text{ }^\circ\text{C}$ |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-80.



Cathode indicated by yellow band.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Average forward current (averaged  
over any 20 ms period)

$I_F(AV)$  max. 250 mA

Repetitive peak forward current

$I_{FRM}$  max. 250 mA

Total power dissipation

if flanges are kept at  $T_{flange} = 75\text{ }^{\circ}\text{C}$

$P_{tot}$  max. 500 mW

Derating factor

4 mW/K

Non-repetitive peak reverse power dissipation

$T_j = 55\text{ }^{\circ}\text{C}$ ;  $t_p = 8,3\text{ ms}$ , square wave

$P_{ZSM}$  max. 10 W

Storage temperature

$T_{stg}$   $-65$  to  $+200\text{ }^{\circ}\text{C}$

Junction temperature

$T_j$   $-65$  to  $+200\text{ }^{\circ}\text{C}$

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise stated

Forward voltage

$I_F = 200\text{ mA}$

$V_F$  max. 1,1 V

| type<br>number | working<br>voltage<br>$V_Z$<br>(V)<br>at $I_{Ztest}$<br><br>(note 1)<br>nom. | test<br>current<br>$I_{Ztest}$<br>(mA) | max. Zener<br>impedance<br>$Z_{ZT}$<br>( $\Omega$ )<br>at $I_{Ztest}$<br><br>(note 2) | differential<br>resistance<br>$r_{diff}$<br>( $\Omega$ )<br>at $I_{ZK} =$<br>0,25 mA<br>(note 2)<br>max. | reverse<br>current<br>$I_R$<br>( $\mu\text{A}$ )<br>at $V_R$<br><br>max. | test<br>voltage<br>$V_R$<br>(V) | temp.<br>coeff.<br>$S_Z$<br>(%/K)<br><br>(note 3)<br>max. |
|----------------|------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------------|
| PMLL5225B      | 3,0                                                                          | 20                                     | 29                                                                                    | 1600                                                                                                     | 50                                                                       | 1,0                             | -0,075                                                    |
| PMLL5226B      | 3,3                                                                          | 20                                     | 28                                                                                    | 1600                                                                                                     | 25                                                                       | 1,0                             | -0,070                                                    |
| PMLL5227B      | 3,6                                                                          | 20                                     | 24                                                                                    | 1700                                                                                                     | 15                                                                       | 1,0                             | -0,065                                                    |
| PMLL5228B      | 3,9                                                                          | 20                                     | 23                                                                                    | 1900                                                                                                     | 10                                                                       | 1,0                             | -0,060                                                    |
| PMLL5229B      | 4,3                                                                          | 20                                     | 22                                                                                    | 2000                                                                                                     | 5                                                                        | 1,0                             | $\pm 0,055$                                               |
| PMLL5230B      | 4,7                                                                          | 20                                     | 19                                                                                    | 1900                                                                                                     | 5                                                                        | 2,0                             | $\pm 0,030$                                               |
| PMLL5231B      | 5,1                                                                          | 20                                     | 17                                                                                    | 1600                                                                                                     | 5                                                                        | 2,0                             | $\pm 0,030$                                               |
| PMLL5232B      | 5,6                                                                          | 20                                     | 11                                                                                    | 1600                                                                                                     | 5                                                                        | 3,0                             | +0,038                                                    |
| PMLL5233B      | 6,0                                                                          | 20                                     | 7                                                                                     | 1600                                                                                                     | 5                                                                        | 3,5                             | +0,038                                                    |
| PMLL5234B      | 6,2                                                                          | 20                                     | 7                                                                                     | 1000                                                                                                     | 5                                                                        | 4,0                             | +0,045                                                    |
| PMLL5235B      | 6,8                                                                          | 20                                     | 5                                                                                     | 750                                                                                                      | 3                                                                        | 5,0                             | +0,050                                                    |
| PMLL5236B      | 7,5                                                                          | 20                                     | 6                                                                                     | 500                                                                                                      | 3                                                                        | 6,0                             | +0,058                                                    |
| PMLL5237B      | 8,2                                                                          | 20                                     | 8                                                                                     | 500                                                                                                      | 3                                                                        | 6,5                             | +0,062                                                    |
| PMLL5238B      | 8,7                                                                          | 20                                     | 8                                                                                     | 600                                                                                                      | 3                                                                        | 6,5                             | +0,065                                                    |
| PMLL5239B      | 9,1                                                                          | 20                                     | 10                                                                                    | 600                                                                                                      | 3                                                                        | 7,0                             | +0,068                                                    |



| type<br>number | working<br>voltage<br>$V_Z$<br>(V)<br>at $I_{Z\text{test}}$<br><br>(note 1)<br>nom. | test<br>current<br>$I_{Z\text{test}}$<br>(mA) | max. Zener<br>impedance<br>$Z_{ZT}$<br>( $\Omega$ )<br>at $I_{Z\text{test}}$<br><br>(note 2) | differential<br>resistance<br>$r_{\text{diff}}$<br>( $\Omega$ )<br>at $I_{ZK} =$<br>0,25 mA<br>(note 2)<br>max. | reverse<br>current<br>$I_R$<br>( $\mu\text{A}$ )<br>at $V_R$<br><br>max. | test<br>voltage<br>$V_R$<br>(V) | temp.<br>coeff.<br>$S_Z$<br>(%/K)<br><br>(note 3)<br>max. |
|----------------|-------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------|-----------------------------------------------------------|
| PMLL5240B      | 10                                                                                  | 20                                            | 17                                                                                           | 600                                                                                                             | 3                                                                        | 8,0                             | + 0,075                                                   |
| PMLL5241B      | 11                                                                                  | 20                                            | 22                                                                                           | 600                                                                                                             | 2                                                                        | 8,4                             | + 0,076                                                   |
| PMLL5242B      | 12                                                                                  | 20                                            | 30                                                                                           | 600                                                                                                             | 1                                                                        | 9,1                             | + 0,077                                                   |
| PMLL5243B      | 13                                                                                  | 9,5                                           | 13                                                                                           | 600                                                                                                             | 0,5                                                                      | 9,9                             | + 0,079                                                   |
| PMLL5244B      | 14                                                                                  | 9,0                                           | 15                                                                                           | 600                                                                                                             | 0,1                                                                      | 10                              | + 0,082                                                   |
| PMLL5245B      | 15                                                                                  | 8,5                                           | 16                                                                                           | 600                                                                                                             | 0,1                                                                      | 11                              | + 0,082                                                   |
| PMLL5246B      | 16                                                                                  | 7,8                                           | 17                                                                                           | 600                                                                                                             | 0,1                                                                      | 12                              | + 0,083                                                   |
| PMLL5247B      | 17                                                                                  | 7,4                                           | 19                                                                                           | 600                                                                                                             | 0,1                                                                      | 13                              | + 0,084                                                   |
| PMLL5248B      | 18                                                                                  | 7,0                                           | 21                                                                                           | 600                                                                                                             | 0,1                                                                      | 14                              | + 0,085                                                   |
| PMLL5249B      | 19                                                                                  | 6,6                                           | 23                                                                                           | 600                                                                                                             | 0,1                                                                      | 14                              | + 0,086                                                   |
| PMLL5250B      | 20                                                                                  | 6,2                                           | 25                                                                                           | 600                                                                                                             | 0,1                                                                      | 15                              | + 0,086                                                   |
| PMLL5251B      | 22                                                                                  | 5,6                                           | 29                                                                                           | 600                                                                                                             | 0,1                                                                      | 17                              | + 0,087                                                   |
| PMLL5252B      | 24                                                                                  | 5,2                                           | 33                                                                                           | 600                                                                                                             | 0,1                                                                      | 18                              | + 0,088                                                   |
| PMLL5253B      | 25                                                                                  | 5,0                                           | 35                                                                                           | 600                                                                                                             | 0,1                                                                      | 19                              | + 0,089                                                   |
| PMLL5254B      | 27                                                                                  | 4,6                                           | 41                                                                                           | 600                                                                                                             | 0,1                                                                      | 21                              | + 0,090                                                   |
| PMLL5255B      | 28                                                                                  | 4,5                                           | 44                                                                                           | 600                                                                                                             | 0,1                                                                      | 21                              | + 0,091                                                   |
| PMLL5256B      | 30                                                                                  | 4,2                                           | 49                                                                                           | 600                                                                                                             | 0,1                                                                      | 23                              | + 0,091                                                   |
| PMLL5257B      | 33                                                                                  | 3,8                                           | 58                                                                                           | 700                                                                                                             | 0,1                                                                      | 25                              | + 0,092                                                   |
| PMLL5258B      | 36                                                                                  | 3,4                                           | 70                                                                                           | 700                                                                                                             | 0,1                                                                      | 27                              | + 0,093                                                   |
| PMLL5259B      | 39                                                                                  | 3,2                                           | 80                                                                                           | 800                                                                                                             | 0,1                                                                      | 30                              | + 0,094                                                   |
| PMLL5260B      | 43                                                                                  | 3,0                                           | 93                                                                                           | 900                                                                                                             | 0,1                                                                      | 33                              | + 0,095                                                   |
| PMLL5261B      | 47                                                                                  | 2,7                                           | 105                                                                                          | 1000                                                                                                            | 0,1                                                                      | 36                              | + 0,095                                                   |
| PMLL5262B      | 51                                                                                  | 2,5                                           | 125                                                                                          | 1100                                                                                                            | 0,1                                                                      | 39                              | + 0,096                                                   |
| PMLL5263B      | 56                                                                                  | 2,2                                           | 150                                                                                          | 1300                                                                                                            | 0,1                                                                      | 43                              | + 0,096                                                   |
| PMLL5264B      | 60                                                                                  | 2,1                                           | 170                                                                                          | 1400                                                                                                            | 0,1                                                                      | 46                              | + 0,097                                                   |
| PMLL5265B      | 62                                                                                  | 2,0                                           | 185                                                                                          | 1400                                                                                                            | 0,1                                                                      | 47                              | + 0,097                                                   |
| PMLL5266B      | 68                                                                                  | 1,8                                           | 230                                                                                          | 1600                                                                                                            | 0,1                                                                      | 52                              | + 0,097                                                   |
| PMLL5267B      | 75                                                                                  | 1,7                                           | 270                                                                                          | 1700                                                                                                            | 0,1                                                                      | 56                              | + 0,098                                                   |

## Notes to the characteristics

1.  $V_Z$  is measured with device at thermal equilibrium while held in clips in still air at 25 °C.
2.  $I_{\text{ac rms}} = 10\%$  of  $I_{Z\text{test}}$  resp.  $I_{ZK}$ , 60 Hz superimposed.
3. For types PMLL5225B to PMLL5242B the current  $I_Z = 7,5$  mA; for PMLL5243B and higher  $I_Z = I_{Z\text{test}}$ . Testpoints at  $T_1 = 25$  °C,  $T_2 = 125$  °C.

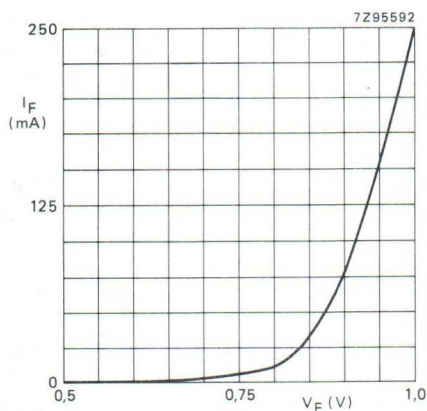


Fig. 2  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; typical values.

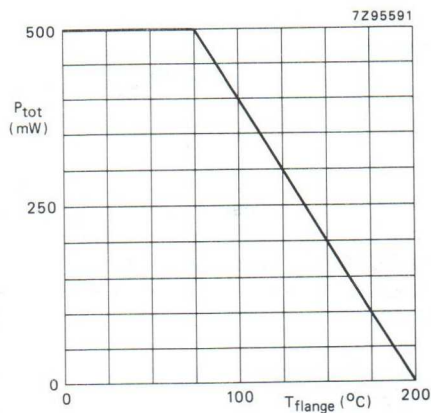


Fig. 3 Total power dissipation versus flange temperature.

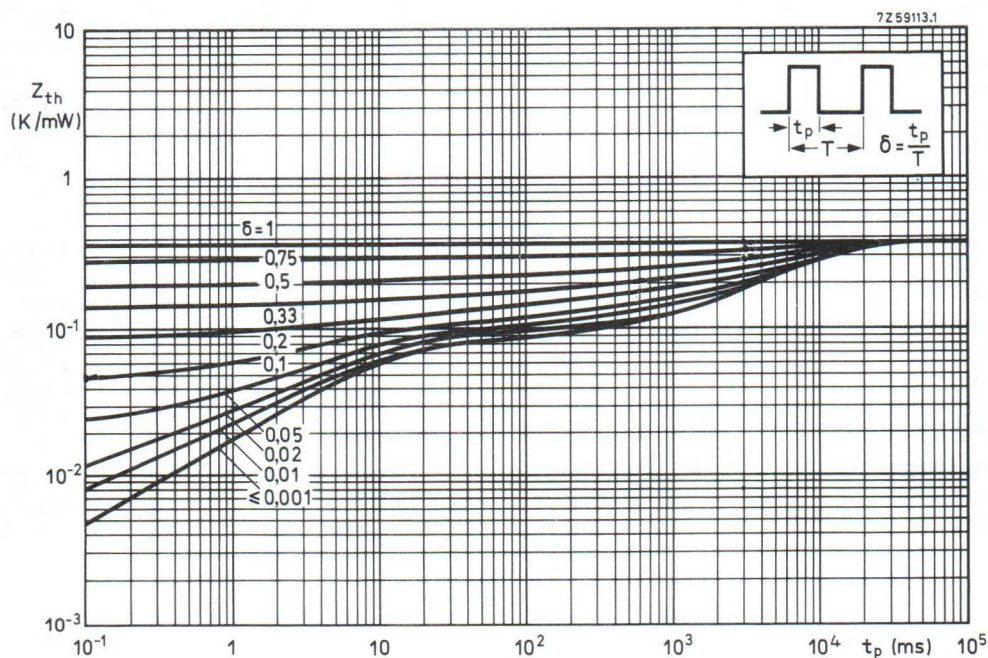


Fig. 4 Thermal impedance versus pulse duration.

## SILICON DIFFUSED RECTIFIER DIODES

A range of silicon rectifier diodes for general use in leadless **SMID\*** envelopes.

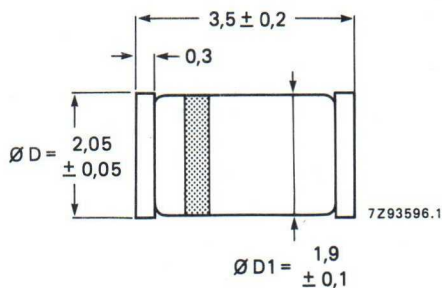
### QUICK REFERENCE DATA

|                                     |           |      | PRLL4001 | PRLL4002 |
|-------------------------------------|-----------|------|----------|----------|
| Repetitive peak reverse voltage     | $V_{RRM}$ | max. | 50       | 100 V    |
| Continuous reverse voltage          | $V_R$     | max. | 50       | 100 V    |
| Average forward current             | $I_F(AV)$ | max. | 1.6      | A        |
| Repetitive peak forward current     | $I_{FRM}$ | max. | 10       | A        |
| Non-repetitive peak forward current | $I_{FSM}$ | max. | 20       | A        |

### MECHANICAL DATA

Dimensions in mm

Fig.1 SOD87.



\* Surface-mounted implosion diode.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                             |             |      | PRLL4001    | PRLL4002           |
|-------------------------------------------------------------------------------------------------------------|-------------|------|-------------|--------------------|
| Repetitive peak reverse voltage                                                                             | $V_{RRM}$   | max. | 50          | 100 V              |
| Continuous reverse voltage                                                                                  | $V_R$       | max. | 50          | 100 V              |
| Average forward current<br>(averaged over any 20 ms period)<br>up to $T_{tp} = 105\text{ }^{\circ}\text{C}$ | $I_{F(AV)}$ | max. | 1.6         | A                  |
| at $T_{amb} = 65\text{ }^{\circ}\text{C}$<br>mounted on a printed-circuit board                             | $I_{F(AV)}$ | max. | 0.68        | A                  |
| Repetitive peak forward current                                                                             | $I_{FRM}$   | max. | 10          | A                  |
| Non-repetitive peak forward current<br>(half-cycle sinewave, 60 Hz)                                         | $I_{FSM}$   | max. | 20          | A                  |
| Storage temperature range                                                                                   | $T_{stg}$   |      | -65 to +175 | $^{\circ}\text{C}$ |
| Junction temperature                                                                                        | $T_j$       | max. | 175         | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point  $R_{th\ j-tp} = 30\text{ K/W}$
2. Thermal resistance from junction to ambient;  
device mounted on an 1.5 mm thick epoxy-  
glass printed-circuit board;  
Cu-thickness  $\geq 40\text{ }\mu\text{m}$  (see Fig.2)  $R_{th\ j-a} = 150\text{ K/W}$

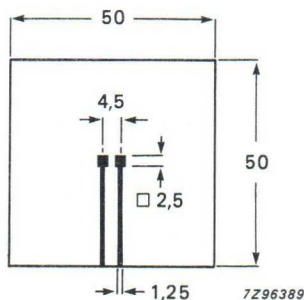


Fig.2 Mounted on a printed-circuit board.

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise stated

Forward voltage

$I_F = 1\text{ A}$

|       |      |     |   |
|-------|------|-----|---|
| $V_F$ | max. | 1.1 | V |
|-------|------|-----|---|

Full-cycle average forward voltage

$I_F(AV) = 1\text{ A}$

|           |      |     |   |
|-----------|------|-----|---|
| $V_F(AV)$ | max. | 0.8 | V |
|-----------|------|-----|---|

Reverse current

$V_R = V_{Rmax}$

|       |      |    |               |
|-------|------|----|---------------|
| $I_R$ | max. | 10 | $\mu\text{A}$ |
|-------|------|----|---------------|

$V_R = V_{Rmax}; T_{amb} = 100\text{ }^{\circ}\text{C}$

|       |      |    |               |
|-------|------|----|---------------|
| $I_R$ | max. | 50 | $\mu\text{A}$ |
|-------|------|----|---------------|

Full-cycle average reverse current

$V_R = V_{RRMmax}; T_{amb} = 75\text{ }^{\circ}\text{C}$

|           |      |    |               |
|-----------|------|----|---------------|
| $I_R(AV)$ | max. | 30 | $\mu\text{A}$ |
|-----------|------|----|---------------|

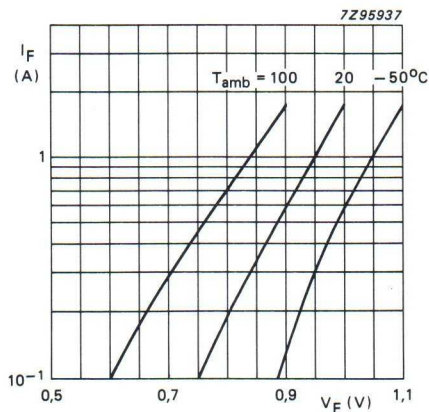


Fig.3 Typical forward current as a function of forward voltage.

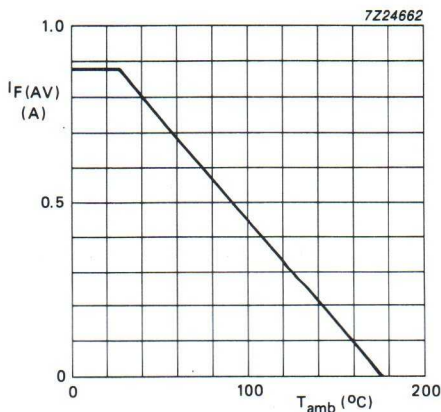


Fig.4 Maximum forward current as a function of temperature.





# DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PRLL5817  
PRLL5818  
PRLL5819

## SCHOTTKY BARRIER DIODES

Schottky barrier diodes in hermetically sealed leadless SOD87 SMID\* envelope. They are intended for use in low output voltage, low power switched-mode power supplies and high-frequency circuits where low conduction and switching losses are important.

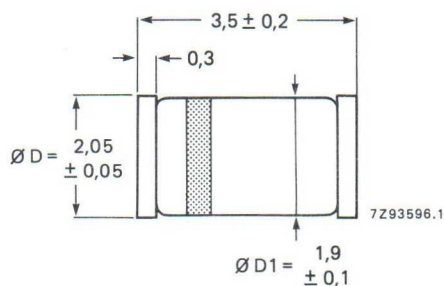
### QUICK REFERENCE DATA

|                                     |           | PRLL5817 | 18  | 19   |
|-------------------------------------|-----------|----------|-----|------|
| Repetitive peak reverse voltage     | $V_{RRM}$ | max. 20  | 30  | 40 V |
| Crest working reverse voltage       | $V_{RWM}$ | max. 20  | 30  | 40 V |
| Continuous reverse voltage          | $V_R$     | max. 20  | 30  | 40 V |
| Non-repetitive peak reverse voltage | $V_{RSM}$ | max. 24  | 36  | 48 V |
| Average forward current             | $I_F(AV)$ | max.     | 1   | A    |
| Non-repetitive peak forward current | $I_{FSM}$ | max.     | 25  | A    |
| Junction temperature                | $T_j$     | max.     | 125 | °C   |

### MECHANICAL DATA

Dimensions in mm

Fig.1 SOD87.



\* Surface Mounted Implosion Diode.

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                                                                                   |           | PRLL5817 | 18           | 19                 |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------|----------|--------------|--------------------|
| Repetitive peak reverse voltage                                                                                                   | $V_{RRM}$ | max. 20  | 30           | 40 V               |
| Crest working reverse voltage                                                                                                     | $V_{RWM}$ | max. 20  | 30           | 40 V               |
| Continuous reverse voltage                                                                                                        | $V_R$     | max. 20  | 30           | 40 V               |
| Non-repetitive peak reverse voltage                                                                                               | $V_{RSM}$ | max. 24  | 36           | 48 V               |
| Average forward current<br>( $a = 1$ ); $T_{amb} = 60\text{ }^{\circ}\text{C}$ ; see Fig.2                                        | $I_F(AV)$ | max.     | 1            | A                  |
| Non-repetitive peak forward current<br>$t = 10\text{ ms}$ ; half sine wave;<br>$T_j = T_{j\text{ max}}$ prior to surge; $V_R = 0$ | $I_{FSM}$ | max.     | 25           | A                  |
| Storage temperature range                                                                                                         | $T_{stg}$ |          | -65 to + 175 | $^{\circ}\text{C}$ |
| Junction temperature                                                                                                              | $T_j$     | max.     | 125          | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

Influence of mounting method

|                                                                                                                                                                                    |                       |   |     |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---|-----|-----|
| 1. Thermal resistance from junction to tie-point                                                                                                                                   | $R_{th\ j\text{-}tp}$ | = | 30  | K/W |
| 2. Thermal resistance from junction to ambient;<br>device mounted on a 1.5 mm thick epoxy-glass<br>printed-circuit board; Cu thickness $\geq 40\text{ }\mu\text{m}$ ;<br>see Fig.2 | $R_{th\ j\text{-}a}$  | = | 150 | K/W |

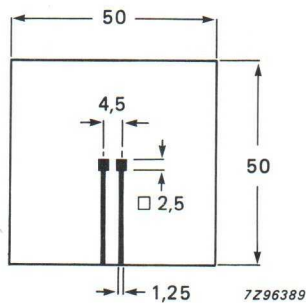


Fig.2 Mounted on a printed-circuit board.

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

## Forward voltage

$I_F = 0.1\text{ A}$

$I_F = 1\text{ A}$

$I_F = 3\text{ A}$

## Reverse current

$V_R = V_{RRM\text{ max}}$

$V_R = V_{RRM\text{ max}}; T_j = 100\text{ }^{\circ}\text{C}$

## Diode capacitance

$V_R = 4\text{ V}; f = 1\text{ MHz}$

|       | PRLL5817 | 18  | 19     |
|-------|----------|-----|--------|
| $V_F$ | max. 320 | 330 | 340 mV |
| $V_F$ | max. 450 | 550 | 600 mV |
| $V_F$ | max. 750 | 875 | 900 mV |
| $I_R$ | max. 1.0 | 0.5 | 0.5 mA |
| $I_R$ | max. 10  | 5   | 5 mA   |
| $C_d$ | typ. 70  | 50  | 50 pF  |

## OPERATING NOTE

### Calculation of $I_{F(AV)}$ -rating

For Schottky barrier diodes thermal runaway has to be considered, as in some applications the reverse power losses are a significant part of the total power losses. For that reason the starting point for the calculation of the  $I_{F(AV)}$ -rating should be the maximum permissible junction temperature  $T_{j\max}$ .

Method of calculation

1. Input:

type

$V_{RWM}$  and its duty cycle  $\delta$

$T_{amb}$

$a = I_{F(RMS)}/I_{F(AV)}$

2. Determine the maximum permissible junction temperature  $T_{j\max}$  (125 °C or the temperature at which thermal runaway occurs, whichever is lowest) from Figs 7, 9 or 11.
3. Determine the reverse power losses  $P_R$  from Figs 8, 10 or 12 and multiply  $P_R$  by 150 K/W, giving a certain number of degrees centigrade (this being the increase of junction temperature caused by reverse power dissipation).
4. Calculate  $T_R$  by subtracting the calculated number of degrees centigrade (15 °C or less) from the maximum permissible junction temperature.
5. Subtract  $T_{amb}$  from  $T_R$  (giving the admissible increase of junction temperature caused by forward dissipation) and calculate the admissible forward power dissipation by means of the formula;  
 $P_F = (T_R - T_{amb})/R_{thj-a}$ .
6. Determine the  $I_{F(AV)}$ -rating from Figs 4, 5 or 6.

Example: PRLL5818;  $V_{RWM} = 22$  V;  $\delta = 0.5$ ;  $T_{amb} = 60$  °C;  $a = 1.42$ .

Find  $T_{j\max}$  from Fig.9: 112 °C.

Find  $P_R$  from Fig.10: 0.1 W.

$P_R \times R_{thj-a} = 0.1 \times 150 = 15$  °C.

Calculate  $T_R$ :  $112 - 15 = 97$  °C.

Calculate  $P_F$ :  $(97 - 60)/150 = 0.25$  W.

Find  $I_{F(AV)\max}$  from Fig.5, for  $a = 1.42$ :  $I_{F(AV)\max} = 0.5$  A.



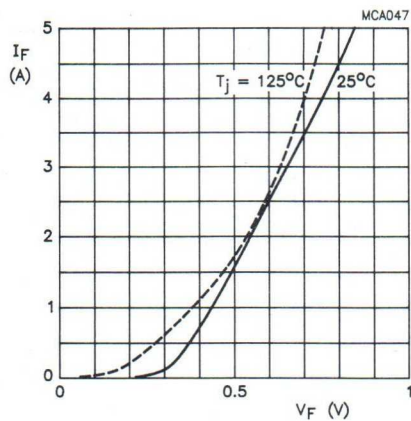
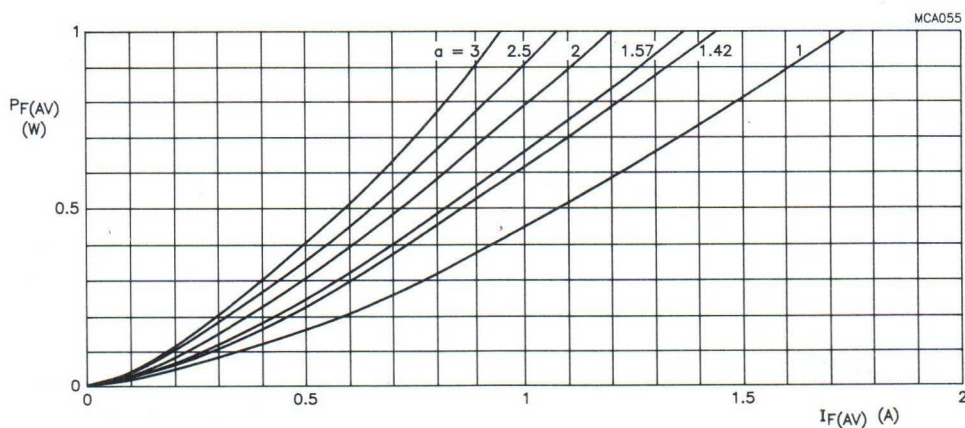


Fig.3 PRL5817; 18; 19. Typical forward voltage.


 Fig.4 PRL5817. Maximum values steady state forward power dissipation as a function of the average forward current;  $a = I_{F(RMS)}/I_{F(AV)}$ .

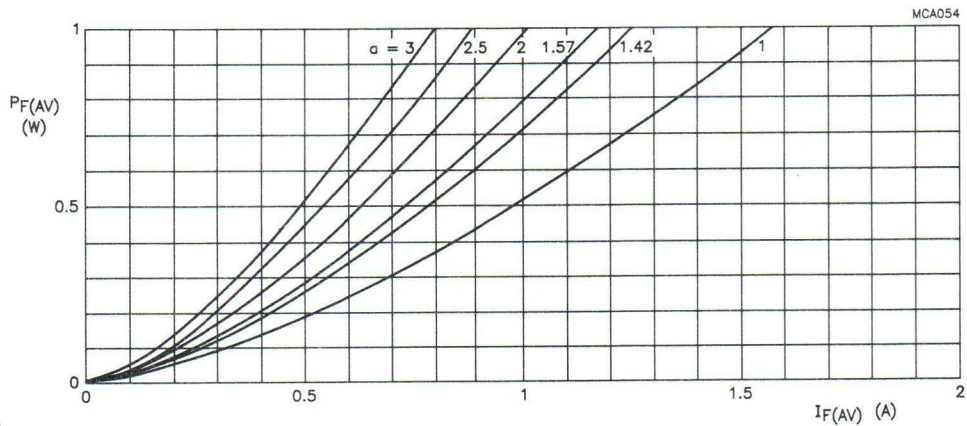


Fig.5 **PRLL5818**. Maximum values steady state forward power dissipation as a function of the average forward current;  $a = I_{F(RMS)}/I_{F(AV)}$ .

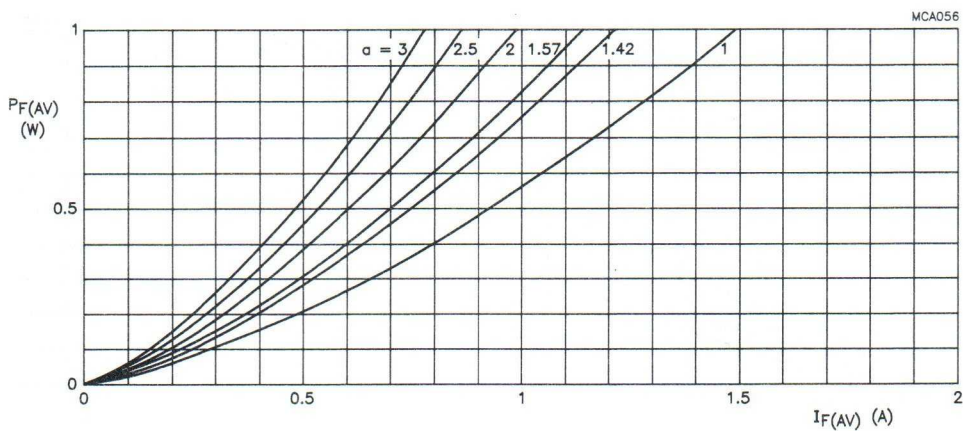


Fig.6 **PRLL5819**. Maximum values steady state forward power dissipation as a function of the average forward current;  $a = I_{F(RMS)}/I_{F(AV)}$ .

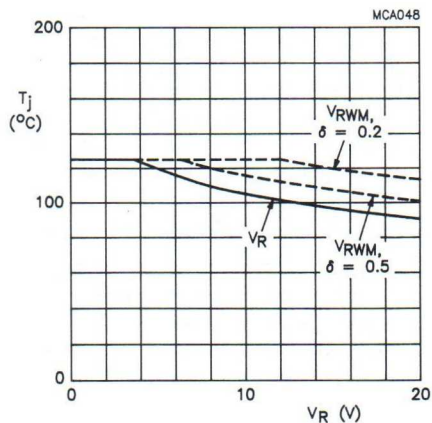


Fig.7 PRLL5817. Maximum permissible junction temperature as a function of reverse voltage; device mounted as shown in Fig.2.

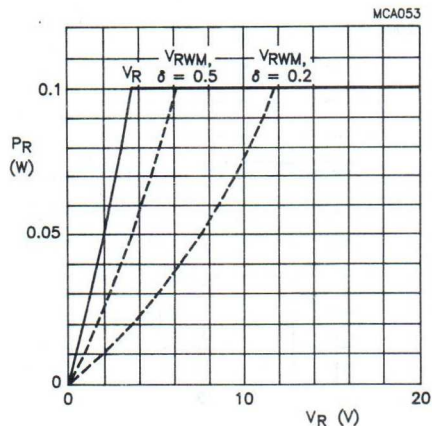


Fig.8 PRLL5817. Reverse power dissipation as a function of reverse voltage (max. values); device mounted as shown in Fig.2.

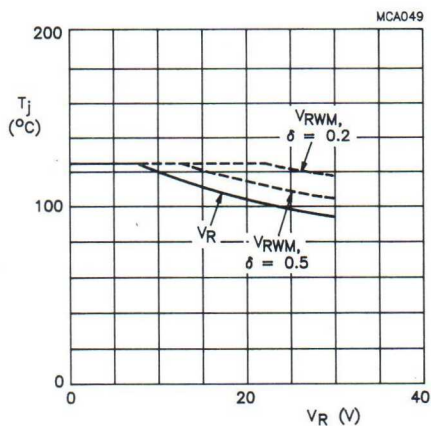


Fig.9 PRLL5818. Maximum permissible junction temperature as a function of reverse voltage; device mounted as shown in Fig.2.

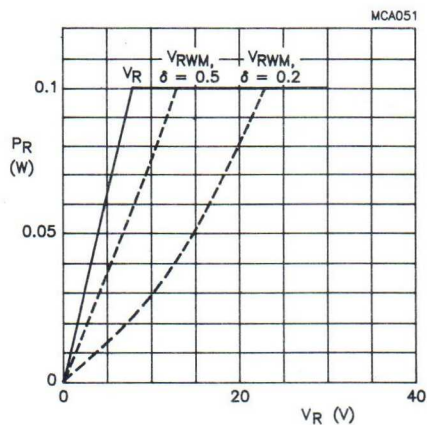


Fig.10 PRLL5818. Reverse power dissipation as a function of reverse voltage (max. values); device mounted as shown in Fig.2.

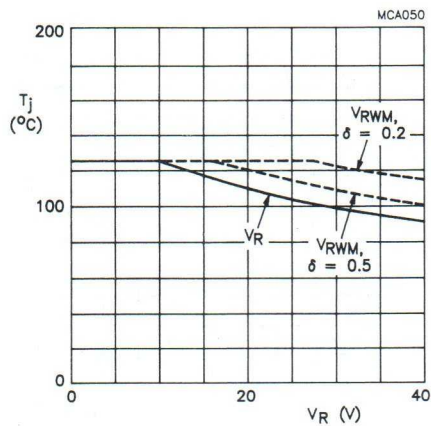


Fig.11 PRLL5819. Maximum permissible junction temperature as a function of reverse voltage; device mounted as shown in Fig.2.

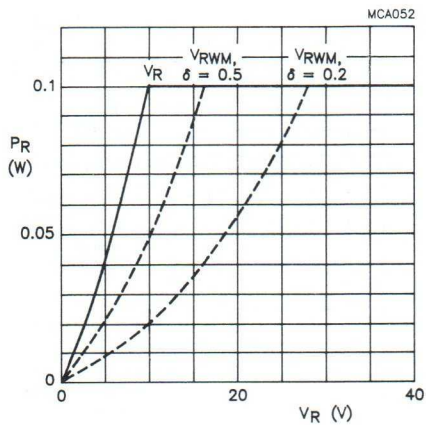


Fig.12 PRLL5819. Reverse power dissipation as a function of reverse voltage (max. values); device mounted as shown in Fig.2.

# SILICON PLANAR EPITAXIAL TRANSISTOR

NPN silicon planar epitaxial transistor, housed in a SOT89 envelope.

It is intended for switching and linear applications.

The complementary type is PXT2907/A.

## QUICK REFERENCE DATA

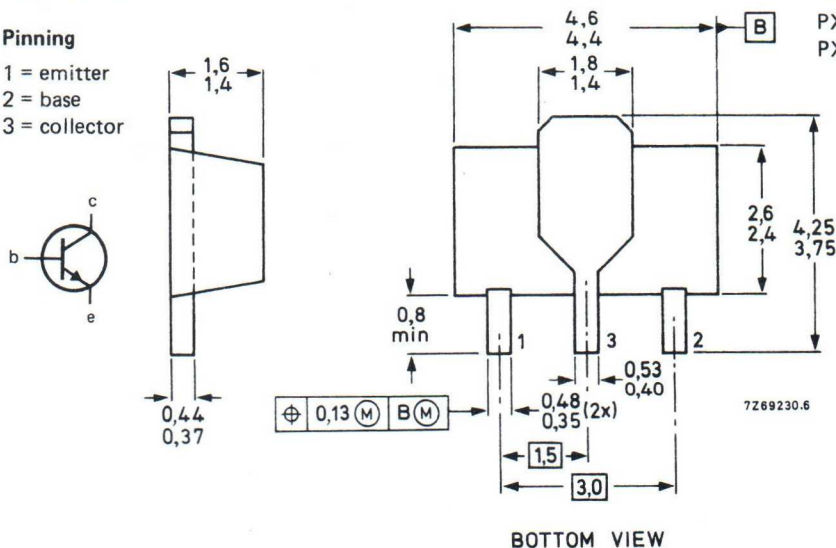
|                                                                                            |                          | PXT2222    | PXT2222A   |
|--------------------------------------------------------------------------------------------|--------------------------|------------|------------|
| Collector-emitter voltage (open base)                                                      | $V_{CEO}$ max.           | 30         | 40 V       |
| Collector-base voltage (open emitter)                                                      | $V_{CBO}$ max.           | 60         | 75 V       |
| Emitter-base voltage (open collector)                                                      | $V_{EBO}$ max.           | 5.0        | 6.0 V      |
| Collector current (DC)                                                                     | $I_C$ max.               | 600        | mA         |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$                  | $P_{tot}$ max.           | 1.0        | W          |
| DC current gain<br>$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$                             | $h_{FE}$                 | 100 to 300 | 100 to 300 |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 20\text{ mA}; V_{CE} = 20\text{ V}$ | $f_T$ min.               | 250        | 300 MHz    |
| Saturation voltage<br>$I_C = 150\text{ mA}; I_B = 15\text{ mA}$                            | $V_{CE\text{ sat}}$ max. | 400        | 300 mV     |

## MECHANICAL DATA

Fig.1 SOT89.

### Pinning

- 1 = emitter  
2 = base  
3 = collector



Dimensions in mm

Marking codes:

PXT2222 : p1B  
PXT2222A: p1P

\* Mounted on a ceramic substrate; area = 2.5 cm<sup>2</sup>; thickness = 0.7 mm.



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      | PXT2222      | PXT2222A |                    |
|---------------------------------------------------------------------------|-----------|------|--------------|----------|--------------------|
| Collector-emitter voltage                                                 | $V_{CEO}$ | max. | 30           | 40       | V                  |
| Collector-base voltage                                                    | $V_{CBO}$ | max. | 60           | 75       | V                  |
| Emitter-base voltage                                                      | $V_{EBO}$ | max. | 5.0          | 6.0      | V                  |
| Collector current (DC)                                                    | $I_C$     | max. | 600          |          | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$ | max. | 1.0          |          | W                  |
| Storage temperature range                                                 | $T_{stg}$ |      | -65 to + 150 |          | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150          |          | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                           |             |   |     |     |
|---------------------------|-------------|---|-----|-----|
| From junction to ambient* | $R_{thj-a}$ | = | 125 | K/W |
|---------------------------|-------------|---|-----|-----|

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                        |                     |      | PXT2222 | PXT2222A   |               |
|------------------------------------------------------------------------|---------------------|------|---------|------------|---------------|
| Collector cut-off current                                              |                     |      |         |            |               |
| $V_{CB} = 50\text{ V}; I_E = 0$                                        | $I_{CBO}$           | max. | 10      | —          | nA            |
| $V_{CB} = 50\text{ V}; I_E = 0; T_{amb} = 125\text{ }^{\circ}\text{C}$ | $I_{CBO}$           | max. | 10      | —          | $\mu\text{A}$ |
| $V_{CB} = 60\text{ V}; I_E = 0$                                        | $I_{CBO}$           | max. | —       | 10         | nA            |
| $V_{CB} = 60\text{ V}; I_E = 0; T_{amb} = 125\text{ }^{\circ}\text{C}$ | $I_{CBO}$           | max. | —       | 10         | $\mu\text{A}$ |
| $V_{CE} = 60\text{ V}; V_{EB} = 3\text{ V}$                            | $I_{CEX}$           | min. | —       | 10         | nA            |
| Base current<br>with reverse biased emitter junction                   |                     |      |         |            |               |
| $V_{CE} = 60\text{ V}; V_{BE} = 3\text{ V}$                            | $I_{BEX}$           | max. | —       | 20         | nA            |
| Emitter cut-off current                                                |                     |      |         |            |               |
| $V_{BE} = 3\text{ V}; I_C = 0$                                         | $I_{EBO}$           | max. | —       | 10         | nA            |
| Saturation voltage                                                     |                     |      |         |            |               |
| $I_C = 150\text{ mA}; I_B = 15\text{ mA}$                              | $V_{CE\text{ sat}}$ | max. | 0.4     | 0.3        | V             |
|                                                                        | $V_{BE\text{ sat}}$ | max. | 1.3     | 0.6 to 1.2 | V             |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$                              | $V_{CE\text{ sat}}$ | max. | 1.6     | 1.0        | V             |
|                                                                        | $V_{BE\text{ sat}}$ | max. | 2.6     | 2.0        | V             |
| Breakdown voltages                                                     |                     |      |         |            |               |
| $I_C = 10\text{ mA}; I_B = 0$                                          | $V_{(BR)CEO}$       | min. | 30      | 40         | V             |
| $I_C = 10\text{ }\mu\text{A}; I_E = 0$                                 | $V_{(BR)CBO}$       | min. | 60      | 75         | V             |
| $I_E = 10\text{ }\mu\text{A}; I_C = 0$                                 | $V_{(BR)EBO}$       | min. | 5.0     | 6.0        | V             |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

|                                                                           |          |      | PXT2222 | PXT2222A                |
|---------------------------------------------------------------------------|----------|------|---------|-------------------------|
| DC current gain                                                           |          |      |         |                         |
| $I_C = 0.1 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | min. | 35      | 35                      |
| $I_C = 1.0 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | min. | 50      | 50                      |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$                              | $h_{FE}$ | min. | 75      | 75                      |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = -55^\circ\text{C}$ | $h_{FE}$ | min. | —       | 35                      |
| $I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | min. | 100     | 100                     |
|                                                                           |          | max. | 300     | 300                     |
| $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$                              | $h_{FE}$ | min. | 50      | 50                      |
| $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$ | min. | 30      | 40                      |
| Transition frequency at $f = 100 \text{ MHz}$                             |          |      |         |                         |
| $I_C = 20 \text{ mA}; V_{CE} = 10 \text{ V}$                              | $f_T$    | min. | 250     | 300 MHz                 |
| Output capacitance at $f = 1 \text{ MHz}$                                 |          |      |         |                         |
| $V_{CB} = 10 \text{ V}; I_E = 0$                                          | $C_O$    | max. | 8.0     | 8.0 pF                  |
| Input capacitance at $f = 1 \text{ MHz}$                                  |          |      |         |                         |
| $V_{EB} = 0.5 \text{ V}; I_C = 0$                                         | $C_i$    | max. | 30      | 25 pF                   |
| Collector-base time constant                                              |          |      |         |                         |
| $I_E = 20 \text{ mA}; V_{CB} = 20 \text{ V}$                              | $rb'C_C$ | max. | —       | 150 ps                  |
| Noise figure at $R_s = 1 \text{ K}\Omega$                                 |          |      |         |                         |
| $I_C = 100 \mu\text{A}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$         | F        | max. | —       | 4.0 dB                  |
| h-parameters (common emitter) at $f = 1 \text{ kHz}$                      |          |      |         |                         |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                               |          |      |         |                         |
| input impedance                                                           | $h_{ie}$ | —    | —       | 4.0 to 8.0 k $\Omega$   |
| voltage feedback ratio                                                    | $h_{re}$ | —    | —       | $8.0 \times 10^{-4}$    |
| small-signal current gain                                                 | $h_{fe}$ | —    | —       | 50 to 300               |
| output admittance                                                         | $h_{oe}$ | —    | —       | 5.0 to 35 $\mu\text{S}$ |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$                              |          |      |         |                         |
| input impedance                                                           | $h_{ie}$ | —    | —       | 0.25 to 1.25 k $\Omega$ |
| voltage feedback ratio                                                    | $h_{re}$ | —    | —       | $4.0 \times 10^{-4}$    |
| small-signal current gain                                                 | $h_{fe}$ | —    | —       | 75 to 375               |
| output admittance                                                         | $h_{oe}$ | —    | —       | 25 to 200 $\mu\text{S}$ |
| Switching times                                                           |          |      |         |                         |
| Turn-on time                                                              |          |      |         |                         |
| $(V_{CC} = 30 \text{ V}; V_{EB \text{ off}} = 0.5 \text{ V};$             |          |      |         |                         |
| $I_C = 150 \text{ mA}; I_{B1} = 15 \text{ mA})$                           |          |      |         |                         |
| Delay time                                                                | $t_d$    | max. | 10      | ns                      |
| Rise time                                                                 | $t_r$    | max. | 25      | ns                      |
| Turn-off time                                                             |          |      |         |                         |
| $(V_{CC} = 30 \text{ V}; I_C = 150 \text{ mA};$                           |          |      |         |                         |
| $I_{B1} = I_{B2} = 15 \text{ mA})$                                        |          |      |         |                         |
| Storage time                                                              | $t_s$    | max. | 225     | ns                      |
| Fall time                                                                 | $t_f$    | max. | 60      | ns                      |



# SILICON PLANAR EPITAXIAL TRANSISTOR

PNP silicon planar epitaxial transistor, housed in a SOT89 envelope.

It is intended for switching and linear applications.

The complementary type is PXT2222/A.

## QUICK REFERENCE DATA

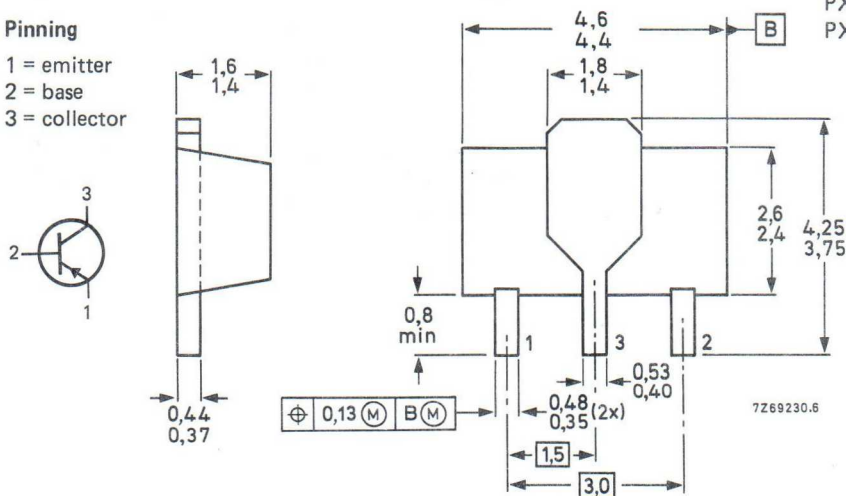
|                                                                                              |                      |      | PXT2907    | PXT2907A   |     |
|----------------------------------------------------------------------------------------------|----------------------|------|------------|------------|-----|
| Collector-emitter voltage (open base)                                                        | $-V_{CEO}$           | max. | 40         | 60         | V   |
| Collector-base voltage (open emitter)                                                        | $-V_{CBO}$           | max. |            | 60         | V   |
| Emitter-base voltage (open collector)                                                        | $-V_{EBO}$           | max. |            | 5.0        | V   |
| Collector current (DC)                                                                       | $-I_C$               | max. |            | 600        | mA  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$                    | $P_{tot}$            | max. |            | 1.0        | W   |
| DC current gain<br>$-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}$                             | $h_{FE}$             |      | 100 to 300 | 100 to 300 |     |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 20\text{ mA}; -V_{CE} = 20\text{ V}$ | $f_T$                | min. |            | 200        | MHz |
| Saturation voltage<br>$-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$                            | $-V_{CE\text{ sat}}$ | max. |            | 0.4        | V   |

## MECHANICAL DATA

Fig.1 SOT89.

## Pinning

- 1 = emitter  
2 = base  
3 = collector



BOTTOM VIEW

\* Mounted on a ceramic substrate; area = 2.5 cm<sup>2</sup>; thickness = 0.7 mm.

Dimensions in mm

Marking code:

PXT2907 : p2B

PXT2907A: p2F

## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            | PXT2907 |              | PXT2907A |                    |
|---------------------------------------------------------------------------|------------|---------|--------------|----------|--------------------|
| Collector-emitter voltage                                                 | $-V_{CEO}$ | max.    | 40           | 60       | V                  |
| Collector-base voltage                                                    | $-V_{CBO}$ | max.    | 60           |          | V                  |
| Emitter-base voltage                                                      | $-V_{EBO}$ | max.    | 5.0          |          | V                  |
| Collector current (DC)                                                    | $-I_C$     | max.    | 600          |          | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max.    | 1.0          |          | W                  |
| Storage temperature range                                                 | $T_{stg}$  |         | -65 to + 150 |          | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max.    | 150          |          | $^{\circ}\text{C}$ |

## THERMAL RESISTANCE

|                           |             |   |     |     |
|---------------------------|-------------|---|-----|-----|
| From junction to ambient* | $R_{thj-a}$ | = | 125 | K/W |
|---------------------------|-------------|---|-----|-----|

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                         |                      | PXT2907 |     | PXT2907A |               |
|-------------------------------------------------------------------------|----------------------|---------|-----|----------|---------------|
| Collector-cut-off current                                               |                      |         |     |          |               |
| $-V_{CB} = 50\text{ V}; I_E = 0$                                        | $-I_{CBO}$           | max.    | 20  | 10       | nA            |
| $-V_{CB} = 50\text{ V}; I_E = 0; T_{amb} = 125\text{ }^{\circ}\text{C}$ | $-I_{CBO}$           | max.    | 20  | 10       | $\mu\text{A}$ |
| $-V_{CE} = 30\text{ V}; -V_{EB} = 0.5\text{ V}$                         | $-I_{CEX}$           | max.    | 50  |          | nA            |
| Base current                                                            |                      |         |     |          |               |
| with reverse biased emitter junction                                    |                      |         |     |          |               |
| $-V_{CE} = 60\text{ V}; -V_{BE} = 0.5\text{ V}$                         | $-I_{BEX}$           | max.    | 50  |          | nA            |
| Saturation voltage                                                      |                      |         |     |          |               |
| $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$                             | $-V_{CE\text{ sat}}$ | max.    | 0.4 |          | V             |
|                                                                         | $-V_{BE\text{ sat}}$ | max.    | 1.3 |          | V             |
| $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$                             | $-V_{CE\text{ sat}}$ | max.    | 1.6 |          | V             |
|                                                                         | $-V_{BE\text{ sat}}$ | max.    | 2.6 |          | V             |
| Breakdown voltages                                                      |                      |         |     |          |               |
| $-I_C = 10\text{ mA}; I_B = 0$                                          | $-V_{(BR)CEO}$       | min.    | 40  | 60       | V             |
| $-I_C = 10\text{ }\mu\text{A}; I_E = 0$                                 | $-V_{(BR)CBO}$       | min.    | 60  |          | V             |
| $-I_E = 10\text{ }\mu\text{A}; I_C = 0$                                 | $-V_{(BR)EBO}$       | min.    | 5.0 |          | V             |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.



## DC current gain

$$-I_C = 0.1 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 1.0 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$$

$$-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$$

$$-I_C = 500 \text{ mA}; -V_{CE} = 2 \text{ V}$$

Transition frequency at  $f = 100 \text{ MHz}$ 

$$-I_C = 20 \text{ mA}; -V_{CE} = 10 \text{ V}$$

Output capacitance at  $f = 1 \text{ MHz}$ 

$$-V_{CB} = 10 \text{ V}; I_E = 0$$

Input capacitance at  $f = 1 \text{ MHz}$ 

$$-V_{EB} = 0.5 \text{ V}; I_C = 0$$

h-parameters (common emitter) at  $f = 1 \text{ kHz}$ 

$$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$$

input impedance

voltage feedback ratio

small-signal current gain

output admittance

## Switching times

## Turn-on time

$$(-V_{CC} = 30 \text{ V}; -I_C = 150 \text{ mA})$$

$$-I_{B1} = 15 \text{ mA})$$

## Delay time

## Rise time

## Turn-off time

$$(-V_{CC} = 6.0 \text{ V}; -I_C = 150 \text{ mA};$$

$$-I_{B1} = I_{B2} = 15 \text{ mA})$$

## Storage time

## Fall time

|           |            | PXT2907    | PXT2907A             |
|-----------|------------|------------|----------------------|
| $h_{FE}$  | min.       | 35         | 75                   |
| $h_{FE}$  | min.       | 50         | 100                  |
| $h_{FE}$  | min.       | 75         | 100                  |
| $h_{FE}$  | 100 to 300 | 100 to 300 | 100 to 300           |
| $h_{FE}$  | min.       | 30         | 50                   |
| $f_T$     | min.       | 200        | MHz                  |
| $C_O$     | max.       | 8.0        | pF                   |
| $C_i$     | max.       | 35         | pF                   |
| $h_{ie}$  |            | 1.5 to     | 15 k $\Omega$        |
| $h_{re}$  |            | 0.1 to     | $8.0 \times 10^{-4}$ |
| $h_{fe}$  |            | 60 to      | 500                  |
| $h_{oe}$  |            | 1.0 to     | 100 $\mu\text{mhos}$ |
| $t_{on}$  | max.       | 45         | ns                   |
| $t_d$     | max.       | 10         | ns                   |
| $t_r$     | max.       | 40         | ns                   |
| $t_{off}$ | max.       | 100        | ns                   |
| $t_s$     | max.       | 80         | ns                   |
| $t_f$     | max.       | 30         | ns                   |



## SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a SOT-89 envelope primarily intended for high-speed, saturated switching applications for industrial service.

## QUICK REFERENCE DATA

|                                                                   |           |      |                        |
|-------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                             | $V_{CBO}$ | max. | 60 V                   |
| Collector-emitter voltage (open base)                             | $V_{CEO}$ | max. | 40 V                   |
| Collector current (d.c.)                                          | $I_C$     | max. | 200 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 1,0 W                  |
| Junction temperature                                              | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                 |           |      |                        |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                         | $h_{FE}$  | $>$  | 100                    |
|                                                                   |           | $<$  | 300                    |
| Transistion frequency at $f = 100\text{ MHz}$                     |           |      |                        |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                        | $f_T$     | $>$  | 300 MHz                |
| Storage time                                                      |           |      |                        |
| $I_{Con} = 10\text{ mA}; I_{Bon} = -I_{Boff} = 1\text{ mA}$       | $t_s$     | $<$  | 200 ns                 |

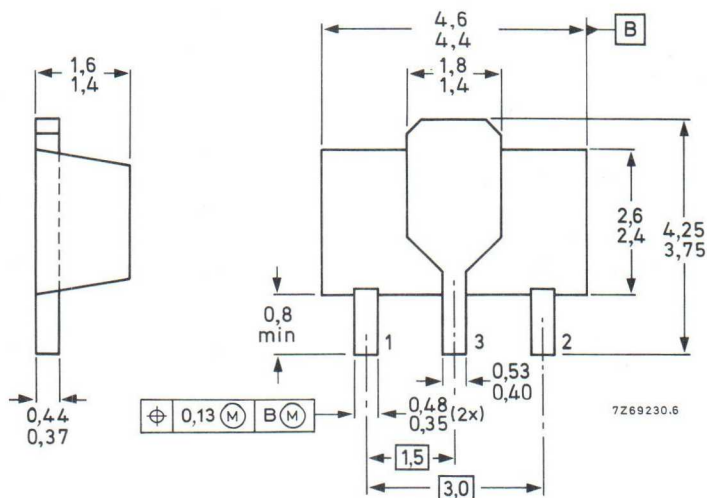
## MECHANICAL DATA

Fig. 1 SOT-89.

Dimensions in mm

**Marking code**

p1A



BOTTOM VIEW

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |      |                                |
|---------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                               | $V_{CBO}$ | max. | 60 V                           |
| Collector-emitter voltage (open base)                               | $V_{CEO}$ | max. | 40 V                           |
| Emitter-base voltage (open collector)                               | $V_{EBO}$ | max. | 6 V                            |
| Collector current (d.c.)                                            | $I_C$     | max. | 200 mA                         |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 1,0 W                          |
| Storage temperature                                                 | $T_{stg}$ |      | -55 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

|                                      |               |   |         |
|--------------------------------------|---------------|---|---------|
| From junction to ambient in free air | $R_{th\ j-a}$ | = | 125 K/W |
|--------------------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Currents at reverse biased emitter junction

 $V_{CE} = 30\text{ V}; -V_{BE} = 3\text{ V}$ 

|            |   |       |
|------------|---|-------|
| $I_{CEX}$  | < | 50 nA |
| $-I_{BEX}$ | < | 50 nA |

Saturation voltages

 $I_C = 10\text{ mA}; I_B = 1\text{ mA}$ 

|             |   |               |
|-------------|---|---------------|
| $V_{CEsat}$ | < | 200 mV        |
| $V_{BEsat}$ |   | 650 to 850 mV |

 $I_C = 50\text{ mA}; I_B = 5\text{ mA}$ 

|             |   |        |
|-------------|---|--------|
| $V_{CEsat}$ | < | 300 mV |
| $V_{BEsat}$ | < | 950 mV |

D.C. current gain

 $I_C = 0,1\text{ mA}; V_{CE} = 1\text{ V}$  $I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$  $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$  $I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$  $I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$ 

|          |   |     |
|----------|---|-----|
| $h_{FE}$ | > | 40  |
| $h_{FE}$ | > | 70  |
| $h_{FE}$ | > | 100 |
| $h_{FE}$ | < | 300 |
| $h_{FE}$ | > | 60  |
| $h_{FE}$ | > | 30  |

Collector capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$  $I_E = I_e = 0; V_{CB} = 5\text{ V}$ 

|       |   |        |
|-------|---|--------|
| $C_c$ | < | 4,0 pF |
|-------|---|--------|

Emitter capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$  $I_C = I_c = 0; V_{EB} = 0,5\text{ V}$ 

|       |   |        |
|-------|---|--------|
| $C_e$ | < | 8,0 pF |
|-------|---|--------|

Transition frequency at  $f = 100\text{ MHz}$  $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ 

|       |   |         |
|-------|---|---------|
| $f_T$ | > | 300 MHz |
|-------|---|---------|

Noise figure at  $R_S = 1\text{ k}\Omega$  $I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$  $f = 10\text{ Hz to }15,7\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ 

|     |   |        |
|-----|---|--------|
| $F$ | < | 5,0 dB |
|-----|---|--------|

\* Mounted on a ceramic substrate area =  $2,5\text{ cm}^2$ ; thickness = 0,7 mm.

**h-parameters** (common emitter)
 $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ 

Input impedance

Reverse voltage transfer ratio

Small-signal current gain

Output admittance

|          |                           |
|----------|---------------------------|
| $h_{ie}$ | 1 to 10 $\text{k}\Omega$  |
| $h_{re}$ | 0,5 to $8 \times 10^{-4}$ |
| $h_{fe}$ | 100 to 400                |
| $h_{oe}$ | 1 to 40 $\mu\text{S}$     |

**Switching times**

Turn-on time (see Figs 2 and 3) when switched from

 $-V_{BE\text{off}} = 0,5 \text{ V}$  to  $I_{C\text{on}} = 10 \text{ mA}; I_{B\text{on}} = 1 \text{ mA}$ 

Delay time

Rise time

|       |   |       |
|-------|---|-------|
| $t_d$ | < | 35 ns |
| $t_r$ | < | 35 ns |

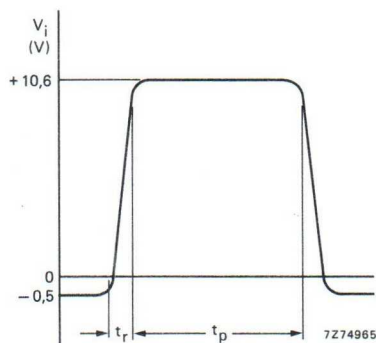


Fig. 2 Input waveform;  $t_r < 1 \text{ ns}$ ;  $t_p = 300 \text{ ns}$ ;  $\delta = 0,02$ .

Turn-off time (see Figs 4 and 5)

 $I_{C\text{on}} = 10 \text{ mA}; I_{B\text{on}} = -I_{B\text{off}} = 1 \text{ mA}$ 

Storage time

Fall time

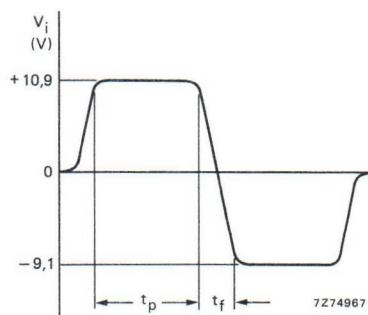


Fig. 4 Input waveform;  $t_f < 1 \text{ ns}$ ;  $10 \mu\text{s} < t_p < 500 \mu\text{s}$ ;  $\delta = 0,02$ .

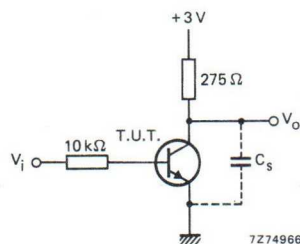


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .

|       |   |        |
|-------|---|--------|
| $t_s$ | < | 200 ns |
| $t_f$ | < | 50 ns  |

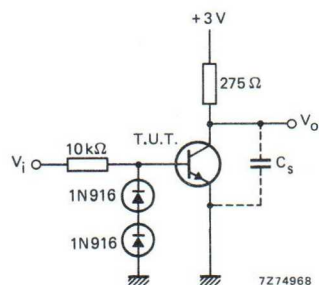


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .





## SILICON PLANAR EPITAXIAL TRANSISTOR

P-N-P transistor in a SOT-89 envelope primarily intended for high-speed, saturated switching applications for industrial service.

## QUICK REFERENCE DATA

|                                                                   |            |      |                        |
|-------------------------------------------------------------------|------------|------|------------------------|
| Collector-base voltage (open emitter)                             | $-V_{CBO}$ | max. | 40 V                   |
| Collector-emitter voltage (open base)                             | $-V_{CEO}$ | max. | 40 V                   |
| Collector current (d.c.)                                          | $-I_C$     | max. | 200 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 1,0 W                  |
| Junction temperature                                              | $T_j$      | max. | 150 $^{\circ}\text{C}$ |
| D.C. current gain                                                 |            |      |                        |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                       | $h_{FE}$   | $>$  | 100                    |
|                                                                   |            | $<$  | 300                    |
| Transition frequency at $f = 100\text{ MHz}$                      |            |      |                        |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$                      | $f_T$      | $>$  | 250 MHz                |
| Storage time                                                      |            |      |                        |
| $-I_{Con} = 10\text{ mA}; -I_{Bon} = I_{Boff} = 1\text{ mA}$      | $t_s$      | $<$  | 225 ns                 |

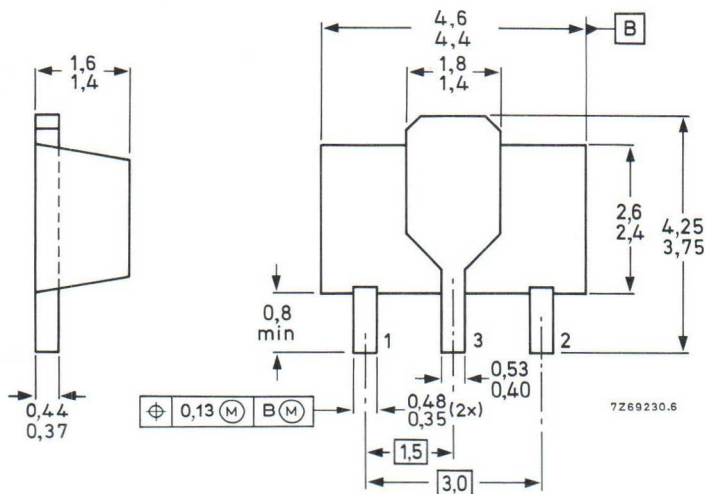
## MECHANICAL DATA

Dimensions in mm

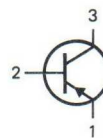
Fig. 1 SOT-89.

Marking code

p2A



BOTTOM VIEW



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |            |      |                                         |
|---------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                               | $-V_{CBO}$ | max. | 40 V                                    |
| Collector-emitter voltage (open base)                               | $-V_{CEO}$ | max. | 40 V                                    |
| Emitter-base voltage (open collector)                               | $-V_{EBO}$ | max. | 5 V                                     |
| Collector current (d.c.)                                            | $-I_C$     | max. | 200 mA                                  |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 1,0 W                                   |
| Storage temperature                                                 | $T_{stg}$  |      | $-55$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$      | max. | $150\text{ }^{\circ}\text{C}$           |

**THERMAL RESISTANCE**

|                                       |               |   |         |
|---------------------------------------|---------------|---|---------|
| From junction to ambient in free air* | $R_{th\ j-a}$ | = | 125 K/W |
|---------------------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Currents at reverse biased emitter junction

|                                               |            |   |       |
|-----------------------------------------------|------------|---|-------|
| $-V_{CE} = 30\text{ V}; +V_{BE} = 3\text{ V}$ | $-I_{CEX}$ | < | 50 nA |
|                                               | $+I_{BEX}$ | < | 50 nA |

Saturation voltages

|                                           |              |   |               |
|-------------------------------------------|--------------|---|---------------|
| $-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$ | $-V_{CEsat}$ | < | 250 mV        |
|                                           | $-V_{BEsat}$ |   | 650 to 850 mV |
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$ | $-V_{CEsat}$ | < | 400 mV        |
|                                           | $-V_{BEsat}$ | < | 950 mV        |

D.C. current gain

|                                              |          |   |     |
|----------------------------------------------|----------|---|-----|
| $-I_C = 0,1\text{ mA}; -V_{CE} = 1\text{ V}$ | $h_{FE}$ | > | 60  |
| $-I_C = 1\text{ mA}; -V_{CE} = 1\text{ V}$   | $h_{FE}$ | > | 80  |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$  | $h_{FE}$ | > | 100 |
| $-I_C = 50\text{ mA}; -V_{CE} = 1\text{ V}$  | $h_{FE}$ | < | 300 |
| $-I_C = 100\text{ mA}; -V_{CE} = 1\text{ V}$ | $h_{FE}$ | > | 60  |
|                                              | $h_{FE}$ | > | 30  |

Collector capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

|                                       |       |   |        |
|---------------------------------------|-------|---|--------|
| $I_E = I_C = 0; -V_{CB} = 5\text{ V}$ | $C_c$ | < | 4,5 pF |
|---------------------------------------|-------|---|--------|

Emitter capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

|                                         |       |   |       |
|-----------------------------------------|-------|---|-------|
| $I_C = I_E = 0; -V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 10 pF |
|-----------------------------------------|-------|---|-------|

Transition frequency at  $f = 100\text{ MHz}$ 

|                                                                                    |       |   |         |
|------------------------------------------------------------------------------------|-------|---|---------|
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $f_T$ | > | 250 MHz |
|------------------------------------------------------------------------------------|-------|---|---------|

Noise figure at  $R_S = 1\text{ k}\Omega$ 

|                                                                             |     |   |        |
|-----------------------------------------------------------------------------|-----|---|--------|
| $-I_C = 100\text{ }\mu\text{A}; -V_{CE} = 5\text{ V}$                       | $F$ | < | 4,0 dB |
| $f = 10\text{ Hz to }15,7\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ |     |   |        |

\* Mounted on a ceramic substrate area =  $2,5\text{ cm}^2$ ; thickness = 0,7 mm.

**h-parameters** (common emitter)

$$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}; T_{\text{amb}} = 25^\circ \text{C}$$

Input impedance

Reverse voltage transfer ratio

Small-signal current gain

Output admittance

|          |                            |
|----------|----------------------------|
| $h_{ie}$ | 2 to 12 $k\Omega$          |
| $h_{re}$ | 0,1 to $10 \times 10^{-4}$ |
| $h_{fe}$ | 100 to 400                 |
| $h_{oe}$ | 3 to 60 $\mu S$            |

**Switching times**

Turn-on time (see Figs 2 and 3) when switched from

$$+V_{BE\text{off}} = 0,5 \text{ V to } -I_{C\text{on}} = 10 \text{ mA}; -I_{B\text{on}} = 1 \text{ mA}$$

Delay time

Rise time

|       |   |       |
|-------|---|-------|
| $t_d$ | < | 35 ns |
| $t_r$ | < | 35 ns |

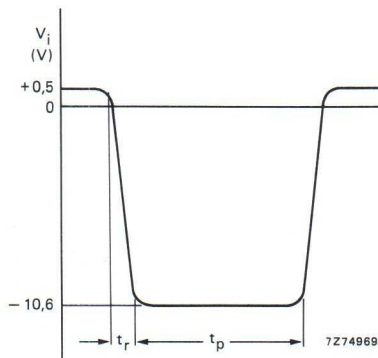


Fig. 2 Input waveform;  $t_r < 1 \text{ ns}$ ;  $t_p = 300 \text{ ns}$ ;  $\delta = 0,02$ .

Turn-off time (see Figs 4 and 5)

$$-I_{C\text{on}} = 10 \text{ mA}; -I_{B\text{on}} = I_{B\text{off}} = 1 \text{ mA}$$

Storage time

Fall time

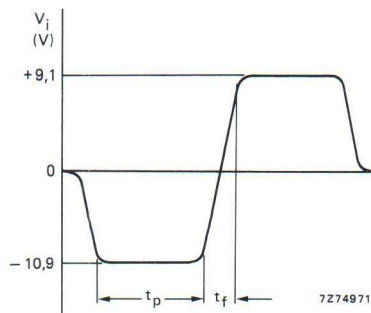


Fig. 4 Input waveform;  $t_f < 1 \text{ ns}$ ;  $10 \mu s < t_p < 500 \mu s$ ;  $\delta = 0,02$ .

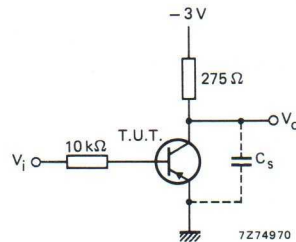


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .

|       |   |        |
|-------|---|--------|
| $t_s$ | < | 225 ns |
| $t_f$ | < | 75 ns  |

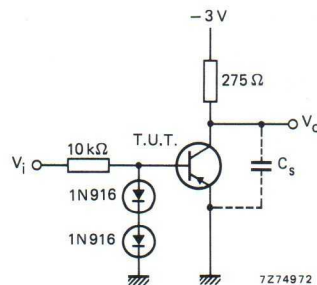


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .



## SILICON PLANAR EPITAXIAL TRANSISTOR

NPN silicon planar epitaxial transistor, housed in a SOT-89 envelope.

It is intended for use in linear, switching, and general purpose applications.

### QUICK REFERENCE DATA

|                                                      |                      |      |         |
|------------------------------------------------------|----------------------|------|---------|
| Collector-emitter voltage                            | $V_{CEO}$            | max. | 40 V    |
| Collector current (DC)                               | $I_C$                | max. | 600 mA  |
| DC current gain                                      | $h_{FE}$             | min. | 100     |
| $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$         |                      | max. | 300     |
| Collector-emitter saturation voltage                 | $V_{CE \text{ sat}}$ | max. | 0.75 V  |
| $I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$          |                      |      |         |
| Total power dissipation                              | $P_{\text{tot}}$     | max. | 1000 mW |
| up to $T_{\text{amb}} = 25 \text{ }^\circ\text{C}^*$ |                      |      |         |

### MECHANICAL DATA

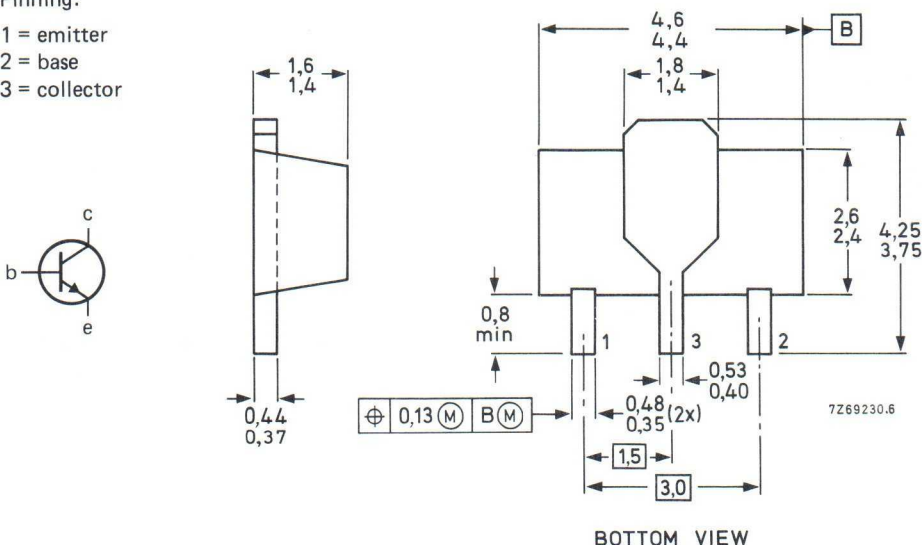
Dimensions in mm

Fig. 1 SOT-89

Marking code = p2X

Pinning:

- 1 = emitter
- 2 = base
- 3 = collector



\* Mounted on a ceramic substrate; area =  $2.5 \text{ cm}^2$ ; thickness = 0.7 mm.



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                         |
|---------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-emitter voltage                                                 | $V_{CEO}$ | max. | 40 V                                    |
| Collector-base voltage                                                    | $V_{CBO}$ | max. | 60 V                                    |
| Emitter-base voltage                                                      | $V_{EBO}$ | max. | 6.0 V                                   |
| Collector current (DC)                                                    | $I_C$     | max. | 600 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 1000 mW                                 |
| Storage temperature range                                                 | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | $150\text{ }^{\circ}\text{C}$           |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 125 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                             |               |      |                          |
|-----------------------------------------------------------------------------|---------------|------|--------------------------|
| Collector-emitter breakdown voltage<br>$I_C = 1.0\text{ mA}; I_B = 0$       | $V_{(BR)CEO}$ | min. | 40 V                     |
| Collector-base breakdown voltage<br>$I_C = 0.1\text{ mA}; I_E = 0$          | $V_{(BR)CBO}$ | min. | 60 V                     |
| Emitter-base breakdown voltage<br>$I_E = 0.1\text{ mA}; I_C = 0$            | $V_{(BR)EBO}$ | min. | 6.0 V                    |
| Base cut-off current<br>$V_{CE} = 35\text{ V}; -V_{EB} = 0.4\text{ V}$      | $I_{BEX}$     | max. | $0.1\text{ }\mu\text{A}$ |
| Collector cut-off current<br>$V_{CE} = 35\text{ V}; -V_{EB} = 0.4\text{ V}$ | $I_{CEX}$     | max. | $0.1\text{ }\mu\text{A}$ |
| DC current gain<br>$I_C = 0.1\text{ mA}; V_{CE} = 1\text{ V}$               | $h_{FE}$      | min. | 20                       |
| $I_C = 1.0\text{ mA}; V_{CE} = 1\text{ V}$                                  | $h_{FE}$      | min. | 40                       |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                                   | $h_{FE}$      | min. | 80                       |
| $I_C = 150\text{ mA}; V_{CE} = 1\text{ V}$                                  | $h_{FE}$      |      | 100 to 300               |
| $I_C = 500\text{ mA}; V_{CE} = 2\text{ V}$                                  | $h_{FE}$      | min. | 40                       |
| Saturation voltage<br>$I_C = 150\text{ mA}; I_B = 15\text{ mA}$             | $V_{CE\ sat}$ | max. | 0.4 V                    |
|                                                                             | $V_{BE\ sat}$ |      | 0.75 to 0.95 V           |
| $I_C = 500\text{ mA}; I_B = 50\text{ mA}$                                   | $V_{CE\ sat}$ | max. | 0.75 V                   |
|                                                                             | $V_{BE\ sat}$ | max. | 1.2 V                    |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

Transition frequency;  $f = 100 \text{ MHz}$ ; $I_C = 20 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ 

|       |      |         |
|-------|------|---------|
| $f_T$ | min. | 250 MHz |
|-------|------|---------|

Collector-base capacitance

 $I_E = 0$ ;  $V_{CB} = 5 \text{ V}$ ;  $f = 100 \text{ kHz}$ 

|          |      |        |
|----------|------|--------|
| $C_{cb}$ | max. | 8.0 pF |
|----------|------|--------|

Emitter-base capacitance

 $I_C = 0$ ;  $V_{BE} = 0.5 \text{ V}$ ;  $f = 100 \text{ kHz}$ 

|          |      |       |
|----------|------|-------|
| $C_{eb}$ | max. | 30 pF |
|----------|------|-------|

Input impedance;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ 

|          |      |                |
|----------|------|----------------|
| $h_{ie}$ | min. | 1.0 k $\Omega$ |
|          | max. | 15 k $\Omega$  |

Voltage feed-back ratio;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ 

|          |      |                      |
|----------|------|----------------------|
| $h_{re}$ | min. | $0.1 \times 10^{-4}$ |
|          | max. | $8.0 \times 10^{-4}$ |

Small-signal current gain;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ 

|          |      |     |
|----------|------|-----|
| $h_{fe}$ | min. | 40  |
|          | max. | 500 |

Output admittance;  $f = 1 \text{ kHz}$ ; $I_C = 1 \text{ mA}$ ;  $V_{CE} = 10 \text{ V}$ 

|          |      |                   |
|----------|------|-------------------|
| $h_{oe}$ | min. | 1.0 $\mu\text{S}$ |
|          | max. | 30 $\mu\text{S}$  |

Switching times (resistive load)

Turn-on time

 $I_C = 150 \text{ mA}$ ;  $I_{B1} = 15 \text{ mA}$ ; $V_{CC} = 30 \text{ V}$ ;  $V_{EB} = 2 \text{ V}$ 

delay time

rise time

|       |      |       |
|-------|------|-------|
| $t_d$ | max. | 15 ns |
|-------|------|-------|

|       |      |       |
|-------|------|-------|
| $t_r$ | max. | 20 ns |
|-------|------|-------|

Turn-off time

 $I_C = 150 \text{ mA}$ ;  $V_{CC} = 30 \text{ V}$ ; $I_{B1} = I_{B2} = 15 \text{ mA}$ 

storage time

fall time

|       |      |        |
|-------|------|--------|
| $t_s$ | max. | 225 ns |
|-------|------|--------|

|       |      |       |
|-------|------|-------|
| $t_f$ | max. | 30 ns |
|-------|------|-------|



# SILICON PLANAR EPITAXIAL TRANSISTOR

PNP silicon planar epitaxial transistor, housed in a SOT89 envelope.

It is intended for linear switching applications.

The complementary type is PXT4401.

## QUICK REFERENCE DATA

|                                                                 |            |      |            |
|-----------------------------------------------------------------|------------|------|------------|
| Collector-emitter voltage                                       | $-V_{CEO}$ | max. | 40 V       |
| Collector current (DC)                                          | $-I_C$     | max. | 600 mA     |
| DC current gain                                                 |            |      |            |
| $-I_C = 0.1 \text{ mA}; -V_{CE} = 1 \text{ V}$                  | $h_{FE}$   | min. | 30         |
| $-I_C = 1.0 \text{ mA}; -V_{CE} = 1 \text{ V}$                  | $h_{FE}$   | min. | 60         |
| $-I_C = 10 \text{ mA}; -V_{CE} = 1 \text{ V}$                   | $h_{FE}$   | min. | 100        |
| $-I_C = 150 \text{ mA}; -V_{CE} = 2 \text{ V}$                  | $h_{FE}$   | min. | 100 to 300 |
| $-I_C = 500 \text{ mA}; -V_{CE} = 2 \text{ V}$                  | $h_{FE}$   | min. | 20         |
| Total power dissipation<br>up to $T_{amb} = 25^\circ\text{C}^*$ | $P_{tot}$  | max. | 1.0 W      |
| Transition frequency at $f = 100 \text{ MHz}$                   |            |      |            |
| $-I_C = 20 \text{ mA}; -V_{CE} = 10 \text{ V}$                  | $f_T$      | min. | 200 MHz    |

## MECHANICAL DATA

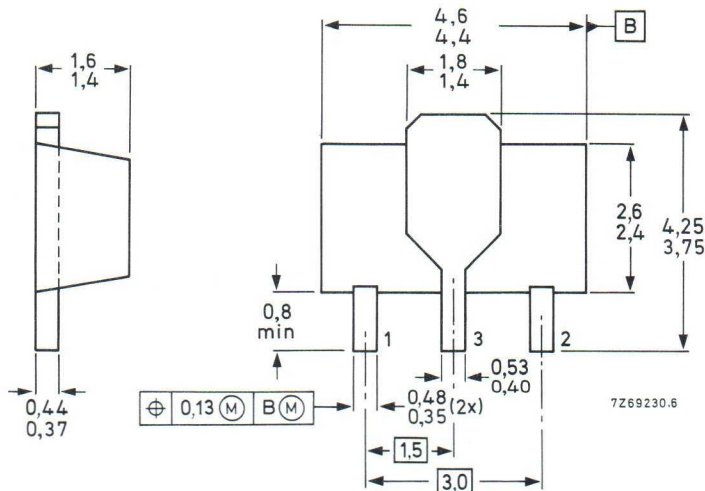
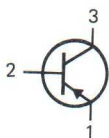
Dimensions in mm

Fig.1 SOT89.

Marking code = p2T

## Pinning

- 1 = emitter  
2 = base  
3 = collector



BOTTOM VIEW

\* Mounted on a ceramic substrate; area = 2.5 cm<sup>2</sup>; thickness = 0.7 mm.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                              |
|---------------------------------------------------------------------------|------------|------|----------------------------------------------|
| Collector-emitter voltage                                                 | $-V_{CEO}$ | max. | 40 V                                         |
| Emitter-base voltage                                                      | $-V_{EBO}$ | max. | 5.0 V                                        |
| Collector-base voltage                                                    | $-V_{CBO}$ | max. | 40 V                                         |
| Collector current (DC)                                                    | $-I_C$     | max. | 600 mA                                       |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 1.0 W                                        |
| Storage temperature range                                                 | $T_{stg}$  |      | $-55\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | 150 $^{\circ}\text{C}$                       |

**THERMAL RESISTANCE**

|                           |             |   |         |
|---------------------------|-------------|---|---------|
| From junction to ambient* | $R_{thj-a}$ | = | 125 K/W |
|---------------------------|-------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector-emitter breakdown voltage

 $-I_C = 1.0\text{ mA}; I_B = 0$ 

|                |      |      |
|----------------|------|------|
| $-V_{(BR)CEO}$ | min. | 40 V |
|----------------|------|------|

Collector-base breakdown voltage

 $-I_C = 100\text{ }\mu\text{A}; I_E = 0$ 

|                |      |      |
|----------------|------|------|
| $-V_{(BR)CBO}$ | min. | 40 V |
|----------------|------|------|

Emitter-base breakdown voltage

 $-I_E = 100\text{ }\mu\text{A}; I_C = 0$ 

|                |      |       |
|----------------|------|-------|
| $-V_{(BR)EBO}$ | min. | 5.0 V |
|----------------|------|-------|

Base cut-off current

 $-V_{CE} = 35\text{ V}; -V_{BE} = 0.4\text{ V}$ 

|            |      |                   |
|------------|------|-------------------|
| $-I_{BEV}$ | max. | 0.1 $\mu\text{A}$ |
|------------|------|-------------------|

Collector cut-off current

 $-V_{CE} = 35\text{ V}; V_{BE} = 0.4\text{ V}$ 

|            |      |                   |
|------------|------|-------------------|
| $-I_{CEX}$ | max. | 0.1 $\mu\text{A}$ |
|------------|------|-------------------|

DC current gain

 $-I_C = 0.1\text{ mA}; -V_{CE} = 1\text{ V}$ 

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 30 |
|----------|------|----|

 $-I_C = 1.0\text{ mA}; -V_{CE} = 1\text{ V}$ 

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 60 |
|----------|------|----|

 $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$ 

|          |      |     |
|----------|------|-----|
| $h_{FE}$ | min. | 100 |
|----------|------|-----|

 $-I_C = 150\text{ mA}; -V_{CE} = 2\text{ V}$ 

|          |      |            |
|----------|------|------------|
| $h_{FE}$ | min. | 100 to 300 |
|----------|------|------------|

 $-I_C = 500\text{ mA}; -V_{CE} = 2\text{ V}$ 

|          |      |    |
|----------|------|----|
| $h_{FE}$ | min. | 20 |
|----------|------|----|

Saturation voltage

 $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$ 

|                      |      |       |
|----------------------|------|-------|
| $-V_{CE\text{ sat}}$ | max. | 0.4 V |
|----------------------|------|-------|

|                      |  |                |
|----------------------|--|----------------|
| $-V_{BE\text{ sat}}$ |  | 0.70 to 0.95 V |
|----------------------|--|----------------|

 $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$ 

|                      |      |        |
|----------------------|------|--------|
| $-V_{CE\text{ sat}}$ | max. | 0.75 V |
|----------------------|------|--------|

|                      |      |       |
|----------------------|------|-------|
| $-V_{BE\text{ sat}}$ | max. | 1.3 V |
|----------------------|------|-------|

Transition frequency at  $f = 100\text{ MHz}$  $-I_C = 20\text{ mA}; -V_{CE} = 10\text{ V}$ 

|       |      |         |
|-------|------|---------|
| $f_T$ | min. | 200 MHz |
|-------|------|---------|

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

## Collector-base capacitance

 $-V_{CB} = 10 \text{ V}; I_E = 0; f = 0.14 \text{ MHz}$ 

|          |      |        |
|----------|------|--------|
| $C_{cb}$ | max. | 8.5 pF |
|----------|------|--------|

## Emitter-base capacitance

 $-V_{EB} = 0.5 \text{ V}; I_C = 0; f = 0.14 \text{ MHz}$ 

|          |      |       |
|----------|------|-------|
| $C_{eb}$ | max. | 35 pF |
|----------|------|-------|

## Input impedance

 $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

|          |  |                      |
|----------|--|----------------------|
| $h_{ie}$ |  | 1.5 to 15 k $\Omega$ |
|----------|--|----------------------|

## Voltage feedback ratio

 $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

|          |  |                                      |
|----------|--|--------------------------------------|
| $h_{re}$ |  | $0.1 \text{ to } 8.0 \times 10^{-4}$ |
|----------|--|--------------------------------------|

## Small-signal current gain

 $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

|          |  |           |
|----------|--|-----------|
| $h_{fe}$ |  | 60 to 500 |
|----------|--|-----------|

## Output admittance

 $-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}$ 

|          |  |                          |
|----------|--|--------------------------|
| $h_{oe}$ |  | 1.0 to 100 $\mu\text{S}$ |
|----------|--|--------------------------|

**SWITCHING CHARACTERISTICS**

## Turn-on time

 $-I_C = 150 \text{ mA}; -I_{B1} = 15 \text{ mA}$  $-V_{CC} = 30 \text{ V}; -V_{BE} = 2 \text{ V}$ 

## Delay time

|       |      |       |
|-------|------|-------|
| $t_d$ | max. | 15 ns |
|-------|------|-------|

## Rise time

|       |      |       |
|-------|------|-------|
| $t_r$ | max. | 20 ns |
|-------|------|-------|

## Turn-off time

 $-I_C = 150 \text{ mA}; -I_{B1} = I_{B2} = 15 \text{ mA}$  $-V_{CC} = 30 \text{ V}$ 

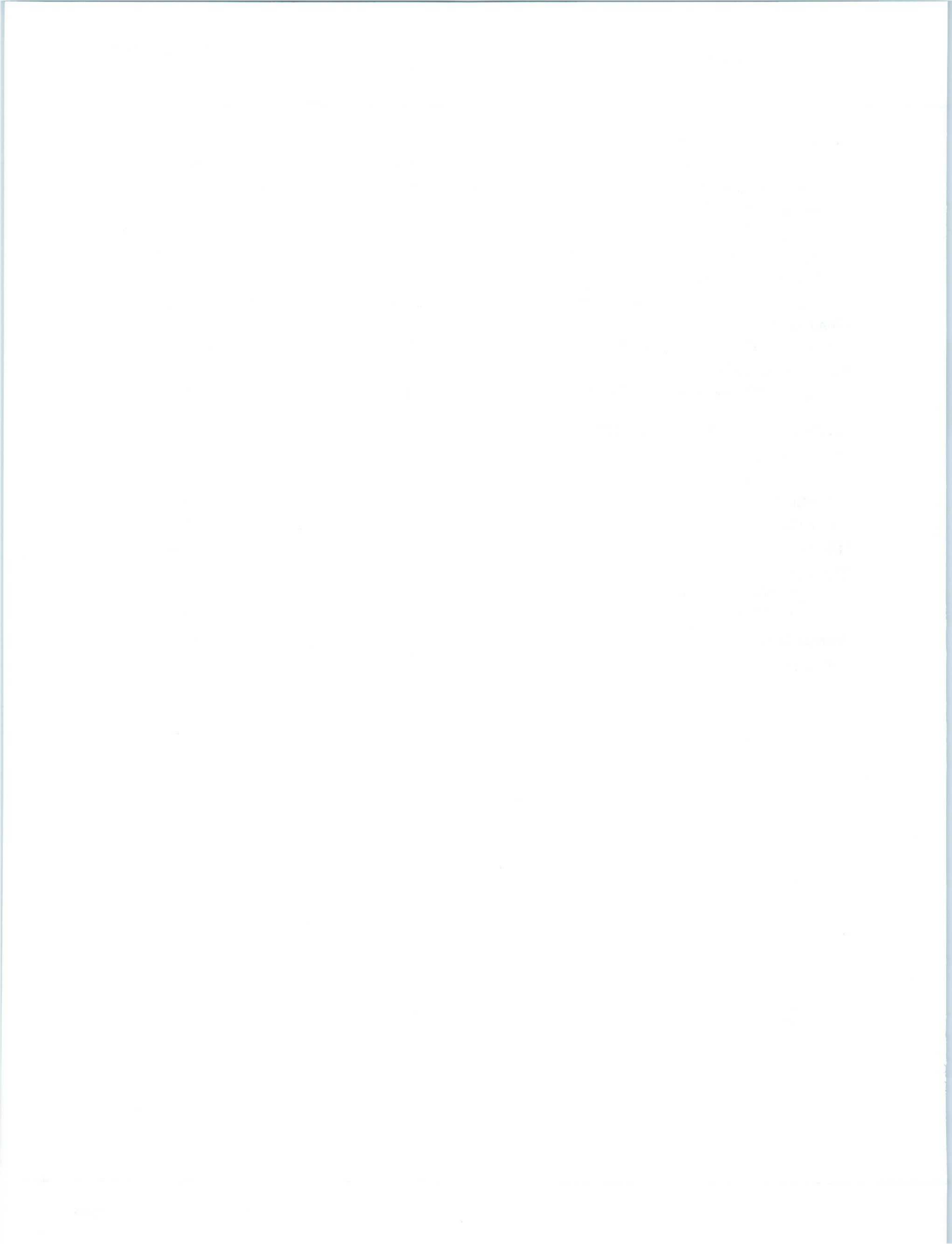
## Storage time

|       |      |        |
|-------|------|--------|
| $t_s$ | max. | 225 ns |
|-------|------|--------|

## Fall time

|       |      |       |
|-------|------|-------|
| $t_f$ | max. | 30 ns |
|-------|------|-------|





## NPN SMALL-SIGNAL DARLINGTON TRANSISTOR

NPN small-signal darlington transistor, housed in a microminiature envelope (SOT-89).

It is intended primarily for use in preamplifier input applications requiring a high input impedance.

The complementary type is the PXTA64.

### QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

$V_{CES}$  max. 30 V

Collector current (DC)

$I_C$  max. 300 mA

DC current gain

$$I_C = 100 \text{ mA}; V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 20 000

Total power dissipation

$$\text{up to } T_{amb} = 25 \text{ }^{\circ}\text{C}^*$$

$P_{tot}$  max. 1.0 W

Transition frequency at  $f = 100 \text{ MHz}$ ;

$$I_C = 30 \text{ mA}; V_{CE} = 5 \text{ V}$$

$f_T$  min. 125 MHz

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89.

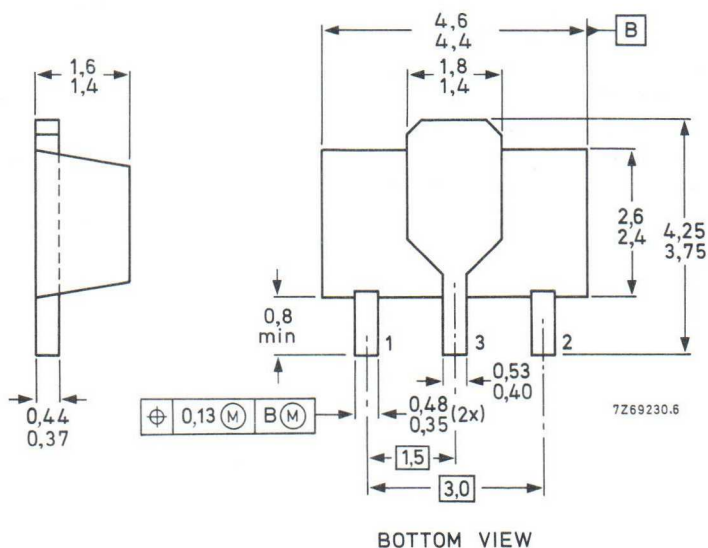
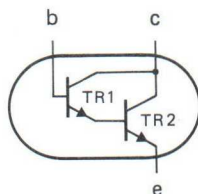
Marking code = p1N

Pinning:

1 = emitter

2 = collector

3 = base



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |                                 |                        |
|---------------------------------------------------------------------------|-----------|---------------------------------|------------------------|
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $V_{CES}$ | max.                            | 30 V                   |
| Collector-base voltage (open emitter)                                     | $V_{CBO}$ | max.                            | 30 V                   |
| Emitter-base voltage (open collector)                                     | $V_{EBO}$ | max.                            | 10 V                   |
| Collector current (DC)                                                    | $I_C$     | max.                            | 300 mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max.                            | 1.0 W                  |
| Storage temperature range                                                 | $T_{stg}$ | —65 to + 150 $^{\circ}\text{C}$ |                        |
| Junction temperature                                                      | $T_j$     | max.                            | 150 $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 125 K/W |
|---------------------------|---------------|---|---------|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                            |                      |                            |                   |
|------------------------------------------------------------------------------------------------------------|----------------------|----------------------------|-------------------|
| Collector-emitter breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}$                                      | $V_{(BR)CES}$        | min.                       | 30 V              |
| Emitter-base cut-off current<br>$V_{BE} = 10\text{ V}$                                                     | $I_{EBO}$            | max.                       | 0.1 $\mu\text{A}$ |
| Collector-base cut-off current<br>$V_{CB} = 30\text{ V}$                                                   | $I_{CBO}$            | max.                       | 0.1 $\mu\text{A}$ |
| DC current gain<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$<br>$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$ | $h_{FE}$<br>$h_{FE}$ | min. 10 000<br>min. 20 000 |                   |
| Collector-emitter saturation voltage<br>$I_C = 100\text{ mA}; I_B = 0.1\text{ mA}$                         | $V_{CE\ sat}$        | max.                       | 1.5 V             |
| Base-emitter on-state voltage<br>$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                                | $V_{BE(on)}$         | max.                       | 2.0 V             |
| Transition frequency at $f = 100\text{ MHz}$ ;<br>$I_C = 30\text{ mA}; V_{CE} = 5\text{ V}$                | $f_T$                | min.                       | 125 MHz           |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

## SMALL-SIGNAL DARLINGTON TRANSISTOR

NPN small-signal darlington transistors, housed in a microminiature envelope (SOT89).

The complementary type is the PXTA77.

### QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

$V_{CES}$  max. 60 V

Collector current (DC)

$I_C$  max. 500 mA

DC current gain

$$I_C = 10 \text{ mA}; V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 10000

$$I_C = 100 \text{ mA}; V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 10000

Total power dissipation

$$\text{up to } T_{amb} = 25 \text{ }^\circ\text{C}^*$$

$P_{tot}$  max. 1.0 W

Transition frequency at  $f = 100 \text{ MHz}$

$$I_C = 30 \text{ mA}; V_{CE} = 5 \text{ V}$$

$f_T$  min. 125 MHz

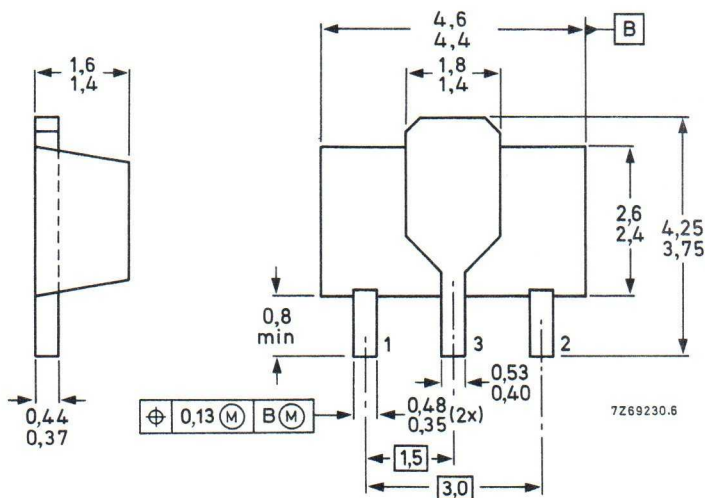
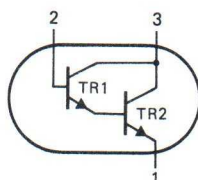
### MECHANICAL DATA

Dimensions in mm

Fig.1 SOT89.

#### Pinning

- 1 = emitter
- 2 = collector
- 3 = base



BOTTOM VIEW

\* Mounted on a ceramic substrate; area = 2.5 cm<sup>2</sup>; thickness = 0.7 mm.

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage

$V_{BE} = 0$

$V_{CES}$  max. 60 V

Emitter-base voltage (open collector)

$V_{EBO}$  max. 10 V

Collector current (DC)

$I_C$  max. 500 mA

Total power dissipation

up to  $T_{amb} = 25\text{ }^{\circ}\text{C}^*$

$P_{tot}$  max. 1.0 W

Storage temperature range

$T_{stg}$   $-55$  to  $+150\text{ }^{\circ}\text{C}$

Junction temperature

$T_j$  max.  $150\text{ }^{\circ}\text{C}$

**THERMAL RESISTANCE**

From junction to ambient\*

$R_{thj-a}$  = 125 K/W

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector-emitter breakdown voltage

$I_C = 100\text{ }\mu\text{A}; -V_{BE} = 0$

$V_{(BR)CES}$  min. 60 V

Collector-base breakdown voltage

$I_C = 100\text{ }\mu\text{A}; I_E = 0$

$V_{(BR)CBO}$  min. 60 V

Emitter-base cut-off current

$V_{BE} = 10\text{ V}; I_C = 0$

$I_{EBO}$  max.  $0.1\text{ }\mu\text{A}$

Collector-base cut-off current

$V_{CB} = 50\text{ V}; I_E = 0$

$I_{CBO}$  max.  $0.1\text{ }\mu\text{A}$

Collector-emitter cut-off current

$V_{CB} = 50\text{ V}; V_{BE} = 0$

$I_{CES}$  max.  $0.5\text{ }\mu\text{A}$

DC current gain

$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE}$  min. 10000

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

$h_{FE}$  min. 10000

Collector-emitter saturation voltage

$I_C = 100\text{ mA}; I_B = 0.1\text{ mA}$

$V_{CE\text{ sat}}$  max. 1.5 V

Base-emitter on-state voltage

$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$

$V_{BE(on)}$  max. 2.0 V

Transition frequency at  $f = 100\text{ MHz}$ 

$I_C = 30\text{ mA}; V_{CE} = 5\text{ V} /$

$f_T$  min. 125 MHz

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

## PNP SMALL-SIGNAL DARLINGTON TRANSISTOR

PNP small-signal darlington transistor, housed in a microminiature envelope (SOT-89).

It is intended primarily for use in preamplifier input applications requiring high input impedance.

The complementary type is the PXTA14.

## QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

$-V_{CES}$  max. 30 V

Collector current (DC)

$-I_C$  max. 300 mA

DC current gain

$$-I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 10.000

Total power dissipation

$$\text{up to } T_{amb} = 25 \text{ }^\circ\text{C}^*$$

$P_{tot}$  max. 1.0 W

Transition frequency at  $f = 100 \text{ MHz}$ ;

$$-I_C = 100 \text{ mA}; -V_{CE} = 5 \text{ V}$$

$f_T$  min. 125 MHz

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-89

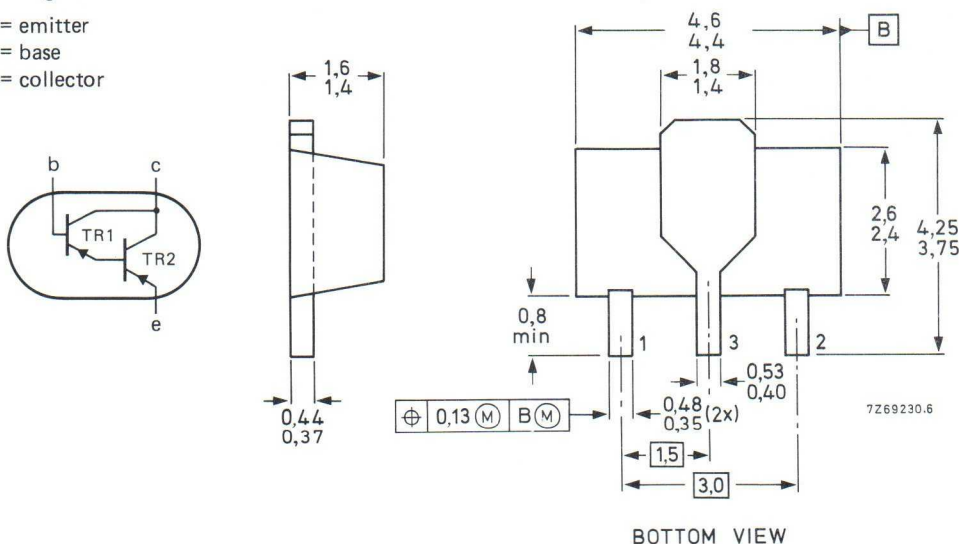
Marking code = p2V

Pinning:

1 = emitter

2 = base

3 = collector



\* Mounted on a ceramic substrate; area =  $2.5 \text{ cm}^2$ ; thickness = 0.7 mm.



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                         |            |      |             |                    |
|-------------------------------------------------------------------------|------------|------|-------------|--------------------|
| Collector-emitter voltage<br>$V_{BE} = 0$                               | $-V_{CES}$ | max. | 30          | V                  |
| Collector-base voltage (open emitter)                                   | $-V_{CBO}$ | max. | 30          | V                  |
| Emitter-base voltage (open collector)                                   | $-V_{EBO}$ | max. | 10          | V                  |
| Collector current (DC)                                                  | $-I_C$     | max. | 300         | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 1.0         | W                  |
| Storage temperature range                                               | $T_{stg}$  |      | -65 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                    | $T_j$      | max. | 150         | $^{\circ}\text{C}$ |

**THERMAL RESISTANCE**

|                           |               |   |     |     |
|---------------------------|---------------|---|-----|-----|
| From junction to ambient* | $R_{th\ j-a}$ | = | 125 | K/W |
|---------------------------|---------------|---|-----|-----|

**CHARACTERISTICS** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                |                      |      |                  |               |
|----------------------------------------------------------------------------------------------------------------|----------------------|------|------------------|---------------|
| Collector-emitter breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}$                                         | $-V_{(BR)CES}$       | min. | 30               | V             |
| Emitter-base cut-off current<br>$-V_{BE} = 10\text{ V}$                                                        | $-I_{EBO}$           | max. | 0.1              | $\mu\text{A}$ |
| Collector-base cut-off current<br>$-V_{CB} = 30\text{ V}$                                                      | $-I_{CBO}$           | max. | 0.1              | $\mu\text{A}$ |
| DC current gain<br>$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$ | $h_{FE}$<br>$h_{FE}$ | min. | 10.000<br>20.000 |               |
| Collector-emitter saturation voltage<br>$-I_C = 100\text{ mA}; -I_B = 0.1\text{ mA}$                           | $-V_{CEsat}$         | max. | 1.5              | V             |
| Base-emitter on-state voltage<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                  | $-V_{BE(on)}$        | max. | 2.0              | V             |
| Transition frequency at $f = 100\text{ MHz}$ ;<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                 | $f_T$                | min. | 125              | MHz           |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

## SMALL-SIGNAL DARLINGTON TRANSISTOR

PNP small-signal darlington transistors, housed in a microminiature envelope (SOT89).

The complementary type is the PXTA27.

### QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

$-V_{CES}$  max. 60 V

Collector current (DC)

$-I_C$  max. 500 mA

DC current gain

$$-I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 10 000

$$-I_C = 100 \text{ mA}; -V_{CE} = 5 \text{ V}$$

$h_{FE}$  min. 10 000

Total power dissipation

$$\text{up to } T_{amb} = 25 \text{ }^{\circ}\text{C}^*$$

$P_{tot}$  max. 1.0 W

Transition frequency at  $f = 100 \text{ MHz}$

$$-I_C = 30 \text{ mA}; -V_{CE} = 5 \text{ V}$$

$f_T$  min. 125 MHz

### MECHANICAL DATA

Dimensions in mm

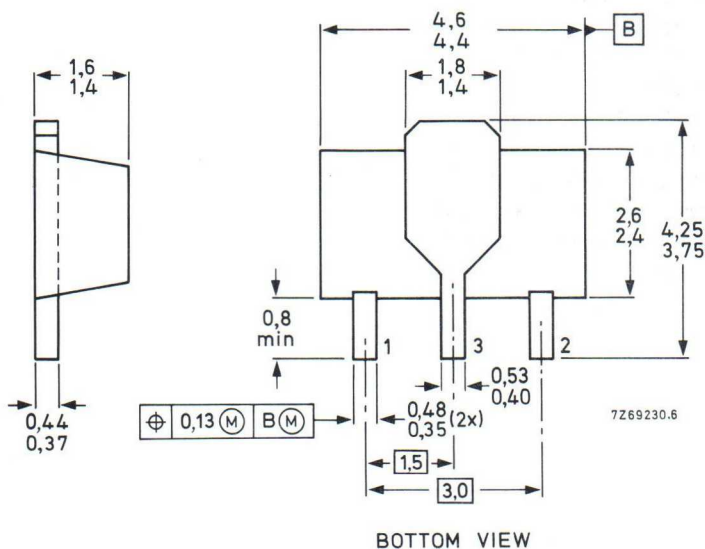
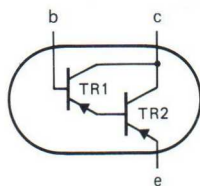
Fig.1 SOT89.

#### Pinning

1 = emitter

2 = base

3 = collector



\* Mounted on a ceramic substrate; area = 2.5 cm<sup>2</sup>; thickness = 0.7 mm.

# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                              |
|---------------------------------------------------------------------------|------------|------|----------------------------------------------|
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $-V_{CES}$ | max. | 60 V                                         |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 10 V                                         |
| Collector current (DC)                                                    | $-I_C$     | max. | 500 mA                                       |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 1.0 W                                        |
| Storage temperature range                                                 | $T_{stg}$  |      | $-55\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | 150 $^{\circ}\text{C}$                       |

# THERMAL RESISTANCE

|                           |               |   |         |
|---------------------------|---------------|---|---------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 125 K/W |
|---------------------------|---------------|---|---------|

# CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                |                      |      |                   |
|----------------------------------------------------------------------------------------------------------------|----------------------|------|-------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}; V_{BE} = 0$                             | $-V_{(BR)CES}$       | min. | 60 V              |
| Collector-base breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}; I_E = 0$                                   | $-V_{(BR)CBO}$       | min. | 60 V              |
| Emitter-base cut-off current<br>$-V_{BE} = 10\text{ V}; I_C = 0$                                               | $-I_{EBO}$           | max. | 0.1 $\mu\text{A}$ |
| Collector-base cut-off current<br>$-V_{CB} = 50\text{ V}; I_E = 0$                                             | $-I_{CBO}$           | max. | 0.1 $\mu\text{A}$ |
| Collector-emitter cut-off current<br>$-V_{CB} = 50\text{ V}; V_{BE} = 0$                                       | $-I_{CES}$           | max. | 0.5 $\mu\text{A}$ |
| DC current gain<br>$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$ | $h_{FE}$<br>$h_{FE}$ | min. | 10 000<br>10 000  |
| Collector-emitter saturation voltage<br>$-I_C = 100\text{ mA}; -I_B = 0.1\text{ mA}$                           | $-V_{CE\ sat}$       | max. | 1.5 V             |
| Base-emitter on-state voltage<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                  | $-V_{BE\ (on)}$      | max. | 2.0 V             |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 30\text{ mA}; -V_{CE} = 5\text{ V}$                    | $f_T$                | min. | 125 MHz           |

\* Mounted on a ceramic substrate; area =  $2.5\text{ cm}^2$ ; thickness = 0.7 mm.

# SILICON EPITAXIAL TRANSISTORS

PNP high voltage transistors in a SOT89 envelope, intended for surface-mounted applications. They are primarily intended for use in telephony and professional communications equipment.

## QUICK REFERENCE DATA

|                                                            |            |      | PXTA92 | PXTA93 |     |
|------------------------------------------------------------|------------|------|--------|--------|-----|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ | max. | 300    | 200    | V   |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ | max. | 300    | 200    | V   |
| Emitter-base voltage (open collector)                      | $-V_{EBO}$ | max. |        | 5      | V   |
| Collector current (DC)                                     | $-I_C$     | max. |        | 500    | mA  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. |        | 1.0    | W   |
| DC current gain                                            |            |      |        |        |     |
| $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$               | $h_{FE}$   | min. |        | 40     |     |
| Transition frequency at $f = 100\text{ MHz}$               |            |      |        |        |     |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$               | $f_T$      | min. |        | 50     | MHz |
| Collector-base capacitance at $f = 1\text{ MHz}$           |            |      |        |        |     |
| $I_E = 0; -V_{CB} = 20\text{ V}$                           | $C_{cb}$   | max. | 6      | 8      | pF  |

## MECHANICAL DATA

Fig.1 SOT89.

### Marking code

PXTA92: p2D

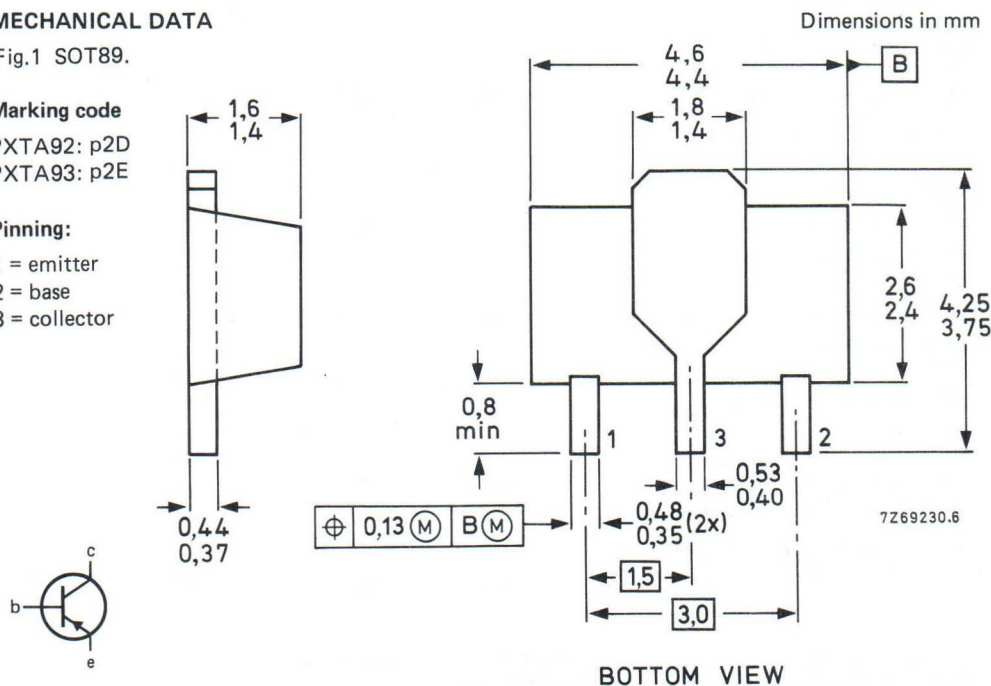
PXTA93: p2E

### Pinning:

1 = emitter

2 = base

3 = collector



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                 |            |      | PXTA92      | PXTA93           |
|-----------------------------------------------------------------|------------|------|-------------|------------------|
| Collector-base voltage (open emitter)                           | $-V_{CBO}$ | max. | 300         | 200 V            |
| Collector-emitter voltage (open base)                           | $-V_{CEO}$ | max. | 300         | 200 V            |
| Emitter-base voltage (open collector)                           | $-V_{EBO}$ | max. | 5           | V                |
| Collector current (DC)                                          | $-I_C$     | max. | 500         | mA               |
| Total power dissipation *<br>up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 1.0         | W                |
| Storage temperature range                                       | $T_{stg}$  |      | -65 to +150 | $^\circ\text{C}$ |
| Junction temperature                                            | $T_j$      | max. | 150         | $^\circ\text{C}$ |

## THERMAL CHARACTERISTICS

Thermal resistance

from junction to ambient\*

|               |   |     |     |
|---------------|---|-----|-----|
| $R_{th\ j-a}$ | = | 125 | K/W |
|---------------|---|-----|-----|

## CHARACTERISTICS

$T_{amb} = 25^\circ\text{C}$  unless otherwise specified

|                                                                                                                                                                  |                              |                      | PXTA92         | PXTA93                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------|----------------|---------------------------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 1\text{ mA}; I_B = 0$                                                                                             | $-V_{(BR)CEO}$               | min.                 | 300            | 200 V                                 |
| Collector-base breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}; I_E = 0$                                                                                     | $-V_{(BR)CBO}$               | min.                 | 300            | 200 V                                 |
| Collector cut-off current<br>$-V_{CB} = 200\text{ V}; I_E = 0$<br>$-V_{CB} = 160\text{ V}; I_E = 0$                                                              | $-I_{CBO}$                   | max.<br>max.         | 0.25<br>—      | — $\mu\text{A}$<br>0.25 $\mu\text{A}$ |
| Emitter-base breakdown voltage<br>$-I_E = 100\text{ }\mu\text{A}; I_C = 0$                                                                                       | $-V_{(BR)EBO}$               | min.                 | 5              | V                                     |
| Emitter cut-off current<br>$I_C = 0; -V_{BE} = 3\text{ V}$                                                                                                       | $-I_{EBO}$                   | max.                 | 0.1            | $\mu\text{A}$                         |
| Collector-base capacitance<br>at $f = 1\text{ MHz}$ ;<br>$I_E = 0; -V_{CB} = 20\text{ V}$                                                                        | $C_{cb}$                     | max.                 | 6              | 8 pF                                  |
| Saturation voltages<br>$-I_C = 20\text{ mA}; -I_B = 2\text{ mA}$<br>$-I_C = 20\text{ mA}; -I_B = 2\text{ mA}$                                                    | $-V_{CEsat}$<br>$-V_{BEsat}$ | max.<br>max.         | 0.5<br>0.9     | V<br>V                                |
| DC current gain**<br>$-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$<br>$-I_C = 30\text{ mA}; -V_{CE} = 10\text{ V}$ | $h_{FE}$                     | min.<br>min.<br>min. | 25<br>40<br>25 |                                       |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$                                                                     | $f_T$                        | min.                 | 50             | MHz                                   |

\* Device mounted on a ceramic substrate; area  $2.5\text{ cm}^2$ ; thickness 0.7 mm.

\*\* Pulse test conditions:  $t_p = 300\text{ }\mu\text{s}$ ; duty factor  $\leq 2\%$ .



## SILICON PLANAR EPITAXIAL TRANSISTORS

NPN silicon planar epitaxial transistors in a microminiature SMD envelope (SOT-223), primarily intended for linear and switching applications.

PNP complements are PZT2907/2907A.

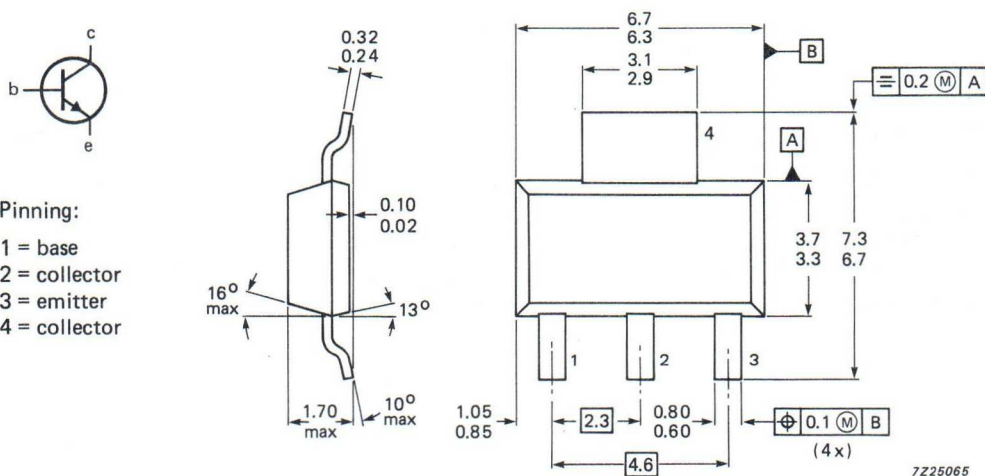
### QUICK REFERENCE DATA

|                                                                                   |             |              | PZT2222    | PZT2222A |
|-----------------------------------------------------------------------------------|-------------|--------------|------------|----------|
| Collector-emitter voltage<br>(open base)                                          | $V_{CEO}$   | max.         | 30         | 40 V     |
| Collector-base voltage<br>(open emitter)                                          | $V_{CBO}$   | max.         | 60         | 75 V     |
| Collector current (DC)                                                            | $I_C$       | max.         | 600        | mA       |
| Total power dissipation<br>up to $T_{amb} = 25^\circ\text{C}$ *                   | $P_{tot}$   | max.         | 1,5        | W        |
| Collector-emitter saturation voltage<br>$I_C = 150\text{ mA}; I_B = 15\text{ mA}$ | $V_{CEsat}$ | max.         | 0,4        | 0,3 V    |
| DC current gain<br>$I_C = 150\text{ mA}; V_{CE} = 10\text{ V}$                    | $h_{FE}$    | min.<br>max. | 100<br>300 |          |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



7225065



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      | PZT2222     | PZT2222A           |
|---------------------------------------------------------------------------|-----------|------|-------------|--------------------|
| Collector-emitter voltage<br>(open base)                                  | $V_{CEO}$ | max. | 30          | 40 V               |
| Collector-base voltage<br>(open emitter)                                  | $V_{CBO}$ | max. | 60          | 75 V               |
| Emitter-base voltage<br>(open collector)                                  | $V_{EBO}$ | max. | 5,0         | 6,0 V              |
| Collector current (DC)                                                    | $I_C$     | max. | 600         | mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ * | $P_{tot}$ | max. | 1,5         | W                  |
| Storage temperature range                                                 | $T_{stg}$ |      | -55 to +150 | $^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150         | $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

From junction to ambient in free air \*

|               |   |      |     |
|---------------|---|------|-----|
| $R_{th\ j-a}$ | = | 83,3 | K/W |
|---------------|---|------|-----|

# CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                               |               |       | PZT2222 | PZT2222A         |
|-------------------------------------------------------------------------------|---------------|-------|---------|------------------|
| Collector-emitter breakdown voltage<br>$I_B = 0$ ; $I_C = 10\text{ mA}$       | $V_{(BR)CEO}$ | min.  | 30      | 40 V             |
| Collector-base breakdown voltage<br>$I_E = 0$ ; $I_C = 10\text{ }\mu\text{A}$ | $V_{(BR)CBO}$ | min.  | 60      | 75 V             |
| Emitter-base breakdown voltage<br>$I_E = 10\text{ }\mu\text{A}$ ; $I_C = 0$   | $V_{(BR)EBO}$ | min.  | 5,0     | 6,0 V            |
| Base cut-off current<br>$V_{CE} = 60\text{ V}$ ; $-V_{BE} = 3\text{ V}$       | $I_{BEX}$     | max.  | —       | 20 nA            |
| Collector cut-off current<br>$V_{CE} = 60\text{ V}$ ; $-V_{BE} = 3\text{ V}$  | $I_{CEX}$     | r ax. | —       | 10 nA            |
| Emitter cut-off current<br>$I_C = 0$ ; $V_{EB} = 3\text{ V}$                  | $I_{EBO}$     | max.  | —       | 10 nA            |
| Collector cut-off current<br>$I_E = 0$ ; $V_{CB} = 50\text{ V}$               | $I_{CBO}$     | max.  | 10      | — nA             |
| $I_E = 0$ ; $V_{CB} = 60\text{ V}$                                            | $I_{CBO}$     | max.  | —       | 10 nA            |
| $I_E = 0$ ; $V_{CB} = 50\text{ V}$ ; $T_{amb} = 125\text{ }^{\circ}\text{C}$  | $I_{CBO}$     | max.  | 10      | — $\mu\text{A}$  |
| $I_E = 0$ ; $V_{CB} = 60\text{ V}$ ; $T_{amb} = 125\text{ }^{\circ}\text{C}$  | $I_{CBO}$     | max.  | —       | 10 $\mu\text{A}$ |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

|                                                                           |             |              | PZT2222    | PZT2222A             |
|---------------------------------------------------------------------------|-------------|--------------|------------|----------------------|
| DC current gain                                                           |             |              |            |                      |
| $I_C = 0,1 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$    | min.         | 35         |                      |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$                               | $h_{FE}$    | min.         | 50         |                      |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$                              | $h_{FE}$    | min.         | 75         |                      |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = -55^\circ\text{C}$ | $h_{FE}$    | min.         | —          | 35                   |
| $I_C = 150 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$    | min.<br>max. | 100<br>300 |                      |
| $I_C = 150 \text{ mA}; V_{CE} = 1 \text{ V}$                              | $h_{FE}$    | min.         | 50         |                      |
| $I_C = 500 \text{ mA}; V_{CE} = 10 \text{ V}$                             | $h_{FE}$    | min.         | 30         | 40                   |
| Saturation voltages                                                       |             |              |            |                      |
| $I_C = 150 \text{ mA}; I_B = 15 \text{ mA}$                               | $V_{CEsat}$ | max.         | 0,4        | 0,3 V                |
| $I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$                               | $V_{CEsat}$ | min.         | 1,6        | 1,0 V                |
| $I_C = 150 \text{ mA}; I_B = 15 \text{ mA}$                               | $V_{BEsat}$ | max.         | 1,3        | — V                  |
| $I_C = 150 \text{ mA}; I_B = 15 \text{ mA}$                               | $V_{BEsat}$ | min.         |            | 0,6 V                |
|                                                                           | $V_{BEsat}$ | max.         |            | 1,2 V                |
| $I_C = 500 \text{ mA}; I_B = 50 \text{ mA}$                               | $V_{BEsat}$ | max.         | 2,6        | 2,0 V                |
| Transition frequency at $f = 100 \text{ MHz}$                             |             |              |            |                      |
| $I_C = 20 \text{ mA}; V_{CE} = 20 \text{ V}; T_{amb} = 25^\circ\text{C}$  | $f_T$       | min.         | 250        | 300 MHz              |
| Output capacitance at $f = 1 \text{ MHz}$                                 |             |              |            |                      |
| $I_E = 0; V_{CB} = 10 \text{ V}$                                          | $C_C$       | max.         | 8,0        | pF                   |
| Input capacitance at $f = 1 \text{ MHz}$                                  |             |              |            |                      |
| $I_C = 0; V_{EB} = 0,5 \text{ V}$                                         | $C_e$       | max.         | 30         | 25 pF                |
| Input impedance at $f = 1 \text{ kHz}$                                    |             |              |            |                      |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$   | $h_{ie}$    | min.         | —          | 2,0 k $\Omega$       |
|                                                                           |             | max.         | —          | 8,0 k $\Omega$       |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$  | $h_{ie}$    | min.         | —          | 0,25 k $\Omega$      |
|                                                                           |             | max.         | —          | 1,25 k $\Omega$      |
| Voltage feedback ratio at $f = 1 \text{ kHz}$                             |             |              |            |                      |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$   | $h_{re}$    | max.         | —          | $8,0 \times 10^{-4}$ |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$  | $h_{re}$    | max.         | —          | $4,0 \times 10^{-4}$ |
| Small-signal current gain at $f = 1 \text{ kHz}$                          |             |              |            |                      |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$   | $h_{fe}$    | min.         | —          | 50                   |
|                                                                           |             | max.         | —          | 300                  |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$  | $h_{fe}$    | min.         | —          | 75                   |
|                                                                           |             | max.         | —          | 375                  |
| Output admittance at $f = 1 \text{ kHz}$                                  |             |              |            |                      |
| $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$   | $h_{oe}$    | min.         | —          | 5,0 $\mu\text{mhos}$ |
|                                                                           |             | max.         | —          | 35 $\mu\text{mhos}$  |
| $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}; T_{amb} = 25^\circ\text{C}$  | $h_{oe}$    | min.         | —          | 25 $\mu\text{mhos}$  |
|                                                                           |             | max.         | —          | 200 $\mu\text{mhos}$ |

**PZT2222A**

Noise figure at  $R_S = 1 \text{ k}\Omega$   
 $I_C = 100 \mu\text{A}$ ;  $V_{CE} = 10 \text{ V}$ ;  
 $f = 1 \text{ kHz}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

|   |      |        |
|---|------|--------|
| F | max. | 4,0 dB |
|---|------|--------|

**Switching times at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$**

Turn-on time (see Fig. 2)

$I_C = 150 \text{ mA}$ ;  $I_{\text{Bon}} = 15 \text{ mA}$   
 $V_{CC} = 30 \text{ V}$ ;  $V_{\text{EB(off)}} = 0,5 \text{ V}$

delay time

|       |      |       |
|-------|------|-------|
| $t_d$ | max. | 10 ns |
|-------|------|-------|

rise time

|       |      |       |
|-------|------|-------|
| $t_r$ | max. | 25 ns |
|-------|------|-------|

Turn-off time (see Fig. 3)

$I_C = 150 \text{ mA}$ ;  $I_{\text{Bon}} = I_{\text{Boff}} = 15 \text{ mA}$   
 $V_{CC} = 30 \text{ V}$

storage time

|       |      |        |
|-------|------|--------|
| $t_s$ | max. | 225 ns |
|-------|------|--------|

fall time

|       |      |       |
|-------|------|-------|
| $t_f$ | max. | 60 ns |
|-------|------|-------|

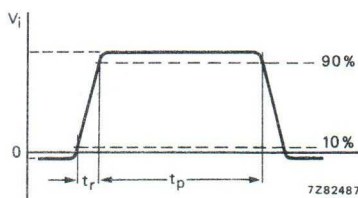


Fig. 2 Input waveform and test circuit for determining delay time and rise time.

$V_i = -0,5 \text{ V to } +9,9 \text{ V}$ ;  $V_{CC} = +30 \text{ V}$ ;  $R1 = 619 \Omega$ ;  $R2 = 200 \Omega$ .

Pulse generator:

|                |          |                       |
|----------------|----------|-----------------------|
| pulse duration | $t_p$    | $\leq 200 \text{ ns}$ |
| rise time      | $t_r$    | $\leq 2 \text{ ns}$   |
| duty factor    | $\delta$ | $= 0,02$              |

Oscilloscope:

|                   |       |                         |
|-------------------|-------|-------------------------|
| input impedance   | $Z_i$ | $> 100 \text{ k}\Omega$ |
| input capacitance | $C_i$ | $< 12 \text{ pF}$       |
| rise time         | $t_r$ | $< 5 \text{ ns}$        |

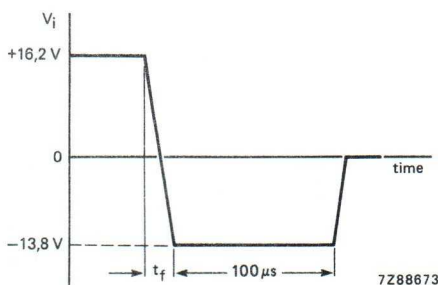


Fig. 3 Input waveform and test circuit for determining storage time and fall time.

## SILICON PLANAR EPITAXIAL TRANSISTORS

PNP medium power transistors in a microminiature SMD envelope (SOT-223). Designed primarily for high-speed switching and driver applications.

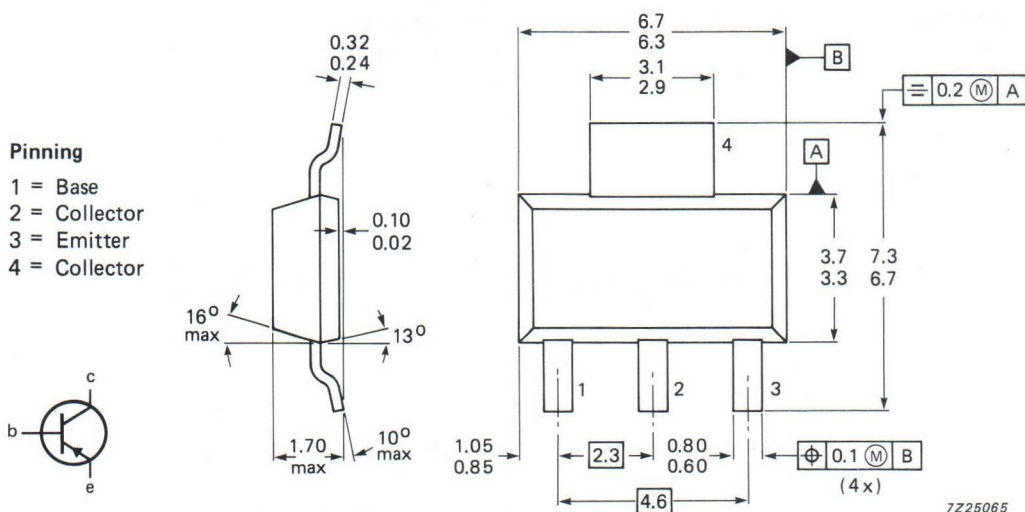
### QUICK REFERENCE DATA

|                                                                |          |            |      |                      |
|----------------------------------------------------------------|----------|------------|------|----------------------|
| Collector-base voltage (open emitter)                          |          | $-V_{CBO}$ | max. | 60 V                 |
| Collector-emitter voltage (open base)                          | PZT2907  | $-V_{CEO}$ | max. | 40 V                 |
|                                                                | PZT2907A | $-V_{CEO}$ | max. | 60 V                 |
| Collector current (DC)                                         |          | $-I_C$     | max. | 600 mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$     |          | $P_{tot}$  | max. | 1,5 W                |
| Junction temperature                                           |          | $T_j$      | max. | 150 $^\circ\text{C}$ |
| DC current gain at $T_j = 25^\circ\text{C}$                    |          | $h_{FE}$   |      | 100 to 300           |
| Transition frequency at $f = 100\text{ MHz}$                   |          | $f_T$      | min. | 200 MHz              |
|                                                                |          |            |      |                      |
| Storage time                                                   |          | $t_s$      | max. | 80 ns                |
| $-I_{Con} = 150\text{ mA}; -I_{Bon} = I_{Boff} = 15\text{ mA}$ |          |            |      |                      |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                      |          |            |             |                        |
|----------------------------------------------------------------------|----------|------------|-------------|------------------------|
| Collector-base voltage (open emitter)                                |          | $-V_{CBO}$ | max.        | 60 V                   |
| Collector-emitter voltage (open base)                                | PZT2907  | $-V_{CEO}$ | max.        | 40 V                   |
|                                                                      | PZT2907A | $-V_{CEO}$ | max.        | 60 V                   |
| Emitter-base voltage (open collector)                                |          | $-V_{EBO}$ | max.        | 5 V                    |
| Collector current (DC)                                               |          | $-I_C$     | max.        | 600 mA                 |
| Total power dissipation up to $T_{amb} = 25\text{ }^{\circ}\text{C}$ |          | $P_{tot}$  | max.        | 1,5 W                  |
| Storage temperature range                                            |          | $T_{stg}$  | -65 to +150 | $^{\circ}\text{C}$     |
| Junction temperature                                                 |          | $T_j$      | max.        | 150 $^{\circ}\text{C}$ |

# THERMAL RESISTANCE

|                           |               |   |          |
|---------------------------|---------------|---|----------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 83,3 K/W |
|---------------------------|---------------|---|----------|

\* Device mounted on an epoxy printed-circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Collector cut-off current

 $I_E = 0; -V_{CB} = 50\text{ V}$  $-I_{CBO} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 20 & 10 \end{array} \text{ nA}$  $I_E = 0; -V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^{\circ}\text{C}$  $-I_{CBO} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 20 & 10 \end{array} \text{ }\mu\text{A}$  $+V_{BE} = 0,5\text{ V}; -V_{CE} = 30\text{ V}$  $-I_{CEX} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 50 & 50 \end{array} \text{ nA}$ 

Base current

 $+V_{BE} = 0,5\text{ V}; -V_{CE} = 30\text{ V}$  $I_{BEX} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 50 & 50 \end{array} \text{ nA}$ 

Collector-base breakdown voltage

open emitter;  $-I_C = 10\text{ }\mu\text{A}$  $-V_{(BR)CBO} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 60 & 60 \end{array} \text{ V}$ 

Collector-emitter breakdown voltage\*

open base;  $-I_C = 10\text{ mA}$  $-V_{(BR)CEO} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 40 & 60 \end{array} \text{ V}$ 

Emitter-base breakdown voltage

open collector;  $-I_E = 10\text{ }\mu\text{A}$  $-V_{(BR)EBO} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 5 & 5 \end{array} \text{ V}$ 

Saturation voltages\*

 $-I_C = 150\text{ mA}; -I_B = 15\text{ mA}$  $-V_{CEsat} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 0,4 & 0,4 \end{array} \text{ V}$  $-V_{BEsat} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 1,3 & 1,3 \end{array} \text{ V}$  $-I_C = 500\text{ mA}; -I_B = 50\text{ mA}$  $-V_{CEsat} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 1,6 & 1,6 \end{array} \text{ V}$  $-V_{BEsat} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 2,6 & 2,6 \end{array} \text{ V}$ 

DC current gain

 $-I_C = 0,1\text{ mA}; -V_{CE} = 10\text{ V}$  $h_{FE} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 35 & 75 \end{array}$  $-I_C = 1\text{ mA}; -V_{CE} = 10\text{ V}$  $h_{FE} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 50 & 100 \end{array}$  $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$  $h_{FE} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 75 & 100 \end{array}$  $-I_C = 150\text{ mA}; -V_{CE} = 10\text{ V}^*$  $h_{FE} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 100 & 100 \end{array}$  $h_{FE} < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 300 & 300 \end{array}$  $-I_C = 500\text{ mA}; -V_{CE} = 10\text{ V}^*$  $h_{FE} > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 30 & 50 \end{array}$ Collector capacitance at  $f = 100\text{ kHz}$  $I_E = I_e = 0; -V_{CB} = 10\text{ V}$  $C_c < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 8 & \end{array} \text{ pF}$ Emitter capacitance at  $f = 100\text{ kHz}$  $I_C = I_c = 0; -V_{EB} = 2\text{ V}$  $C_e < \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 30 & \end{array} \text{ pF}$ Transition frequency at  $f = 100\text{ MHz}$  $-I_C = 50\text{ mA}; -V_{CE} = 20\text{ V}^*$  $f_T > \begin{array}{c|c} \text{PZT2907} & \text{PZT2907A} \\ \hline 200 & \end{array} \text{ MHz}$ \* Measured under pulse conditions to avoid excessive dissipation:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0,02$ .



Turn-on time (see Fig. 2)

when switched to  $-I_{Con} = 150 \text{ mA}$ ;  $-I_{Bon} = 15 \text{ mA}$

delay time

rise time

turn-on time

|          |   |       |
|----------|---|-------|
| $t_d$    | < | 10 ns |
| $t_r$    | < | 40 ns |
| $t_{on}$ | < | 45 ns |

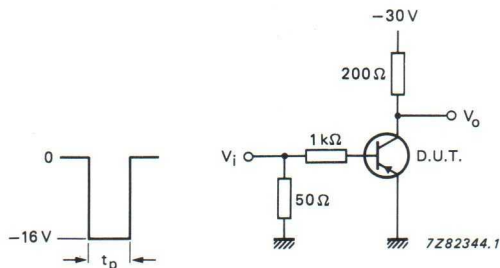


Fig. 2 Input waveform and test circuit for determining delay, rise and turn-on time.

Turn-off time (see Fig. 3)

when switched from  $-I_{Con} = 150 \text{ mA}$ ;  $-I_{Bon} = 15 \text{ mA}$

to cut-off with  $+I_{Boff} = 15 \text{ mA}$

storage time

fall time

turn-off time

|           |   |        |
|-----------|---|--------|
| $t_s$     | < | 80 ns  |
| $t_f$     | < | 30 ns  |
| $t_{off}$ | < | 100 ns |

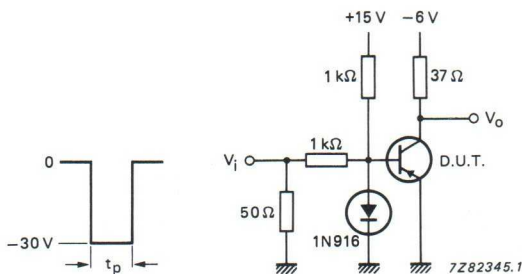


Fig. 3 Input waveform and test circuit for determining storage, fall and turn-off time.

Pulse generator (see Figs 2 and 3)

|                  |       |   |        |
|------------------|-------|---|--------|
| frequency        | $f$   | = | 150 Hz |
| pulse duration   | $t_p$ | = | 200 ns |
| rise time        | $t_r$ | ≤ | 2 ns   |
| output impedance | $Z_o$ | = | 50 Ω   |

Oscilloscope (see Figs 2 and 3)

|                 |       |   |       |
|-----------------|-------|---|-------|
| rise time       | $t_r$ | ≤ | 5 ns  |
| input impedance | $Z_i$ | ≤ | 10 MΩ |

# SILICON PLANAR EPITAXIAL TRANSISTOR

NPN transistor in a microminiature SMD envelope (SOT-223). Designed primarily for high-speed, saturated switching applications in industrial service.

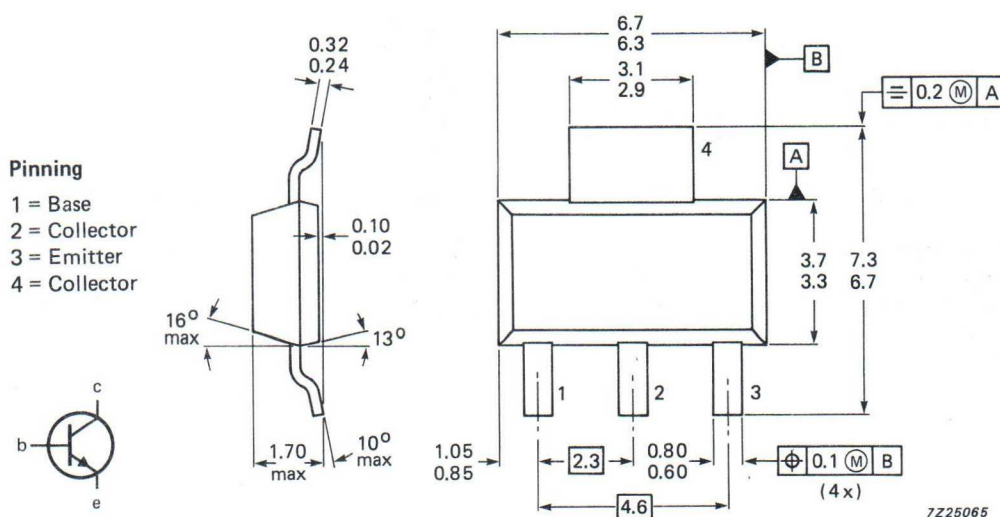
## QUICK REFERENCE DATA

|                                                                   |           |      |                        |
|-------------------------------------------------------------------|-----------|------|------------------------|
| Collector-base voltage (open emitter)                             | $V_{CBO}$ | max. | 60 V                   |
| Collector-emitter voltage (open base)                             | $V_{CEO}$ | max. | 40 V                   |
| Collector current (DC)                                            | $I_C$     | max. | 200 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$ | max. | 1,5 W                  |
| Junction temperature                                              | $T_j$     | max. | 150 $^{\circ}\text{C}$ |
| DC current gain                                                   | $h_{FE}$  | $>$  | 100                    |
| $I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$                         | $h_{FE}$  | $<$  | 300                    |
| Transition frequency at $f = 100\text{ MHz}$                      | $f_T$     | $>$  | 300 MHz                |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                        | $f_T$     | $>$  | 300 MHz                |
| Storage time                                                      | $t_s$     | $<$  | 200 ns                 |
| $I_{Con} = 10\text{ mA}; I_{Bon} = -I_{Boff} = 1\text{ mA}$       | $t_s$     | $<$  | 200 ns                 |

## MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |           |      |                                |
|---------------------------------------------------------------------|-----------|------|--------------------------------|
| Collector-base voltage (open emitter)                               | $V_{CBO}$ | max. | 60 V                           |
| Collector-emitter voltage (open base)                               | $V_{CEO}$ | max. | 40 V                           |
| Emitter-base voltage (open collector)                               | $V_{EBO}$ | max. | 6 V                            |
| Collector current (DC)                                              | $I_C$     | max. | 200 mA                         |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 1,5 W                          |
| Storage temperature range                                           | $T_{stg}$ |      | -65 to +150 $^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$     | max. | 150 $^{\circ}\text{C}$         |

**THERMAL RESISTANCE**

From junction to ambient\*

$$R_{th\ j-a} = 83,3\text{ K/W}$$

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Currents at reverse biased emitter junction

$$V_{CE} = 30\text{ V}; -V_{BE} = 3\text{ V}$$

|            |   |       |
|------------|---|-------|
| $I_{CEX}$  | < | 50 nA |
| $-I_{BEX}$ | < | 50 nA |

Saturation voltages

$$I_C = 10\text{ mA}; I_B = 1\text{ mA}$$

|             |   |               |
|-------------|---|---------------|
| $V_{CEsat}$ | < | 200 mV        |
| $V_{BEsat}$ |   | 650 to 850 mV |

$$I_C = 50\text{ mA}; I_B = 5\text{ mA}$$

|             |   |        |
|-------------|---|--------|
| $V_{CEsat}$ | < | 300 mV |
| $V_{BEsat}$ | < | 950 mV |

DC current gain

$$I_C = 0,1\text{ mA}; V_{CE} = 1\text{ V}$$

$$I_C = 1\text{ mA}; V_{CE} = 1\text{ V}$$

$$I_C = 10\text{ mA}; V_{CE} = 1\text{ V}$$

$$I_C = 50\text{ mA}; V_{CE} = 1\text{ V}$$

$$I_C = 100\text{ mA}; V_{CE} = 1\text{ V}$$

|          |   |     |
|----------|---|-----|
| $h_{FE}$ | > | 40  |
| $h_{FE}$ | > | 70  |
| $h_{FE}$ | > | 100 |
| $h_{FE}$ | < | 300 |
| $h_{FE}$ | > | 60  |
| $h_{FE}$ | > | 30  |

Collector capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

$$I_E = I_C = 0; V_{CB} = 5\text{ V}$$

|       |   |        |
|-------|---|--------|
| $C_c$ | < | 4,0 pF |
|-------|---|--------|

Emitter capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

$$I_C = I_E = 0; V_{EB} = 0,5\text{ V}$$

|       |   |        |
|-------|---|--------|
| $C_e$ | < | 8,0 pF |
|-------|---|--------|

Transition frequency at  $f = 100\text{ MHz}$ 

$$I_C = 10\text{ mA}; V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$$

|       |   |         |
|-------|---|---------|
| $f_T$ | > | 300 MHz |
|-------|---|---------|

Noise figure at  $R_S = 1\text{ k}\Omega$ 

$$I_C = 100\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$$

$$f = 10\text{ Hz to }15,7\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$$

|     |   |        |
|-----|---|--------|
| $F$ | < | 5,0 dB |
|-----|---|--------|

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

**h-parameters** (common emitter)
 $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ 

Input impedance

 $h_{ie}$  1 to 10 k $\Omega$ 

Reverse voltage transfer ratio

 $h_{re}$  0,5 to  $8 \times 10^{-4}$ 

Small-signal current gain

 $h_{fe}$  100 to 400

Output admittance

 $h_{oe}$  1 to 40  $\mu\text{S}$ **Switching times**

Turn-on time (see Figs 2 and 3) when switched from

 $-V_{BE\text{off}} = 0,5 \text{ V}$  to  $I_{\text{Con}} = 10 \text{ mA}; I_{\text{Bon}} = 1 \text{ mA}$ 

Delay time

 $t_d$  < 35 ns

Rise time

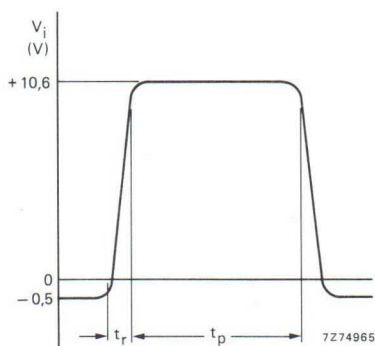
 $t_r$  < 35 ns

Fig. 2 Input waveform;  $t_r < 1 \text{ ns}$ ;  $t_p = 300 \text{ ns}$ ;  $\delta = 0,02$ .

Turn-off time (see Figs 4 and 5)

 $I_{\text{Con}} = 10 \text{ mA}; I_{\text{Bon}} = -I_{\text{Boff}} = 1 \text{ mA}$ 

Storage time

 $t_s$  < 200 ns

Fall time

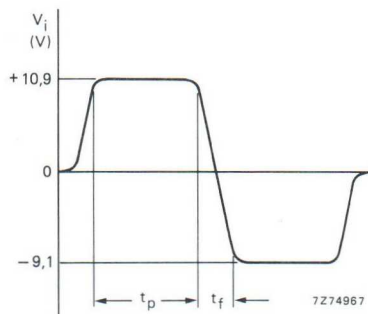
 $t_f$  < 50 ns

Fig. 4 Input waveform;  $t_f < 1 \text{ ns}$ ;  $10 \mu\text{s} < t_p < 500 \mu\text{s}$ ;  $\delta = 0,02$ .

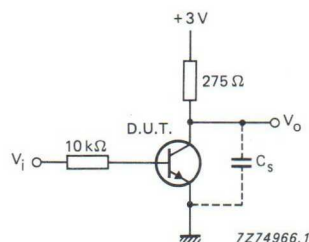


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance = 10 M $\Omega$ .

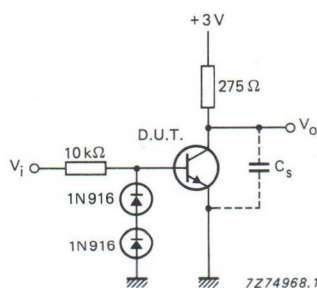
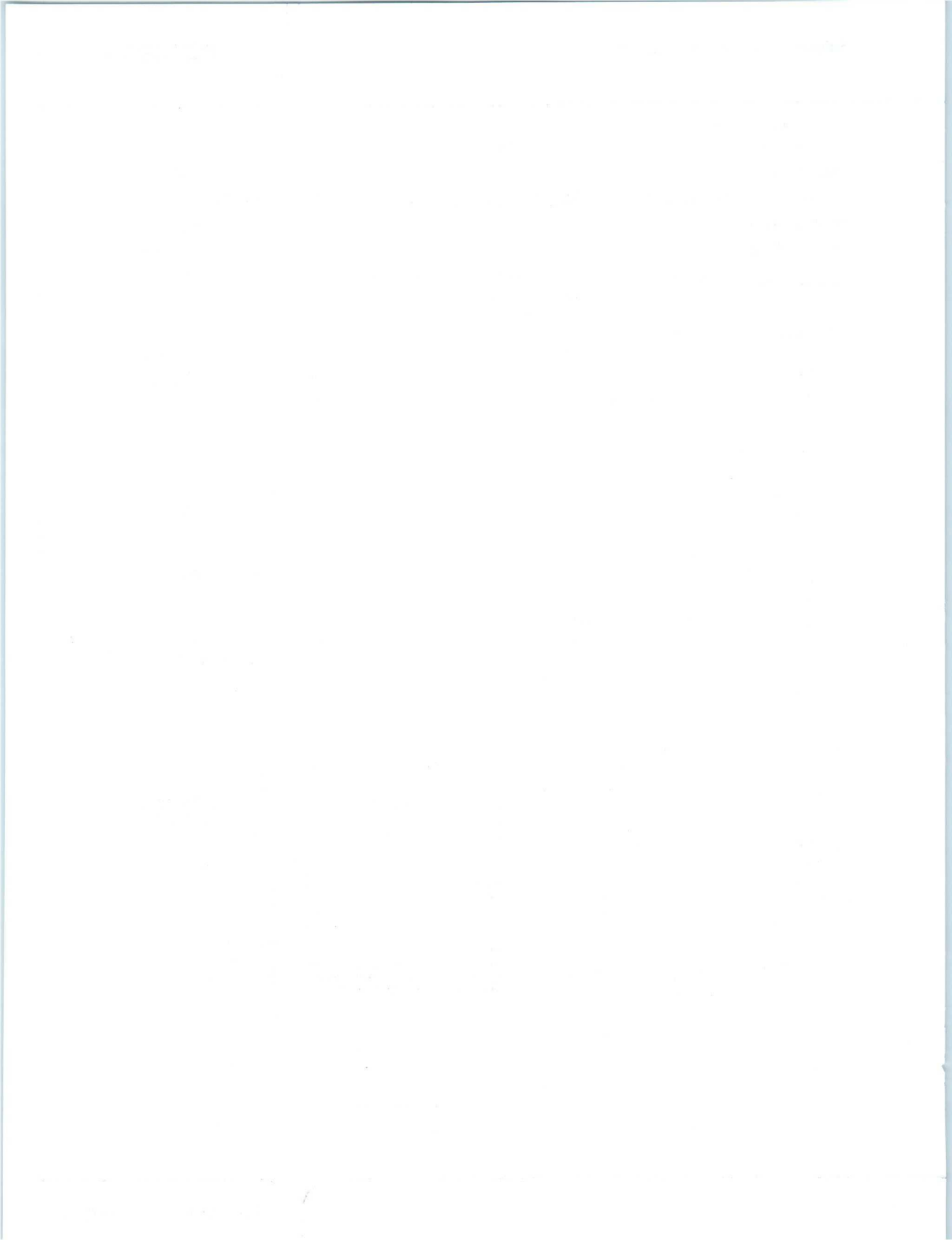


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance = 10 M $\Omega$ .



## SILICON PLANAR EPITAXIAL TRANSISTOR

PNP transistor in a microminiature SMD envelope (SOT-223). Designed primarily for high-speed, saturated switching applications in industrial service.

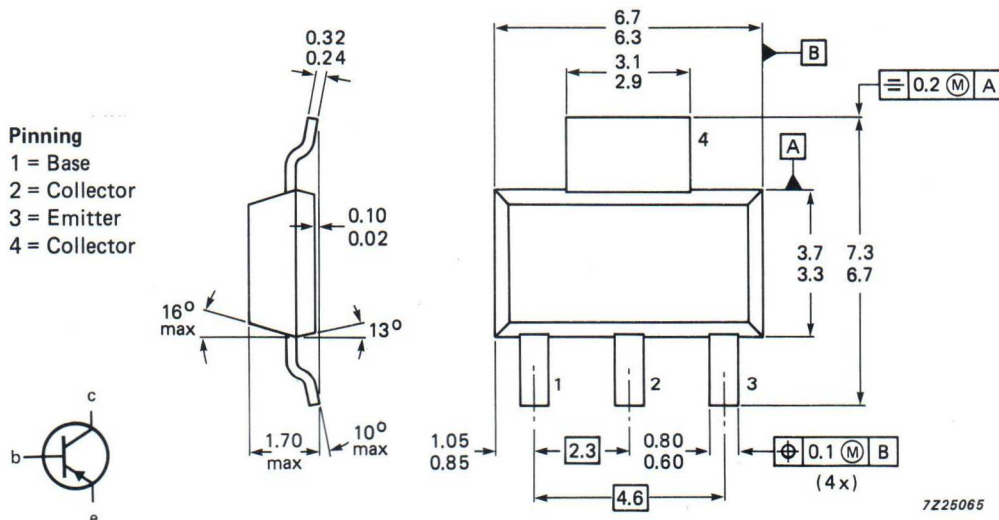
### QUICK REFERENCE DATA

|                                                                   |            |      |                        |
|-------------------------------------------------------------------|------------|------|------------------------|
| Collector-base voltage (open emitter)                             | $-V_{CBO}$ | max. | 40 V                   |
| Collector-emitter voltage (open base)                             | $-V_{CEO}$ | max. | 40 V                   |
| Collector current (DC)                                            | $-I_C$     | max. | 200 mA                 |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}$ | $P_{tot}$  | max. | 1,5 W                  |
| Junction temperature                                              | $T_j$      | max. | 150 $^{\circ}\text{C}$ |
| DC current gain                                                   | $h_{FE}$   | >    | 100                    |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$                       |            | <    | 300                    |
| Transition frequency at $f = 100\text{ MHz}$                      | $f_T$      | >    | 250 MHz                |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$                      |            |      |                        |
| Storage time                                                      | $t_s$      | <    | 225 ns                 |
| $-I_{Con} = 10\text{ mA}; -I_{Bon} = I_{Boff} = 1\text{ mA}$      |            |      |                        |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223





**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                     |            |      |                                              |
|---------------------------------------------------------------------|------------|------|----------------------------------------------|
| Collector-base voltage (open emitter)                               | $-V_{CBO}$ | max. | 40 V                                         |
| Collector-emitter voltage (open base)                               | $-V_{CEO}$ | max. | 40 V                                         |
| Emitter-base voltage (open collector)                               | $-V_{EBO}$ | max. | 5 V                                          |
| Collector current (DC)                                              | $-I_C$     | max. | 200 mA                                       |
| Total power dissipation at $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 1,5 W                                        |
| Storage temperature range                                           | $T_{stg}$  |      | $-65\text{ to }+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                | $T_j$      | max. | 150 $^{\circ}\text{C}$                       |

**THERMAL RESISTANCE**

|                           |               |   |          |
|---------------------------|---------------|---|----------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 83,3 K/W |
|---------------------------|---------------|---|----------|

**CHARACTERISTICS** $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

Currents at reverse biased emitter junction

|                                               |            |   |       |
|-----------------------------------------------|------------|---|-------|
| $-V_{CE} = 30\text{ V}; +V_{BE} = 3\text{ V}$ | $-I_{CEX}$ | < | 50 nA |
|                                               | $+I_{BEX}$ | < | 50 nA |

Saturation voltages

|                                           |              |   |               |
|-------------------------------------------|--------------|---|---------------|
| $-I_C = 10\text{ mA}; -I_B = 1\text{ mA}$ | $-V_{CEsat}$ | < | 250 mV        |
|                                           | $-V_{BEsat}$ |   | 650 to 850 mV |
| $-I_C = 50\text{ mA}; -I_B = 5\text{ mA}$ | $-V_{CEsat}$ | < | 400 mV        |
|                                           | $-V_{BEsat}$ | < | 950 mV        |

DC current gain

|                                              |          |   |     |
|----------------------------------------------|----------|---|-----|
| $-I_C = 0,1\text{ mA}; -V_{CE} = 1\text{ V}$ | $h_{FE}$ | > | 60  |
| $-I_C = 1\text{ mA}; -V_{CE} = 1\text{ V}$   | $h_{FE}$ | > | 80  |
| $-I_C = 10\text{ mA}; -V_{CE} = 1\text{ V}$  | $h_{FE}$ | > | 100 |
|                                              |          | < | 300 |
| $-I_C = 50\text{ mA}; -V_{CE} = 1\text{ V}$  | $h_{FE}$ | > | 60  |
| $-I_C = 100\text{ mA}; -V_{CE} = 1\text{ V}$ | $h_{FE}$ | > | 30  |

Collector capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

|                                       |       |   |        |
|---------------------------------------|-------|---|--------|
| $I_E = I_C = 0; -V_{CB} = 5\text{ V}$ | $C_c$ | < | 4,5 pF |
|---------------------------------------|-------|---|--------|

Emitter capacitance at  $100\text{ kHz} \leq f \leq 1\text{ MHz}$ 

|                                         |       |   |       |
|-----------------------------------------|-------|---|-------|
| $I_C = I_E = 0; -V_{EB} = 0,5\text{ V}$ | $C_e$ | < | 10 pF |
|-----------------------------------------|-------|---|-------|

Transition frequency at  $f = 100\text{ MHz}$ 

|                                                                                    |       |   |         |
|------------------------------------------------------------------------------------|-------|---|---------|
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $f_T$ | > | 250 MHz |
|------------------------------------------------------------------------------------|-------|---|---------|

Noise figure at  $R_S = 1\text{ k}\Omega$ 

|                                                                             |   |   |        |
|-----------------------------------------------------------------------------|---|---|--------|
| $-I_C = 100\text{ }\mu\text{A}; -V_{CE} = 5\text{ V}$                       | F | < | 4,0 dB |
| $f = 10\text{ Hz to }15,7\text{ kHz}; T_{amb} = 25\text{ }^{\circ}\text{C}$ |   |   |        |

\* Device mounted on an epoxy printed circuit board  $40\text{ mm} \times 40\text{ mm} \times 1,5\text{ mm}$ ; mounting pad for the collector lead min.  $6\text{ cm}^2$ .

**h-parameters** (common emitter)

$$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}; f = 1 \text{ kHz}; T_{\text{amb}} = 25 \text{ }^{\circ}\text{C}$$

Input impedance

$$h_{ie} \quad 2 \text{ to } 12 \text{ k}\Omega$$

Reverse voltage transfer ratio

$$h_{re} \quad 0,1 \text{ to } 10 \times 10^{-4}$$

Small-signal current gain

$$h_{fe} \quad 100 \text{ to } 400$$

Output admittance

$$h_{oe} \quad 3 \text{ to } 60 \text{ }\mu\text{S}$$

**Switching times**

Turn-on time (see Figs 2 and 3) when switched from

$$+V_{BE\text{off}} = 0,5 \text{ V to } -I_{C\text{on}} = 10 \text{ mA}; -I_{B\text{on}} = 1 \text{ mA}$$

Delay time

$$t_d < 35 \text{ ns}$$

Rise time

$$t_r < 35 \text{ ns}$$

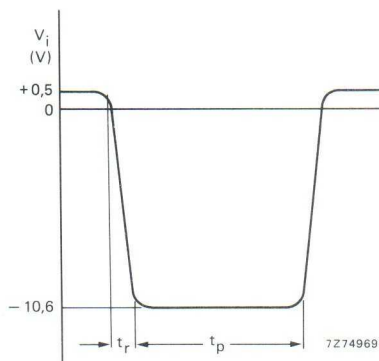


Fig. 2 Input waveform;  $t_r < 1 \text{ ns}$ ;  $t_p = 300 \text{ ns}$ ;  $\delta = 0,02$ .

Turn-off time (see Figs 4 and 5)

$$-I_{C\text{on}} = 10 \text{ mA}; -I_{B\text{on}} = I_{B\text{off}} = 1 \text{ mA}$$

Storage time

Fall time

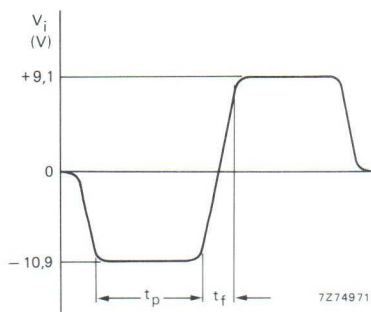


Fig. 4 Input waveform;  $t_f < 1 \text{ ns}$ ;  $10 \text{ }\mu\text{s} < t_p < 500 \text{ }\mu\text{s}$ ;  $\delta = 0,02$ .

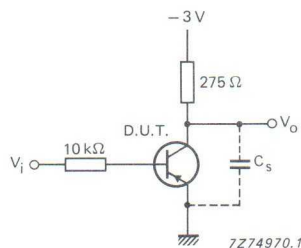


Fig. 3 Delay and rise time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .

$$t_s < 225 \text{ ns}$$

$$t_f < 75 \text{ ns}$$

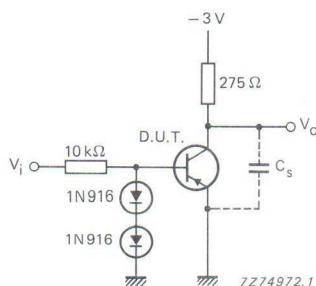


Fig. 5 Storage and fall time test circuit; total shunt capacitance of test jig and connectors  $C_s < 4 \text{ pF}$ ; scope impedance =  $10 \text{ M}\Omega$ .



| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# PZTA05/PZTA06

## Silicon epitaxial transistors

### DESCRIPTION

NPN transistors in a microminiature plastic envelope intended for surface mounted (SMD) applications. They are primarily intended for use in telephony and professional communication equipment.

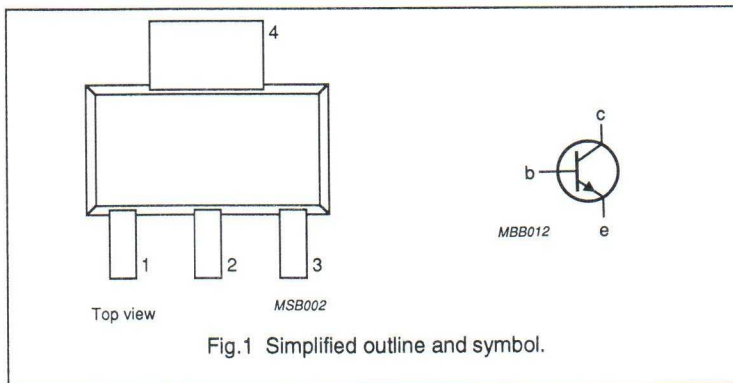
### PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | collector   |
| 3   | emitter     |
| 4   | collector   |

### QUICK REFERENCE DATA

| SYMBOL              | PARAMETER                                     | CONDITIONS                                                              | MIN. | MAX. | UNIT |
|---------------------|-----------------------------------------------|-------------------------------------------------------------------------|------|------|------|
| $V_{CBO}$           | collector-base voltage<br>PZTA05<br>PZTA06    | open emitter                                                            | —    | 60   | V    |
|                     |                                               |                                                                         | —    | 80   | V    |
| $V_{CEO}$           | collector-emitter voltage<br>PZTA05<br>PZTA06 | open base                                                               | —    | 60   | V    |
|                     |                                               |                                                                         | —    | 80   | V    |
| $V_{EBO}$           | emitter-base voltage                          | open collector                                                          | —    | 4    | V    |
| $I_C$               | collector current                             | DC value                                                                | —    | 500  | mA   |
| $P_{tot}$           | total power dissipation                       | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                  | —    | 1.5  | W    |
| $h_{FE}$            | DC current gain                               | $I_C = 100\text{ mA};$<br>$V_{CE} = 1\text{ V}$                         | 50   | —    |      |
| $f_T$               | transition frequency                          | $I_C = 10\text{ mA};$<br>$V_{CE} = 2\text{ V};$<br>$f = 100\text{ MHz}$ | 100  | —    | MHz  |
| $V_{CE\text{ sat}}$ | collector-emitter saturation voltage          | $I_C = 100\text{ mA};$<br>$I_B = 10\text{ mA}$                          | —    | 0.25 | V    |

### PIN CONFIGURATION



**Silicon epitaxial transistors****PZTA05/PZTA06****LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134)

| SYMBOL    | PARAMETER                                     | CONDITIONS                         | MIN. | MAX. | UNIT |
|-----------|-----------------------------------------------|------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage<br>PZTA05<br>PZTA06    | open emitter                       | —    | 60   | V    |
|           |                                               |                                    | —    | 80   | V    |
| $V_{CEO}$ | collector-emitter voltage<br>PZTA05<br>PZTA06 | open base                          | —    | 60   | V    |
|           |                                               |                                    | —    | 80   | V    |
| $V_{EBO}$ | emitter-base voltage                          | open collector                     | —    | 4    | V    |
| $I_C$     | collector current                             | DC value                           | —    | 500  | mA   |
| $P_{tot}$ | total power dissipation                       | $T_{amb} = 25\text{ °C}$<br>note 1 | —    | 1.5  | W    |
| $T_{stg}$ | storage temperature range                     |                                    | −65  | 150  | °C   |
| $T_j$     | junction storage                              |                                    | —    | 150  | °C   |

**Note**

1. Mounted on a ceramic substrate: area = 10 x 8 mm; thickness = 0.7 mm.

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                | CONDITIONS | NOM. | UNIT |
|---------------|--------------------------|------------|------|------|
| $R_{th\ j-a}$ | from junction to ambient | on PCB     | 83.3 | K/W  |

## Silicon epitaxial transistors

## PZTA05/PZTA06

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| SYMBOL              | PARAMETER                                                   | CONDITIONS                                                                               | MIN.     | MAX.       | UNIT                           |
|---------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------|----------|------------|--------------------------------|
| $V_{(BR)CEO}$       | collector-emitter breakdown voltage<br><br>PZTA05<br>PZTA06 | $I_C = 1\text{ mA};$<br>$I_B = 0;$<br>$t_p = 300\text{ }\mu\text{s};$<br>$\delta = 0.02$ | 60<br>80 | —<br>—     | V<br>V                         |
| $V_{(BR)EBO}$       | emitter-base breakdown voltage                              | $I_C = 0;$<br>$I_E = 100\text{ }\mu\text{A}$                                             | 4        | —          | V                              |
| $I_{CEO}$           | collector cut-off current                                   | $V_{CE} = 60\text{ V};$<br>$I_B = 0$                                                     | —        | 0.1        | $\mu\text{A}$                  |
| $I_{CBO}$           | collector cut-off current                                   | $I_E = 0$<br>$V_{CB} = 60\text{ V}$<br>$V_{CB} = 80\text{ V}$                            | —<br>—   | 0.1<br>0.1 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $V_{CE\text{ sat}}$ | collector-emitter saturation voltage                        | $I_C = 100\text{ mA};$<br>$I_B = 10\text{ mA}$                                           | —        | 0.25       | V                              |
| $V_{BE(on)}$        | base-emitter on voltage                                     | $I_C = 100\text{ mA}$<br>$V_{CE} = 1\text{ V}$                                           | —        | 1.2        | V                              |
| $h_{FE}$            | DC current gain                                             | $V_{CE} = 1\text{ V};$<br>$I_C = 10\text{ mA};$<br>$I_C = 100\text{ mA}$                 | 50<br>50 | —<br>—     |                                |
| $f_T$               | transition frequency                                        | $V_{CE} = 2\text{ V};$<br>$I_C = 10\text{ mA};$<br>$f = 100\text{ MHz}$                  | 100      | —          | MHz                            |





## SMALL-SIGNAL DARLINGTON TRANSISTORS

NPN small-signal Darlington transistors in a microminiature SMD envelope (SOT-223).  
Designed primarily for preamplifier input applications requiring high input impedance.  
PNP complement is the PZTA63/64.

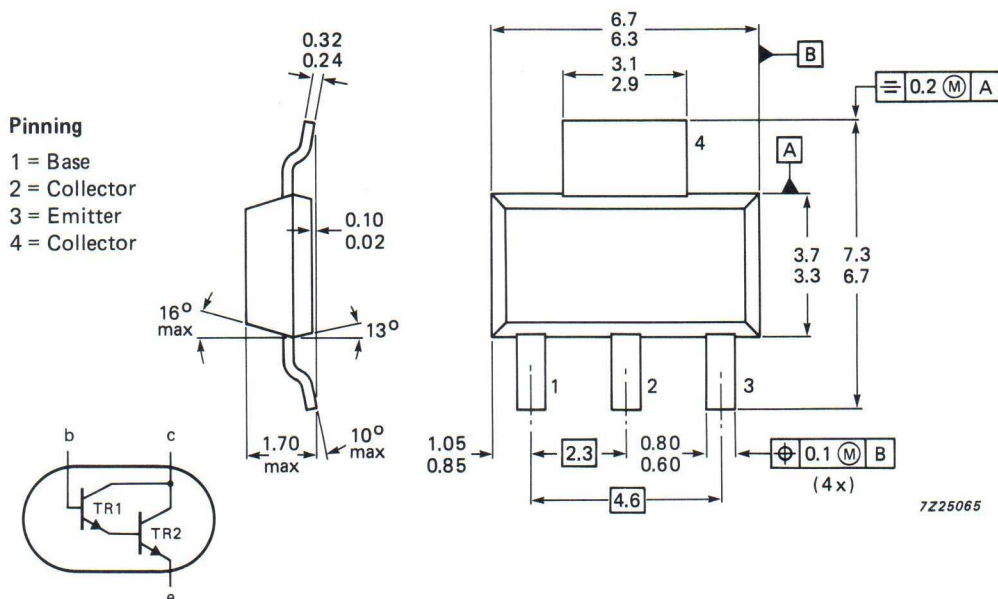
### QUICK REFERENCE DATA

|                                                                                              |                                          |      |                        |
|----------------------------------------------------------------------------------------------|------------------------------------------|------|------------------------|
| Collector-emitter voltage<br>$V_{BE} = 0$                                                    | $V_{CES}$                                | max. | 30 V                   |
| Collector current (DC)                                                                       | $I_C$                                    | max. | 300 mA                 |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}$                      | $P_{tot}$                                | max. | 1,5 W                  |
| Junction temperature                                                                         | $T_j$                                    | max. | 150 $^{\circ}\text{C}$ |
| DC current gain<br>$I_C = 10\text{ mA}$ ; $V_{CE} = 5\text{ V}$                              | PZTA13<br>PZTA14<br>$h_{FE}$<br>$h_{FE}$ | min. | 5000<br>10 000         |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 10\text{ mA}$ ; $V_{CE} = 5\text{ V}$ | $f_T$                                    | min. | 125 MHz                |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



# **RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |           |      |                                         |
|---------------------------------------------------------------------------|-----------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                     | $V_{CBO}$ | max. | 30 V                                    |
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $V_{CES}$ | max. | 30 V                                    |
| Emitter-base voltage (open collector)                                     | $V_{EBO}$ | max. | 10 V                                    |
| Collector current (DC)                                                    | $I_C$     | max. | 300 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$ | max. | 1,5 W                                   |
| Storage temperature range                                                 | $T_{stg}$ |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$     | max. | 150 $^{\circ}\text{C}$                  |

# **THERMAL RESISTANCE**

|                           |               |          |
|---------------------------|---------------|----------|
| From junction to ambient* | $R_{th\ j-a}$ | 83,3 K/W |
|---------------------------|---------------|----------|

# **CHARACTERISTICS**

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                           |                    |      |                   |
|-------------------------------------------------------------------------------------------|--------------------|------|-------------------|
| Collector-emitter breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}$                     | $V_{(BR)CES}$      | min. | 30 V              |
| Emitter-base cut-off current<br>$V_{BE} = 10\text{ V}$                                    | $I_{EBO}$          | max. | 0,1 $\mu\text{A}$ |
| Collector-base cut-off current<br>$V_{CB} = 30\text{ V}$                                  | $I_{CBO}$          | max. | 0,1 $\mu\text{A}$ |
| DC current gain<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$                              | PZTA13<br>$h_{FE}$ | min. | 5000              |
|                                                                                           | PZTA14<br>$h_{FE}$ | min. | 10 000            |
| $I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                                                | PZTA13<br>$h_{FE}$ | min. | 10 000            |
|                                                                                           | PZTA14<br>$h_{FE}$ | min. | 20 000            |
| Collector-emitter saturation voltage<br>$I_C = 100\text{ mA}; I_B = 0,1\text{ mA}$        | $V_{CEsat}$        | max. | 1,5 V             |
| Base-emitter ON-voltage<br>$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$                     | $V_{BE(on)}$       | max. | 2,0 V             |
| Transition frequency at $f = 100\text{ MHz}$<br>$I_C = 10\text{ mA}; V_{CE} = 5\text{ V}$ | $f_T$              | min. | 125 MHz           |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## SILICON EPITAXIAL TRANSISTORS

NPN transistors in a microminiature SMD envelope (SOT-223).

They are primarily intended for use in telephony and professional communication equipment.

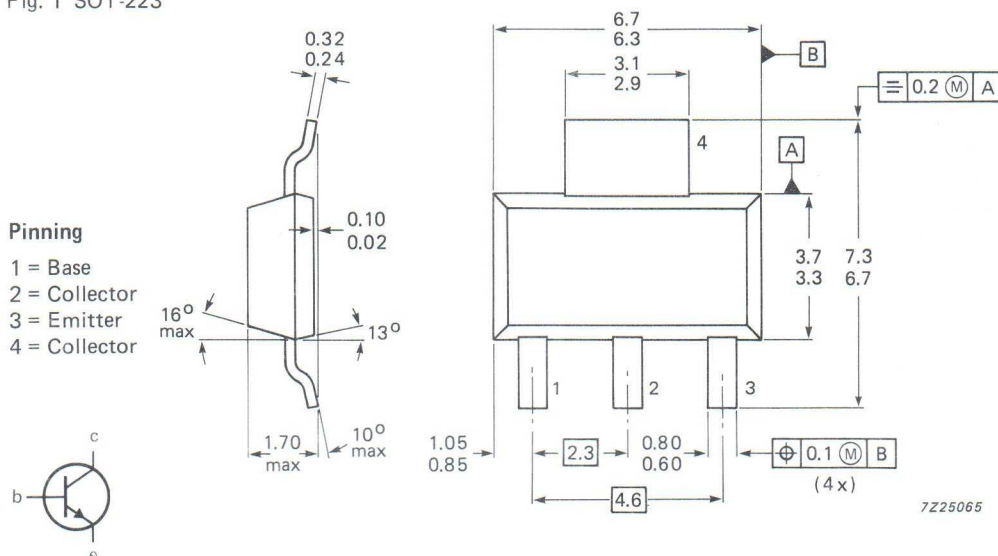
### QUICK REFERENCE DATA

|                                                            |           |      | PZTA42 | PZTA43 |                  |
|------------------------------------------------------------|-----------|------|--------|--------|------------------|
| Collector-base voltage (open emitter)                      | $V_{CBO}$ | max. | 300    | 200    | V                |
| Collector-emitter voltage (open base)                      | $V_{CEO}$ | max. | 300    | 200    | V                |
| Emitter-base voltage (open collector)                      | $V_{EBO}$ | max. |        | 6      | V                |
| Collector current (DC)                                     | $I_C$     | max. | 500    |        | mA               |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. | 1,5    |        | W                |
| Junction temperature                                       | $T_j$     | max. | 150    |        | $^\circ\text{C}$ |
| DC current gain                                            | $h_{FE}$  | >    | 40     |        |                  |
| Transition frequency at $f = 35\text{ MHz}$                | $f_T$     | >    | 50     |        | MHz              |
| Feedback capacitance at $f = 1\text{ MHz}$                 | $C_{re}$  | <    | 3      | 4      | pF               |
| $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$                 |           |      |        |        |                  |
| $I_C = 10\text{ mA}; V_{CE} = 20\text{ V}$                 |           |      |        |        |                  |
| $I_C = 0; V_{CE} = 20\text{ V}$                            |           |      |        |        |                  |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



# RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                |           |      | PZTA42      | PZTA43           |
|----------------------------------------------------------------|-----------|------|-------------|------------------|
| Collector-base voltage (open emitter)                          | $V_{CBO}$ | max. | 300         | 200 V            |
| Collector-emitter voltage (open base)                          | $V_{CEO}$ | max. | 300         | 200 V            |
| Emitter-base voltage (open collector)                          | $V_{EBO}$ | max. | 6           | V                |
| Collector current (DC)                                         | $I_C$     | max. | 500         | mA               |
| Total power dissipation*<br>up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$ | max. | 1,5         | W                |
| Storage temperature range                                      | $T_{stg}$ |      | -65 to +150 | $^\circ\text{C}$ |
| Junction temperature                                           | $T_j$     | max. | 150         | $^\circ\text{C}$ |

# THERMAL CHARACTERISTICS

|                                                 |               |   |      |     |
|-------------------------------------------------|---------------|---|------|-----|
| Thermal resistance<br>from junction to ambient* | $R_{th\ j-a}$ | = | 83,3 | K/W |
|-------------------------------------------------|---------------|---|------|-----|

# CHARACTERISTICS

$T_{amb} = 25^\circ\text{C}$  unless otherwise specified

|                                                                               |               |   | PZTA42 | PZTA43            |
|-------------------------------------------------------------------------------|---------------|---|--------|-------------------|
| Collector-emitter breakdown voltage**<br>$I_C = 1\text{ mA}; I_B = 0$         | $V_{(BR)CEO}$ | > | 300    | 200 V             |
| Collector-base breakdown voltage<br>$I_C = 100\text{ }\mu\text{A}; I_E = 0$   | $V_{(BR)CBO}$ | > | 300    | 200 V             |
| Emitter-base breakdown voltage<br>$I_E = 100\text{ }\mu\text{A}; I_C = 0$     | $V_{(BR)EBO}$ | > | 6      | 6 V               |
| Collector cut-off current<br>$I_E = 0; V_{CB} = 200\text{ V}$                 | $I_{CBO}$     | < | 0,1    | — $\mu\text{A}$   |
|                                                                               |               | < | —      | 0,1 $\mu\text{A}$ |
| Emitter cut-off current<br>$I_C = 0; V_{BE} = 6\text{ V}$                     | $I_{EBO}$     | < | 0,1    | — $\mu\text{A}$   |
|                                                                               |               | < | —      | 0,1 $\mu\text{A}$ |
| Feedback capacitance at $f = 1\text{ MHz}$<br>$I_E = 0; V_{CB} = 20\text{ V}$ | $C_{re}$      | < | 3      | 4 pF              |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

\*\* Pulse test conditions  $t_p = 300\text{ }\mu\text{s}; \delta = 0,02$ .

## Saturation voltages

 $I_C = 20 \text{ mA}; I_B = 2 \text{ mA}$  $V_{CEsat} <$ 

0,5

V

 $V_{BEsat} <$ 

0,9

V

## DC current gain

 $I_C = 1 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 10 \text{ mA}; V_{CE} = 10 \text{ V}$  $I_C = 30 \text{ mA}; V_{CE} = 10 \text{ V}$  $h_{FE} >$ 

25

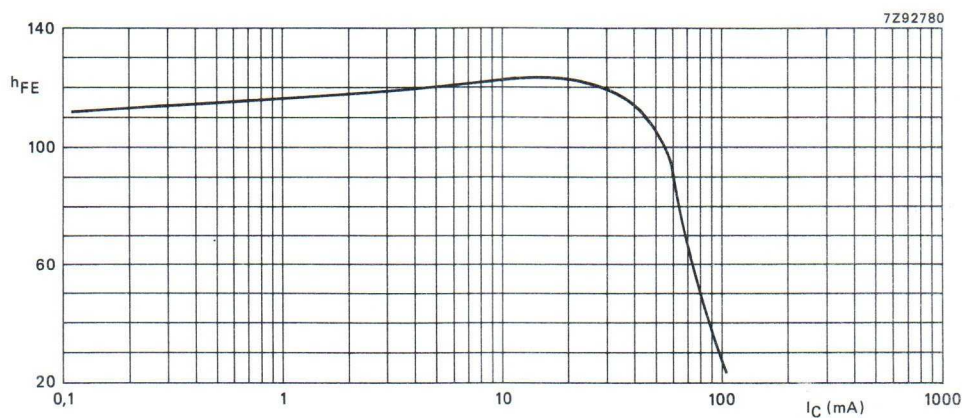
40

40

Transition frequency at  $f = 100 \text{ MHz}$  $I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V}$  $f_T >$ 

50

MHz

Fig. 2  $T_j = 25^\circ\text{C}; V_{CE} = 20 \text{ V}$ ; typical values.





| Data sheet    |                           |
|---------------|---------------------------|
| status        | Preliminary specification |
| date of issue | April 1991                |
|               |                           |

# PZTA55/PZTA56

## Silicon epitaxial transistors

DESCRIPTION

PNP transistors in a microminiature plastic envelope intended for surface mounted (SMD) applications. They are primarily intended for use in telephony and professional communication equipment.

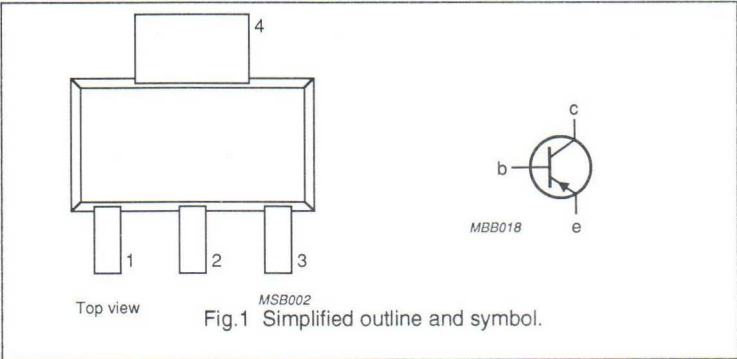
PINNING - SOT223

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | collector   |
| 3   | emitter     |
| 4   | collector   |

QUICK REFERENCE DATA

| SYMBOL              | PARAMETER                            | CONDITIONS                                                                 | MIN. | MAX. | UNIT |
|---------------------|--------------------------------------|----------------------------------------------------------------------------|------|------|------|
| $-V_{CBO}$          | collector-base voltage               | open emitter                                                               | —    | 60   | V    |
|                     | PZTA55                               |                                                                            | —    | 80   | V    |
|                     | PZTA56                               |                                                                            |      |      |      |
| $-V_{CEO}$          | collector-emitter voltage            | open base                                                                  | —    | 60   | V    |
|                     | PZTA55                               |                                                                            | —    | 80   | V    |
|                     | PZTA56                               |                                                                            |      |      |      |
| $-V_{EBO}$          | emitter-base voltage                 | open collector                                                             | —    | 4    | V    |
| $-I_C$              | collector current                    | DC value                                                                   | —    | 500  | mA   |
| $P_{tot}$           | total power dissipation              | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                     | —    | 1.5  | W    |
| $h_{FE}$            | DC current gain                      | $-I_C = 100\text{ mA};$<br>$-V_{CE} = 1\text{ V}$                          | 50   | —    |      |
| $f_T$               | transition frequency                 | $-I_C = 100\text{ mA};$<br>$-V_{CE} = 1\text{ V};$<br>$f = 100\text{ MHz}$ | 50   | —    | MHz  |
| $V_{CE\text{ sat}}$ | collector-emitter saturation voltage | $-I_C = 100\text{ mA};$<br>$I_B = 10\text{ mA}$                            | —    | 0.25 | V    |

PIN CONFIGURATION



**Silicon epitaxial transistors****PZTA55/PZTA56****LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL     | PARAMETER                                     | CONDITIONS                         | MIN. | MAX. | UNIT |
|------------|-----------------------------------------------|------------------------------------|------|------|------|
| $-V_{CBO}$ | collector-base voltage<br>PZTA55<br>PZTA56    | open emitter                       | —    | 60   | V    |
|            |                                               |                                    | —    | 80   | V    |
| $-V_{CEO}$ | collector-emitter voltage<br>PZTA55<br>PZTA56 | open base                          | —    | 60   | V    |
|            |                                               |                                    | —    | 80   | V    |
| $-V_{EBO}$ | emitter-base voltage                          | open collector                     | —    | 4    | V    |
| $-I_C$     | collector current                             | DC value                           | —    | 500  | mA   |
| $P_{tot}$  | total power dissipation                       | $T_{amb} = 25\text{ °C}$<br>note 1 | —    | 1.5  | W    |
| $T_{stg}$  | storage temperature range                     |                                    | −65  | 150  | °C   |
| $T_j$      | junction storage                              |                                    | —    | 150  | °C   |

**Note**

1. Mounted on a ceramic substrate: area = 10 x 8 mm; thickness = 0.7 mm.

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                | CONDITIONS | NOM. | UNIT |
|---------------|--------------------------|------------|------|------|
| $R_{th\ j-a}$ | from junction to ambient | on PCB     | 83.3 | K/W  |

## Silicon epitaxial transistors

## PZTA55/PZTA56

## CHARACTERISTICS

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| SYMBOL               | PARAMETER                            | CONDITIONS                                                                                | MIN.     | MAX.   | UNIT          |
|----------------------|--------------------------------------|-------------------------------------------------------------------------------------------|----------|--------|---------------|
| $-V_{(BR)CEO}$       | collector-emitter breakdown voltage  | $-I_C = 1\text{ mA};$<br>$I_B = 0;$<br>$t_p = 300\text{ }\mu\text{s};$<br>$\delta = 0.02$ |          |        |               |
|                      | PZTA55                               |                                                                                           | 60       | —      | V             |
|                      | PZTA56                               |                                                                                           | 80       | —      | V             |
| $-V_{(BR)EBO}$       | emitter-base breakdown voltage       | $-I_C = 0;$<br>$I_E = 100\text{ }\mu\text{A}$                                             | 4        | —      | V             |
| $-I_{CEO}$           | collector cut-off current            | $-V_{CE} = 60\text{ V};$<br>$I_B = 0$                                                     | —        | 0.1    | $\mu\text{A}$ |
| $-I_{CBO}$           | collector cut-off current            | $I_E = 0$                                                                                 |          |        |               |
|                      |                                      | $-V_{CB} = 60\text{ V};$                                                                  | —        | 0.1    | $\mu\text{A}$ |
|                      |                                      | $-V_{CB} = 80\text{ V}$                                                                   | —        | 0.1    | $\mu\text{A}$ |
| $-V_{CE\text{ sat}}$ | collector-emitter saturation voltage | $-I_C = 100\text{ mA};$<br>$-I_B = 10\text{ mA}$                                          | —        | 0.25   | V             |
| $-V_{BE(on)}$        | base-emitter on voltage              | $-I_C = 100\text{ mA};$<br>$-V_{CE} = 1\text{ V}$                                         | —        | 1.2    | V             |
| $h_{FE}$             | DC current gain                      | $-V_{CE} = 1\text{ V};$<br>$-I_C = 10\text{ mA};$<br>$-I_C = 100\text{ mA}$               | 50<br>50 | —<br>— |               |
| $f_T$                | transition frequency                 | $-V_{CE} = 1\text{ V};$<br>$-I_C = 100\text{ mA};$<br>$f = 100\text{ MHz}$                | 50       | —      | MHz           |



## SMALL-SIGNAL DARLINGTON TRANSISTORS

PNP small-signal Darlington transistors in a microminiature SMD envelope (SOT-223).  
Designed primarily for preamplifier input applications requiring high input impedance.  
NPN complement is the PZTA13/14.

### QUICK REFERENCE DATA

Collector-emitter voltage

$$V_{BE} = 0$$

Collector current (DC)

Total power dissipation

up to  $T_{amb} = 25^{\circ}\text{C}$

Junction temperature

DC current gain

$$-I_C = 10 \text{ mA}; -V_{CE} = 5 \text{ V}$$

Transition frequency at  $f = 100 \text{ MHz}$

$$-I_C = 10 \text{ mA}; -V_{CE} = 50 \text{ V}$$

$$-V_{CES} \quad \text{max.} \quad 30 \text{ V}$$

$$-I_C \quad \text{max.} \quad 500 \text{ mA}$$

$$P_{tot} \quad \text{max.} \quad 1,5 \text{ W}$$

$$T_j \quad \text{max.} \quad 150^{\circ}\text{C}$$

$$\text{PZTA63} \quad h_{FE} \quad \text{min.} \quad 5000$$

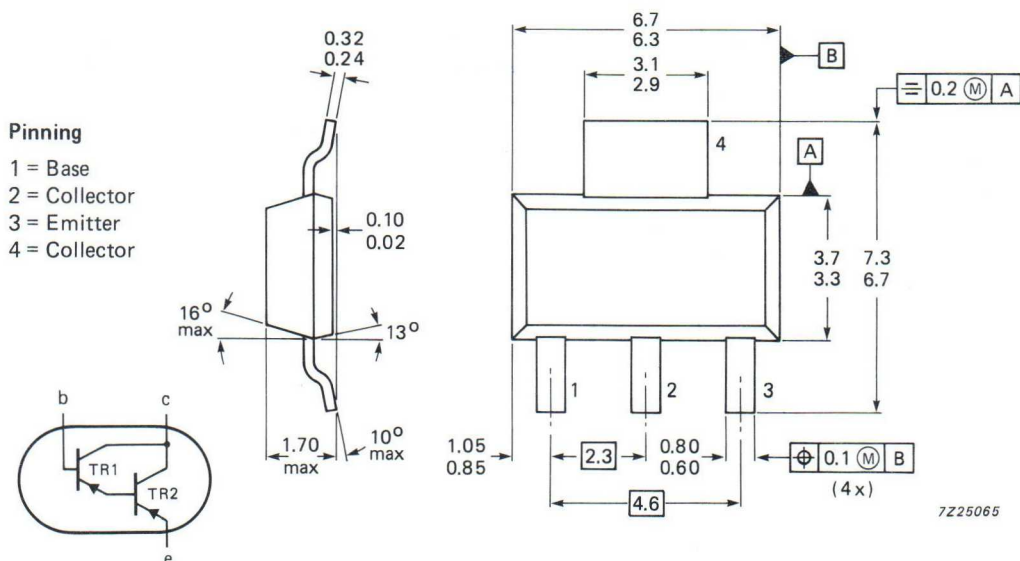
$$\text{PZTA64} \quad h_{FE} \quad \text{min.} \quad 10\,000$$

$$f_T \quad \text{min.} \quad 125 \text{ MHz}$$

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223





## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                           |            |      |                                         |
|---------------------------------------------------------------------------|------------|------|-----------------------------------------|
| Collector-base voltage (open emitter)                                     | $-V_{CBO}$ | max. | 30 V                                    |
| Collector-emitter voltage<br>$V_{BE} = 0$                                 | $-V_{CES}$ | max. | 30 V                                    |
| Emitter-base voltage (open collector)                                     | $-V_{EBO}$ | max. | 10 V                                    |
| Collector current (DC)                                                    | $-I_C$     | max. | 500 mA                                  |
| Total power dissipation<br>up to $T_{amb} = 25\text{ }^{\circ}\text{C}^*$ | $P_{tot}$  | max. | 1,5 W                                   |
| Storage temperature range                                                 | $T_{stg}$  |      | $-65$ to $+150\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                      | $T_j$      | max. | $150\text{ }^{\circ}\text{C}$           |

## THERMAL RESISTANCE

|                           |               |   |          |
|---------------------------|---------------|---|----------|
| From junction to ambient* | $R_{th\ j-a}$ | = | 83,3 K/W |
|---------------------------|---------------|---|----------|

## CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

|                                                                                                                                    |                  |          |                            |
|------------------------------------------------------------------------------------------------------------------------------------|------------------|----------|----------------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 100\text{ }\mu\text{A}$                                                             | $-V_{(BR)CES}$   | min.     | 30 V                       |
| Emitter-base cut-off current<br>$-V_{BE} = 10\text{ V}$                                                                            | $-I_{EBO}$       | max.     | 0,1 $\mu\text{A}$          |
| Collector-base cut-off current<br>$-V_{CB} = 30\text{ V}$                                                                          | $-I_{CBO}$       | max.     | 0,1 $\mu\text{A}$          |
| DC current gain<br>$-I_C = 10\text{ mA}; -V_{CE} = 5\text{ V}$                                                                     | PZTA63<br>PZTA64 | $h_{FE}$ | min. 5000<br>min. 10 000   |
| $-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                                                                       | PZTA63<br>PZTA64 | $h_{FE}$ | min. 10 000<br>min. 20 000 |
| Collector-emitter saturation voltage<br>$-I_C = 100\text{ mA}; -I_B = 0,1\text{ mA}$                                               | $-V_{CEsat}$     | max.     | 1,5 V                      |
| Base-emitter ON-voltage<br>$-I_C = 100\text{ mA}; -V_{CE} = 5\text{ V}$                                                            | $-V_{BE(on)}$    | max.     | 2,0 V                      |
| Transition frequency at $f = 100\text{ MHz}$<br>$-I_C = 10\text{ mA}; -V_{CE} = 50\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | $f_T$            | min.     | 125 MHz                    |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 cm<sup>2</sup>.

## SILICON EPITAXIAL TRANSISTORS

PNP transistors in a microminiature SMD envelope (SOT-223).

They are primarily intended for use in telephony and professional communication equipment.

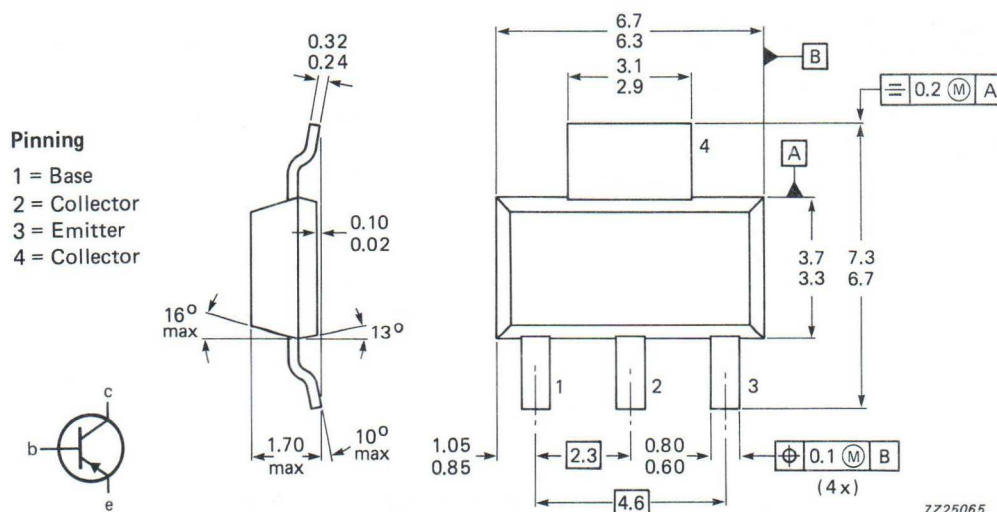
### QUICK REFERENCE DATA

|                                                            |            |      | PZTA92 | PZTA93 |     |
|------------------------------------------------------------|------------|------|--------|--------|-----|
| Collector-base voltage (open emitter)                      | $-V_{CBO}$ | max. | 300    | 200    | V   |
| Collector-emitter voltage (open base)                      | $-V_{CEO}$ | max. | 300    | 200    | V   |
| Emitter-base voltage (open collector)                      | $-V_{EBO}$ | max. |        | 5      | V   |
| Collector current (DC)                                     | $-I_C$     | max. | 500    |        | mA  |
| Total power dissipation up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 1,5    |        | W   |
| DC current gain                                            |            |      |        |        |     |
| $-I_C = 10\text{ mA}; -V_{CE} = 10\text{ V}$               | $h_{FE}$   | min. | 40     |        |     |
| Transition frequency at $f = 100\text{ MHz}$               |            |      |        |        |     |
| $-I_C = 10\text{ mA}; -V_{CE} = 20\text{ V}$               | $f_T$      | min. | 50     |        | MHz |
| Collector-base capacitance at $f = 1\text{ MHz}$           |            |      |        |        |     |
| $I_E = 0; -V_{CB} = 20\text{ V}$                           | $C_{cb}$   | max. | 6      | 8      | pF  |

### MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-223



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

|                                                                 |            |      | PZTA92      | PZTA93           |
|-----------------------------------------------------------------|------------|------|-------------|------------------|
| Collector-base voltage (open emitter)                           | $-V_{CBO}$ | max. | 300         | 200 V            |
| Collector-emitter voltage (open base)                           | $-V_{CEO}$ | max. | 300         | 200 V            |
| Emitter-base voltage (open collector)                           | $-V_{EBO}$ | max. | 5           | V                |
| Collector current (DC)                                          | $-I_C$     | max. | 500         | mA               |
| Total power dissipation *<br>up to $T_{amb} = 25^\circ\text{C}$ | $P_{tot}$  | max. | 1,5         | W                |
| Storage temperature range                                       | $T_{stg}$  |      | -65 to +150 | $^\circ\text{C}$ |
| Junction temperature                                            | $T_j$      | max. | 150         | $^\circ\text{C}$ |

## THERMAL CHARACTERISTICS

Thermal resistance

from junction to ambient\*

$$R_{th\ j-a} = 83,3 \text{ K/W}$$

## CHARACTERISTICS

$T_{amb} = 25^\circ\text{C}$  unless otherwise specified

|                                                                                                                                                                        |                                  |                      | PZTA92         | PZTA93                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------|----------------|---------------------------------------|
| Collector-emitter breakdown voltage<br>$-I_C = 1 \text{ mA}; I_E = 0$                                                                                                  | $-V_{(BR)CEO}$                   | min.                 | 300            | 200 V                                 |
| Collector-base breakdown voltage<br>$-I_C = 100 \mu\text{A}; I_E = 0$                                                                                                  | $-V_{(BR)CBO}$                   | min.                 | 300            | 200 V                                 |
| Collector cut-off current<br>$-V_{CB} = 200 \text{ V}; I_E = 0$<br>$-V_{CB} = 160 \text{ V}; I_E = 0$                                                                  | $-I_{CBO}$                       | max.<br>max.         | 0,25<br>—      | — $\mu\text{A}$<br>0,25 $\mu\text{A}$ |
| Emitter-base breakdown voltage<br>$-I_E = 100 \mu\text{A}; I_C = 0$                                                                                                    | $-V_{(BR)EBO}$                   | min.                 | 5              | V                                     |
| Emitter cut-off current<br>$I_C = 0; -V_{BE} = 3 \text{ V}$                                                                                                            | $-I_{EBO}$                       | max.                 | 0,1            | $\mu\text{A}$                         |
| Collector-base capacitance<br>at $f = 1 \text{ MHz};$<br>$I_E = 0; -V_{CB} = 20 \text{ V}$                                                                             | $C_{cb}$                         | max.                 | 6              | 8 pF                                  |
| Saturation voltages<br>$-I_C = 20 \text{ mA}; -I_B = 2 \text{ mA}$<br>$-I_C = 20 \text{ mA}; -I_B = 2 \text{ mA}$                                                      | $-V_{CEsat}$<br>$-V_{BEsat}$     | max.<br>max.         | 0,5<br>0,9     | V<br>V                                |
| DC current gain**<br>$-I_C = 1 \text{ mA}; -V_{CE} = 10 \text{ V}$<br>$-I_C = 10 \text{ mA}; -V_{CE} = 10 \text{ V}$<br>$-I_C = 30 \text{ mA}; -V_{CE} = 10 \text{ V}$ | $h_{FE}$<br>$h_{FE}$<br>$h_{FE}$ | min.<br>min.<br>min. | 25<br>40<br>25 |                                       |

\* Device mounted on an epoxy printed circuit board 40 mm x 40 mm x 1,5 mm;  
mounting pad for the collector lead min. 6 mm<sup>2</sup>.

\*\* Pulse test conditions:  $t_p = 300 \mu\text{s}$ ; duty cycle  $\leq 2\%$ .

| Data sheet    |                       |
|---------------|-----------------------|
| status        | Product specification |
| date of issue | April 1991            |
|               |                       |

# 2N7002

## N-channel vertical D-MOS transistor

### FEATURES

- Direct interface to C-MOS, TTL, etc.
- High-speed switching
- No secondary breakdown.

### DESCRIPTION

N-channel enhancement mode vertical D-MOS transistor in a SOT23 envelope. It is designed for use as a Surface Mounted Device (SMD) in thin and thick-film circuits, with applications in relay, high-speed and line transformer drivers.

### PINNING - SOT23

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | gate        |
| 2   | source      |
| 3   | drain       |

### QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                     | CONDITIONS                                        | MAX. | UNIT     |
|--------------|-------------------------------|---------------------------------------------------|------|----------|
| $V_{DS}$     | drain-source voltage          |                                                   | 60   | V        |
| $I_D$        | drain current                 | DC value                                          | 180  | mA       |
| $R_{DS(on)}$ | drain-source on-resistance    | $I_D = 500 \text{ mA}$<br>$V_{GS} = 10 \text{ V}$ | 5    | $\Omega$ |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1 \text{ mA}$<br>$V_{GS} = V_{DS}$         | 3    | V        |

### PIN CONFIGURATION

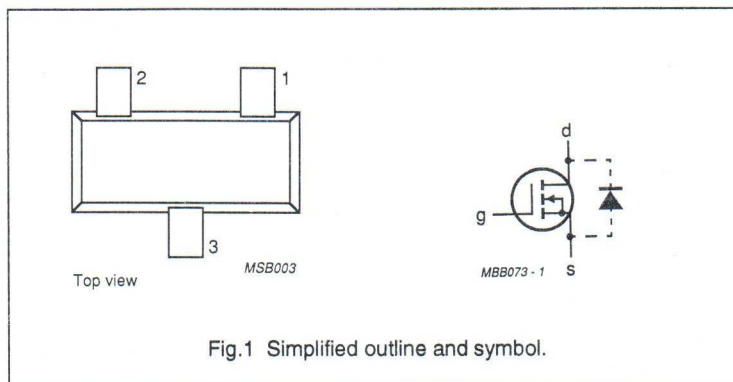


Fig.1 Simplified outline and symbol.

# N-channel vertical D-MOS transistor

**2N7002**

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL        | PARAMETER                 | CONDITIONS                                       | MIN. | MAX.       | UNIT     |
|---------------|---------------------------|--------------------------------------------------|------|------------|----------|
| $V_{DS}$      | drain-source voltage      |                                                  | –    | 60         | V        |
| $\pm V_{GSO}$ | gate-source voltage       | open drain                                       | –    | 40         | V        |
| $I_D$         | drain current             | DC value                                         | –    | 180        | mA       |
| $I_{DM}$      | drain current             | peak value                                       | –    | 800        | mA       |
| $P_{tot}$     | total power dissipation   | $T_{amb} = 25\text{ °C}$<br>(note 1)<br>(note 2) | –    | 300<br>250 | mW<br>mW |
| $T_{stg}$     | storage temperature range |                                                  | –65  | 150        | °C       |
| $T_j$         | junction temperature      |                                                  | –    | 150        | °C       |

## Notes

1. Mounted on a ceramic substrate measuring 10 x 8 x 0.7 mm.
2. Mounted on a printed circuit board.

## THERMAL RESISTANCE

| SYMBOL        | PARAMETER                | CONDITIONS | VALUE | UNIT |
|---------------|--------------------------|------------|-------|------|
| $R_{th\ j-a}$ | from junction to ambient | note 1     | 430   | K/W  |
|               |                          | note 2     | 500   | K/W  |

## Notes

1. Mounted on a ceramic substrate measuring 10 x 8 x 0.7 mm.
2. Mounted on a printed circuit board.



# N-channel vertical D-MOS transistor

**2N7002**

## CHARACTERISTICS

 $T_j = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                                    | PARAMETER                      | CONDITIONS                                                                            | MIN. | TYP. | MAX. | UNIT          |
|-------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)DSS}$                             | drain-source breakdown voltage | $I_D = 10\text{ }\mu\text{A}$<br>$V_{GS} = 0$                                         | 60   | 90   | —    | V             |
| $I_{DSS}$                                 | drain-source leakage current   | $V_{DS} = 48\text{ V}$<br>$V_{GS} = 0$                                                | —    | —    | 1    | $\mu\text{A}$ |
| $\pm I_{GSS}$                             | gate-source leakage current    | $V_{DS} = 0$<br>$\pm V_{GS} = 15\text{ V}$                                            | —    | —    | 10   | nA            |
| $V_{GS(th)}$                              | gate-source threshold voltage  | $I_D = 1\text{ mA}$<br>$V_{GS} = V_{DS}$                                              | 0.8  | —    | 3    | V             |
| $R_{DS(on)}$                              | drain-source on-resistance     | $I_D = 500\text{ mA}$<br>$V_{GS} = 10\text{ V}$                                       | —    | 2.5  | 5    | $\Omega$      |
|                                           |                                | $I_D = 75\text{ mA}$<br>$V_{GS} = 4.5\text{ V}$                                       | —    | —    | 5.3  | $\Omega$      |
| $ Y_{fs} $                                | transfer admittance            | $I_D = 200\text{ mA}$<br>$V_{DS} = 10\text{ V}$                                       | 100  | 200  | —    | mS            |
| $C_{iss}$                                 | input capacitance              | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 25   | 40   | pF            |
| $C_{oss}$                                 | output capacitance             | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 22   | 30   | pF            |
| $C_{rss}$                                 | feedback capacitance           | $V_{DS} = 10\text{ V}$<br>$V_{GS} = 0$<br>$f = 1\text{ MHz}$                          | —    | 6    | 10   | pF            |
| <b>Switching times (see Figs 2 and 3)</b> |                                |                                                                                       |      |      |      |               |
| $t_{on}$                                  | turn-on time                   | $I_D = 200\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0\text{ to }10\text{ V}$ | —    | —    | 10   | ns            |
| $t_{off}$                                 | turn-off time                  | $I_D = 200\text{ mA}$<br>$V_{DD} = 50\text{ V}$<br>$V_{GS} = 0\text{ to }10\text{ V}$ | —    | —    | 15   | ns            |



# N-channel vertical D-MOS transistor

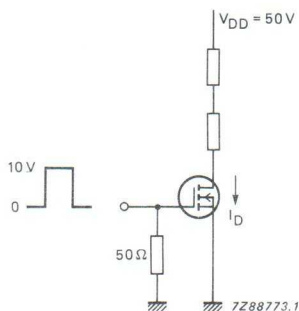
**2N7002**


Fig.2 Switching time test circuit.

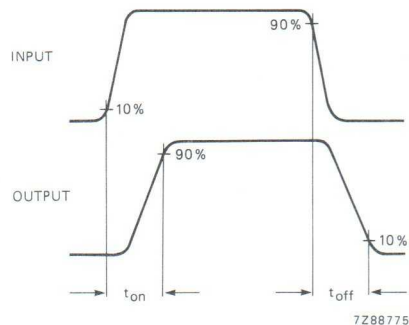
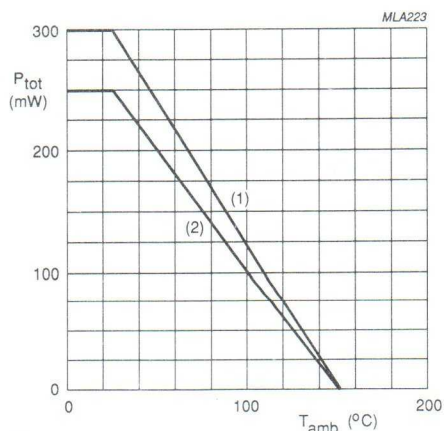
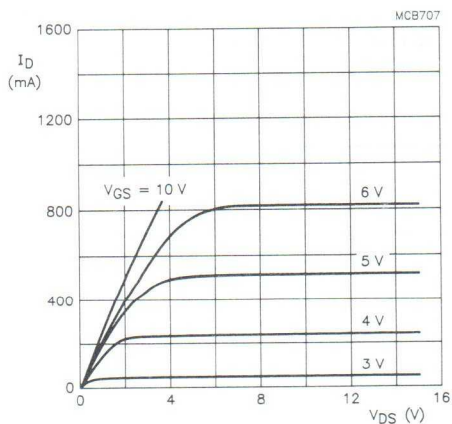


Fig.3 Input and output waveforms.



- (1) On ceramic substrate.  
(2) On printed circuit board.

Fig.4 Power derating curve.


 Fig.5 Typical output characteristics;  $T_I = 25^\circ\text{C}$ .

# N-channel vertical D-MOS transistor

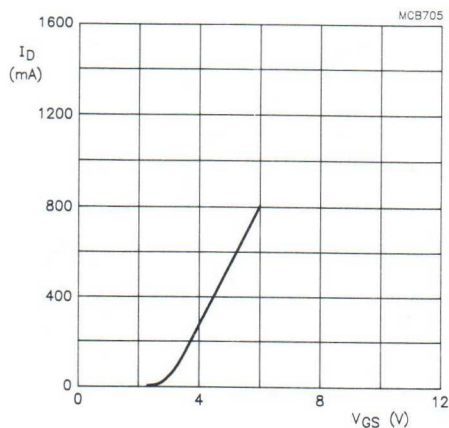
**2N7002**


Fig. 6 Typical transfer characteristic;  $V_{DS} = 10$  V;  
 $T_j = 25$  °C.

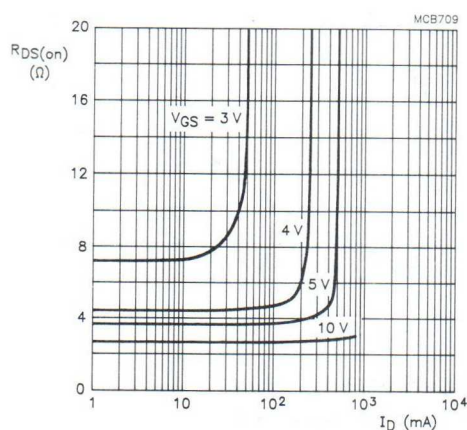


Fig. 7 Typical on-resistance as a function of  
drain current;  $T_j = 25$  °C.

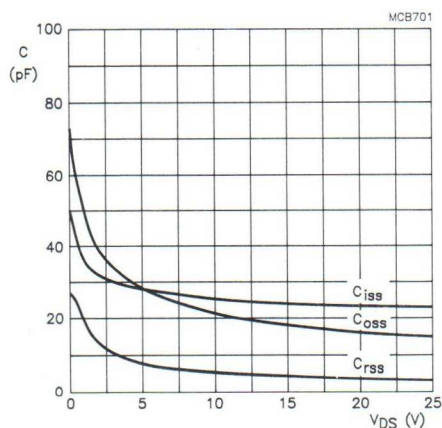
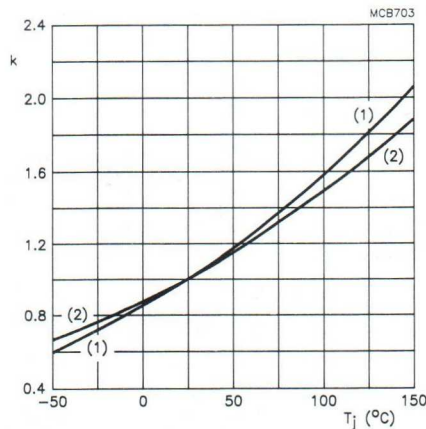


Fig. 8 Typical capacitances as a function of  
drain-source voltage;  $V_{GS} = 0$ ;  $f = 1$  MHz;  
 $T_j = 25$  °C.

**N-channel vertical D-MOS  
transistor**

**2N7002**



- (1)  $I_D = 500 \text{ mA}$ ;  $V_{GS} = 10 \text{ V}$ .  
(2)  $I_D = 75 \text{ mA}$ ;  $V_{GS} = 4.5 \text{ V}$ .

Fig.9 Temperature coefficient of drain-source on-resistance;  $k = \frac{R_{DS(on)} \text{ at } T_j}{R_{DS(on)} \text{ at } 25^{\circ}\text{C}}$ ; typical  $R_{DS(on)}$ .

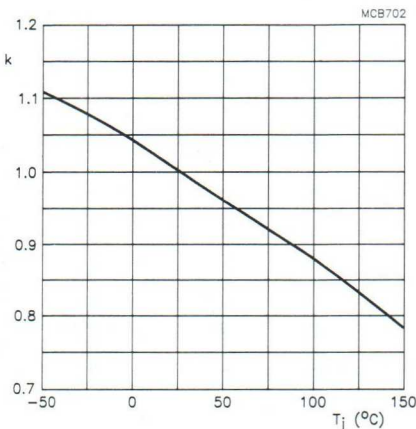
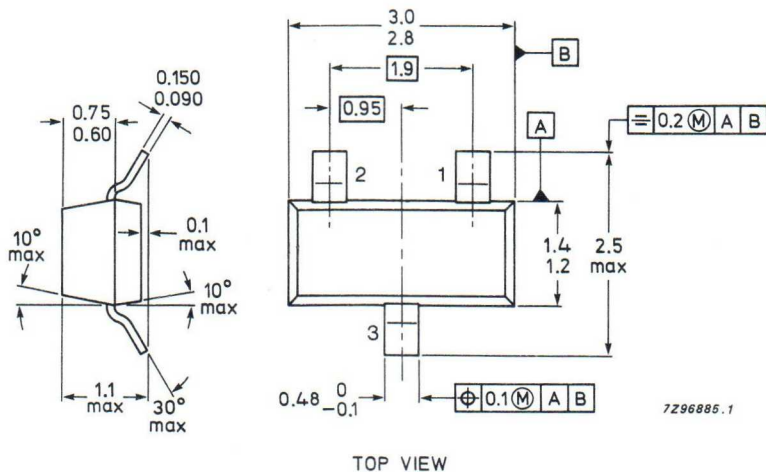


Fig.10 Temperature coefficient of gate-source threshold voltage;  $k = \frac{V_{GS(th)} \text{ at } T_j}{V_{GS(th)} \text{ at } 25^{\circ}\text{C}}$ ; typical  $V_{GS(th)}$  at 1 mA.

## N-channel vertical D-MOS transistor

2N7002

## PACKAGE OUTLINE



Dimensions in mm.

**Marking code:** 2N7002 = 702.

Fig.11 SOT23.



**Envelopes**

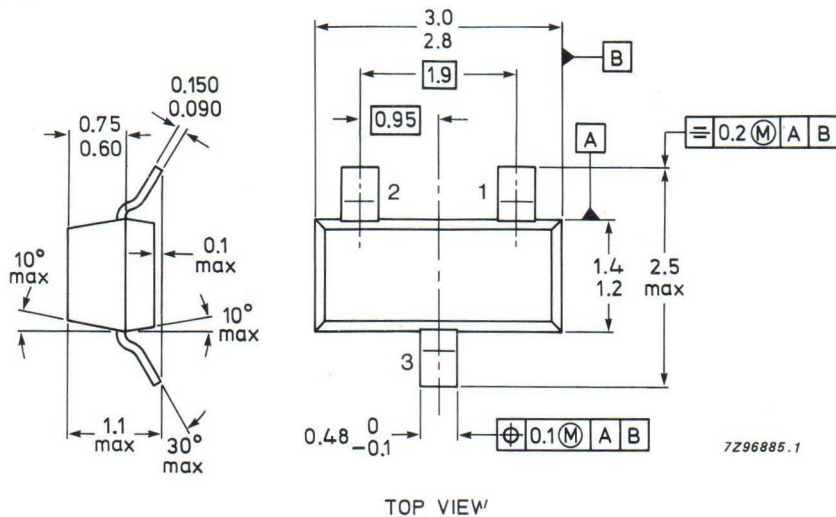




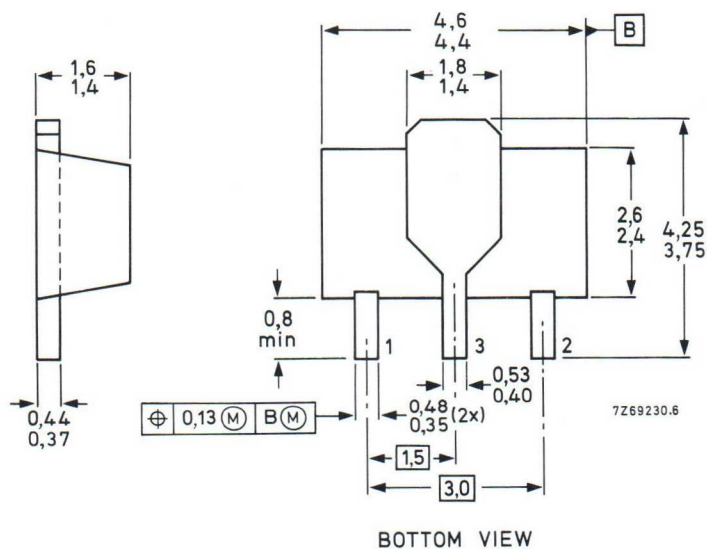
**MECHANICAL DATA**  
(European projection)

Dimensions in mm

**SOT-23**



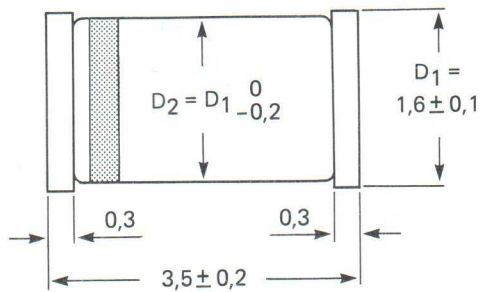
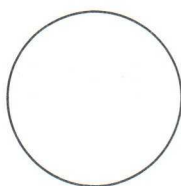
**SOT-89**



### MECHANICAL DATA (European projection)

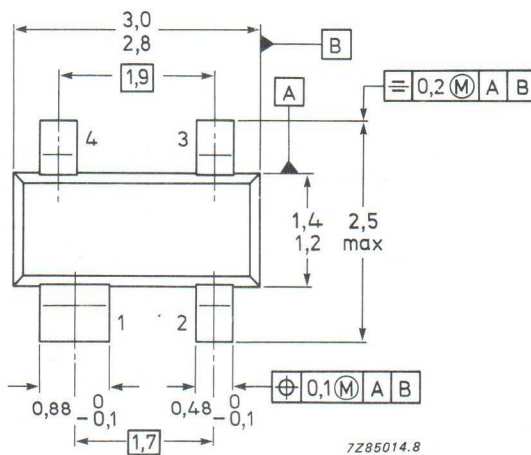
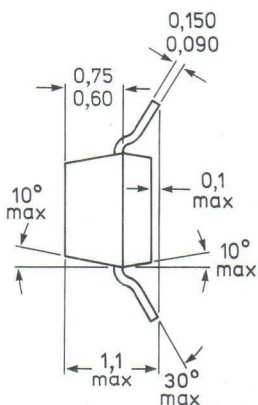
Dimensions in mm

SOD-80



7Z91084.1

SOT-143



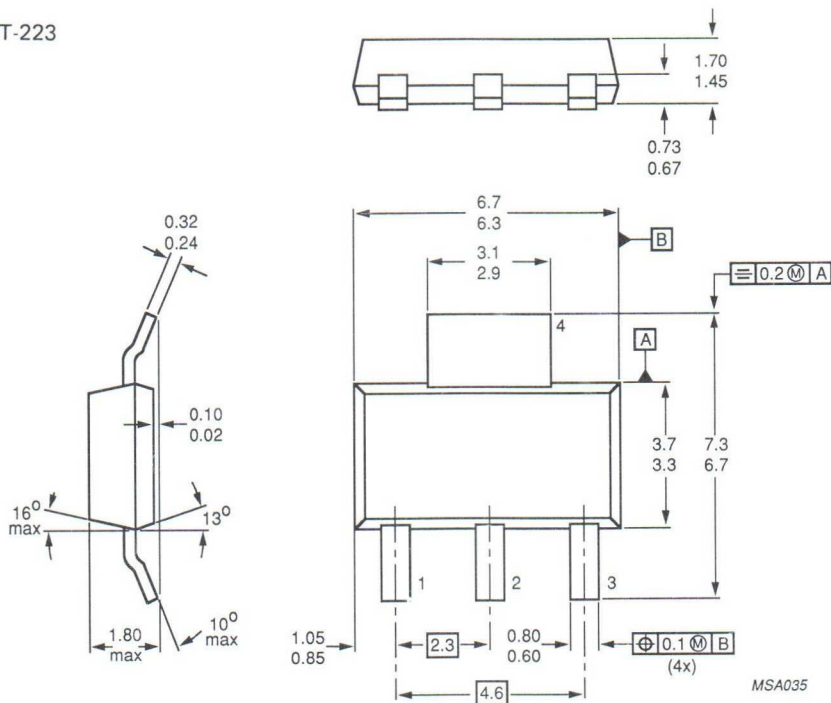
7Z85014.8

TOP VIEW

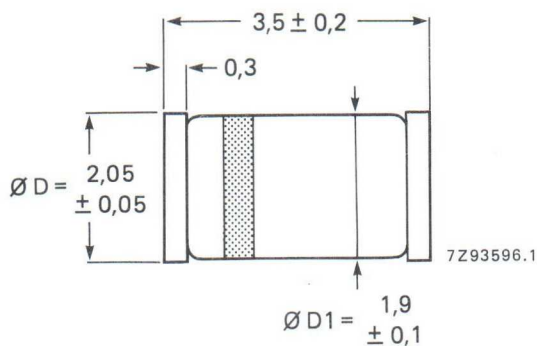
MECHANICAL DATA  
(European projection)

Dimensions in mm

SOT-223



SOD-87





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## DATA HANDBOOK SYSTEM



## DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of seven series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS\*

PROFESSIONAL COMPONENTS\*\*

MAGNETIC PRODUCTS\*

LIQUID CRYSTAL DISPLAYS

The contents of each series are listed on pages iii to ix.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.

Product specialists are at your service and enquiries will be answered promptly.

\* Will replace the Components and materials (green) series of handbooks.

\*\* Will replace the Electron tubes (blue) series of handbooks.

## INTEGRATED CIRCUITS

This series of handbooks comprises:

| code                  | handbook title                                                                                  |
|-----------------------|-------------------------------------------------------------------------------------------------|
| IC01                  | <b>Radio, audio and associated systems</b><br>Bipolar, MOS                                      |
| IC02a/b               | <b>Video and associated systems</b><br>Bipolar, MOS                                             |
| IC03                  | <b>ICs for Telecom ;</b><br>Subscriber sets, Cordless Telephones, Mobile/Cellular, Radio Pagers |
| IC04                  | <b>HE4000B logic family</b><br>CMOS                                                             |
| IC05                  | <b>Advanced Low-power Schottky (ALS) Logic Series</b>                                           |
| IC06                  | <b>High-speed CMOS; 74HC/HCT/HCU</b><br>Logic family                                            |
| IC07                  | <b>Advanced CMOS logic (ACL)</b>                                                                |
| Supplement<br>to IC07 | <b>Advanced CMOS logic (ACL)</b>                                                                |
| IC08                  | <b>10/100K ECL Logic/Memory/PLD</b>                                                             |
| IC09                  | <b>TTL logic series</b>                                                                         |
| IC10                  | <b>Memories</b><br>MOS, TTL, ECL                                                                |
| IC11                  | <b>Linear Products</b>                                                                          |
| IC12                  | <b>I<sup>2</sup>C-bus compatible ICs</b>                                                        |
| IC13                  | <b>Programmable Logic Devices (PLD)</b>                                                         |
| IC14                  | <b>Microcontrollers</b><br>NMOS, CMOS                                                           |
| IC15                  | <b>FAST TTL logic series</b>                                                                    |
| Supplement<br>to IC15 | <b>FAST TTL logic series</b>                                                                    |
| IC16                  | <b>CMOS integrated circuits for clocks and watches</b>                                          |
| IC17                  | <b>ICs for Telecom ;</b><br>ISDN                                                                |
| IC18                  | <b>Microprocessors and peripherals</b>                                                          |
| IC19                  | <b>Data communication products</b>                                                              |
| IC20                  | <b>8051-based 8-bit microcontrollers</b>                                                        |
| IC23                  | <b>Advanced BiCMOS interface logic</b>                                                          |

## DISCRETE SEMICONDUCTORS

This series of data handbooks comprises:

| current<br>code | new<br>code | handbook title                                              |
|-----------------|-------------|-------------------------------------------------------------|
| S1              | SC01        | Diodes<br>High-voltage tripler units                        |
| S2a             | SC02        | Power diodes                                                |
| S2b             | SC03        | Thyristors and triacs                                       |
| S3              | SC04        | Small-signal transistors                                    |
| S4a             | SC05        | Low-frequency power transistors and hybrid IC power modules |
| S4b             | SC06        | High-voltage and switching power transistors                |
| S5              | SC07        | Small-signal field-effect transistors                       |
| S6              | SC08a       | RF power bipolar transistors                                |
|                 | SC08b       | RF power MOS transistors                                    |
|                 | SC09        | RF power modules                                            |
| S7              | SC10        | Surface mounted semiconductors                              |
| S8b             | SC12        | Optocouplers                                                |
| S9              | SC13        | PowerMOS transistors                                        |
| S10             | SC14        | Wideband transistors and wideband hybrid IC modules         |
| S11             | SC15        | Microwave transistors                                       |
| S13             | SC17        | Semiconductor sensors                                       |

## DISPLAY COMPONENTS

This series of data handbooks comprises:

| code | handbook title |
|------|----------------|
|------|----------------|

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- |             |                                                                                                              |
|-------------|--------------------------------------------------------------------------------------------------------------|
| <b>DC01</b> | <b>Colour display components</b><br>Colour TV Picture Tubes and Assemblies<br>Colour Monitor Tube Assemblies |
| <b>DC02</b> | <b>Monochrome monitor tubes and deflection units</b>                                                         |
| <b>DC03</b> | <b>Television tuners, coaxial aerial input assemblies</b>                                                    |
| <b>DC04</b> | <b>Loudspeakers</b>                                                                                          |
| <b>DC05</b> | <b>Flyback transformers, mains transformers and<br/>general-purpose FXC assemblies</b>                       |

## PASSIVE COMPONENTS

This series of data handbooks comprises:

| current<br>code | new<br>code | handbook title                               |
|-----------------|-------------|----------------------------------------------|
| C14             | PA01        | Electrolytic capacitors; solid and non-solid |
| C11             | PA02        | Varistors, thermistors and sensors           |
| C12             | PA03        | Potentiometers and switches                  |
| C7              | PA04        | Variable capacitors                          |
| C22             | PA05*       | Film capacitors                              |
| C15             | PA06        | Ceramic capacitors                           |
| C9              | PA07*       | Piezoelectric quartz devices                 |
| C13             | PA08        | Fixed resistors                              |
|                 | PA11        | Quartz Oscillators                           |

\* Not yet issued with the new code in this series of handbooks.

## PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

| current<br>code | new<br>code | handbook title                                                |
|-----------------|-------------|---------------------------------------------------------------|
| T3              | PC01        | High-power klystrons and accessories                          |
| T5              | PC02*       | Cathode-ray tubes                                             |
| T6              | PC03*       | Geiger-Müller tubes                                           |
| T9              | PC04        | Photo multipliers                                             |
| T10             | PC05        | Plumbicon camera tubes and accessories                        |
| T11             | PC06        | Circulators and Isolators                                     |
| T12             | PC07        | Vidicon and Newvicon camera tubes and deflection units        |
| T13             | PC08        | Image intensifiers                                            |
| T15             | PC09        | Dry-reed switches                                             |
|                 | PC11        | Solid state image sensors and peripherals integrated circuits |
| T9              | PC12*       | Electron multipliers                                          |

\* Not yet issued with the new code in this series of handbooks.



## MAGNETIC PRODUCTS

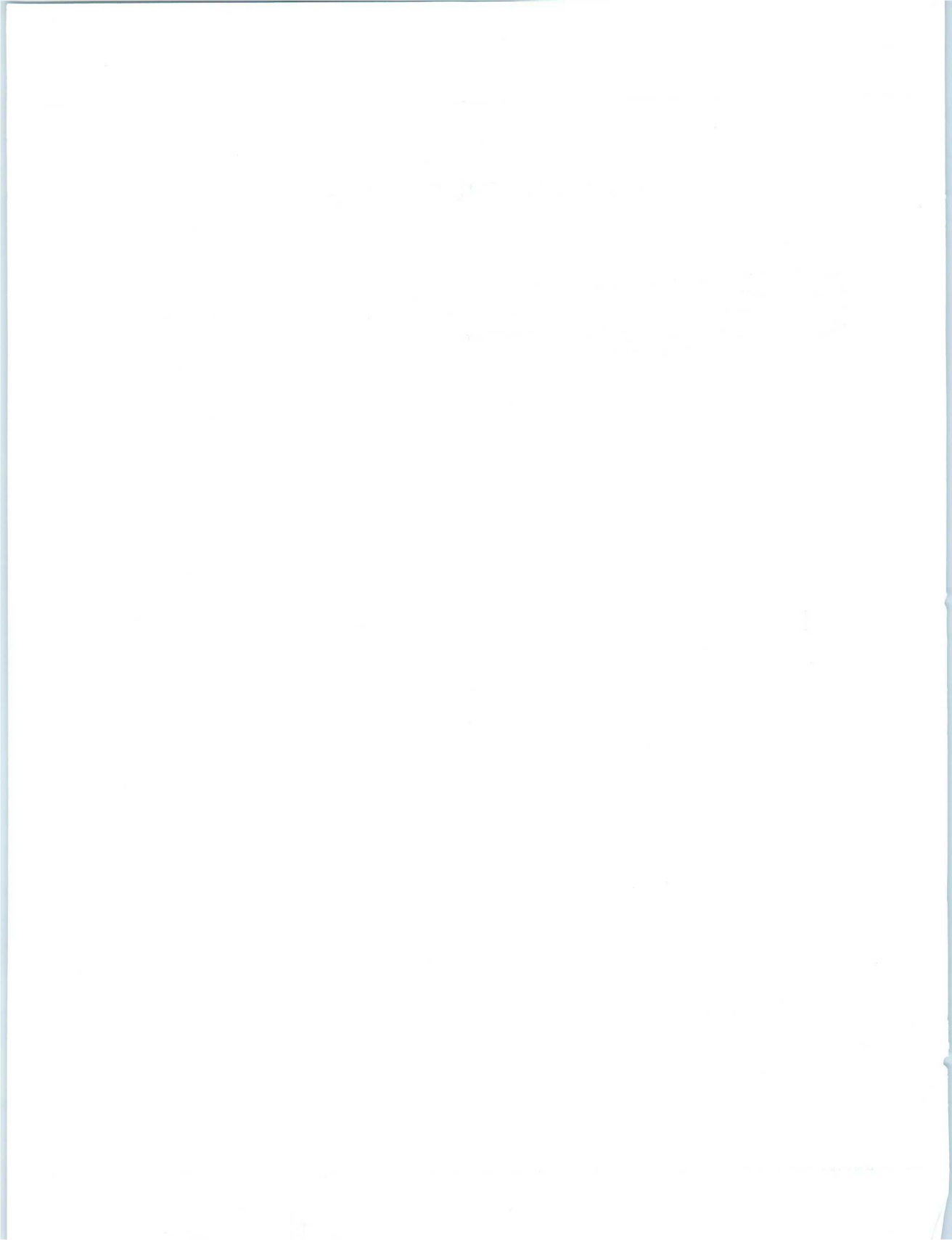
This series of data handbooks comprises:

| current<br>code | new<br>code | handbook title             |
|-----------------|-------------|----------------------------|
| C4 }<br>C5 }    | MA01        | Soft Ferrites              |
| C16             | MA02        | Permanent magnet materials |
| C19             | MA03*       | Piezoelectric ceramics     |

\* Not yet issued with the new code in this series of handbooks.

## LIQUID CRYSTAL DISPLAYS

| current<br>code | new<br>code  | handbook title                                             |
|-----------------|--------------|------------------------------------------------------------|
| <b>S14</b>      | <b>LCD01</b> | <b>Liquid Crystal Displays and driver<br/>ICs for LCDs</b> |





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