

Surface Mount Discrete Ceramics

1999/2000

Data Handbook ACM2

RESISTORS

INDUCTORS

NETWORKS

SUPPRESSORS

CAPACITORS



PHILIPS

Let's make things better.

QUALITY ASSURED

Our quality system focuses on the continuing high quality of our components and the best possible service for our customers. We have a three-sided quality strategy: we apply a system of total quality control and assurance; we operate customer-oriented dynamic improvement programmes; and we promote a partnering relationship with our customers and suppliers.

PRODUCT SAFETY

In striving for state-of-the-art perfection, we continuously improve components and processes with respect to environmental demands. Our components offer no hazard to the environment in normal use when operated or stored within the limits specified in the data sheet.

Some components unavoidably contain substances that, if exposed by accident or misuse, are potentially hazardous to health. Users of these components are informed of the danger by warning notices in the data sheets supporting the components. Where necessary the warning notices also indicate safety precautions to be taken and disposal instructions to be followed. Obviously users of these components, in general the set-making industry, assume responsibility towards the consumer with respect to safety matters and environmental demands.

All used or obsolete components should be disposed of according to the regulations applying at the disposal location. Depending on the location, electronic components are considered to be 'chemical', 'special' or sometimes 'industrial' waste. Disposal as domestic waste is usually not permitted.

Surface Mount Discrete Ceramics

CONTENTS

	Page
CAPACITORS	
Introduction	3
General data	10
Product overview	27
Numerical index	31
Quality flowchart	34
PRODUCT DATA	35
 RESISTORS	
Introduction	183
Resistor programme	198
Selection guide	199
Index of ordering codes	202
Mounting	203
Packaging	208
PRODUCT DATA	213
 RC NETWORKS	
PRODUCT DATA	373
 MULTILAYER SUPPRESSORS AND INDUCTORS	
PRODUCT DATA	393
 Data handbook system	409
Standard values (inside back cover)	

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

CAPACITOR INTRODUCTION

	Page
General data	4
Construction	4
Manufacturing of ceramic capacitors	4
Equivalent circuit for ceramic capacitors	4
Tangent of the loss angle	6
Reliability	7

Surface mount ceramic multilayer capacitors

Introduction

GENERAL DATA

Ceramic capacitors are widely used in electronic circuitry for coupling, decoupling and in filters. These different functions require specific capacitor properties.

Ceramic capacitors can be divided into two classes:

- Class 1

In these capacitors dielectric materials are used which have a very high specific resistance, very good Q and linear temperature dependence (ϵ_r from 6 up to 550). They are used in such applications as oscillators and filters where low losses, capacitance drift compensation and high stability are required.

- Class 2

These capacitors have higher losses and have non-linear characteristics ($\epsilon_r > 250$). They are used for coupling and decoupling.

CONSTRUCTION

The capacitance of a ceramic capacitor depends on the area of the electrodes (A), the thickness of the ceramic dielectric (t) and the dielectric constant of the ceramic material (ϵ_r); and on the number of dielectric layers (n) with multilayer ceramic capacitors:

$$C = \epsilon_r \times \epsilon_0 \times \frac{A}{t} \times n$$

The rated voltage is dependent on the dielectric strength, which is mainly governed by the thickness of the dielectric layer and the ceramic structure. For this reason a reduction of the layer thickness is limited.

Figure 2 shows the construction of a multilayer capacitor.

MANUFACTURING OF CERAMIC CAPACITORS

The raw materials are finely milled and carefully mixed. Thereafter the powders are calcined at temperatures between 1100 and 1300 °C to achieve the required chemical composition. The resultant mass is reground and dopes and/or sintering means are added.

The finely ground material is mixed with a solvent and binding matter. Thin sheets are obtained by casting or rolling.

For multilayer capacitors electrode material is printed on the sheets and after stacking and pressing of the sheets cofired with the ceramic compact at temperatures between 1000 and 1400 °C.

The totally enclosed electrodes of a multilayer capacitor guarantee good life test behaviour as well.

EQUIVALENT CIRCUIT FOR CERAMIC CAPACITORS

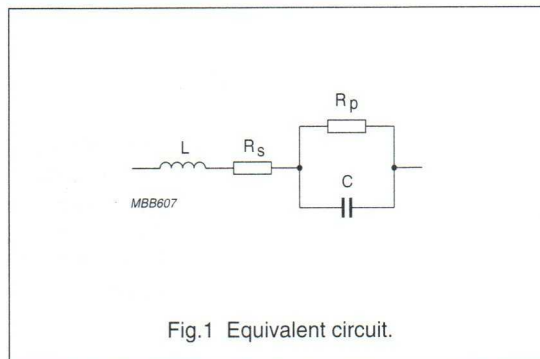


Fig.1 Equivalent circuit.

Definition of symbols; see Fig.1

SYMBOL	DESCRIPTION
C	Capacitance between the two electrodes, plus the stray capacitance at the edges and between the leads.
R_p	Resistance of insulation and dielectric. Generally R_p is very high, and of decreasing importance with increasing frequency. R_p also represents the polarization losses of the material in an alternating electric field.
R_s	Losses in the leads, the electrodes and the contacts. Up to several hundreds of MHz the current penetration depth is greater than the conductor thickness so that no skin-effect occurs. For ceramic capacitors R_s is extremely low.
L	Inductance of the leads and the internal inductance of the capacitor; the latter, however, is almost negligible. The inductance is only important in high frequency applications, since the capacitor will act as an inductance when the frequency is higher than its resonance frequency.

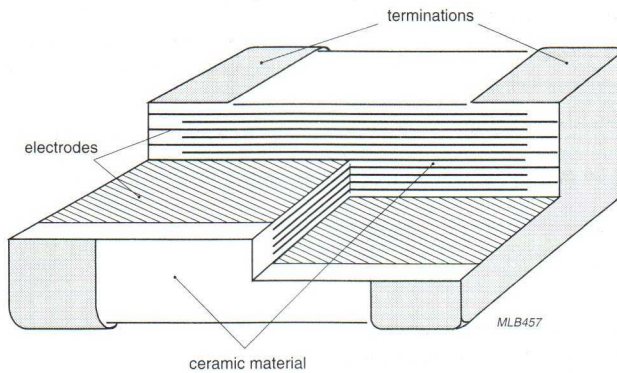


Fig.2 Cross-section of a multilayer capacitor.

Surface mount ceramic
multilayer capacitors

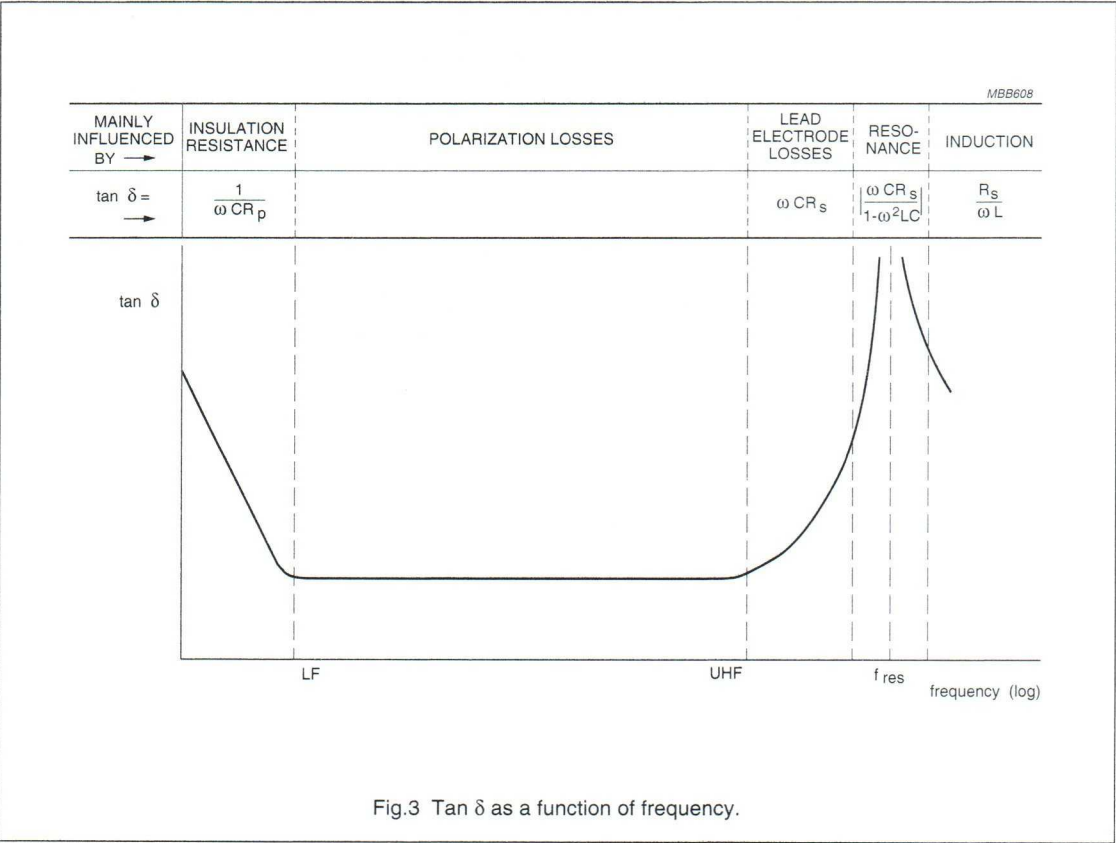
Introduction

TANGENT OF THE LOSS ANGLE

The losses of a capacitor are expressed in terms of $\tan \delta$ which is the relationship between the resistive and reactive parts of the impedance, specified as follows:

$$\tan \delta = \frac{|R|}{|X|} = \frac{R_p + R_s \{1 + (\omega C R_p)^2\}}{(\omega C R_p)^2 - \omega L \{1 + (\omega C R_p)^2\}}$$

From this formula, $\tan \delta$ can be derived for different frequency ranges as shown in Fig.3.



Surface mount ceramic multilayer capacitors

Introduction

RELIABILITY

The failure rates shown in Table 1 have a confidence level of 60% and refer to observations of ceramic multilayer capacitors (CMC) up to and including 1997.

Table 1 Reliability.

CAPACITOR TYPE	NUMBER OF COMPONENT HOURS	FAILURE RATE AT NORMALIZED CONDITIONS
CMC	32130000	2.5 FIT

Remarks

1 FIT = 1 failure rate within 10^9 component hours.

Failure rates are given under normalized conditions, i.e. at $0.5 \times$ rated DC voltage and $T_{amb} = 40^\circ\text{C}$.

Failures include capacitance, $\tan \delta$ and insulation resistance values, which do not meet the requirements after endurance test.

The determination of failure rates is based on the rated conditions as stated in "MIL-HDBK-217D". All the test results should be interpreted as results under rated conditions even if the temperature and voltage exceed the rated values.

GENERAL DATA

	Page
Packaging	10
Labelling	17
Method of mounting and dimensions of solder lands	18
Test conditions in static solder bath	22
Tests and requirements	23
Product overview	27
Numerical index	31
Quality flow chart	34

Surface mount ceramic multilayer capacitors

General data

PACKAGING

Tape on reel

Packaging conforms fully with "IEC 60286-3", "EIA 481-1" and "JIS C0806" industrial standards.

Ceramic Multilayer Capacitors are supplied on tape on reel or in bulk case. For CMCs with a product thickness of <1 mm, paper tape is preferred. CMCs with a product thickness of ≥ 1 mm, are supplied in embossed blister tape.

CARRIER TAPE

Polycarbonate.

Table 1 Properties of carrier tape

PARAMETER	WIDTH	
	8.1 $\pm$ 0.2 mm	12 $\pm$ 0.2 mm
Thickness	190 to 280 μ m	240 $\pm$ 20 μ m
Tensile strength at break	>60 N/mm ²	>60 N/mm ²
Elongation at break	100 to 150%	100 to 150%
Surface resistance	>10 ¹² Ω /sq.	>10 ¹² Ω /sq.

COVER TAPE

Polyester (antistatic).

Table 2 Properties of cover tape

PARAMETER	WIDTH	
	5.5 $\pm$ 0.1 mm	9.5 $\pm$ 0.1 mm
Breaking force	≥ 10.7 N	≥ 17.6 N
Elongation at break	$\geq 63\%$	$\geq 63\%$
Surface resistance	<10 ¹⁰ Ω /sq.	<10 ¹⁰ Ω /sq.
Softening point	71 $\pm$ 5 °C	71 $\pm$ 5 °C
Thickness	62 μ m	62 μ m

General information

For the combination carrier/cover tape no electrostatic behaviour is observed (relative humidity $\geq 30\%$). The products do not stick to the cover tape.

The technical and thermal properties of polycarbonate tapes are excellent, so there is no change in dimensions as a function of time. The peel off force is very stable as a function of time and temperature, and it is defined as 0.1 to 0.7 N at a peel-off speed of 120 mm/minute.

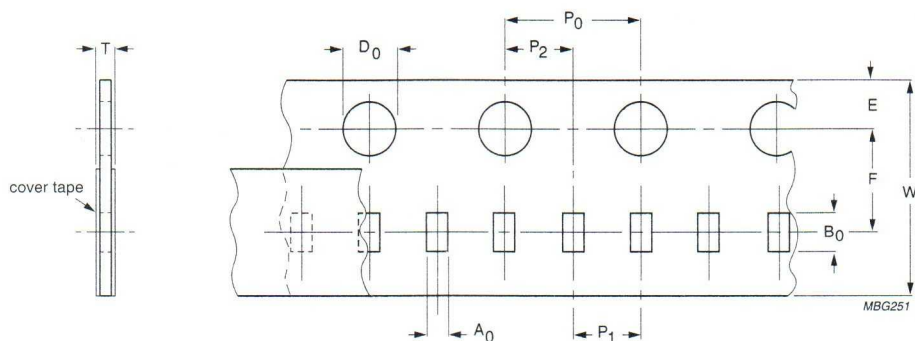
Bulk packaging

For bulk case; see Fig.5 and Table 7.

Surface mount ceramic multilayer capacitors

General data

Paper tape specifications



For dimensions see Table 3.

Fig.1 Paper tape.

Table 3 Dimensions of paper tape for relevant product size; see Fig.1

SYMBOL	PRODUCT SIZE CODE								UNIT
	0402		0603		0805		1206		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
A ₀	0.62	±0.05	1.10	±0.05	1.65	±0.05	2.0	±0.1	mm
B ₀	1.12	±0.05	1.90	±0.05	2.40	±0.05	3.5	±0.1	mm
W	8.0	±0.2	8.0	±0.2	8.0	±0.2	8.0	±0.2	mm
E	1.75	±0.1	1.75	±0.1	1.75	±0.1	1.75	±0.1	mm
F	3.5	±0.05	3.5	±0.05	3.5	±0.05	3.5	±0.05	mm
D ₀	1.5	+0.1/-0	1.5	+0.1/-0	1.5	+0.1/-0	1.5	+0.1/-0	mm
P ₀ ; note 1	4	±0.05	4	±0.05	4	±0.05	4	±0.05	mm
P ₁	2	±0.05	4	±0.1	4	±0.1	4	±0.1	mm
P ₂	2	±0.05	2	±0.05	2	±0.05	2	±0.05	mm
T _{max}	0.6	±0.05	0.95	±0.05	0.95	±0.05	0.95	±0.05	mm

Note

1. P₀ pitch tolerance over any 10 pitches is ±0.2 mm.

Surface mount ceramic
multilayer capacitors

General data

Blister tape specifications

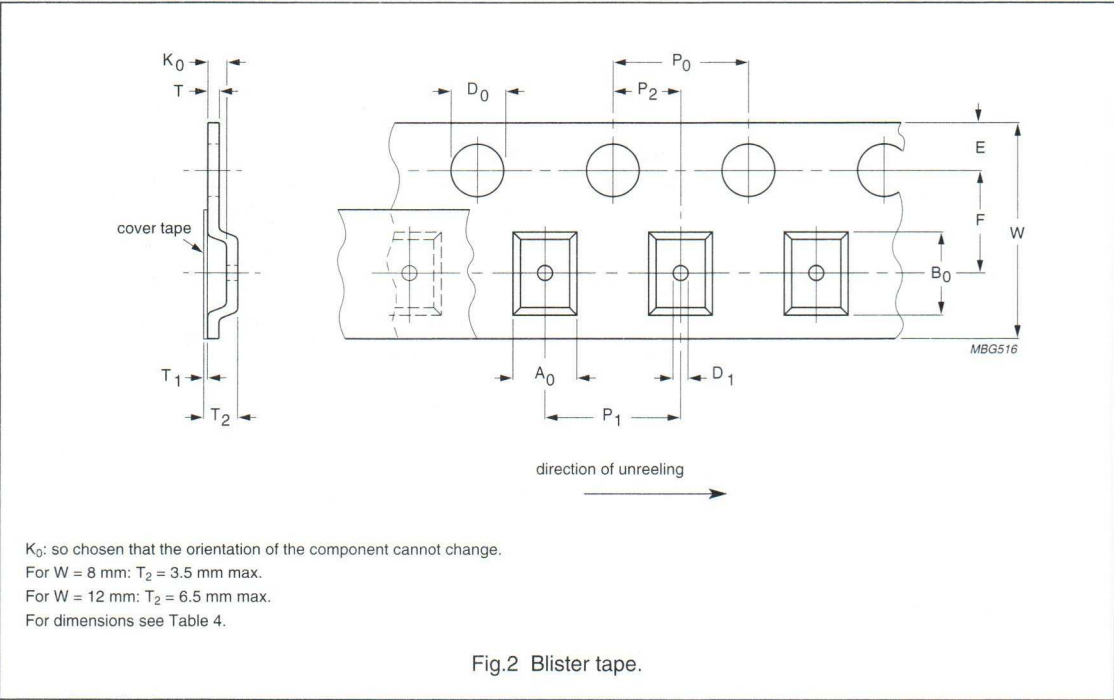


Table 4 Dimensions of blister tape for relevant product size code; see Fig.2

DIMENSION	PRODUCT SIZE CODE					TOLERANCE (mm)
	0805	1206	1210	1812	2220	
A_0 nominal clearance; note 1	0.20	0.30	0.30	0.40	0.40	—
B_0 nominal clearance; note 1	0.20	0.30	0.30	0.40	0.40	—
K_0 minimum clearance; note 1	0.05	0.05	0.05	0.05	0.05	—
W	8.1	8.1	8.1	12.0	12.0	± 0.2
E	1.75	1.75	1.75	1.75	1.75	± 0.1
F	3.5	3.5	3.5	5.5	5.5	± 0.05
D_0	1.5	1.5	1.5	1.5	1.5	$+0.1/-0.0$
D_1	≥ 1	≥ 1	≥ 1	1.5	1.5	$+0.1/-0.0$
P_0 ; note 2	4	4	4	4	4	± 0.1
P_1	4	4	4	8	8	± 0.1
P_2	2	2	2	2	2	± 0.05

Notes

1. Typical capacitor displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is $\pm 0.2 \text{ mm}$.

Surface mount ceramic multilayer capacitors

General data

Reel specifications

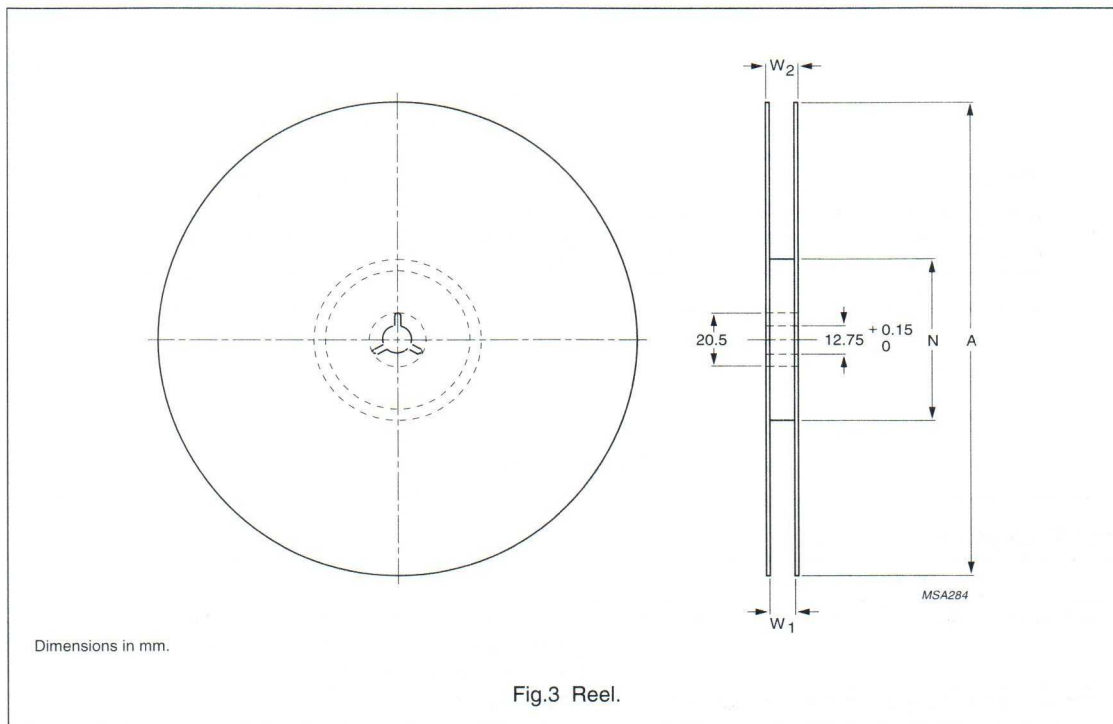


Table 5 Reel dimensions; see Fig.3

TAPE WIDTH (mm)	A (mm)	N (mm)	W ₁ (mm)	W ₂ MAX. (mm)
8	180	62 ±1.5	8.4 +1.5/-0.0	14.4
8	330	62 ±1.5	8.4 +1.5/-0.0	14.4
12	180	62 ±1.5	12.4 +2/-0.0	18.4

Properties of reel

Material: polystyrene

Surface resistance: $<10^{10} \Omega/\text{sq.}$

Surface mount ceramic
multilayer capacitors

General data

Leader/trailer tape specification

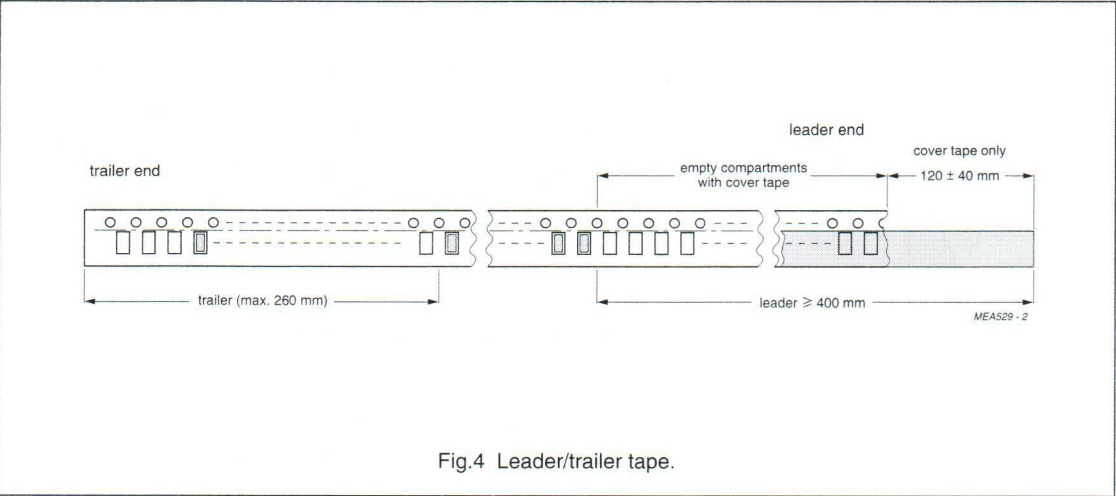


Table 6 Leader/trailer tape data

DESCRIPTION	VALUE
Minimum length of empty compartments at leader end	≥400 mm of which a minimum 240 mm of empty compartments are covered with cover tape and 120 ±40 mm cover tape only
Minimum length of empty compartments at trailer end	208 mm or 260 mm. If the length is 260 mm an extra product is placed at 208 mm to mark this position.

Surface mount ceramic
multilayer capacitors

General data

Bulk case specification

In accordance with "IEC 60286-6".

Features and benefits:

- Reduced costs
 - Storage
 - Transport
 - Machine handling
 - Packaging
- Customized labelling (bar codes).

Table 7 Packaging quantities for component size; see note 1 and Fig.5

SIZE CODE	DIMENSIONS OF CAPACITOR (mm)			QUANTITY
	L ₁	W	T	
0402	1.0	0.5	0.5	50000
0603	1.6	0.8	0.8	15000
0805	2.0	1.25	0.6	10000
0805	2.0	1.25	0.9	8000
0805	2.0	1.25	1.25	5000

Note

1. Refer to the selection charts in product data for specific values.

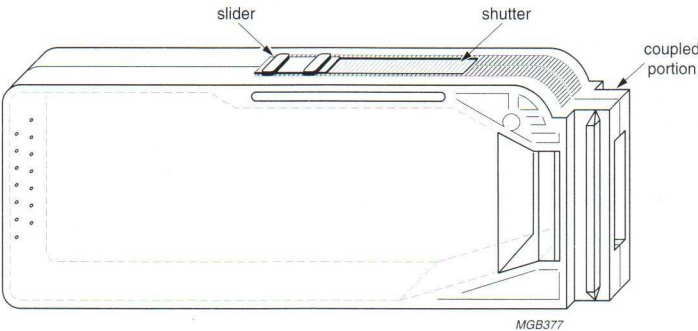


Fig.5 Bulk case outline.

Surface mount ceramic multilayer capacitors

General data

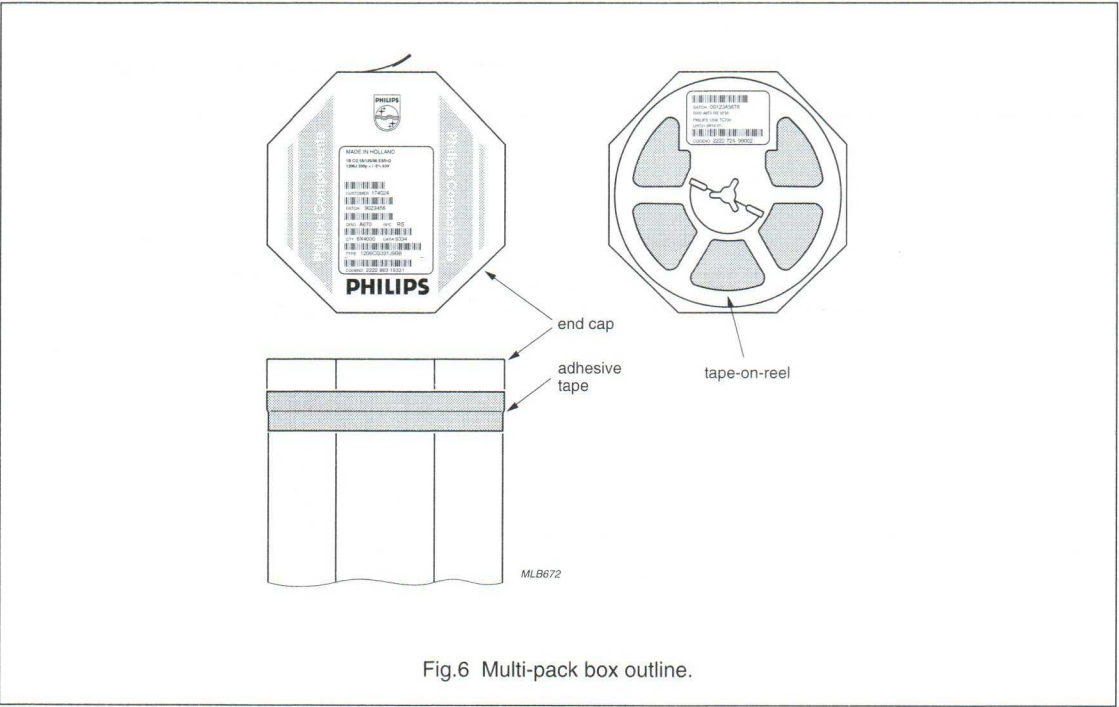
Multi-pack box specification

Features and benefits:

- Minimum recycling costs
- Maximum environmental friendliness
- Reduced handling time
- Economic usage of packaging
- Customized labelling (bar codes).

Table 8 Number of reels per box; see Fig.6

REEL SIZE (mm)	TAPE SIZE (mm)	QUANTITY PER BOX	
		MIN.	MAX.
Ø180	8	5	25
	12	5	10
Ø330	8	5	15



Surface mount ceramic multilayer capacitors

General data

LABELLING

Label examples are shown in Figs 7 and 8 (bar code according to EN 800 code 39).

1. 2. 3. 4. 5. 6. 7. 8.	 MADE IN HOLLAND 2R1 55/125/56 1206J 100n +/-10% 50V BATCH 8400251 ORIG A670 RPC RS QTY 4000 DATE 9841 TYPE 12062R104K9BB0D CODENO 2222 581 15649	LINE MARKING EXPLANATION 1. Country of origin 2. Material code and climatic category 3. Size, termination code, value, tolerance and rated voltage 4. Unique batch number 5. Country of origin in code: A670 is Holland 6. Quantity and production period, year and week code 7. 15-digit code 8. Catalogue number (12NC)
--	---	--

CCB719

Fig.7 Packaging label (example).

1. 2. 3. 4. 5. 6.	 BATCH 8400251 PHILIPS 4000 A670 RS 9841 2R1 55/126/56 1206J 100n +/-10% 50V 12062R104K9BB0D CODENO 2222 581 15649	LINE MARKING EXPLANATION 1. Unique batch number 2. Quantity and date code 3. Material code and climatic category 4. Size, termination code, value, tolerance and rated voltage 5. 15-digit code 6. Catalogue number (12NC)
--	---	---

CCB720

Fig.8 Reel label (example).

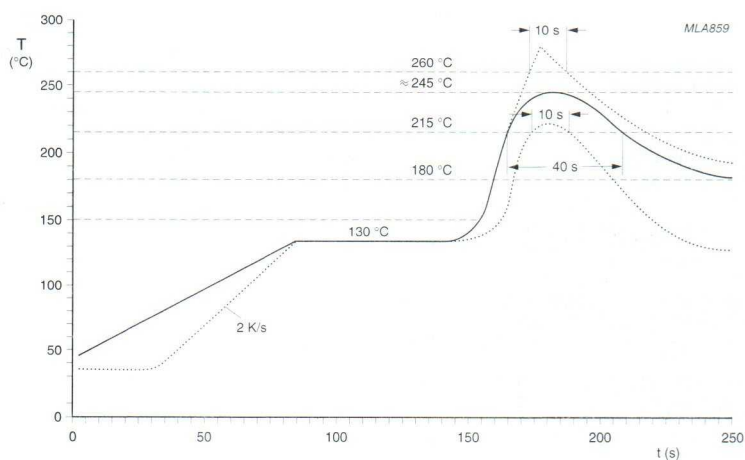
Surface mount ceramic multilayer capacitors

General data

METHOD OF MOUNTING AND DIMENSIONS OF SOLDER LANDS

For normal use the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive in accordance with CECC 00802 classification A. For advised soldering profiles see Figs 9, 10 and 11.

An improper combination of soldering, substrate and chip size can lead to a damaging of the component. The risk increases with the chip size and with temperature fluctuations ($>100\text{ }^{\circ}\text{C}$). Therefore, it is advised to use the smallest possible size and follow the dimensional recommendations given in Tables 9, 10 and 11 for reflow and wave soldering. More detailed information is available on request.



Typical values (solid line).
Process limits (dotted lines).

Fig.9 Reflow soldering.

Surface mount ceramic multilayer capacitors

General data

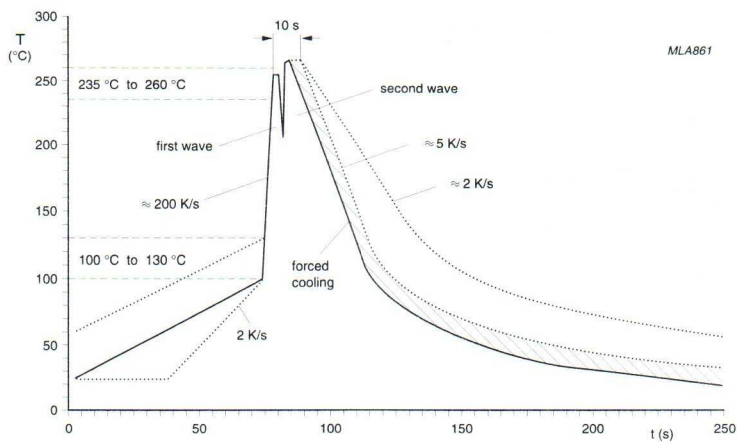


Fig.10 Double wave soldering.

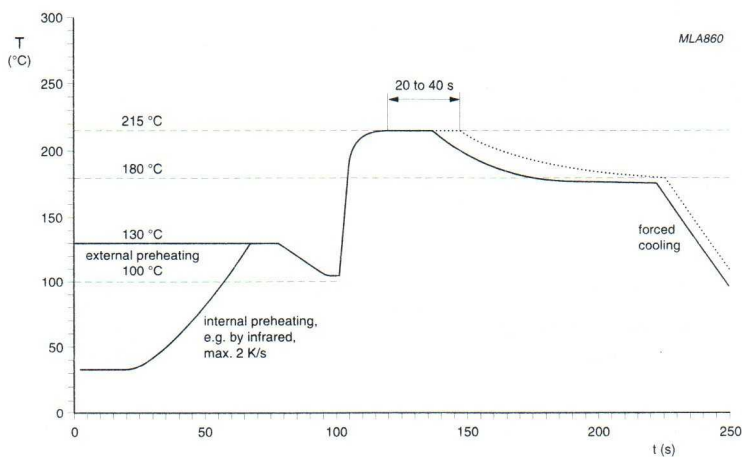


Fig.11 Vapour phase soldering.

Surface mount ceramic
multilayer capacitors

General data

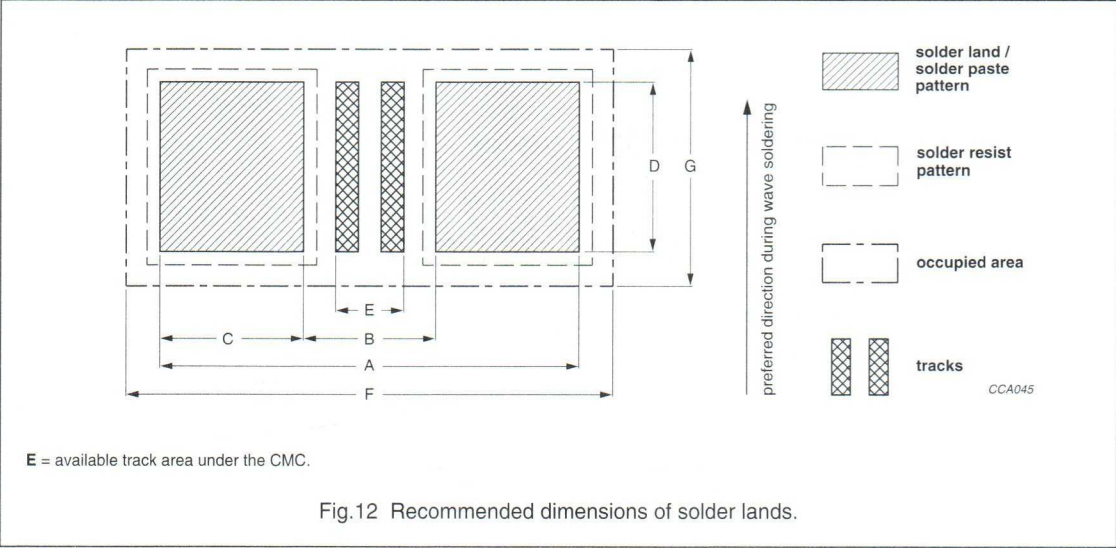


Table 9 Reflow soldering; for dimensions also see Fig.12

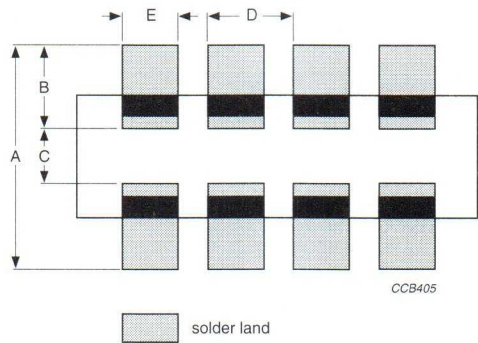
SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROCESSING REMARKS	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0402	1.5	0.5	0.5	0.5	0.10	1.75	0.95	IR or hot plate soldering	±0.15
0603	2.3	0.7	0.8	0.9	0.26	2.7	1.5		±0.15
0603	2.3	0.5	0.9	0.9	0.0	2.7	1.5		±0.25
0805	2.8	0.9	0.95	1.4	0.45	3.2	2.1		±0.25
1206	4.0	2.0	1.0	1.8	1.4	4.4	2.5		±0.25
1210	4.0	2.0	1.0	2.7	1.4	4.4	3.4		±0.25
1808	5.4	3.3	1.05	2.3	2.7	5.8	2.9	ceramic substrate only	±0.25
1812	5.4	3.3	1.05	3.5	2.7	5.8	4.1		±0.25
2220	6.6	4.5	1.05	5.3	3.9	7.0	5.9		±0.25

Table 10 Wave soldering (no dummy tracks allowed for ≥500 V); for dimensions also see Fig.12

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROPOSED NUMBER AND DIMENSIONS OF DUMMY TRACKS (mm)	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0603	2.4	1.0	0.7	0.8	0.2	3.0	1.9	1 × (0.2 × 0.8)	±0.10
0603	2.7	0.9	0.9	0.8	0.0	3.2	2.1	1 × (0.3 × 0.8)	±0.25
0805	3.2	1.4	0.9	1.3	0.36	4.1	2.5	1 × (0.3 × 1.3)	±0.15
0805	3.4	1.3	1.05	1.3	0.2	4.3	2.7	1 × (0.2 × 1.3)	±0.25
1206	4.8	2.3	1.25	1.7	1.25	5.9	3.2	3 × (0.25 × 1.7)	±0.25
1210	5.3	2.3	1.5	2.6	1.25	6.3	4.2	3 × (0.25 × 2.6)	±0.25

Surface mount ceramic
multilayer capacitors

General data



For dimensions see Table 11.

Fig.13 Recommended dimensions of solder lands for C-Array.

Table 11 C-Array solder land dimensions; see Fig.13

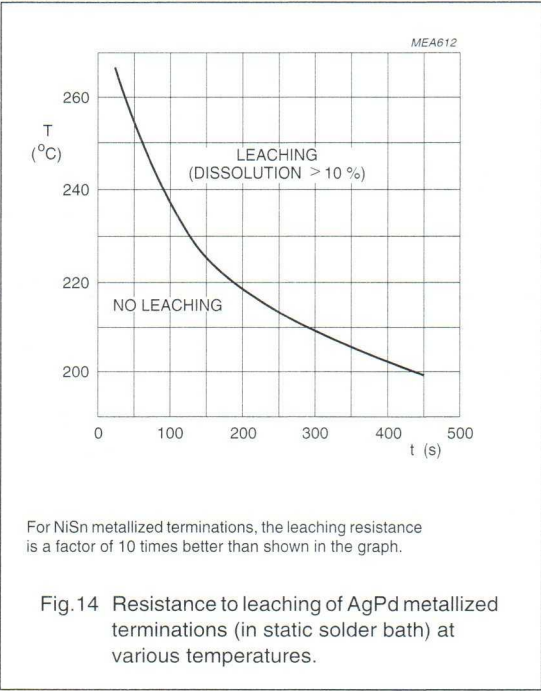
CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

Surface mount ceramic
multilayer capacitors

General data

TEST CONDITIONS IN STATIC SOLDER BATH

PARAMETER	DESCRIPTION
Solderability	
95% covered with smooth and bright solder coating	CECC requirement: 235 ±5 °C for 2 ±0.5 s
	IEC requirement: 215 ±3 °C for 3 ±0.3 s
Resistance to leaching	
10% of the metallization of the edges of the head face may be missing (inner electrodes are not visible)	260 ±5 °C for 30 ±1 s



Surface mount ceramic multilayer capacitors

General data

TESTS AND REQUIREMENTS

Table 12 Test procedures and requirements

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.4		mounting	the capacitors may be mounted on printed-circuit boards or ceramic substrates by applying wave soldering, reflow soldering (including vapour phase soldering) or conductive adhesive	no visible damage
4.5		visual inspection and dimension check	any applicable method using $\times 10$ magnification	in accordance with specification
4.6.1		capacitance	class 1: $C \leq 1000 \text{ pF}$, $f = 1 \text{ MHz}$; $C > 1000 \text{ pF}$, $f = 1 \text{ kHz}$; NP0: measuring voltage 1 V at 20°C class 2: for all capacitors $f = 1 \text{ kHz}$; X7R: measuring voltage 1 V at 20°C Y5V/Z5U: measuring voltage 1 V at 25°C	within specified tolerance
4.6.2		$\tan \delta$	class 1: $C \leq 1000 \text{ pF}$, $f = 1 \text{ MHz}$; $C > 1000 \text{ pF}$, $f = 1 \text{ kHz}$; NP0: measuring voltage 1 V at 20°C class 2: for all capacitors $f = 1 \text{ kHz}$; X7R: measuring voltage 1 V at 20°C Y5V/Z5U: measuring voltage 1 V at 25°C	in accordance with specification
4.6.3		insulation resistance	at U_R (DC) for 1 minute	in accordance with specification
4.6.4		voltage proof	$U_R \leq 100 \text{ V}$: $2.5 \times U_R$ for 1 minute; $U_R > 100 \text{ V}$: $1.5 \times U_R + 100$ for 1 minute	no breakdown or flashover
4.7.1		temperature coefficient	class 1: between minimum and maximum temperature	in accordance with specification
4.7.2		temperature characteristic	class 2: between minimum and maximum temperature	in accordance with specification

Surface mount ceramic multilayer capacitors

General data

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.8		adhesion	a force of 5 N applied for 10 s to the line joining the terminations and in a plane parallel to the substrate	no visible damage
4.9		bond strength of plating on end face	mounted in accordance with CECC 32 100, paragraph 4.4	no visible damage
			conditions: bending 1 mm at a rate of 1 mm/s, radius jig. 340 mm	$\Delta C/C$: class 1: within $\pm 10\%$ class 2, X7R: within $\pm 10\%$ class 2, Y5V: within $\pm 30\%$
4.10	Tb	resistance to soldering heat	260 ± 5 °C for 10 ± 0.5 s in a static solder bath	the terminations shall be well tinned after recovery $\Delta C/C$: class 1: within $\pm 0.5\%$ or 0.5 pF whichever is greater class 2, X7R: > -5% and $\leq 10\%$ class 2, Y5V: > -10% and $\leq 20\%$
		resistance to leaching	260 ± 5 °C for 30 ± 1 s in a static solder bath	using visual enlargement of $\times 10$, dissolution of the terminations shall not exceed 10%
4.11	Ta	solderability	zero hour test, and test after storage (20 to 24 months) in original packing in normal atmosphere; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 5 °C	the terminations shall be well tinned

Surface mount ceramic multilayer capacitors

General data

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12	Na	rapid change of temperature	preconditioning, class 2 only: NP0/X7R: -55 to +125 °C; 5 cycles Y5V: -25 to +85 °C; 5 cycles	no visible damage after 24 hours recovery $\Delta C/C$: class 1: within $\pm 1\%$ or 1 pF class 2, X7R: within $\pm 15\%$ class 2, Y5V: within $\pm 20\%$
4.14	Ca	damp heat	preconditioning, class 2 only: 56 days at 40 °C; 90 to 95% RH; U_R applied (max. 500 V)	no visual damage after recovery class 1: 1 to 2 hours class 2: 24 hours $\Delta C/C$: class 1: within $\pm 2\%$ or 1 pF, whichever is greater class 2, X7R: within $\pm 15\%$, $\pm 20\%$ class 2, Y5V: within $\pm 30\%$, +30/-40% (according to Philips specification) $\tan \delta$: class 1: $\leq 2 \times$ specified value class 2: X7R: $\leq 7\%$ class 2: Y5V: $\leq 12.5\%$, 15% (according to Philips specification) R_{ins} : class 1: 2500 M Ω or $R_i C_R \geq 25$ s, whichever is less class 2: 1000 M Ω or $R_i C_R \geq 25$ s, whichever is less

Surface mount ceramic multilayer capacitors

General data

IEC 60384-10/ CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.15		endurance	preconditioning, class 2 only: 1 000 hours at upper category temperature at: $2 \times U_R$ for $U_R \leq 50$ V; $1.5 \times U_R$ for other rated voltages	no visible damage after 24 hours recovery: $\Delta C/C$: class 1: within $\pm 2\%$ or 1 pF, whichever is greater class 2, X7R: within $\pm 20\%$ class 2, Y5V: within $\pm 30\%$, $+30/-40\%$ (according to Philips specification) $\tan \delta$: class 1: $\leq 2 \times$ specified value class 2: X7R: $\leq 7\%$ class 2: Y5V: $\leq 12.5\%$, 15% (according to Philips specification) R_{ins} : class 1: 4 000 M Ω or $R_i C_R \geq 40$ s, whichever is less class 2: 2 000 M Ω or $R_i C_R \geq 50$ s, whichever is less

Surface mount ceramic
multilayer capacitors

Product overview

PROGRAMME SURVEY

Product overview

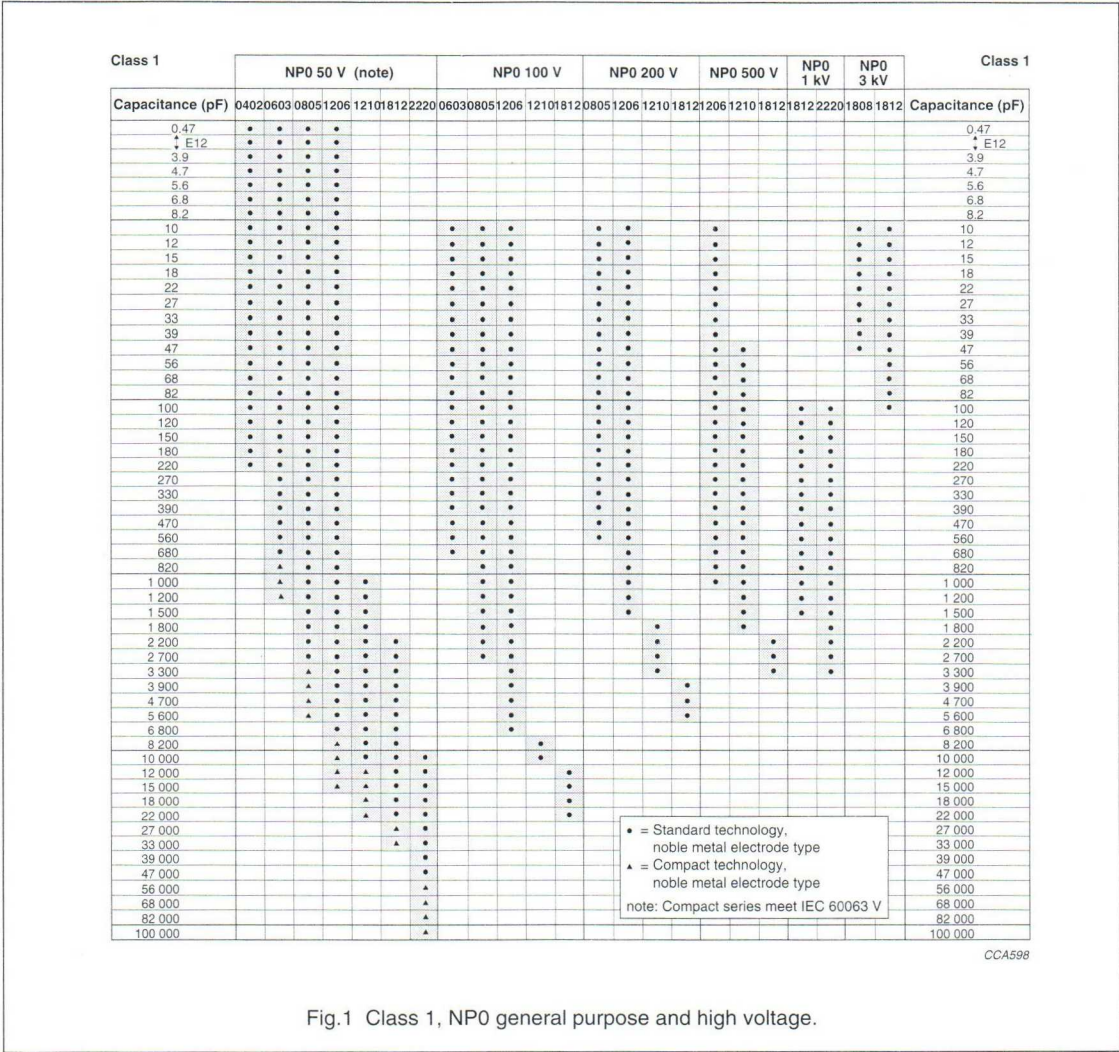


Fig.1 Class 1, NP0 general purpose and high voltage.

Surface mount ceramic multilayer capacitors

Product overview

Class 2		X7R 10 V		X7R 16 V		X7R 25 V				X7R 50 V (note)				X7R 50 V LI	X7R 100 V			X7R 200 V			X7R 500 V			X7R 1 kV		Class 2							
C (pF)	0603	0805	1206	0402	0603	0805	1206	1210	1812	2220	0402	0603	0805	1206	1210	1812	2220	0612	0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812	1808	1812	C (nF)	
100											*	*	*																			0.1	
120											*	*	*																			0.12	
150											*	*	*																			0.15	
180											*	*	*						*					*								0.18	
220											*	*	*	*	*				*	*	*			*								0.22	
270											*	*	*	*	*				*	*	*			*								0.27	
330											*	*	*	*	*				*	*	*			*								0.33	
390											*	*	*	*	*				*	*	*			*								0.39	
470											*	*	*	*	*				*	*	*			*								0.47	
560											*	*	*	*	*				*	*	*			*				*	*			0.56	
680											*	*	*	*	*				*	*	*			*			*	*				0.68	
820											*	*	*	*	*				*	*	*			*			*	*				0.82	
1000											*	*	*	*	*				*	*	*			*			*	*			*	*	1
1200											*	*	*	*	*				*	*	*			*			*	*		*	*	1.2	
1500											*	*	*	*	*				*	*	*			*			*	*		*	*	1.5	
1800											*	*	*	*	*				*	*	*			*			*	*		*	*	1.8	
2200											*	*	*	*	*				*	*	*			*			*	*		*	*	2.2	
2700											*	*	*	*	*				*	*	*			*			*	*		*	*	2.7	
3300											*	*	*	*	*				*	*	*			*			*	*		*	*	3.3	
3900											*	*	*	*	*				*	*	*			*			*	*		*	*	3.9	
4700				*							*	*	*	*	*				*	*	*			*			*	*		*	*	4.7	
5600				*							*	*	*	*	*				*	*	*			*			*	*		*	*	5.6	
6800				*							*	*	*	*	*				*	*	*			*			*	*		*	*	6.8	
8200				*							*	*	*	*	*				*	*	*			*			*	*		*	*	8.2	
10 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	10	
12 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	12	
15 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	15	
18 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	18	
22 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	22	
27 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	27	
33 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	33	
39 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	39	
47 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	47	
56 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	56	
68 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	68	
82 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	82	
100 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	100	
120 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	120	
150 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	150	
180 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	180	
220 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	220	
270 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	270	
330 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	330	
390 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	390	
470 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	470	
560 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	560	
680 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	680	
820 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	820	
1 000 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	1 000	
1 200 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	1 200	
1 500 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	1 500	
1 800 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	1 800	
2 200 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	2 200	
2 700 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	2 700	
3 300 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	3 300	
3 900 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	3 900	
4 700 000				*							*	*	*	*	*				*	*	*			*			*	*		*	*	4 700	

- = Standard technology, noble metal electrode type
- = Standard technology, base metal electrode type
- ▲ = Compact technology, noble metal electrode type
- LI = Low Inductance

note: Compact series meet IEC 60063 V

◆ = Standard technology,
noble metal electrode type
 ■ = Standard technology,
base metal electrode type
 ▲ = Compact technology,
noble metal electrode type
 LI = Low Inductance
 note: Compact series meet IEC 60063 V

CCA599

Fig.2 Class 2, X7R general purpose and high voltage.

Surface mount ceramic
multilayer capacitors

Product overview

Class 2		Y5V 10 V			Y5V 16 V			Y5V 25 V			Y5V 50 V			Z5U 25 V			Z5U 50 V			Class 2	
Capacitance (μF)		0603	0805	1206	0402	0603	0805	1206	0603	0805	1206	0603	0805	1206	0603	1206	0805	1206	1210	Capacitance (nF)	
0.010					■				■			■	■		■		■	■		10	
0.012					■				■			■	■		■		■	■		12	
0.015					■				■			■	■		■		■	■		15	
0.018					■				■			■	■		■		■	■		18	
0.022					■				■			■	■		■		■	■		22	
0.027					■				■			■	■		■		■	■		27	
0.033					■				■			■	■		■		■	■		33	
0.039					■				■			■	■		■		■	■		39	
0.047					■				■			■	■		■		■	■		47	
0.056					■				■			■	■		■		■	■		56	
0.068					■				■			■	■		■		■	■		68	
0.082					■				■			■	■		■		■	■		82	
0.10					■				■	■	■	■	■	■	■		■	■	■	100	
0.12					■				■	■	■	■	■	■	■		■	■	■	120	
0.15					■				■	■	■	■	■	■	■		■	■	■	150	
0.18					■				■	■	■	■	■	■	■		■	■	■	180	
0.22					■				■	■	■	■	■	■	■		■	■	■	220	
0.27					■				■	■	■	■	■	■	■		■	■	■	270	
0.33					■				■	■	■	■	■	■	■		■	■	■	330	
0.39					■				■	■	■	■	■	■	■		■	■	■	390	
0.47					■	■			■	■	■	■	■	■	■		■	■	■	470	
0.56					■	■			■	■	■	■	■	■	■		■	■	■	560	
0.68					■	■			■	■	■	■	■	■	■		■	■	■	680	
0.82					■	■			■	■	■	■	■	■	■		■	■	■	820	
1.0	■		■		■	■			■	■	■	■	■	■	■		■	■	■	1000	
1.2			■		■	■			■	■	■	■	■	■	■		■	■	■	1200	
1.5			■		■	■			■	■	■	■	■	■	■		■	■	■	1500	
1.8			■		■	■			■	■	■	■	■	■	■		■	■	■	1800	
2.2		■	■		■	■			■	■	■	■	■	■	■		■	■	■	2200	
2.7					■	■			■	■	■	■	■	■	■		■	■	■	2700	
3.3		■	■		■	■			■	■	■	■	■	■	■		■	■	■	3300	
3.9					■	■			■	■	■	■	■	■	■		■	■	■	3900	
4.7					■	■			■	■	■	■	■	■	■		■	■	■	4700	
5.6					■	■			■	■	■	■	■	■	■		■	■	■	5600	
6.8					■	■			■	■	■	■	■	■	■		■	■	■	6800	
8.2					■	■			■	■	■	■	■	■	■		■	■	■	8200	
10					■	■			■	■	■	■	■	■	■		■	■	■	10000	

■ = Standard technology,
base metal electrode type

CCA600

Fig.3 Class 2, Y5V and Z5U Base Metal Electrode.

Class 1		NP0 50 V		
Capacitance (pF)		0603	0805	1206
0.47		•	•	•
1 E12		•	•	•
3.9		•	•	•
4.7		•	•	•
5.6		•	•	•
6.8		•	•	•
8.2		•	•	•
10		•	•	•
12		•	•	•
15		•	•	•
18		•	•	•
22		•	•	•
27		•	•	•
33		•	•	•
39		•	•	•
47		•	•	•
56		•	•	•
68		•	•	•
82		•	•	•
100				•
120				•

CCA714

Fig.4 Class 1, NP0 microwave.

Class 1		NP0 25 V				
C (pF)		0402	0603	0805	1206	1210
220	▲					
270	▲					
330	▲					
390						
470						
560						
680						
820			•			
1 000			•			
1 200			•			
1 500			•			
1 800						
2 200						
2 700						
3 300				•		
3 900				•		
4 700				•		
5 600						
6 800						
8 200					•	
10 000					•	
12 000						•
15 000						•
18 000						•
22 000						•

• = Standard technology,
noble metal
electrode type
▲ = Compact
technology,
noble metal
electrode type

CCB775

Fig.5 Class 1, NP0 25 V.

Class 1		NP0 50/63 V	
Capacitance (pF)		4 × 0603	
22		•	
27		•	
33		•	
39		•	
47		•	
56		•	
68		•	
82		•	
100		•	
120		•	
150		•	
180		•	
220		•	
270		•	
330		•	
390		•	
470		•	
560		•	
680		•	
820		•	
1000		•	

CCA715

Fig.6 C-Array Class 1, NP0.

Surface mount ceramic multilayer capacitors

Product overview

Class 1				
NP0 50 V				
Capacitance (pF)	0402	0603	0805	1206
0.47	•	•	•	•
† E12	•	•	•	•
3.9	•	•	•	•
4.7	•	•	•	•
5.6	•	•	•	•
6.8	•	•	•	•
8.2	•	•	•	•
10	•	•	•	•
12	•	•	•	•
15	•	•	•	•
18	•	•	•	•
22	•	•	•	•
27	•	•	•	•
33	•	•	•	•
39	•	•	•	•
47	•	•	•	•
56	•	•	•	•
68	•	•	•	•
82	•	•	•	•
100	•	•	•	•
120	•	•	•	•
150	•	•	•	•
180	•	•	•	•
220	•	•	•	•
270	•	•	•	•
330	•	•	•	•
390	•	•	•	•
470	•	•	•	•
560	•	•	•	•
680	•	•	•	•
820	•	•	•	•
1000	•	•	•	•
1200	•	•	•	•
1500	•	•	•	•
1800	•	•	•	•
2200	•	•	•	•
2700	•	•	•	•
3300	•	•	•	•
3900	•	•	•	•
4700	•	•	•	•
5600	•	•	•	•
6800	•	•	•	•

CCA713

Fig.7 Class 1, NP0
narrow tolerance.

Class 2		X7R 16 V	X7R 25 V	X7R 50 V
Capacitance (nF)	4 × 0603	4 × 0603	4 × 0603	
2.2			•	
2.7			•	
3.3			•	
3.9			•	
4.7			•	
5.6			•	
6.8			•	
8.2			•	
10	•	•	•	
12	•	•	•	
15	•	•	•	
18	•	•	•	
22	•	•	•	
27	•	•	•	
33	•	•	•	
39	•	•	•	
47	•	•	•	
56	•	•	•	
68	•	•	•	
82	•	•	•	
100	•	•	•	
120				
150				

CCA805

Fig.8 C-Array Class 2, X7R.

Class 2		X7R 16 V	Y5V 25 V
Capacitance (nF)	4 × 0603	4 × 0603	
10	■	■	
12	■	■	
15	■	■	
18	■	■	
22	■	■	
27	■	■	
33	■	■	
39	■	■	
47	■	■	
56	■	■	
68	■	■	
82	■	■	
100	■	■	

CCB774

Fig.9 C-Array, X7R and Y5V
Base Metal Electrode.

Surface mount ceramic multilayer capacitors

Numerical index

NUMERICAL INDEX

Sequence of catalogue numbers in accordance with the "12-DIGIT CODE"

SERIES	DESCRIPTION	TERMINATION	PAGE
2222 550.6	X7R 10 V, Compact	Ni-barrier	142
2222 57	NP0 50 V, Microwave	Ni-barrier	68
2222 58..5	X7R 50 V	Ni-barrier	92
2222 58..6	X7R 50 V, NME	Ni-barrier	104
2222 58..9	Y5V 50 V	Ni-barrier	124
2222 595.6	X7R 50 V, NME (size 2220)	AgPd	104
2222 60..1	NP0 100 V, NME	Ni-barrier	42
2222 60..6	X7R 100 V, NME	Ni-barrier	104
2222 615.1	NP0 100 V, NME (size 2220)	AgPd	42
2222 62..8	Z5U 50 V	Ni-barrier	136
2222 78..6	X7R 16 V, NME	Ni-barrier	104
2222 78..9	Y5V 16 V	Ni-barrier	124
2222 86	NP0 50 V, NME	Ni-barrier	42
2222 866	NP0 50 V, NME (size 2220)	AgPd	42
2222 87..6	X7R 25 V, Compact	Ni-barrier	142
2222 877.0	NP0 25 V, Compact (size 0402)	Ni-barrier	140
2222 885	X7R 25 V, Compact (size 2220)	Ni-barrier	142
2222 89..0	NP0 50 V/63 V, Compact	Ni-barrier	142
2222 89..6	X7R 50 V/63 V, Compact	Ni-barrier	142
2222 90..0	NP0 50 V/63 V, Compact	AgPd	142
2222 905.6	X7R 50 V/63 V, Compact	AgPd	142
2222 91..5	X7R 25 V	Ni-barrier	92
2222 91..6	X7R 25 V, NME	Ni-barrier	104
2222 91..9	Y5V 25 V	Ni-barrier	124
2222 93..1	NP0 200 V, NME	Ni-barrier	42
2222 93..6	X7R 200 V, NME	Ni-barrier	104
2222 95	X7R 16 V, Compact	Ni-barrier	142
2222 964	X7R 16 V, Compact (size 1812)	AgPd	142
2222 97..1	NP0 500 V, NME	Ni-barrier	42
2222 97..6	X7R 500 V, NME	Ni-barrier	104
2238 57	NP0 50 V, Microwave	Ni-barrier	68
2238 58..5	X7R 50 V	Ni-barrier	92
2238 58..6	X7R 50 V, NME	Ni-barrier	104
2238 58..9	Y5V 50 V	Ni-barrier	124
2238 60..1	NP0 100 V, NME	Ni-barrier	42
2238 60	X7R 100 V, NME	Ni-barrier	104
2238 62	Z5U 50 V	Ni-barrier	136
2238 78..6	X7R 16 V, NME	Ni-barrier	104

Surface mount ceramic multilayer capacitors

Numerical index

SERIES	DESCRIPTION	TERMINATION	PAGE
2238 78..9	Y5V 16 V	Ni-barrier	124
2238 86	NP0 50 V, NME	Ni-barrier	42
2238 87	X7R 25 V, Compact	Ni-barrier	142
2238 877	NP0 25 V, Compact (size 0402)	Ni-barrier	142
2238 89..0	NP0 50 V/63 V, Compact	Ni-barrier	142
2238 89..6	X7R 50 V/63 V, Compact	Ni-barrier	142
2238 91..5	X7R 25 V	Ni-barrier	92
2238 91..6	X7R 25 V, NME	Ni-barrier	104
2238 91..9	Y5V 25 V	Ni-barrier	124
2238 93..1	NP0 200 V, NME	Ni-barrier	42
2238 93..6	X7R 200 V, NME	Ni-barrier	104
2238 95	X7R 16 V, Compact	Ni-barrier	142
2238 97..1	NP0 500 V, NME	Ni-barrier	42
2238 97..6	X7R 500 V, NME	Ni-barrier	104
2250 00..1	NP0 1 kV, NME	Ni-barrier	78
2250 00..6	X7R 1 kV, NME	Ni-barrier	114
2250 01..1	NP0 1 kV, NME	AgPd	78
2250 04..1	NP0 3 kV, NME	Ni-barrier	82
2250 10..6	C-Array X7R 16 V, NME	Ni-barrier	161
2250 11..6	C-Array X7R 16 V, NME	AgPd	161
2250 12..6	C-Array X7R 25 V, NME	Ni-barrier	161
2250 13..6	C-Array X7R 25 V, NME	AgPd	161
2250 14..1	C-Array NP0 50/63 V, NME	Ni-barrier	155
2250 15..1	C-Array NP0 50/63 V, NME	AgPd	155
2254 550	X7R 16 V, Compact	Ni-barrier	142
2254 57	NP0 50 V, Microwave	Ni-barrier	68
2254 58..5	X7R 50 V	Ni-barrier	92
2254 58..6	X7R 50 V, NME	Ni-barrier	104
2254 58..9	Y5V 50 V	Ni-barrier	124
2254 60..1	NP0 100 V, NME	Ni-barrier	42
2254 60..6	X7R 100 V, NME	Ni-barrier	104
2254 62	Z5U 50 V	Ni-barrier	136
2254 78..6	X7R 16 V, NME	Ni-barrier	104
2254 78..9	Y5V 16 V	Ni-barrier	124
2254 86	NP0 50 V, NME	Ni-barrier	42
2254 87	X7R 25 V, Compact	Ni-barrier	142
2254 877	X7R 25 V, Compact (size 0402)	Ni-barrier	142
2254 89..0	NP0 50 V/63 V, Compact	Ni-barrier	142
2254 89..6	X7R 50 V/63 V, Compact	Ni-barrier	142
2254 91..5	X7R 25 V	Ni-barrier	92
2254 91..6	X7R 25 V, NME	Ni-barrier	104

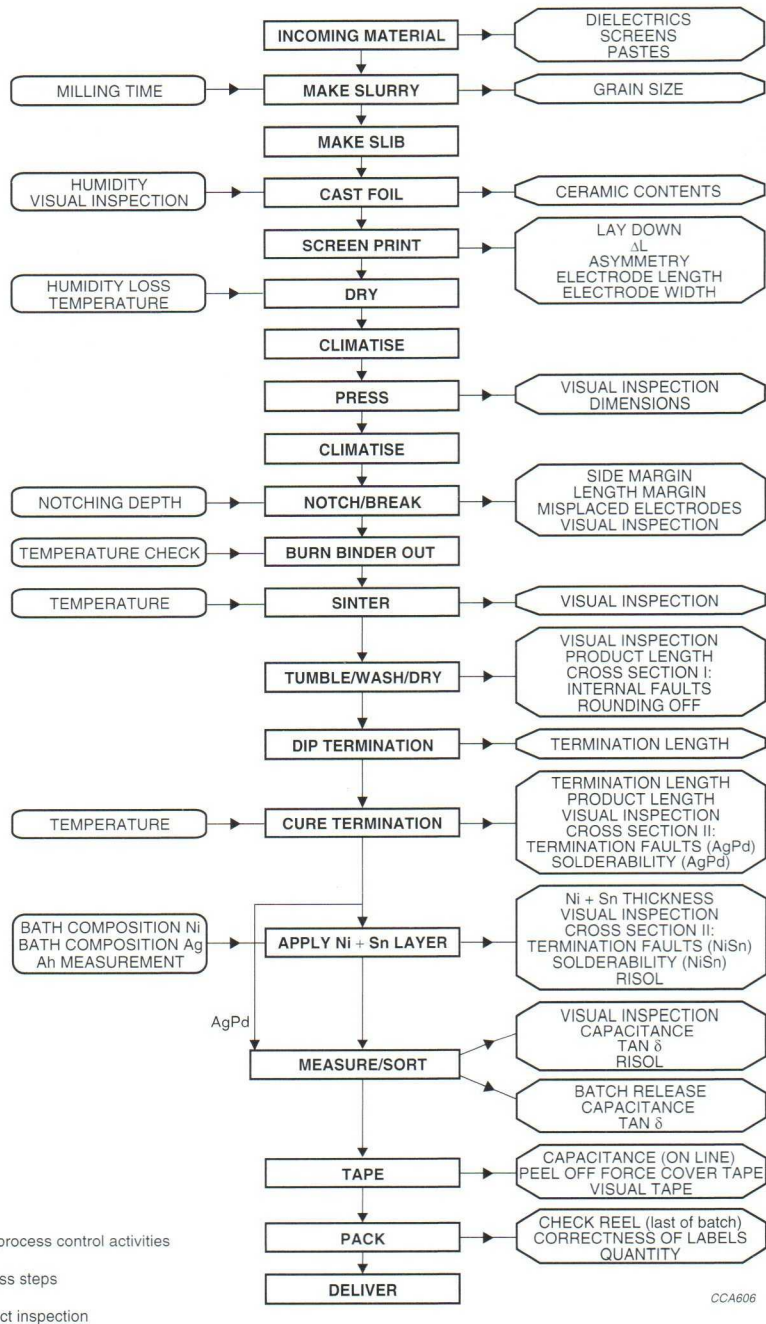
**Surface mount ceramic
multilayer capacitors**

Numerical index

SERIES	DESCRIPTION	TERMINATION	PAGE
2254 91..9	Y5V 25 V	Ni-barrier	124
2254 93..1	NP0 200 V, NME	Ni-barrier	42
2254 93..6	X7R 200 V, NME	Ni-barrier	104
2254 95	X7R 16 V, Compact	Ni-barrier	142
2255 10..6	C-Array X7R 16 V	Ni-barrier	169
2255 11..6	C-Array X7R 16 V	AgPd	169
2255 12..6	C-Array X7R 25 V, NME	Ni-barrier	161
2255 13..6	C-Array X7R 25 V, NME	AgPd	161
2255 14..6	C-Array NP0 50/63 V, NME	Ni-barrier	155
2255 15..6	C-Array NP0 50/63 V, NME	AgPd	155
2256 04..1	NP0 3 kV, NME	Ni-barrier	82
2256 00..6	X7R 1 kV, NME	Ni-barrier	114

Surface mount ceramic multilayer capacitors

Quality flow chart



CCA606

CAPACITOR PRODUCT DATA

	Page
NP0 25 V, NME	36
NP0 50/100/200/500 V, NME	42
NP0 narrow tolerance, NME	58
NP0 microwave, NME	68
NP0 1 kV high voltage, NME	78
NP0 3 kV high voltage, NME	82
X7R 10 V	86
X7R 16/25/50 V	92
X7R 50 V low inductance	100
X7R 16/25/50/100/200/500 V, NME	104
X7R 1 kV high voltage, NME	114
Y5V 10 V	118
Y5V 16/25//50 V	124
Z5U 25 V	130
Z5U 50 V	136
Compact series NP0 and X7R	142
C-Arrays NP0 50/63 V, NME	155
C-Arrays X7R 16/25/50 V, NME	161
C-Arrays X7R 16 V	169
C-Arrays Y5V 25 V	175

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V Noble Metal Electrode

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in bulk case or in tape on reel.

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V (IEC)
Capacitance range (E12 series); Class 1, subclass 1B, letter code CG (NP0): case size 0603 case size 0805 case size 1206 case size 1210	820 pF to 1.5 nF 3.3 nF to 4.7 nF 8.2 nF to 10 nF 12 nF to 22 nF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

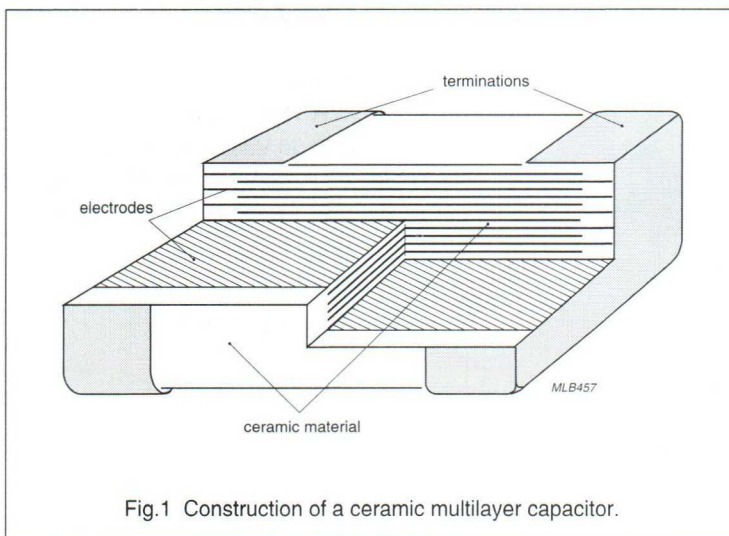
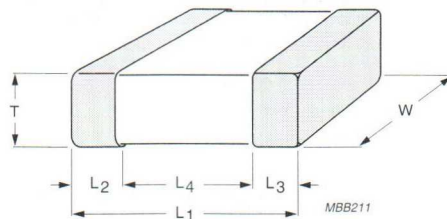


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V Noble Metal Electrode

SELECTION CHART FOR 25 V

C (pF)	LAST TWO DIGITS OF 12NC	25 V			
		0603	0805	1206	1210
820	48	0.8 ±0.07			
1000	49				
1200	51				
1500	52				
1800	53				
2200	54				
2700	55				
3300	56				
3900	57				
4700	58				
5600	59				
6800	61				
8200	62				
10000	63				
12000	64				
15000	65	Values in shaded cells indicate thickness classification.			0.5 to 1.0
18000	66				
22000	67				

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"			
	PAPER	BLISTER	PAPER	BLISTER	0603	0805
0.8 ±0.07	4000	4000	20000	10000	15000	10000
0.85 ±0.1	4000	4000	15000	10000	—	8000
0.5 to 1.0	—	4000	—	10000	—	—
0.9 to 1.3	—	3000	—	10000	—	—
1.25 ±0.1	—	3000	—	10000	—	5000

Surface mount ceramic
multilayer capacitors

Class 1, NP0 25 V
Noble Metal Electrode

ORDERING INFORMATION FOR 25 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG102J8B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	F $\pm$ 1% G $\pm$ 2% J $\pm$ 5% K $\pm$ 10%	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	0 = conv. ceramic

Ordering code 12NC

22XX91XX1XXX

Carrier type

22 blister⁽²⁾
38 paper
54 bulk

Size - Termination

6 0603 Ni-barrier
0 0805 Ni-barrier
1 1206 Ni-barrier
2 1210 Ni-barrier

Packaging⁽³⁾

1 reel: Ø180 mm
5 reel: Ø330 mm
4 bulk case (sizes 0603 and 0805 only)

Capacitance value⁽¹⁾

Tolerance

3 1%
4 2%
5 5%
6 10%

CCB106

(1) Refer to Chapter "Selection chart for 25 V".

(2) Blister tape only for products with a thickness >1 mm.

(3) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

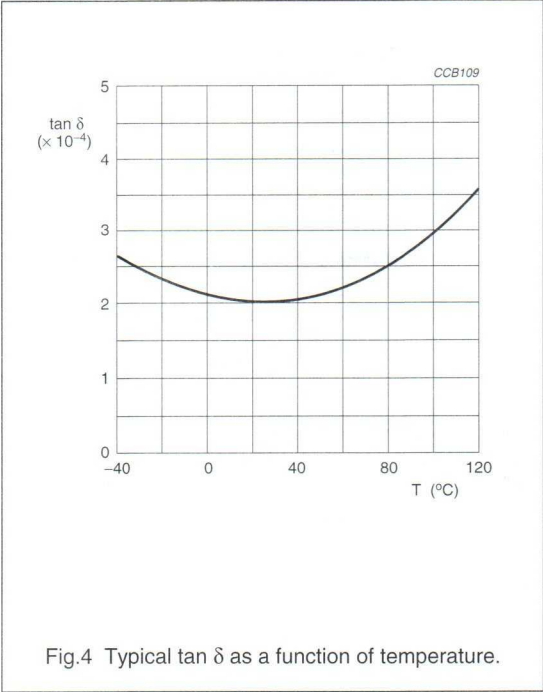
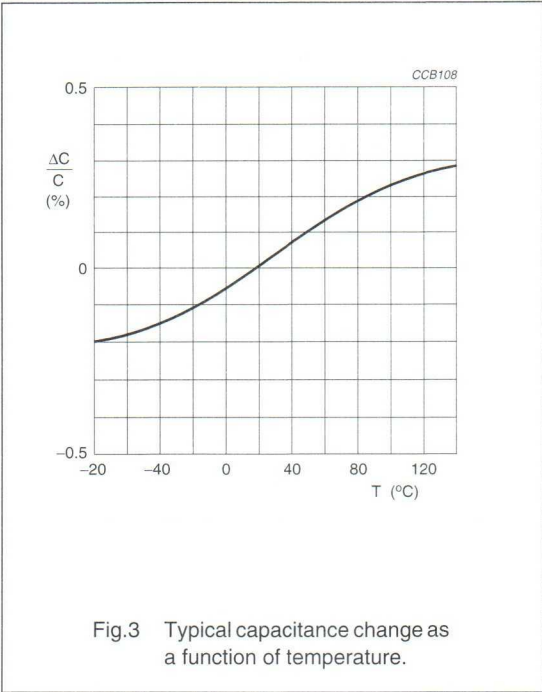
Class 1, NP0 25 V
Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); Class 1, subclass 1B, letter code CG (NP0): case size 0603 case size 0805 case size 1206 case size 1210	820 pF to 1.5 nF 3.3 nF to 4.7 nF 8.2 nF to 10 nF 12 nF to 22 nF
Tolerance on capacitance after 1000 hours	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100\text{ G}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$



Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V Noble Metal Electrode

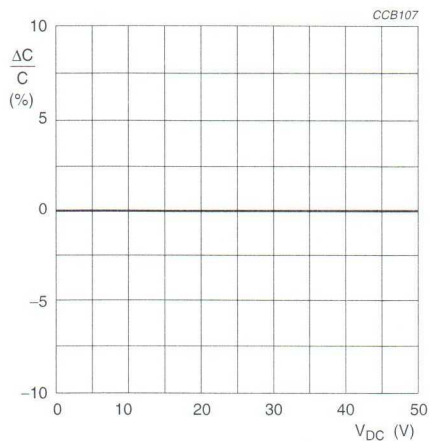


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

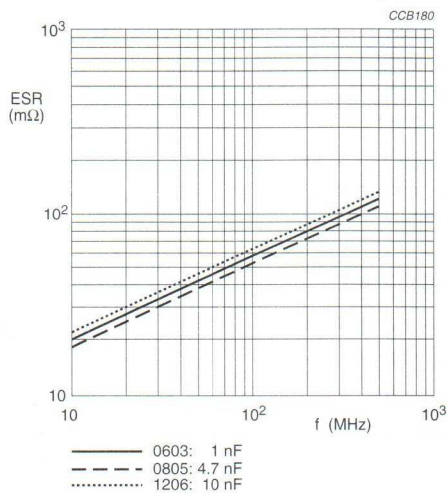


Fig.6 Typical ESR as a function of frequency.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V
Noble Metal Electrode

TFEATURES

- Seven standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0402, 0603 and 0805 only)
- For high frequency applications
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

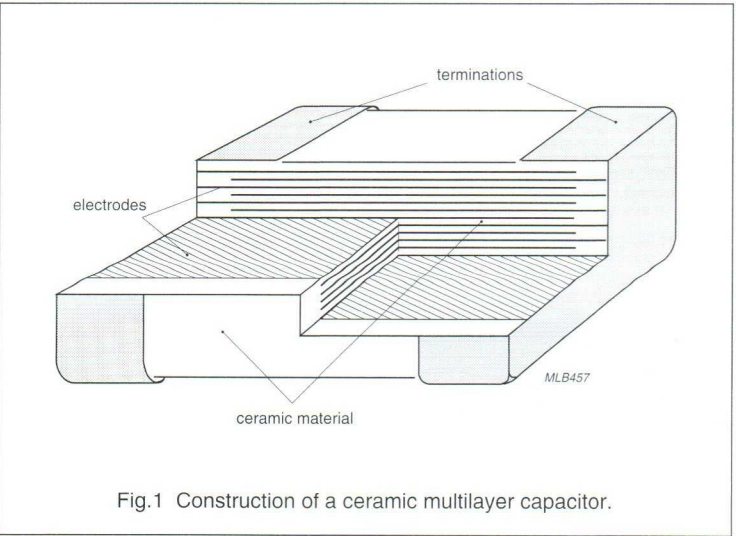
The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1: 50 V; note 2 100 V 200 V 500 V	0.47 pF to 47 000 pF 10 pF to 22 nF 10 pF to 5600 pF 10 pF to 3300 pF
Tolerance on capacitance: $C \geq 10$ pF $C < 10$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ ± 0.5 pF, ± 0.25 pF
Test voltage (DC) for 1 minute: 50 V and 100 V 200 V 500 V	$2.5 \times U_R$ $3 \times U_R$ $2 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

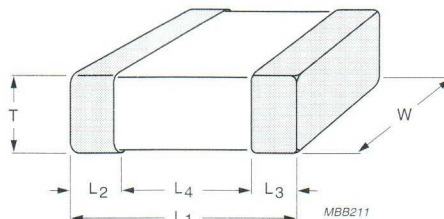
1. Other values below 10 pF and non E12 series are available on request.
2. Also applicable for applications up to 63 V.



Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V Noble Metal Electrode

SELECTION CHART FOR 50 V

C (pF)	LAST THREE DIGITS OF 12NC	50 V						
		0402	0603	0805	1206	1210	1812	2220
0.47	477	0.5 ±0.05	0.8 ±0.07	0.6 ±0.1	0.6 ±0.1			
0.56	567							
0.68	687							
0.82	827							
1.0	108							
1.2	128							
1.5	158							
1.8	188							
2.2	228							
2.7	278							
3.3	338							
3.9	398							
4.7	478							
5.6	568							
6.8	688							
8.2	828							
10	109							
12	129							
15	159							
18	189							
22	229							
27	279							
33	339			0.85 ±0.1	1.15 ±0.1	0.5 to 1.0	0.5 to 1.0	0.5 to 1.0
39	399							
47	479							
56	569							
68	689							
82	829							
100	101							
120	121							
150	151							
180	181							
220	221							
270	271							
330	331							
390	391							
470	471							
560	561							
680	681							
820	821							
1000	102							
1200	122							
1500	152							
1800	182							
2200	222							
2700	272							
3300	332							
3900	392							
4700	472							
5600	562							
6800	682							
8200	822							
10000	103							
12000	123							

Values in shaded cells indicate thickness classification.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V Noble Metal Electrode

C (pF)	LAST THREE DIGITS OF 12NC	50 V							
		0402	0603	0805	1206	1210	1812	2220	
15000	153						0.5 to 1.0	0.5 to 1.0	
18000	183						0.9 to 1.3		
22000	223								
27000	273								
33000	333								
39000	393								
47000	473							0.9 to 1.3	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	—	—	50000	—	—
0.6 ±0.1	4000	4000	20000	10000	—	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	2000	1500	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	—	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	—	5000

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V
Noble Metal Electrode

ORDERING INFORMATION FOR 50 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG102J9B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	C ±0.25 pF	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic
0603			D ±0.5 pF			3 = 330 mm; 13" paper		
0805			F ±1%			B = 180 mm; 7" blister		
1206			G ±2%			F = 330 mm; 13" blister		
1210			J ±5%			P = bulk case		
1812			K ±10%					
2220 (AgPd only)								

Ordering code 12NC

2 2 X X 8 6 X X X X X X

Carrier type

22 blister

38 paper

54 bulk

Size

9 0402

7 0603

1 0805

3 1206

2 1210

5 1812

6 2220 (AgPd only)

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

7 reel: Ø330 mm; 13"

4 bulk case

Capacitance value⁽¹⁾

Tolerance

NiSn terminations

4 ±0.25 pF for C = 5.6 to 8.2 pF

±2% for C ≥ 10 pF

5 ±0.25 pF for C = 0.47 to 4.7 pF

±0.5 pF for C = 5.6 to 8.2 pF

±5% for C ≥ 10 pF

6 ±10% for C ≥ 10 pF

AgPd terminations

1 ±0.25 pF for C = 5.6 to 8.2 pF

±2% for C ≥ 10 pF

2 ±0.25 pF for C = 0.47 to 4.7 pF

±0.5 pF for C = 5.6 to 8.2 pF

±5% for C ≥ 10 pF

3 ±10% for C ≥ 10 pF

CCA622

(1) Refer to Chapter "Selection chart for 50 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

1999 Feb 10

46

Surface mount ceramic multilayer capacitors

THIS PAGE IS INTENTIONALLY BLANK

Surface mount ceramic multilayer capacitors

Class 1, NP0 100 V Noble Metal Electrode

SELECTION CHART FOR 100 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V				
		0603	0805	1206	1210	1812
10	23					
12	24					
15	25					
18	26					
22	27					
27	28					
33	29					
39	31					
47	32					
56	33					
68	34					
82	35	0.8 ±0.07				
100	36					
120	37		0.6 ±0.1			
150	38					
180	39					
220	41			0.6 ±0.1		
270	42					
330	43					
390	44					
470	45					
560	46					
680	47					
820	48					
1000	49					
1200	51					
1500	52		0.85 ±0.1			
1800	53					
2200	54		1.25 ±0.1			
2700	55					
3300	56					
3900	57			0.85 ±0.1		
4700	58					
5600	59			1.15 ±0.1		
6800	61					
8200	62	Values in shaded cells indicate thickness classification.			0.5 to 1.0	
10000	63					
12000	64					0.5 to 1.0
15000	65					
18000	66					0.9 to 1.3
22000	67					
27000	68					
33000	69					
39000	71					
47000	72					

Surface mount ceramic multilayer capacitors

Class 1, NP0 100 V Noble Metal Electrode

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER			
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0603	0805
0.6 ±0.1	4000	4000	20000	10000	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	2000	1500	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	5000

ORDERING INFORMATION FOR 100 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG102G0B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210 1812 2220 (AgPd only)	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	C ±0.25 pF D ±0.5 pF G ±2% J ±5% K ±10%	0 = 100 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X X X Carrier type 22 blister 38 paper 54 bulk Rated voltage - Termination 60 100 V; Ni-barrier 61 100 V; AgPd (2220 only) Size 6 0603 0 0805 1 1206 2 1210 4 1812 5 2220 (AgPd only) Capacitance value⁽¹⁾ 1 ±0.25 pF for C ≤ 8.2 pF 2 ±0.5 pF for C = 5.6 to 8.2 pF 4 ±2% for C ≥ 10 pF 5 ±5% for C ≥ 10 pF 6 ±10% for C ≥ 10 pF Packaging⁽²⁾ 1 reel: Ø180 mm; 7" 5 reel: Ø330 mm; 13" 4 bulk case									
CCA623									

(1) Refer to Chapter "Selection chart for 100 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 1, NP0 200 V and 500 V Noble Metal Electrode

SELECTION CHART FOR 200 V AND 500 V

C (pF)	LAST TWO DIGITS OF 12NC	200 V				500 V							
		0805	1206	1210	1812	1206	1210	1812					
10	23	0.6 ±0.1	0.6 ±0.1			0.6 ±0.1							
12	24												
15	25												
18	26												
22	27												
27	28												
33	29												
39	31												
47	32												
56	33												
68	34												
82	35												
100	36												
120	37												
150	38												
180	39												
220	41	0.85 ±0.1								0.8 to 1.0			
270	42												
330	43												
390	44												
470	45												
560	46										0.85 ±0.1		
680	47											1.15 ±0.1	
820	48												
1000	49	0.85 ±0.1											0.9 to 1.3
1200	51	1.15 ±0.1											0.8 to 1.0
1500	52												
1800	53			0.9 to 1.3									
2200	54												
2700	55	0.9 to 1.3											
3300	56												
3900	57	0.8 to 1.0											
4700	58				0.9 to 1.3								
5600	59												
6800	61		Values in shaded cells indicate thickness classification.										
8200	62												
10000	63												

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER	
	PAPER	BLISTER	PAPER	BLISTER	1812	0805
0.6 ±0.1	4000	4000	20000	10000	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	8000
0.8 to 1.0	—	4000	—	10000	2000	—
0.9 to 1.3	—	3000	—	10000	1500	—
1.15 ±0.1	—	3000	—	10000	—	—
1.25 ±0.1	—	3000	—	10000	—	5000
1.2 to 1.75	—	2500	—	7000	1200	—

Surface mount ceramic
multilayer capacitors

Class 1, NP0 200 V and 500 V
Noble Metal Electrode

ORDERING INFORMATION FOR 200 V AND 500 V

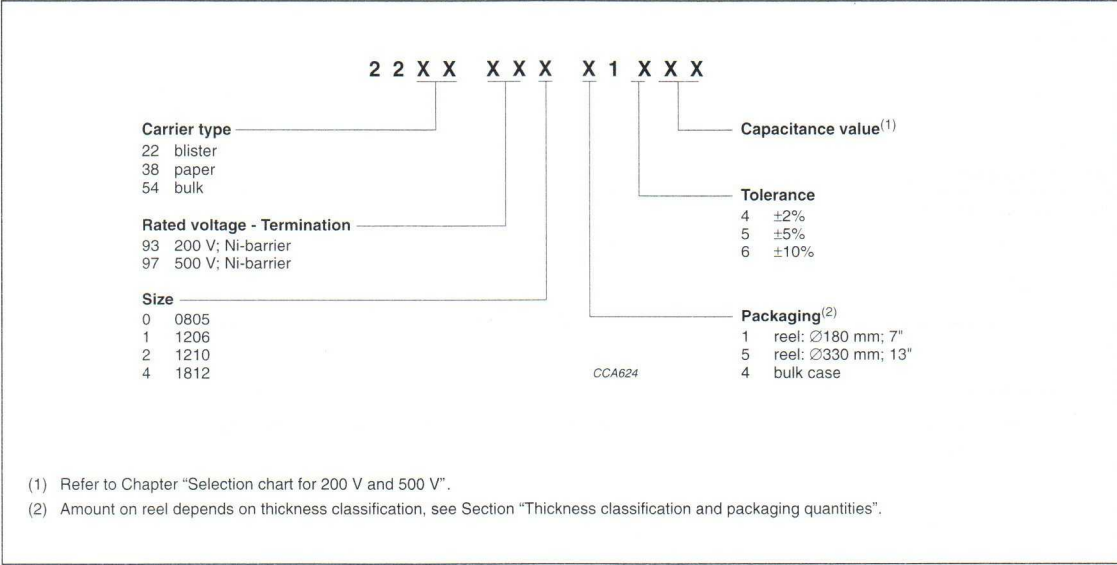
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 1206CG102GBB200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	B = 200 V D = 500 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

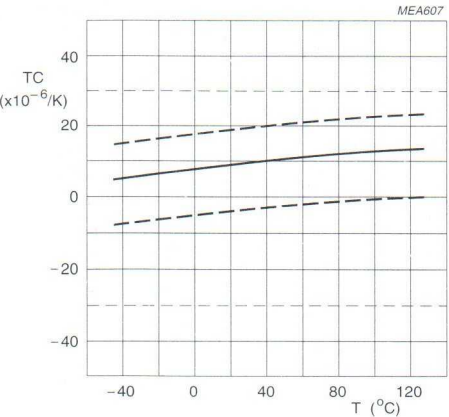
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1: 50 V 100 V 200 V 500 V	0.47 pF to 47 000 pF 10 pF to 22 nF 10 pF to 5600 pF 10 pF to 3300 pF
Tolerance on capacitance after 1000 hours: $C \geq 10$ pF $5 \text{ pF} \leq C < 10$ pF $C < 5$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$ ± 0.5 pF, ± 0.25 pF ± 0.25 pF
Tan δ ; note 1: $C < 10$ pF $C \geq 10$ pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is smallest $\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100 \text{ G}\Omega$
Temperature coefficient: $C < 10$ pF $C \geq 10$ pF	$(0 \pm 150) \times 10^{-6}/\text{K}$; note 2 $(0 \pm 30) \times 10^{-6}/\text{K}$; note 2
Ageing	not applicable

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values from 0.47 pF to 150 pF have a temperature coefficient of $(0 \pm 30) \times 10^{-6}/\text{K}$.

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50/100/200/500 V
Noble Metal Electrode



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as
a function of temperature.

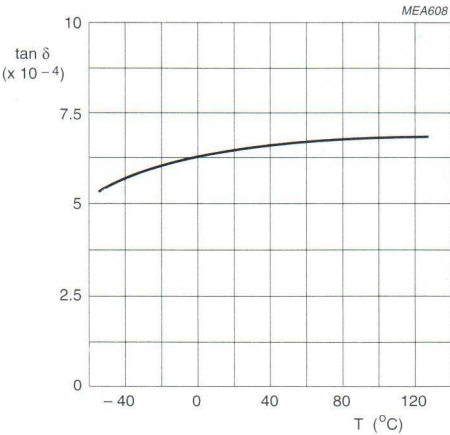


Fig.4 Typical $\tan \delta$ as a function of temperature.

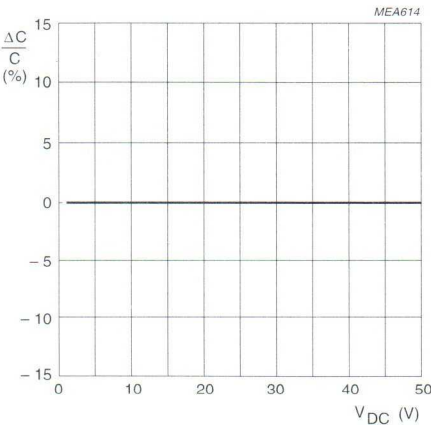
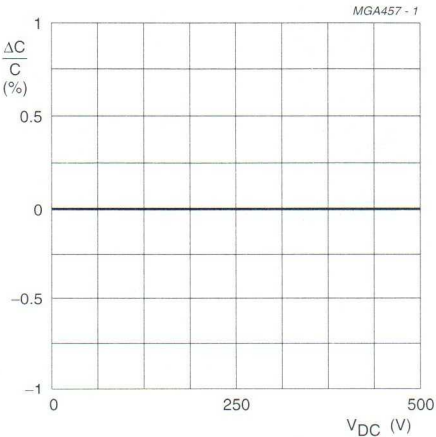


Fig.5 Typical capacitance change with respect
to the capacitance at 1 V as a function of
DC voltage.

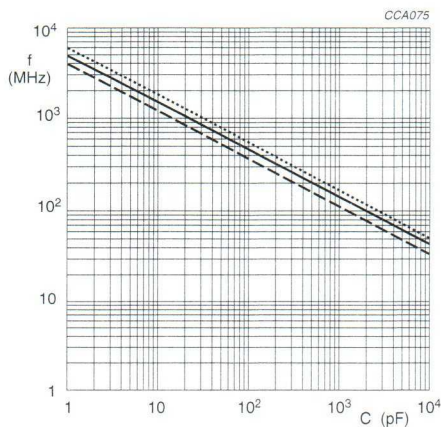


High voltage series.

Fig.6 Typical capacitance change with respect
to the capacitance at 1 V as a function of
DC voltage.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode

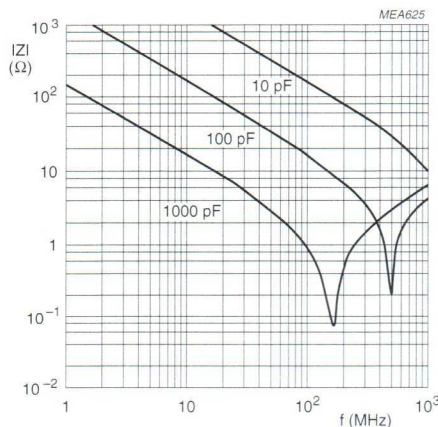


Case size **0603**: $L = 0.6$ nH (dotted line).

Case sizes **0805**, **1206** and **1210**: $L = 1$ nH (solid line).

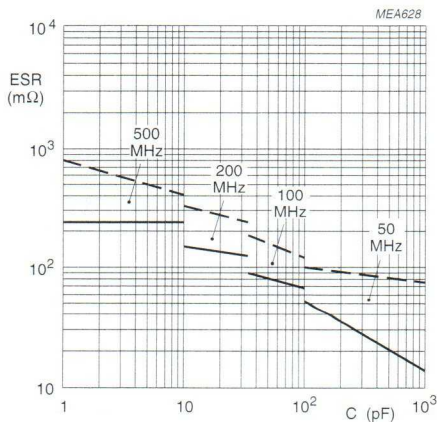
Case sizes **1812** and **2220**: $L = 1.5$ nH (broken line).

Fig.7 Series resonance frequency as a function of capacitance.



Case sizes **0603** to **1210**.

Fig.8 Typical impedance ($|Z|$) as a function of frequency.



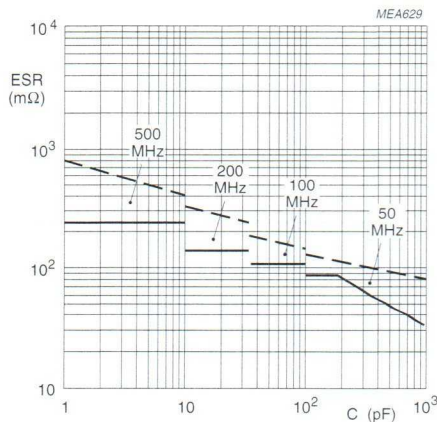
Case sizes **0603** and **0805**.

Typical values (solid lines).

Maximum values (broken lines).

Measuring equipment HP4191A.

Fig.9 Equivalent series resistance (ESR) as a function of capacitance.



Case size **1206**.

Typical values (solid lines).

Maximum values (broken lines).

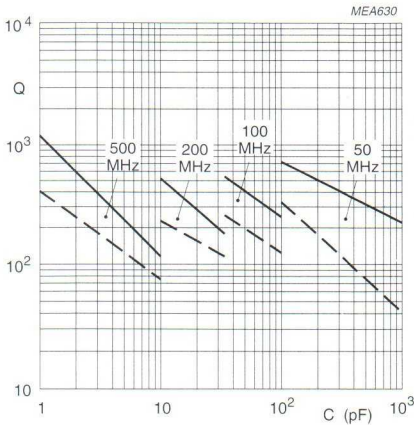
Measuring equipment HP4191A.

For $C > 1$ nF, maximum value of ESR = 80 mΩ measured at 50 MHz.

Fig.10 Equivalent series resistance (ESR) as a function of capacitance.

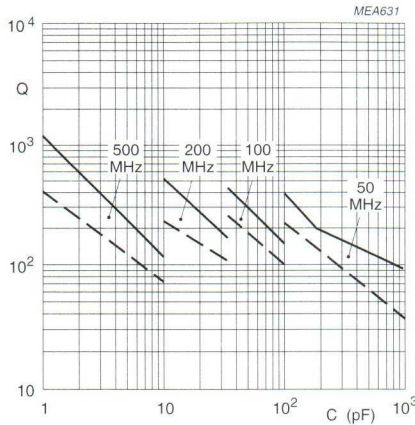
Surface mount ceramic
multilayer capacitors

Class 1, NP0 50/100/200/500 V
Noble Metal Electrode



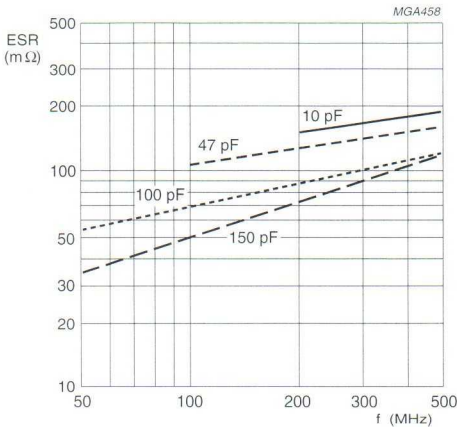
Case sizes **0603** and **0805**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

Fig.11 Quality factor (Q) as a function of the capacitance.



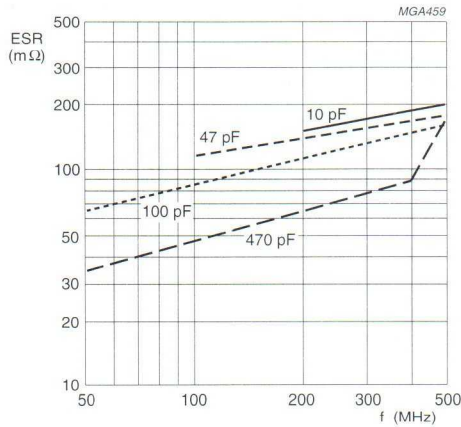
Case size **1206**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.
For C > 1 nF, Q_{min} = 35 measured at 50 MHz.

Fig.12 Quality factor (Q) as a function of the capacitance.



Case size **0805**.
High voltage 200 V.

Fig.13 Typical equivalent series resistance as a function of frequency.

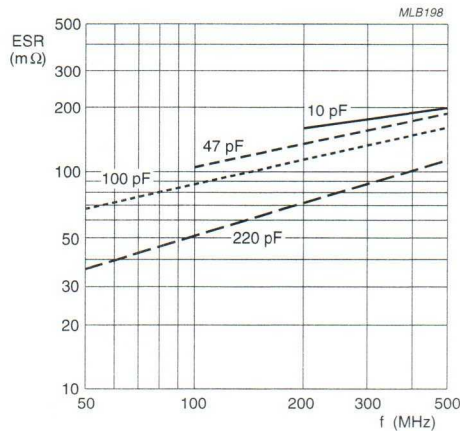


Case size **1206**.
High voltage 200 V.

Fig.14 Typical equivalent series resistance as a function of frequency.

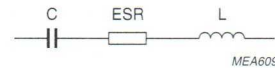
Surface mount ceramic multilayer capacitors

Class 1, NP0 50/100/200/500 V Noble Metal Electrode



Case size 1206.
High voltage 500 V.

Fig. 15 Typical equivalent series resistance as a function of frequency.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig. 16 Equivalent series representation of a CMC.

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig. 16.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent below 1 GHz.

The equivalent series self-inductance L is:

- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
 - 0.6 nH for case size 0603
 - 1 nH for case sizes 0805, 1206 and 1210
 - 1.5 nH for case sizes 1812 and 2220.

These figures are accurate to within 20%.

Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

This is known as the series resonance frequency (SRF) and is given by:

$$\text{SRF} = \frac{1}{2\pi\sqrt{LC}}$$

At the SRF, the CMC will appear as a small resistor. The transmission loss through the CMC at this series resonance frequency will be low.

Using the values of C, L = 1 nH and the ESR at a specific frequency (f), two often used quantities can be derived.

The impedance (Z) is given by:

$$Z = \frac{1 - (2\pi f)^2 LC}{2j\pi f C} + \text{ESR}$$

The quality factor (Q) is given by:

$$Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f \text{ESR} C}$$

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V narrow tolerance series
Noble Metal Electrode

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case (case sizes 0402, 0603 and 0805 only)
- For high frequency applications
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

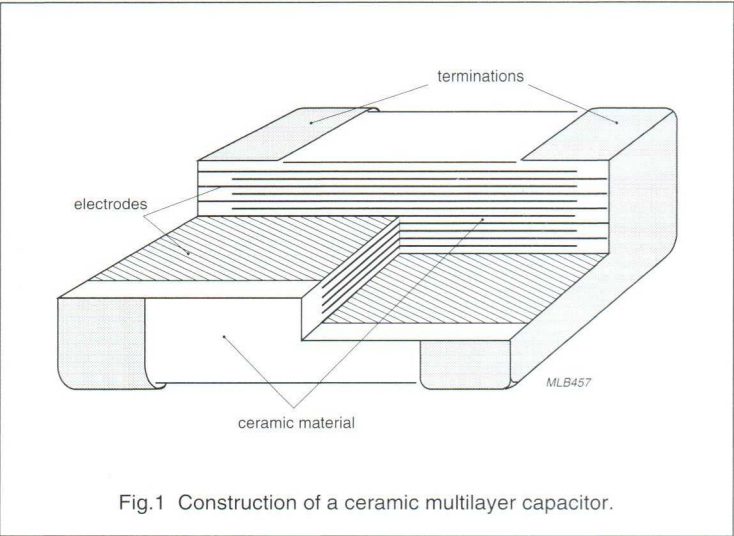
The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V (IEC)
Capacitance range (E12 series); note 1	0.47 pF to 6800 pF
Tolerance on capacitance: $C \geq 10$ pF $C < 10$ pF	$\pm 1\%$ ± 0.1 pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Note

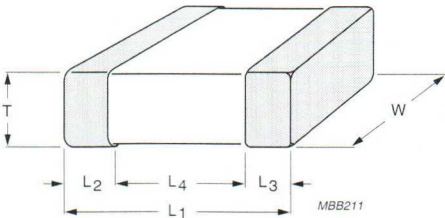
1. Non E12 values are available on request.



Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V narrow tolerance series
Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0402	0.04 ±0.002	0.02 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series Noble Metal Electrode

SELECTION CHART

C (pF)	LAST THREE DIGITS OF 12NC	50 V			
		0402	0603	0805	1206
0.47	477	0.5 ±0.05	0.8 ±0.07	0.6 ±0.1	0.6 ±0.1
0.56	567				
0.68	687				
0.82	827				
1.0	108				
1.2	128				
1.5	158				
1.8	188				
2.2	228				
2.7	278				
3.3	338				
3.9	398				
4.7	478				
5.6	568				
6.8	688				
8.2	828				
10	109				
12	129				
15	159				
18	189				
22	229				
27	279				
33	339				
39	399				
47	479				
56	569				
68	689				
82	829				
100	101				
120	121				
150	151				
180	181				
220	221				
270	271				
330	331				
390	391				
470	471				
560	561				
680	681				
820	821				
1000	102				
1200	122				
1500	152				
1800	182				
2200	222				
2700	272				
3300	332				
3900	392				
4700	472				
5600	562				
6800	682				
Values in shaded cells indicate thickness classification.					0.85 ±0.1
					1.15 ±0.1

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V narrow tolerance series
Noble Metal Electrode

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	50000	—	—
0.6 ±0.1	4000	4000	20000	10000	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	8000
0.8 ±0.07	4000	4000	15000	15000	—	15000	—
1.15 ±0.1	—	3000	—	10000	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	5000

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 0805CG102F9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	B ±0.1 pF F ±1%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X 8 6 X X X X X X

Carrier type

22 blister
38 paper
54 bulk

Size

9 0402
7 0603
1 0805
3 1206

Capacitance value⁽¹⁾

Tolerance

4 ±0.1 pF for C = 0.47 to 4.7 pF
8 ±0.1 pF for C = 5.6 to 8.2 pF
8 ±1% for C ≥ 10 pF

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
7 reel: Ø330 mm; 13"
4 bulk case

CCA615

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

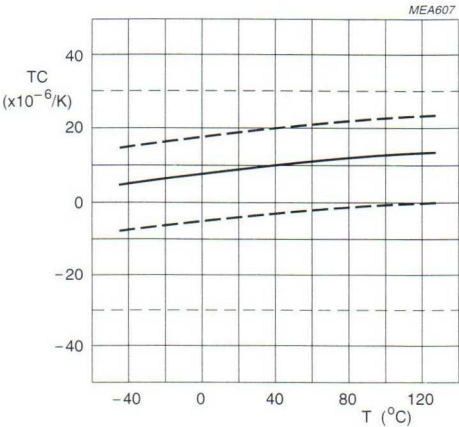
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1: narrow tolerance; 50 V	0.47 pF to 6800 pF
Tolerance on capacitance after 1000 hours: C ≥ 10 pF 5 pF ≤ C < 10 pF	±1% ±0.1 pF
Tan δ; note 1: C < 10 pF C ≥ 10 pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is smallest $\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U _R (DC)	R _{ins} > 100 GΩ
Temperature coefficient: C < 10 pF C ≥ 10 pF	$(0 \pm 150) \times 10^{-6}/K$; note 2 $(0 \pm 30) \times 10^{-6}/K$; note 2
Ageing	not applicable

Notes

1. Measured at 1 V, 1 MHz for C ≤ 1000 pF and 1 V, 1 kHz for C > 1000 pF, using a four-gauge method.
2. For sizes 0402 and 0603 all capacitance values have a temperature coefficient of $(0 \pm 30) \times 10^{-6}/K$.

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V narrow tolerance series
Noble Metal Electrode



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as a function of temperature.

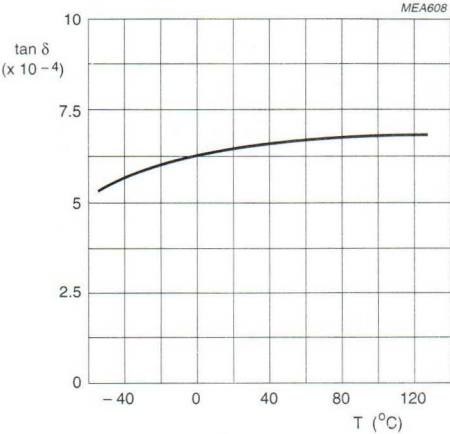


Fig.4 Typical $\tan \delta$ as a function of temperature.

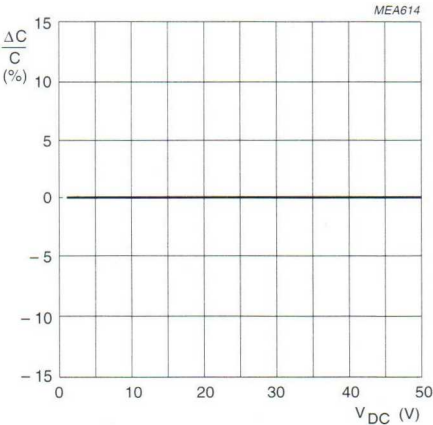
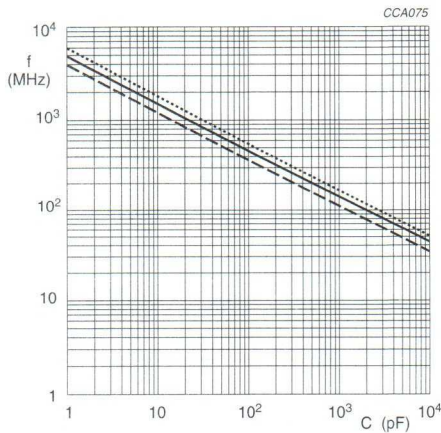


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

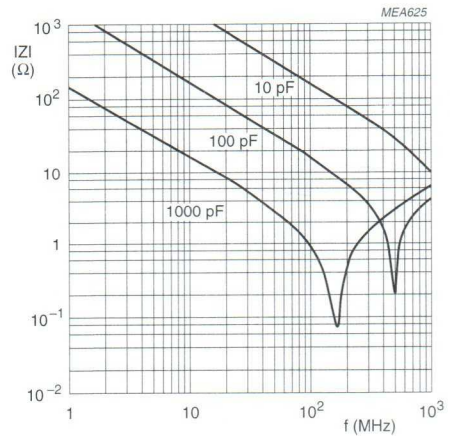
Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series Noble Metal Electrode



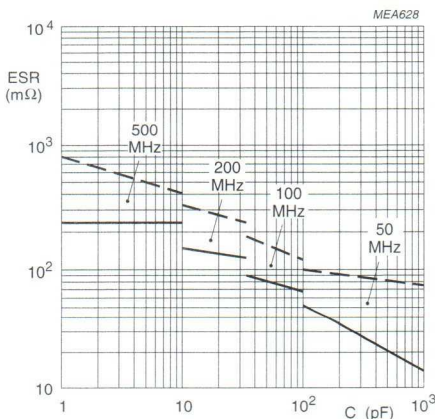
Case size **0603**: $L = 0.6 \text{ nH}$ (dotted line).
Case sizes **0805** and **1206**: $L = 1 \text{ nH}$ (solid line).

Fig. 6 Series resonance frequency as a function of capacitance.



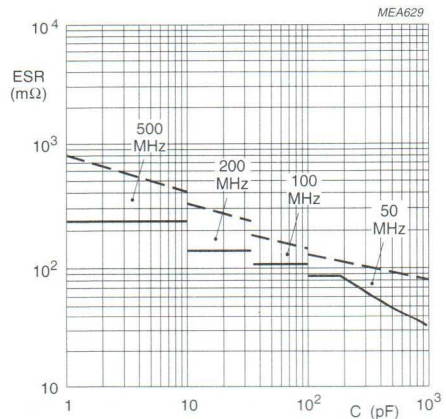
Case sizes **0603** to **1206**.

Fig. 7 Typical impedance ($|Z|$) as a function of frequency.



Case sizes **0603** and **0805**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig. 8 Equivalent series resistance (ESR) as a function of capacitance.

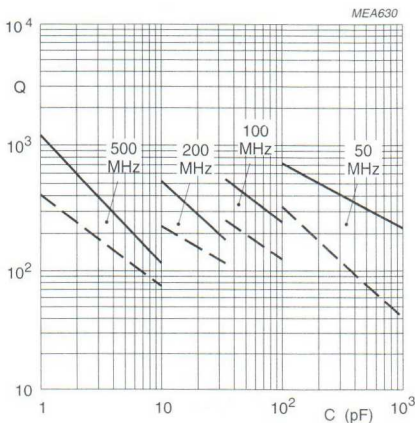


Case size **1206**.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.
For $C > 1 \text{ nF}$, maximum value of $\text{ESR} = 80 \text{ m}\Omega$ measured at 50 MHz.

Fig. 9 Equivalent series resistance (ESR) as a function of capacitance.

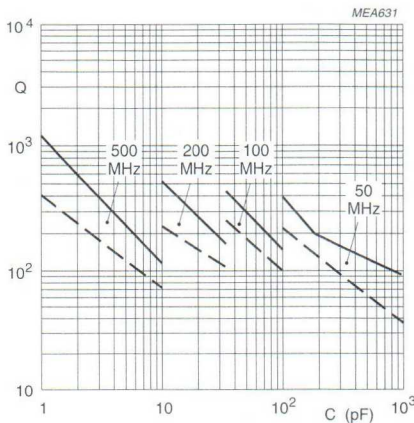
Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V narrow tolerance series
Noble Metal Electrode



Case sizes **0603** and **0805**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

Fig.10 Quality factor (Q) as a function of the capacitance.



Case size **1206**.
Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.
For $C > 1 \text{ nF}$, $Q_{\min} = 35$ measured at 50 MHz.

Fig.11 Quality factor (Q) as a function of the capacitance.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V narrow tolerance series Noble Metal Electrode

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

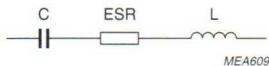
Ceramic multilayer capacitors (CMC) are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.12.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent below 1 GHz.

The equivalent series self-inductance L is:

- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
 - 0.6 nH for case size 0603
 - 1 nH for case sizes 0805.

These figures are accurate to within 20%.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.12 Equivalent series representation of a CMC.

Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

This is known as the series resonance frequency (SRF) and is given by:

$$\text{SRF} = \frac{1}{2\pi\sqrt{LC}}$$

At the SRF, the CMC will appear as a small resistor. The transmission loss through the CMC at this series resonance frequency will be low.

Using the values of C, L = 1 nH and the ESR at a specific frequency (f), two often used quantities can be derived.

The impedance (Z) is given by:

$$Z = \frac{1 - (2\pi f)^2 LC}{2j\pi f C} + \text{ESR}$$

The quality factor (Q) is given by:

$$Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f \text{ESR} C}$$

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

FEATURES

- Low insertion loss/ESR up to 3 GHz:
 - First parallel resonance above 2 GHz
 - Second parallel resonance above 3 GHz
- Small dimensions; sizes 0603, 0805 and 1206 available
- High reliability
- Standard tolerance on capacitance: $\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$
- Suitable for reflow and wave soldering
- s-parameter data available on floppy disk
- NiSn terminations (AgPd on request).

APPLICATIONS

- Mobile telephones
- Satellite television
- Instrumentation.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V (IEC); note 1
Capacitance range (E12 series), NP0 dielectric; note 2: case size 0603 case size 0805 case size 1206	0.47 pF to 47 pF 0.47 pF to 82 pF 0.47 pF to 120 pF
Tolerance on capacitance: $C \geq 10$ pF $5 \text{ pF} \leq C < 10$ pF $C < 5$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$ ± 0.5 pF, ± 0.25 pF and ± 0.1 pF ± 0.25 pF and ± 0.1 pF
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 60 s at U_R (DC)	$> 100 \text{ G}\Omega$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

1. Also applicable for applications up to 63 V.
2. Non E12 values are available on request.

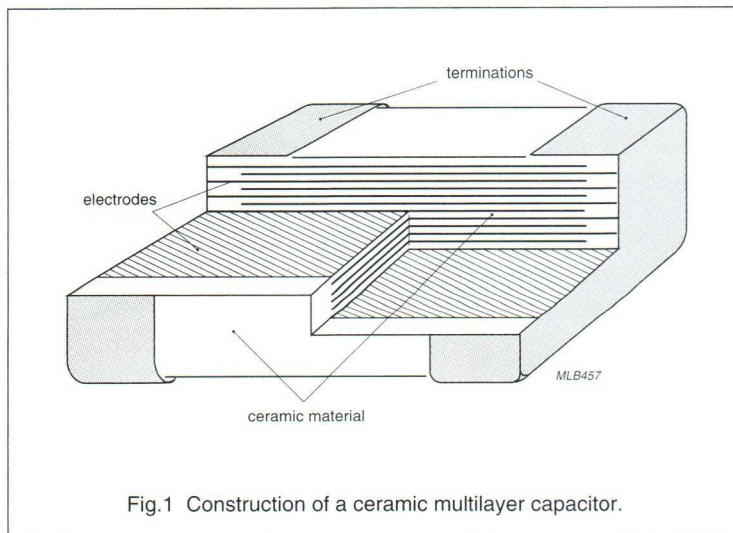
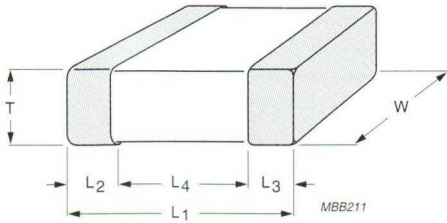


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V microwave series
Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

Surface mount ceramic
multilayer capacitors

Class 1, NP0 50 V microwave series
Noble Metal Electrode

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	50 V		
		0603	0805	1206
0.47	05	0.8 ±0.07	0.6 ±0.1	0.6 ±0.1
0.56	06			
0.68	07			
0.82	08			
1.0	09			
1.2	11			
1.5	12			
1.8	13			
2.2	14			
2.7	15			
3.3	16			
3.9	17			
4.7	18			
5.6	19			
6.8	21			
8.2	22			
10	23			
12	24			
15	25			
18	26			
22	27			
27	28			
33	29			
39	31			
47	32			
56	33			
68	34			
82	35			
100	36			
120	37	Values in shaded cells indicate thickness classification.		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.6 ±0.1	4000	4000	20000	10000	–	10000
0.8 ±0.07	4000	4000	15000	15000	15000	–

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

ORDERING INFORMATION

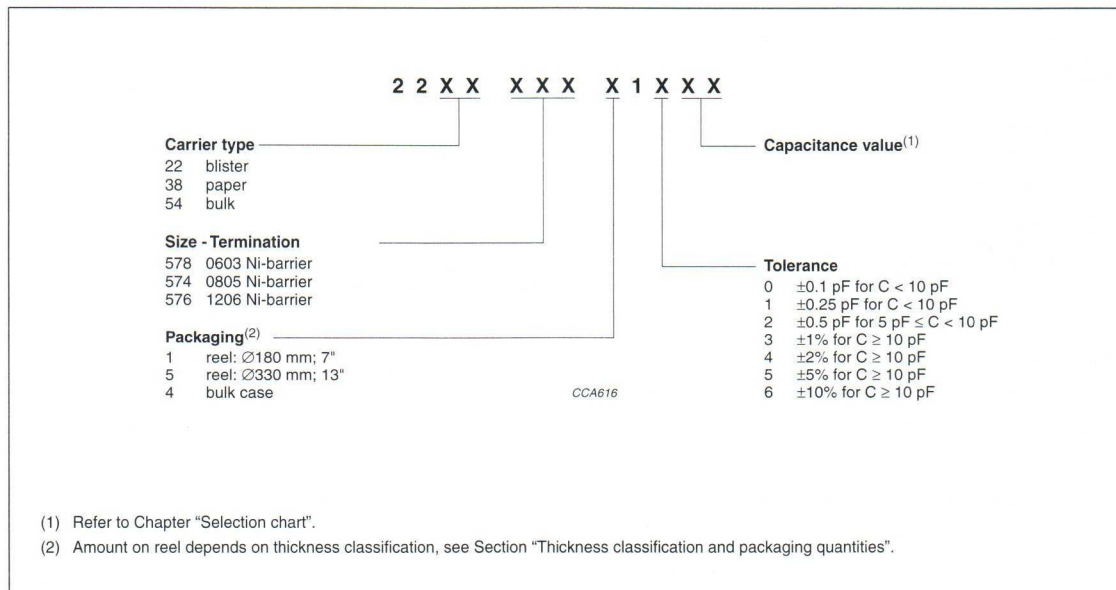
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0805CG100G9BB0M

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	CG = NP0	100 = 10 pF; the third digit signifies the number of zeros	B ± 0.1 pF C ± 0.25 pF D ± 0.5 pF F $\pm 1\%$ G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	M = microwave

Ordering code 12NC



Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

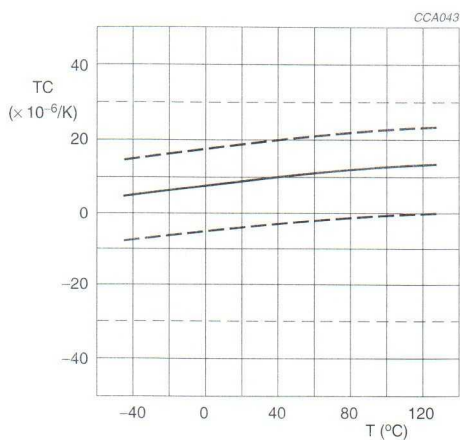
DESCRIPTION	VALUE
Capacitance range (E12 series), NP0 dielectric; note 1: case size 0603 case size 0805 case size 1206	0.47 pF to 47 pF 0.47 pF to 82 pF 0.47 pF to 120 pF
Tolerance on capacitance: $C \geq 10$ pF $5 \text{ pF} \leq C < 10$ pF $C < 5$ pF	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$ and $\pm 1\%$ ± 0.5 pF, ± 0.25 pF and ± 0.1 pF ± 0.25 pF and ± 0.1 pF
Tan δ ; note 1: $C < 10$ pF $C \geq 10$ pF	$\leq 10 \left(\frac{3}{C} + 0.7 \right) \times 10^{-4}$ or 30×10^{-4} , whichever is the smallest $\leq 10 \times 10^{-4}$
Temperature coefficient; note 2: $0.47 \text{ pF} \leq C < 5$ pF $5 \text{ pF} \leq C < 10$ pF $C \geq 10$ pF	$(0 \pm 150) \times 10^{-6}/\text{K}$ $(0 \pm 150) \times 10^{-6}/\text{K}$ $(0 \pm 30) \times 10^{-6}/\text{K}$
High frequency properties	for ESR values see Figs 7, 8 and 9. The first parallel resonance frequency in the s_{21} and s_{12} scattering parameters lies above 2 GHz and the second resonance frequency above 3 GHz.

Notes

1. Measured at 1 V, 1 MHz, using a four-gauge method.
2. For size 0603 all capacitance values from 0.47 pF to 47 pF have a temperature coefficient of $(0 \pm 30) \times 10^{-6}/\text{K}$.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode



Sample limits (broken lines).
Requirement levels (dotted lines).

Fig.3 Typical temperature coefficient as a function of temperature.

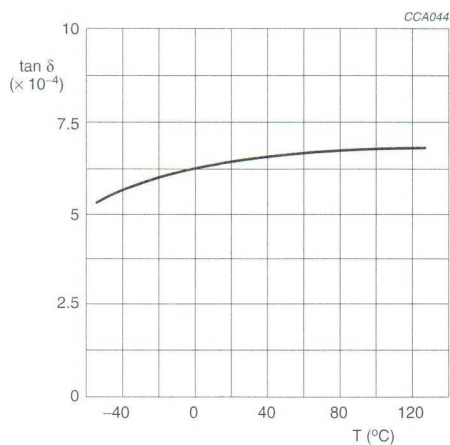


Fig.4 Typical $\tan \delta$ as a function of temperature.

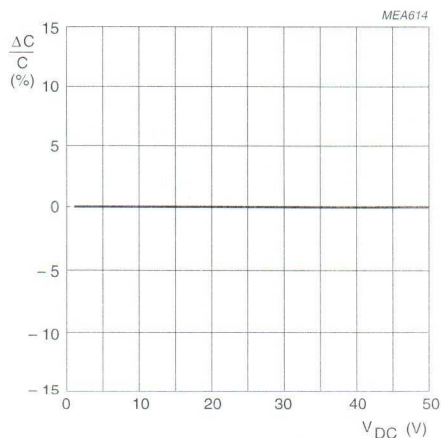
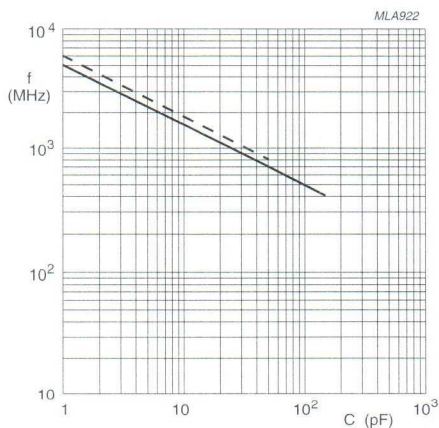


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

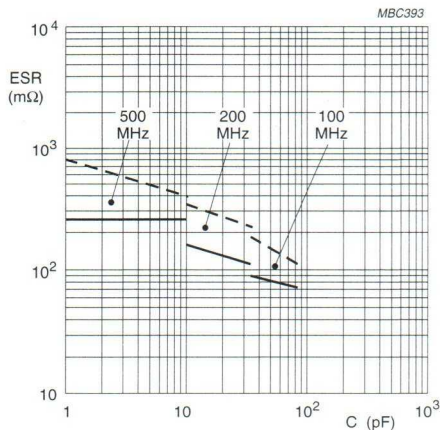


Case sizes **0805** and **1206** (solid line).
Case size **0603** (broken line).

Fig.6 Series resonance frequency as a function of capacitance.

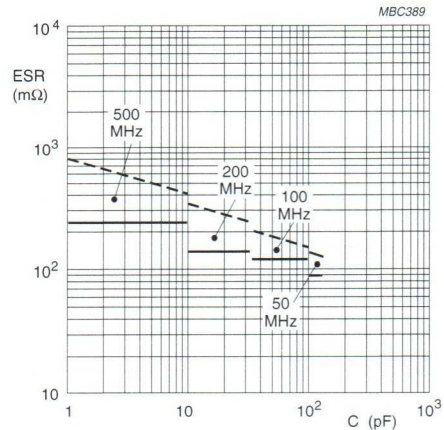
Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode



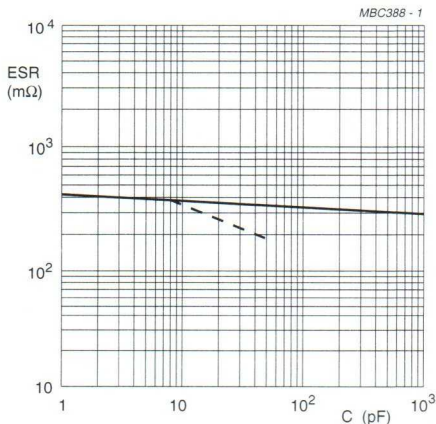
Case sizes 0603 and 0805.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.7 Equivalent series resistance (ESR)
as a function of capacitance.



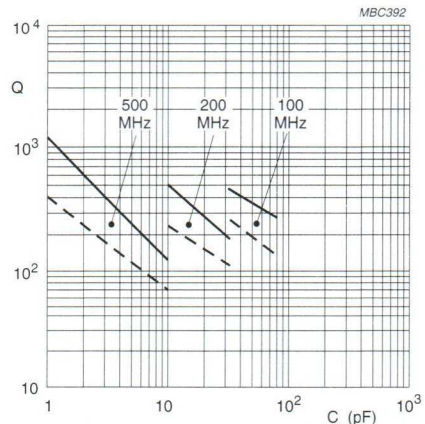
Case size 1206.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.8 Equivalent series resistance (ESR)
as a function of capacitance.



Case sizes 0805 and 1206 (solid line).
Case size 0603 (broken line).
Measuring equipment HP4191A.

Fig.9 Typical ESR values at 1 GHz as a function
of the capacitance value.

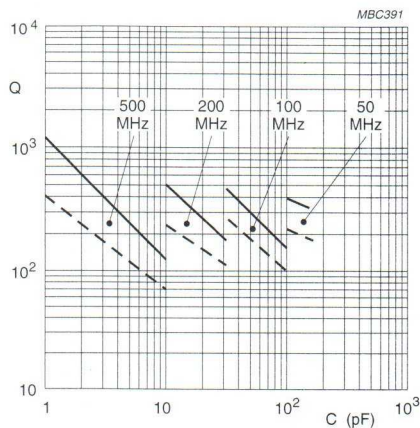


Case sizes 0603 and 0805.
Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.10 Quality factor (Q) as a function
of the capacitance.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode



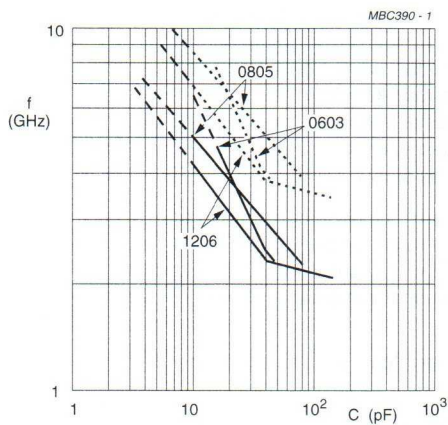
Case size 1206.

Typical values (solid lines).

Maximum values (broken lines).

Measuring equipment HP4191A.

Fig.11 Quality factor (Q) as a function of the capacitance.



Case sizes 0603, 0805 and 1206.

First resonant frequency (solid lines).

Second resonant frequency (dotted lines).

Fig.12 Typical first and second parallel resonance frequencies as a function of capacitance.

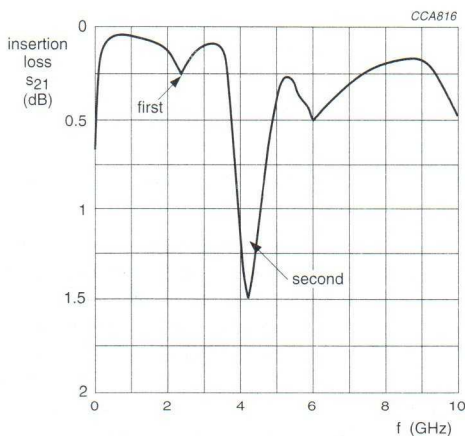


Fig.13 Example of the insertion loss as a function of frequency showing the parallel resonances.

Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

MICROWAVE BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the microwave series are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.14.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent below 1 GHz.

The equivalent series self-inductance L is:

- Independent of the dielectric material
- Dependent on the size of the capacitor and is approximately:
 - 0.6 nH for case size 0603
 - 1 nH for case sizes 0805 and 1206 (these figures are accurate to within $\pm 20\%$).

Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

This is known as the series resonance frequency (SRF) and is given by:

$$\text{SRF} = \frac{1}{2\pi\sqrt{LC}}$$

At the SRF, the CMC will appear as a small resistor. The transmission loss through the CMC at this series resonance frequency will be low.

Using the values of C, L (= 1 nH) and the ESR at a specific frequency (f), two often used quantities can be derived.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.14 Equivalent series representation of a CMC.

The impedance (Z) is given by: $Z = \frac{1 - (2\pi f)^2 LC}{2j\pi f C} + \text{ESR}$

The quality factor (Q) is given by: $Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f \text{ESR} C}$

The frequency region above the SRF is difficult to model using lumped elements and should be described in terms of a network of transmission lines. The behaviour of the CMC in this frequency region can be best described in terms of scattering or 's' parameters. Knowing these parameters, one can predict the response of a network accurately. There are four scattering parameters for a two-port network: s_{11} , s_{12} , s_{21} and s_{22} :

s_{11} is the reflection coefficient at the input port with the output port terminated in a 50 Ω load.

s_{12} is the reverse transmission coefficient in a 50 Ω system.

s_{21} is the forward transmission coefficient in a 50 Ω system.

s_{22} is the reflection coefficient at the output port with the input port terminated into a 50 Ω load.

When comparing the insertion loss (i.e. s_{21}) of a CMC at high frequencies with that of an ideal capacitor, parallel resonances above the SRF are observed. In series or shunt connections parallel resonances are usually detrimental to the operation of the circuit. They may be the cause of unacceptable insertion loss or parasitic oscillations of amplifiers. For the microwave series, we specify that the first parallel resonance frequency lies above 2 GHz and the second above 3 GHz. It is found that the typical insertion loss at the first resonance frequency is more than a factor 5 smaller than at the second resonance frequency.

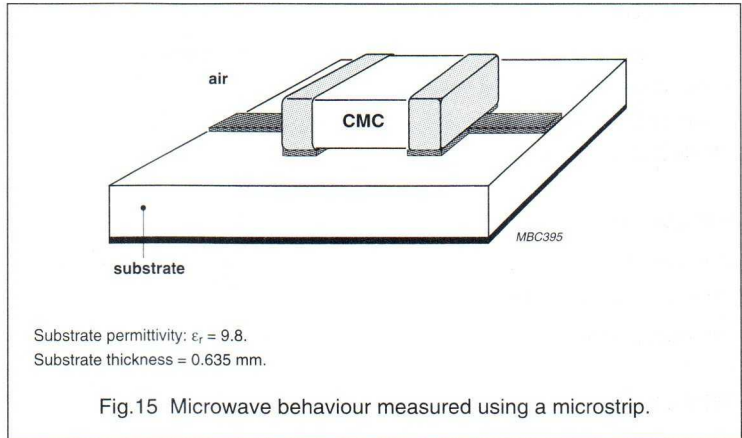
Surface mount ceramic multilayer capacitors

Class 1, NP0 50 V microwave series Noble Metal Electrode

The high frequency behaviour of our CMCs is measured in a strip line configuration as shown in Fig.15 using a test fixture with the following features:

- Microstrip structure (dielectric: Al_2O_3 ; thickness: 0.635 mm)
- Suitable for the TRL calibration method
- De-embedding for the low-frequency range (up to 3 GHz).

The measurements are carried out using the HP 8510B network analyser.



Surface mount ceramic
multilayer capacitors

Class 1, NP0 1 kV high voltage series
Noble Metal Electrode

FEATURES

- Sizes 1812 and 2220
- High capacitance per unit volume
- Supplied in tape on reel
- NiSn and AgPd terminations.

APPLICATIONS

- Power supplies
- Voltage multiplier circuits
- Surge protection.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

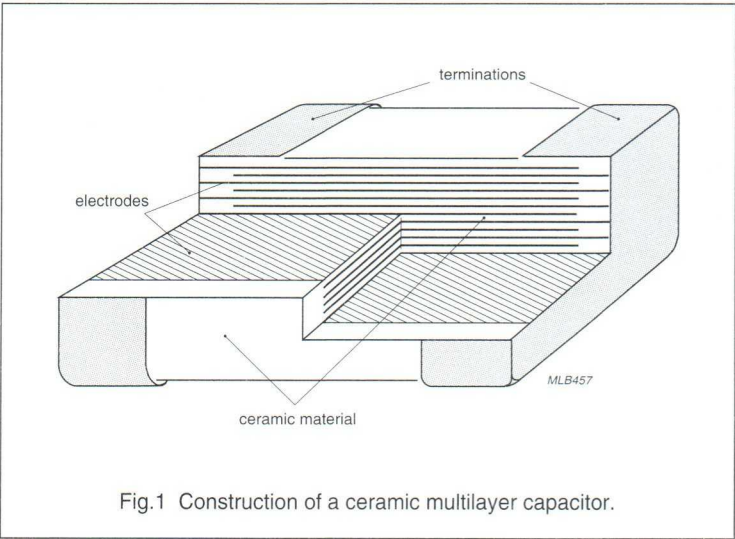
The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	1 kV (IEC)
Capacitance range (E12 series); note 1	100 pF to 3300 pF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 2
Test voltage (DC) for 1 minute	$2 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

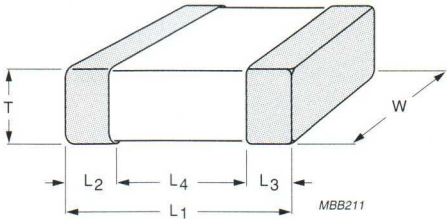
1. Other values and non E12 series are available on request.
2. $\pm 1\%$ tolerance on capacitance is available on request.



Surface mount ceramic
multilayer capacitors

Class 1, NP0 1 kV high voltage series
Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.30	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.30	0.25	0.75	2.90
Dimensions in inches							
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.051	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.051	0.010	0.030	0.114

Surface mount ceramic
multilayer capacitors

Class 1, NP0 1 kV high voltage series
Noble Metal Electrode

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	1 kV		
		1812	2220	
100	36	0.5 to 1.0	0.5 to 1.0	
120	37			
150	38			
180	39			
220	41			
270	42			
330	43			
390	44			
470	45			
560	46			
680	47			
820	48			
1000	49	0.9 to 1.3	0.9 to 1.3	
1200	51			
1500	52	Values in shaded cells indicate thickness classification.		
1800	53			
2200	54			
2700	55			
3300	56			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1812	2220
0.5 to 1.0	2000	1500
0.9 to 1.3	1500	1500

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 1812CG102JEBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1812 2220	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	G ±2% J ±5% K ±10%	E = 1 kV	A = AgPd B = Ni-barrier	B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 5 0 X X X X 1 X X X

Termination
00 NiSn

Size
4 1812
5 2220

Packaging⁽²⁾
1 reel: Ø180 mm; 7" reel
12 mm blister tape

Capacitance value⁽¹⁾

Tolerance
4 ±2%
5 ±5%
6 ±10%

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

CCA640

Surface mount ceramic
multilayer capacitors

Class 1, NP0 1 kV high voltage series
Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

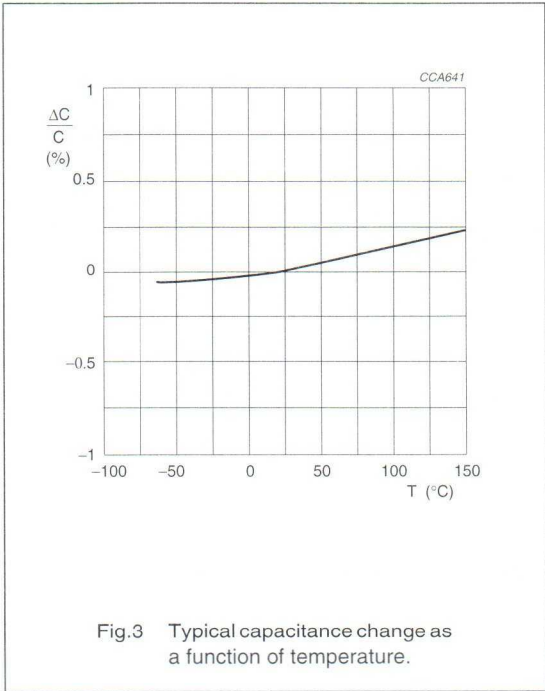
Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 3300 pF
Tolerance on capacitance after 1000 hours	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 1
Rated voltage U_R (DC)	1 kV (IEC)
Test voltage (DC) for 1 minute	$2 \times U_R$
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100\text{ G}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$
Ageing	not applicable

Note

1. Products with a tolerance of 1% are available on request.



Surface mount ceramic
multilayer capacitors

Class 1, NP0 3 kV high voltage series
Noble Metal Electrode

FEATURES

- Sizes 1808 and 1812
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn and AgPd terminations.

APPLICATIONS

These surface mounted high voltage capacitors were developed specifically for circuits requiring voltage up to 3 kV. Typical applications are:

- Inverter circuits for the backlights of liquid crystal displays
- Snubber circuits of power supplies
- Voltage multiplier circuits
- Surge protection.

Due to high voltage across the terminations, circuit applications of 1 to 3 kV or higher may need a coating on the surface to prevent external arcing. This is especially true under humid conditions.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	3 kV (IEC)
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 2
Test voltage (DC) for 1 minute	$1.2 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

1. Other values below 10 pF and non E12 series are available on request.
2. Special tolerance on capacitance is available on request.

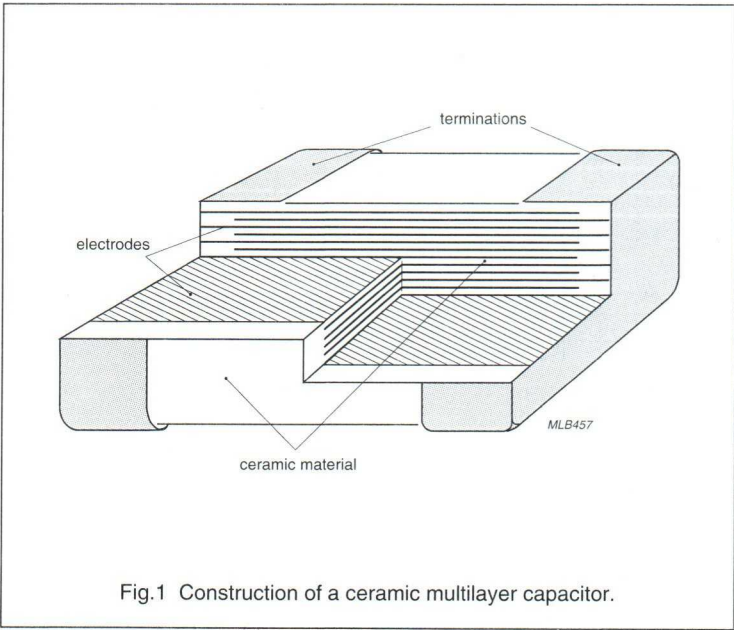
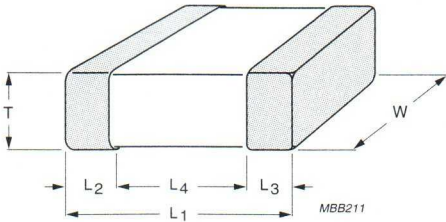


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic
multilayer capacitors

Class 1, NP0 3 kV high voltage series
Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L_1	W	T MAX.	L_2 and L_3 MAX.	L_4 MIN.
Dimensions in millimetres					
1808	4.5 ± 0.20	2.0 ± 0.20	1.30	0.75	2.20
1812	4.5 ± 0.20	3.2 ± 0.20	1.30	0.75	2.20
Dimensions in inches					
1808	0.177 ± 0.008	0.079 ± 0.008	0.051	0.030	0.088
1812	0.177 ± 0.008	0.126 ± 0.008	0.051	0.030	0.088

Surface mount ceramic multilayer capacitors

Class 1, NP0 3 kV high voltage series Noble Metal Electrode

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	3 kV	
		1808	1812
10	23	1.2 to 1.75	1.2 to 1.75
12	24		
15	25		
18	26		
22	27		
27	28		
33	29		
39	31		
47	32		
56	33		1.6 to 2.2
68	34		
82	35		
100	36		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1808	1812
1.2 to 1.75	1000	1000
1.6 to 2.2	1000	1000

ORDERING INFORMATION

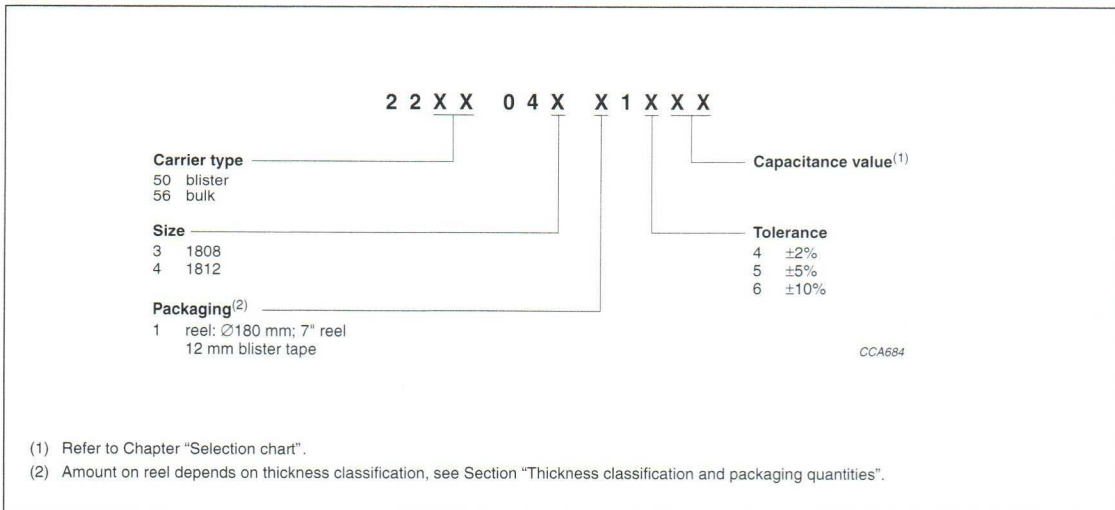
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 1808CG270JGBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1808 1812	CG = NP0	27 = 27 pF; the third digit signifies the number of zeros	G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	G = 3 kV	B = Ni-barrier	B = 180 mm; 7" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC



Surface mount ceramic
multilayer capacitors

Class 1, NP0 3 kV high voltage series
Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

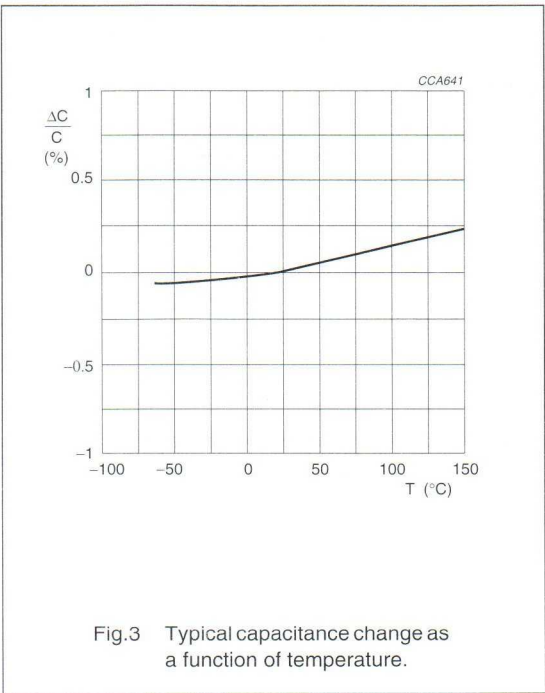
Class 1 capacitors; NP0 dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	10 pF to 100 pF
Tolerance on capacitance after 1000 hours:	$\pm 10\%$, $\pm 5\%$, $\pm 2\%$; note 1
Rated voltage U_R (DC)	3 kV (IEC)
Test voltage (DC) for 1 minute	$1.2 \times U_R$
Tan δ	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 100\text{ G}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$
Ageing	not applicable

Note

1. Products with a tolerance of 1% are available on request.



Surface mount ceramic multilayer capacitors

Class 2, X7R 10 V

FEATURES

- Three standard sizes
- For high frequency applications
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- Tuners
- Television receivers
- Video recorders
- All types of cameras.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	10 V
Capacitance range (E6 series)	150 nF to 1 μ F; note 1
Tolerance on capacitance after 1000 hours	$\pm 10\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	55/125/21

Note

1. Measured at 20 °C, 1 V and 1 kHz, using a four-gauge method.

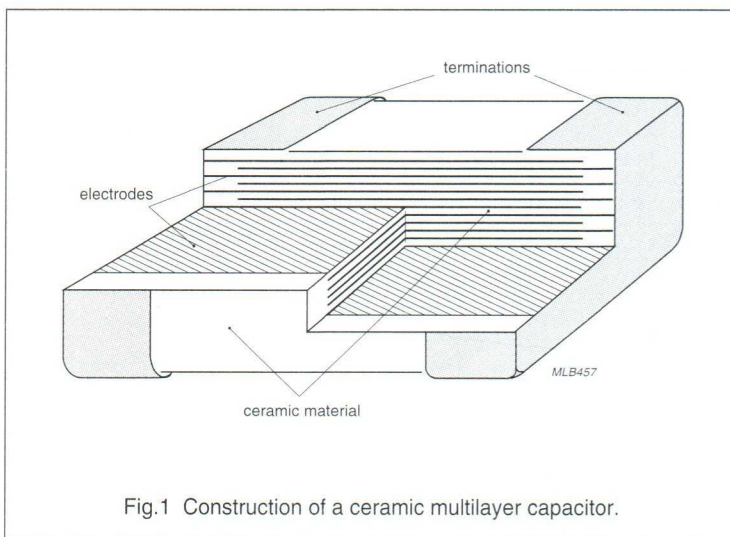
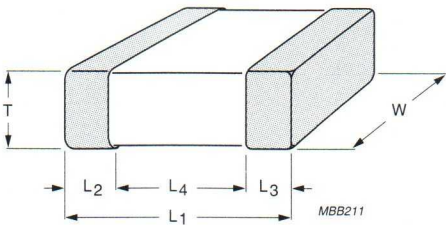


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic
multilayer capacitors

Class 2, X7R 10 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions; see Fig.2

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.50	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022

Surface mount ceramic multilayer capacitors

Class 2, X7R 10 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	10 V		
		0603	0805	1206
150	52	0.80 ±0.07		
180	53			
220	54		0.6 ±0.10	
270	55			
330	56			
390	57		0.85 ±0.10	
470	58			
560	59			
680	61		1.25 ±0.10	
820	62		Values in shaded cells indicate thickness classification	
1000	63			
1200	64	0.85 ±0.10		
1500	65			
1800	66			
2200	67		1.15 ±0.10	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.6 ±0.10	4000	4000	20000	10000	—	—
0.80 ±0.07	4000	4000	15000	15000	15000	—
0.85 ±0.10	4000	4000	15000	10000	—	—
1.15 ±0.10	—	3000	—	10000	—	—
1.25 ±0.10	—	3000	—	10000	—	5000

Surface mount ceramic
multilayer capacitors

Class 2, X7R 10 V

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R105K6BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	2R = X7R	105 = 1 000 000 pF; the third digit signifies the number of zeros	K = ±10%	6 = 10 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	D = BME

Ordering code 12NC

2 2 X X X X X X 5 X X X

Carrier type

22 blister
38 paper tape
54 bulk

Rated voltage - Termination

24 10 V; Ni-barrier

Size

6 0603
0 0805
1 1206

Capacitance value⁽¹⁾

Tolerance

6 ±10%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
5 reel: Ø330 mm; 13"
4 bulk case

CCB409

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 10 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	150 nF to 1 μ F
Tolerance on capacitance after 1000 hours	$\pm 10\%$
Tan δ ; note 1	$\leq 5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ seconds
Maximum capacitance change as a function of temperature	$\pm 15\%$
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 20 °C, 1 V and 1 kHz, using a four-gauge method.

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

FEATURES

- Six standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn terminations.

APPLICATIONS

- Consumer electronics, for example:
 - Tuners
 - Television receivers
 - Video recorders
 - All types of cameras
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved nickel electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations by a copper-dipped layer and finally covered with a layer of plated nickel/tin (Nickel-barrier).

A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V and 50 V (IEC)
Capacitance range (E12 series):	
16 V	22 nF to 1 μ F
25 V	10 nF to 470 nF
50 V	100 pF to 1 μ F
Tolerance on capacitance	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

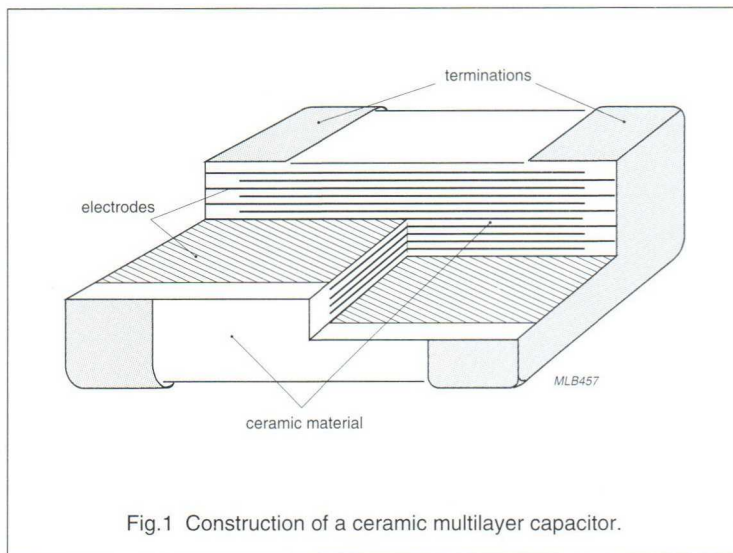
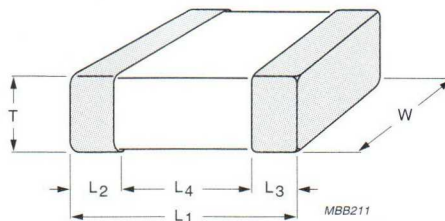


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

SELECTION CHART FOR 16 V AND 25 V

C (pF)	LAST TWO DIGITS OF 12NC	16 V			25 V				
		0603	0805	1206	0603	0805	1206	1210	
10000	36				0.8 ±0.07	0.6 ±0.1			
12000	37								
15000	38								
18000	39								
22000	41								
27000	42	0.8 ±0.07							
33000	43								
39000	44								
47000	45								
56000	46								
68000	47		0.6 ±0.1						
82000	48								
100000	49								
120000	51								
150000	52								
180000	53		0.85 ±0.1			0.85 ±0.1			
220000	54								
270000	55								
330000	56								
390000	57								
470000	58		1.25 ±0.1	0.85 ±0.1			1.15 ±0.1	0.5 to 1.0	
560000	59								
680000	61								
820000	62								
1000000	63								
					Values in shaded cells indicate thickness classification.				

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0603	0805	1206
0.6 ±0.1	4000	4000	20000	10000	—	10000	—
0.85 ±0.1	4000	4000	15000	10000	—	8000	3000
0.5 to 1.0	—	4000	—	10000	—	—	—
0.8 ±0.07	4000	4000	15000	15000	15000	—	—
0.9 to 1.3	—	3000	—	10000	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	3000
1.25 ±0.1	—	3000	—	10000	—	5000	—

Surface mount ceramic
multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R104K7BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210	2R = X7R	104 = 100 000 pF; the third digit signifies the number of zeros	J $\pm$ 5% K $\pm$ 10% M $\pm$ 20%	7 = 16 V 8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC

2 2 X X X X X X 5 X X X

Carrier type

22 blister
38 paper tape
54 bulk

Rated voltage - Termination

78 16 V; Ni-barrier
91 25 V; Ni-barrier

Size

6 0603
0 0805
1 1206
2 1210

Capacitance value⁽¹⁾

Tolerance

5 $\pm$ 5%
6 $\pm$ 10%
7 $\pm$ 20%

Packaging⁽²⁾

1 reel: $\varnothing$ 180 mm; 7"
5 reel: $\varnothing$ 330 mm; 13"
4 bulk case

CCB651

(1) Refer to Chapter "Selection chart for 16 V and 25 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

SELECTION CHART FOR 50 V

C (pF)	LAST TWO DIGITS OF 12NC	50 V					
		0603	0805	1206	1210	1812	2220
100	09						
120	11						
150	12						
180	13						
220	14						
270	15						
330	16						
390	17						
470	18						
560	19						
680	21						
820	22						
1000	23						
1200	24						
1500	25	0.8 ±0.07					
1800	26		0.6 ±0.1				
2200	27						
2700	28						
3300	29						
3900	31			0.85 ±0.1			
4700	32						
5600	33						
6800	34						
8200	35						
10000	36						
12000	37						
15000	38						
18000	39						
22000	41						
27000	42						
33000	43						
39000	44		0.85 ±0.1		0.5 to 1.0		
47000	45						
56000	46						
68000	47						
82000	48		1.25 ±0.1				
100000	49						
120000	51						
150000	52						
180000	53			1.15 ±0.1	0.9 to 1.3		
220000	54					0.5 to 1.0	
270000	55						
330000	56	Values in shaded cells indicate thickness classification.					
390000	57						0.5 to 1.0
470000	58					0.9 to 1.3	
560000	59						
680000	61						
820000	62						
1000000	63						0.9 to 1.3

Surface mount ceramic
multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE			
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER					
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805	1206
0.6 ±0.1	4000	4000	20000	10000	—	—	—	—	10000	—
0.85 ±0.1	4000	4000	15000	10000	—	—	—	—	8000	3000
0.5 to 1.0	—	4000	—	10000	2000	1500	—	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—	—
0.9 to 1.3	—	3000	—	10000	1500	1500	—	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—	—	2000
1.25 ±0.1	—	3000	—	10000	—	—	—	—	5000	—
1.2 to 1.75	—	2500	—	7000	1000	—	—	—	—	—

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R104K9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC

2 2 X X X X X X 5 X X X

Carrier type

22 blister
38 paper tape
54 bulk

Rated voltage - Termination

58 50 V; Ni-barrier

Size

6 0603
0 0805
1 1206
2 1210
4 1812
5 2220

Capacitance value⁽¹⁾

Tolerance

5 ±5%
6 ±10%
7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
5 reel: Ø330 mm; 13"
4 bulk case

CCB652

(1) Refer to Chapter "Selection chart for 50 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

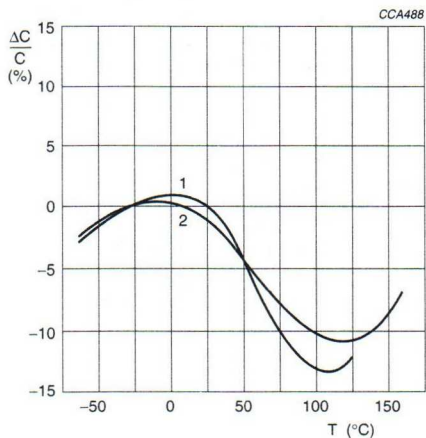
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 1 μF
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Tan δ ; note 1	
16 V	$\leq 3.5\%$
25 V and 50 V	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{\text{ins}} \times C > 500$ seconds
Maximum capacitance change as a function of temperature; see Fig.3	$\pm 15\%$
Ageing	typical 1% per time decade

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

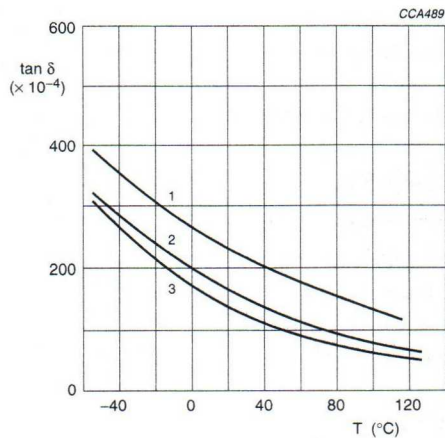
Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V and 50 V



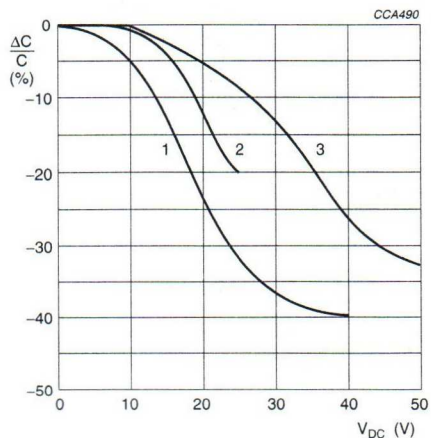
Curve 1 = 16 V product
Curve 2 = 25 V and 50 V products.

Fig.3 Typical capacitance change as a function of temperature.



Curve 1 = 16 V product
Curve 2 = 25 V product
Curve 3 = 50 V product.

Fig.4 Typical $\tan \delta$ as a function of temperature.



Curve 1 = 16 V product
Curve 2 = 25 V product
Curve 3 = 50 V product.

Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

Surface mount ceramic multilayer capacitors

Class 2, X7R 50 V Low Inductance

FEATURES

- One standard size
- For high frequency applications
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- High speed IC packages
- Processor package decoupling
- AC noise reduction in multi-chip modules.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range (E6 series)	10 to 22 nF; note 1
Tolerance on capacitance after 1000 hours	$\pm 10\%$; note 2
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Equivalent series inductance (ESL)	500 pH
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	55/125/21

Notes

1. Other values on request.
2. Special tolerance values available on request.

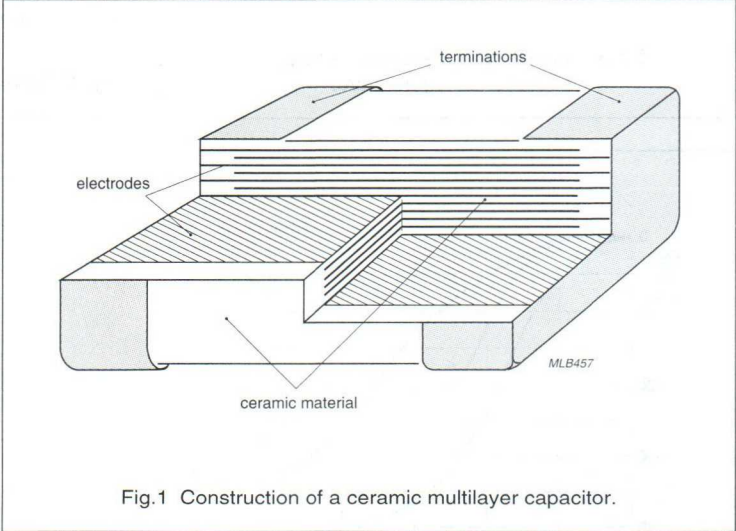
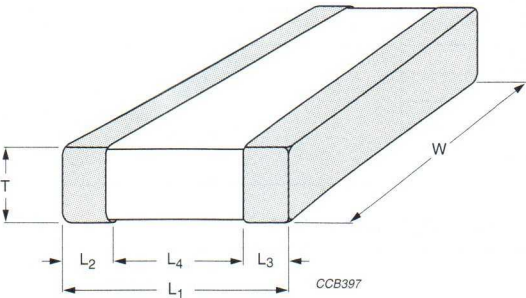


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic
multilayer capacitors

Class 2, X7R 50 V
Low Inductance

MECHANICAL DATA



For dimensions see Table 1.

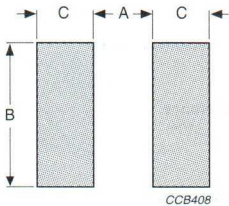
Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions; see Fig.2

CASE SIZE	L ₁	W	T	L ₂ and L ₃		L ₄ MIN.
				MIN.	MAX.	
Dimensions in millimetres						
0612	1.60 ±0.20	3.20 ±0.20	0.85 ±0.10	0.13	0.46	0.50
Dimensions in inches						
0612	0.062 ±0.008	0.125 ±0.008	0.033 ±0.004	0.005	0.018	0.019

Footprint



For dimensions see Table 2.

Fig.3 Footprint dimensions.

Table 2 Footprint dimensions; see Fig.3

FOOTPRINT DIMENSIONS (mm)		
A	B	C
0.762	3.048	0.889

Surface mount ceramic
multilayer capacitors

Class 2, X7R 50 V
Low Inductance

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	50 V
		0612
10	36	thickness classification: 0.85 ±0.10
12	37	
15	38	
18	39	
22	41	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	Ø180 mm; 7"		Ø330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.85 ±0.10	4000	4000	15000	10000

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 06122R101K9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612	2R = X7R	101 = 100 pF; the third digit signifies the number of zeros	K = ±10%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister	0 = no marking	0 = conv. ceramic

Ordering code 12NC

2

2

X

X

X

X

X

X

X

6

X

X

X

Carrier type

50 blister

55 paper tape

56 bulk

Rated voltage - Termination

06 50 V; Ni-barrier

Size

0 0612 low inductance

Capacitance value⁽¹⁾

Tolerance

6 ±10%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

5 reel: Ø330 mm; 13"

4 bulk case

CBC398

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

Class 2, X7R 50 V
Low Inductance

ELECTRICAL CHARACTERISTICS

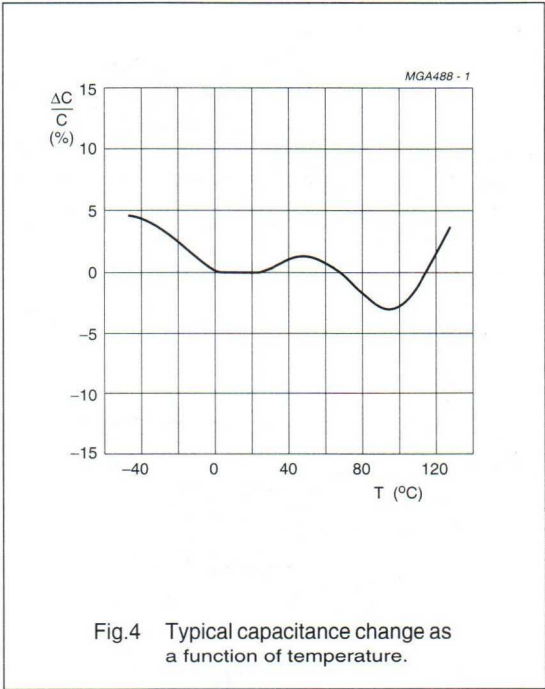
Class 2 capacitors; low inductance; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 to 22 nF
Tolerance on capacitance after 1000 hours	$\pm 10\%$
Tan δ ; note 1	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \geq 1.5\text{ M}\Omega$ or $R_{ins} \times C \geq 1000\text{ seconds}$
Typical capacitance change as a function of temperature	$\pm 15\%$
Ageing	typical 1% per time decade
Resistance to soldering heat	$260\text{ }^{\circ}\text{C}$; 10 seconds

Note

1. Measured at $20\text{ }^{\circ}\text{C}$, 1 V and 1 kHz, using a four-gauge method.



Surface mount ceramic
multilayer capacitors

Class 2, X7R 16/25/50/100/200 and 500 V
Noble Metal Electrode

FEATURES

- Seven standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- NiSn terminations (AgPd on request).

APPLICATIONS

- Consumer electronics, for example:
 - Tuners
 - Television receivers
 - Video recorders
 - All types of cameras
- Telecommunications
- Automotive
- Data processing.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

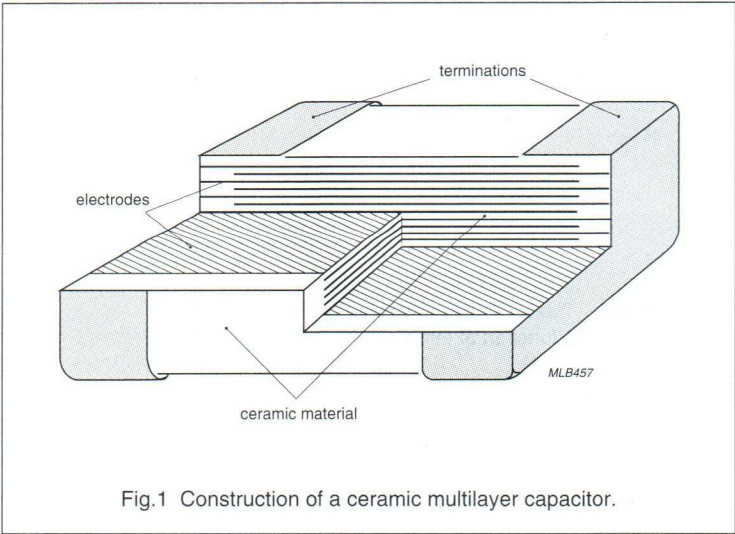
The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V, 50 V, 100 V, 200 V and 500 V (IEC)
Capacitance range (E12 series); note 1: 16 V 25 V 50 V; note 2 100 V 200 V 500 V	4.7 nF to 100 nF 3.3 nF to 220 nF 100 pF to 470 nF 180 pF to 330 nF 180 pF to 120 nF 470 pF to 15 nF
Tolerance on capacitance	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$
Test voltage (DC) for 1 minute: 16 V, 25 V, 50 V and 100 V 200 V 500 V	$2.5 \times U_R$ $3 \times U_R$ $2 \times U_R$
Sectional specifications	IEC 384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 68)	55/125/56

Notes

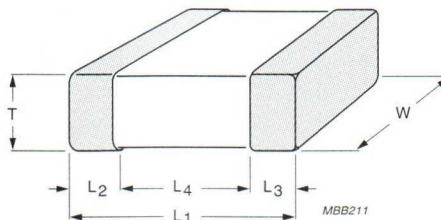
1. Non E12 values are available on request.
2. Also applicable for applications up to 63 V.



Surface mount ceramic multilayer capacitors

Class 2, X7R 16/25/50/100/200 and 500 V Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V and 25 V Noble Metal Electrode

SELECTION CHART FOR 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	16 V				25 V				
		0402	0603	0805	1206	0402	0603	0805	1206	1210
3.3	29	0.5 ±0.05				0.5 ±0.05				
3.9	31									
4.7	32									
5.6	33									
6.8	34									
8.2	35									
10	36									
12	37									
15	38									
18	39									
22	41	0.8 ±0.07				0.8 ±0.07	0.6 ±0.1			
27	42									
33	43									
39	44									
47	45									
56	46									
68	47									
82	48									
100	49									
120	51									
150	52	0.85 ±0.1						0.85 ±0.1		
180	53									
220	54									
270	55									
330	56									
390	57									
470	58									
560	59									
680	61									
820	62									
1000	63									
Values in shaded cells indicate thickness classification.										

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"				
	PAPER	BLISTER	PAPER	BLISTER	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	50000	—	—
0.6 ±0.1	4000	4000	20000	10000	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	8000
0.5 to 1.0	—	4000	—	10000	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	15000	—
0.9 to 1.3	—	3000	—	10000	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	5000

Surface mount ceramic
multilayer capacitors

Class 2, X7R 16 V and 25 V
Noble Metal Electrode

ORDERING INFORMATION FOR 16 V AND 25 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 08052R104K8BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	7 = 16 V 8 = 25 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X X 6 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

78 16 V; Ni-barrier
91 25 V; Ni-barrier

Size

7 0402
6 0603
0 0805
1 1206
2 1210

Capacitance value⁽¹⁾

Tolerance

5 ±5%
6 ±10%
7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
5 reel: Ø330 mm; 13"
4 bulk case

CCA611

(1) Refer to Chapter "Selection chart for 16 V and 25 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 50 V Noble Metal Electrode

SELECTION CHART FOR 50 V

C (pF)	LAST TWO DIGITS OF 12NC	50 V						
		0402	0603	0805	1206	1210	1812	2220
100	01	0.5 ±0.05	0.8 ±0.07	0.6 ±0.1	0.85 ±0.1	0.5 to 1.0	0.5 to 1.0	0.5 to 1.0
120	02							
150	03							
180	04							
220	05							
270	06							
330	07							
390	08							
470	09							
560	11							
680	12							
820	13							
1000	14							
1200	15							
1500	16							
1800	17							
2200	18							
2700	19							
3300	21							
3900	22							
4700	23							
5600	24							
6800	25							
8200	26							
10000	27							
12000	28							
15000	29							
18000	31							
22000	32							
27000	33							
33000	34							
39000	35							
47000	36							
56000	37							
68000	38							
82000	39							
100000	41							
120000	42							
150000	43							
180000	44							
220000	45							
270000	46							
330000	47							
390000	48							
470000	49							
560000	51							
680000	52							
820000	53							
1000000	54							

Values in shaded cells indicate thickness classification.

Surface mount ceramic multilayer capacitors

Class 2, X7R 50 V Noble Metal Electrode

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.5 ±0.05	10000	—	50000	—	—	—	50000	—	—
0.6 ±0.1	4000	4000	20000	10000	—	—	—	—	10000
0.85 ±0.1	4000	4000	15000	10000	—	—	—	—	8000
0.5 to 1.0	—	4000	—	10000	2000	1500	—	—	—
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	10000	1500	1500	—	—	—
1.15 ±0.1	—	3000	—	10000	—	—	—	—	—
1.25 ±0.1	—	3000	—	10000	—	—	—	—	5000
1.2 to 1.75	—	—	—	—	1200	—	—	—	—

ORDERING INFORMATION FOR 50 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 08052R104K9BB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210 1812 2220	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	9 = 50 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

Carrier type

- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination

- 58 50 V; Ni-barrier
- 59 50 V; AgPd (2220 only)

Size

- 7 0402
- 6 0603
- 0 0805
- 1 1206
- 2 1210
- 4 1812
- 5 2220

Capacitance value⁽¹⁾

Tolerance

- 5 ±5%
- 6 ±10%
- 7 ±20%

Packaging⁽²⁾

- 1 reel: Ø180 mm; 7"
- 5 reel: Ø330 mm; 13"
- 4 bulk case

2 2 X X X X X X 6 X X X

CCA612

(1) Refer to Chapter "Selection chart for 50 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 100 V, 200 V and 500 V Noble Metal Electrode

SELECTION CHART FOR 100 V, 200 V AND 500 V

C (pF)	LAST TWO DIGITS OF 12NC	100 V				200 V				500 V		
		0805	1206	1210	1812	0805	1206	1210	1812	1206	1210	1812
180	13											
220	14											
270	15											
330	16											
390	17											
470	18											
560	19											
680	21											
820	22											
1000	23											
1200	24											
1500	25											
1800	26											
2200	27											
2700	28											
3300	29											
3900	31											
4700	32											
5600	33											
6800	34											
8200	35											
10000	36											
12000	37											
15000	38											
18000	39											
22000	41											
27000	42											
33000	43											
39000	44											
47000	45											
56000	46											
68000	47											
82000	48											
100000	49											
120000	51											
150000	52											
180000	53											
220000	54											
270000	55											
330000	56											

Values in shaded cells indicate thickness classification.

Surface mount ceramic multilayer capacitors

Class 2, X7R 100 V, 200 V and 500 V Noble Metal Electrode

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL	AMOUNT PER BULK CASE
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER	
	PAPER	BLISTER	PAPER	BLISTER	1812	
0.6 ±0.1	4 000	4 000	20 000	10 000	—	10 000
0.85 ±0.1	4 000	4 000	15 000	10 000	—	8 000
0.8 to 1.0	—	4 000	—	10 000	—	—
0.5 to 1.0	—	4 000	—	10 000	2 000	—
0.8 ±0.07	4 000	4 000	15 000	15 000	—	—
0.9 to 1.3	—	3 000	—	10 000	1 500	—
1.15 ±0.1	—	3 000	—	10 000	—	—
1.25 ±0.1	—	3 000	—	10 000	—	5 000
1.2 to 1.75	—	2 500	—	10 000	—	—

ORDERING INFORMATION FOR 100 V, 200 V AND 500 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 18122R103KBBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805	2R = X7R	103 = 10 000 pF; the third digit signifies the number of zeros	J ±5%	0 = 100 V	B = Ni-barrier	2 = 180 mm; 7" paper	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic
1206			K ±10%	B = 200 V		3 = 330 mm; 13" paper		
1210			M ±20%	D = 500 V		B = 180 mm; 7" blister		
1812						F = 330 mm; 13" blister P = bulk case		

Ordering code 12NC

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

60 100 V; Ni-barrier
93 200 V; Ni-barrier
97 500 V; Ni-barrier

Size

0 0805
1 1206
2 1210
4 1812

Capacitance value⁽¹⁾

Tolerance

5 ±5%
6 ±10%
7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
5 reel: Ø330 mm; 13"
4 bulk case

2 2 X X X X X X 6 X X X

CCA613

(1) Refer to Chapter "Selection chart for 100 V, 200 V and 500 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

Class 2, X7R 16/25/50/100/200 and 500 V
Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

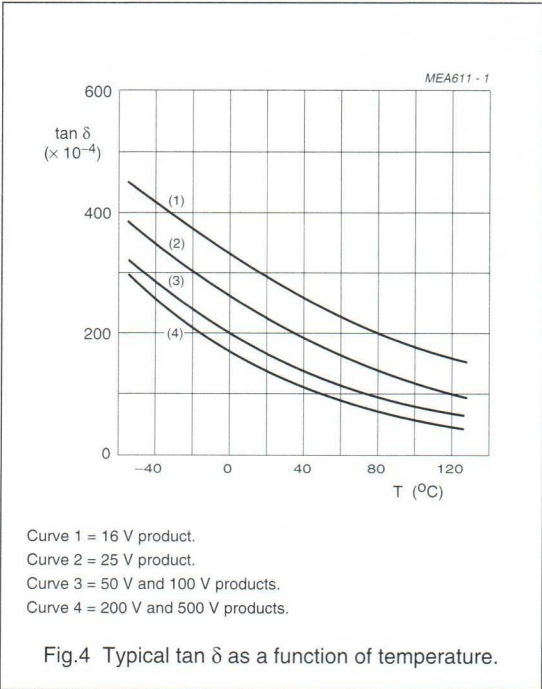
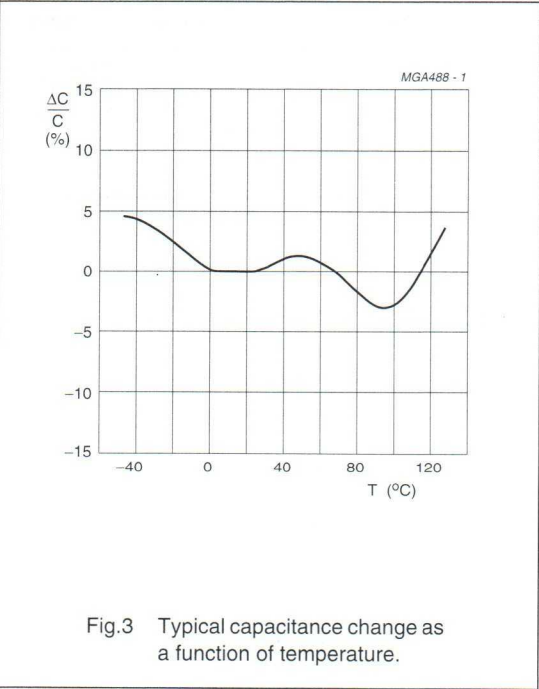
Class 2 capacitors; X7R dielectric; AgPd and NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1^\circ\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	100 pF to 100 nF
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$; note 2
Tan δ ; note 1	$\leq 2.5\%$; 16 V range $\leq 3.5\%$
Insulation resistance after 1 minute at U_R (DC): C ≤ 10 nF C > 10 nF	$R_{\text{ins}} > 100\text{ G}\Omega$ $R_{\text{ins}} \times C > 1000$ seconds
Maximum capacitance change as a function of temperature (for typical values see Fig.3)	$\pm 15\%$
Ageing	typical 1% per time decade

Notes

1. Measured at 1 V, 1 kHz, using a four-gauge method.
2. Tolerance of $\pm 1\%$ available on request.



Surface mount ceramic multilayer capacitors

Class 2, X7R 16/25/50/100/200 and 500 V Noble Metal Electrode

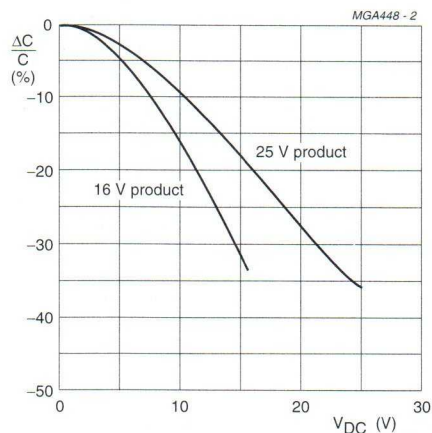


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

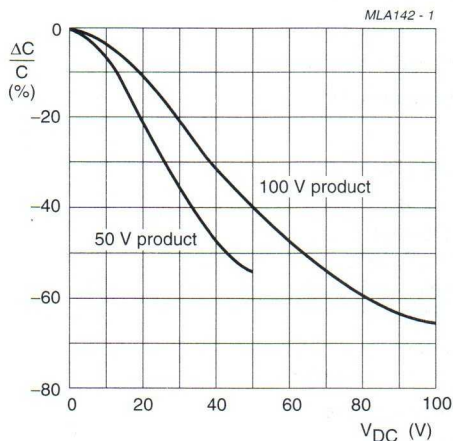


Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

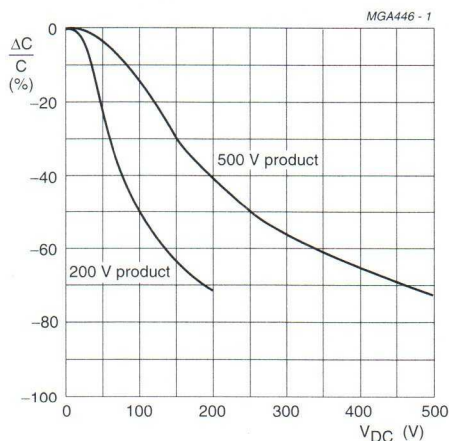


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 20 °C.

Surface mount ceramic multilayer capacitors

Class 2, X7R 1 kV high voltage series Noble Metal Electrode

FEATURES

- Sizes 1808 and 1812
- High capacitance per unit volume
- Supplied in tape on reel
- NiSn terminations.

APPLICATIONS

These surface mounted high voltage capacitors were developed specifically for circuits requiring voltage up to 1 kV. Typical applications are:

- Inverter circuits for the backlights of liquid crystal displays
- Snubber circuits of power supplies
- Voltage multiplier circuits and circuits where surge protection is required.

Due to high voltage across the terminations, circuit applications of 1 kV or higher may need a coating on the surface to prevent external arcing. This is especially true under humid conditions.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (NiSn). A cross section of the structure is shown in Fig. 1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	1 kV (IEC)
Capacitance range (E12 series); note 1	1 nF to 10 nF
Tolerance on capacitance at $T_{amb} = 20\text{ }^{\circ}\text{C}$	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$; note 2
Test voltage (DC) for 1 minute	$1.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

Notes

1. Other values are available on request.
2. Special tolerance on capacitance is available on request.

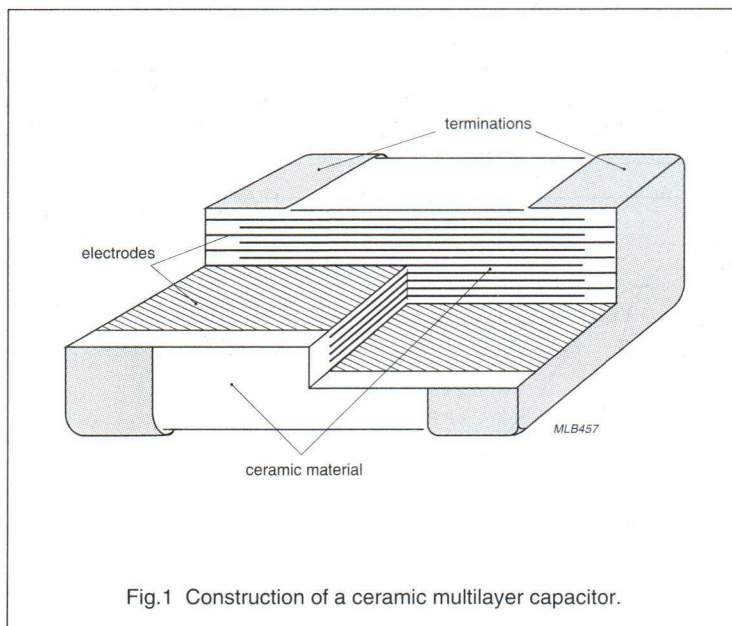
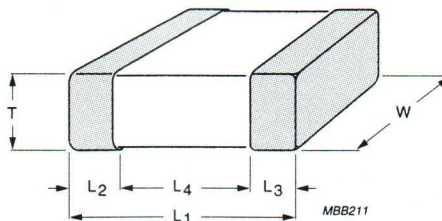


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic multilayer capacitors

Class 2, X7R 1 kV high voltage series Noble Metal Electrode

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T MAX.	L ₂ and L ₃ MAX.	L ₄ MIN.
Dimensions in millimetres					
1808	4.5 ±0.20	2.0 ±0.20	2.0	0.75	2.20
1812	4.5 ±0.20	3.2 ±0.20	2.5	0.75	2.20
Dimensions in inches					
1808	0.177 ±0.008	0.079 ±0.008	0.028	0.030	0.088
1812	0.177 ±0.008	0.126 ±0.008	0.072	0.030	0.088

Surface mount ceramic
multilayer capacitors

Class 2, X7R 1 kV high voltage series
Noble Metal Electrode

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	1 kV	
		1808	1812
1.0	23	1.2 to 1.75	1.2 to 1.75
1.2	24		
1.5	25		
1.8	26		
2.2	27		
2.7	28		
3.3	29		
3.9	31		
4.7	32		
5.6	33		
6.8	34		
8.2	35		
10	36		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	12 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7" BLISTER	
	1808	1812
1.2 to 1.75	1000	1000

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 18082R102KEBB00

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
1808 1812	2R = X7R	102 = 1000 pF; the third digit signifies the number of zeros	J ±5% K ±10% M ±20%	E = 1 kV	B = Ni-barrier	B = 180 mm; 7" blister	0 = no marking 2 = 2-character marking in North America only	0 = conv. ceramic

Ordering code 12NC

2 2 X X 0 0 X X 6 X X X

Carrier type
50 blister
56 bulk

Size
3 1808
4 1812

Packaging⁽²⁾
1 reel: Ø180 mm; 7" reel
12 mm blister tape

Capacitance value⁽¹⁾

Tolerance
5 ±5%
6 ±10%
7 ±20%

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

CCA685

Surface mount ceramic multilayer capacitors

Class 2, X7R 1 kV high voltage series Noble Metal Electrode

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1^\circ\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	1 nF to 10 nF
Tolerance on capacitance	$\pm 20\%$, $\pm 10\%$, $\pm 5\%$; note 2
Tan δ ; note 1	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC): $C \leq 10$ nF $C > 10$ nF	$R_{\text{ins}} > 100$ G Ω $R_{\text{ins}} \times C > 1000$ seconds
Typical capacitance change as a function of temperature; see Fig.3	$\pm 15\%$
Ageing	typical 1% per time decade

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000$ pF, and 1 V, 1 kHz for $C > 1000$ pF, using a four-gauge method.
2. Special tolerance available on request.

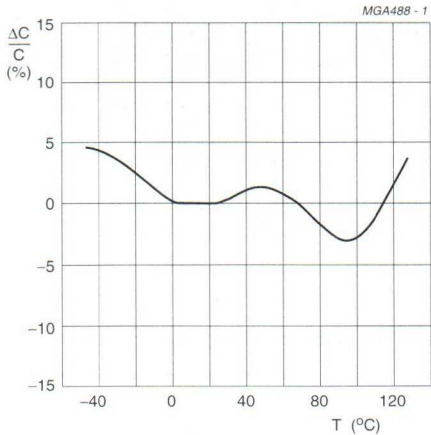


Fig.3 Typical capacitance change as a function of temperature.

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 10 V

FEATURES

- Three standard sizes
- High capacitance per unit volume
- Supplied in tape on reel or in bulk case
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- Tuners
- Television receivers
- Video recorders
- All types of cameras.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	10 V
Capacitance range (E6 series)	1.0 to 10 μ F; note 1
Tolerance on capacitance after 1000 hours	-20% to +80% (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	25/085/21

Note

1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.

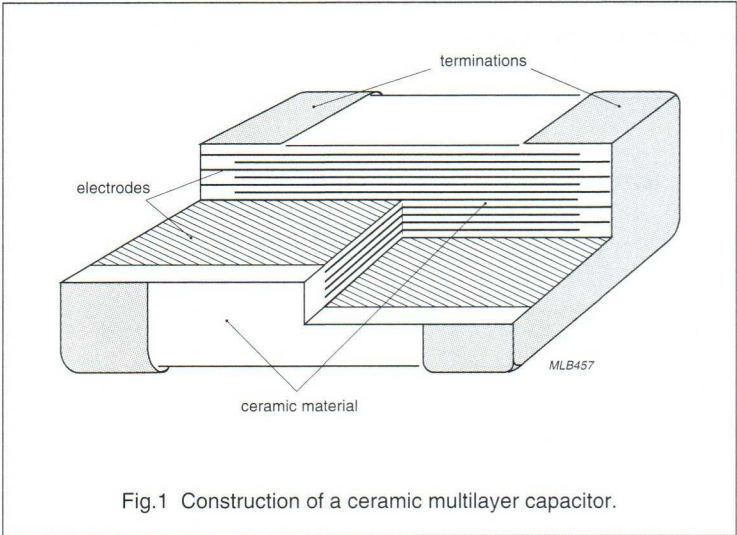
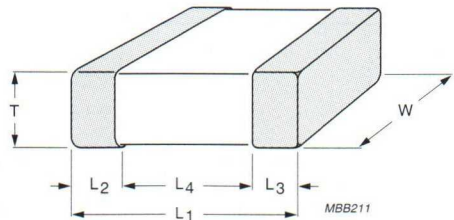


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 10 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.1	1.25 ±0.1	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

Surface mounted ceramic multilayer capacitors

Class 2, Y5V 10 V

SELECTION CHART FOR 10 V

C (nF)	LAST TWO DIGITS OF 12NC	10 V			
		0603	0805	1206	
1000	63	0.8 ±0.07		0.85 ±0.10	
1500	65			1.25 ±0.10	1.15 ±0.10
2200	67				
3300	69				
4700	72				
6800	74	Values in shaded cells indicate thickness classification.			1.60 ±0.15
10000	76				

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE	
	Ø180 mm; 7"		Ø330 mm; 13"		0603	0805
	PAPER	BLISTER	PAPER	BLISTER		
0.8 ±0.07	4000	4000	15000	15000	15000	—
0.85 ±0.10	4000	4000	15000	15000	—	—
1.15 ±0.10	—	3000	—	10000	—	—
1.25 ±0.10	—	3000	—	10000	—	5000
1.60 ±0.15	—	2000	—	7000	—	—

Surface mounted ceramic
multilayer capacitors

Class 2, Y5V 10 V

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 06032F102Z24BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 0805 1206	2F = Y5V	102 = 1000 pF; the third digit signifies the number of zeros	Z = -20%/+80%	6 = 10 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking	D = BME

Ordering code 12NC

2 2 X X X X X X X 9 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

24 10 V; Ni-barrier

Size

6 0603
0 0805
1 1206

Capacitance value⁽¹⁾

Tolerance

8 -20/+80%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"
5 reel: Ø330 mm; 13"
4 bulk case

CCB239

(1) Refer to Chapter "Selection chart for 10 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

**Surface mounted ceramic
multilayer capacitors**

Class 2, Y5V 10 V

ELECTRICAL CHARACTERISTICS**Class 2 capacitors; Y5V dielectric; NiSn terminations**

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1.	1.0 to 10 μ F
Tolerance on capacitance after 1000 hours	-20% to +80% (Z)
Tan δ ; note 1.	$\leq 12.5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500$ seconds
Maximum capacitance change as a function of temperature	+30% to -80%
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.

Surface mount ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

FEATURES

- Four standard sizes
- High capacitance per unit volume
- Supplied in tape on reel
- Nickel-barrier end terminations.

APPLICATIONS

Consumer electronics, for example:

- Tuners
- Television receivers
- Video recorders
- All types of cameras.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

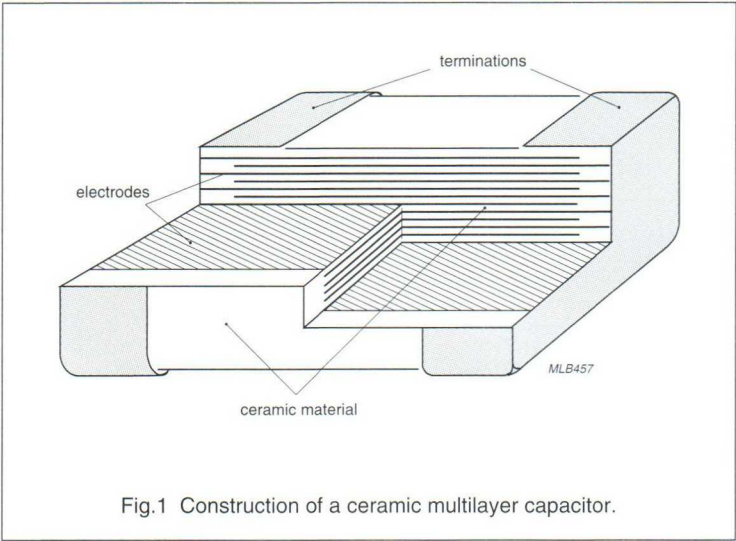
The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V, 25 V, 50 V
Capacitance range (E6 series)	10 nF to 4.7 μ F; note 1
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $+80\%$ (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
End terminations	NiSn
Climatic category (IEC 60068)	25/85/21

Note

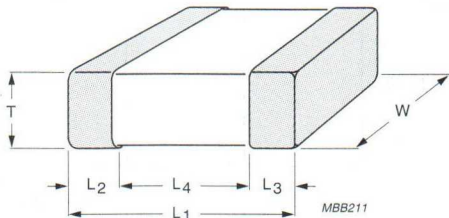
1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.



Surface mount ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.50 ±0.05	0.45	0.55	0.15	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

Surface mount ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

SELECTION CHART FOR 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	16 V				25 V		
		0402	0603	0805	1206	0603	0805	1206
10	36	0.5 ±0.05				0.8 ±0.07		
15	38							
22	41							
33	43							
47	45							
68	47							
100	49						0.6 ±0.1	
150	52		0.8 ±0.07	Values in shaded cells indicate thickness classification.			0.85 ±0.1	0.6 ±0.1
220	54							
330	56				1.25 ±0.1			
470	58		0.85 ±0.1			0.85 ±0.1		
680	61							
1000	63		0.85 ±0.1	1.15 ±0.1				
1500	65		1.25 ±0.1					
2200	67				1.15 ±0.1			
2700	68							
3300	69							
3900	71							
4700	72							

SELECTION CHART FOR 50 V

C (nF)	LAST TWO DIGITS OF 12NC	50 V		
		0603	0805	1206
10	05	0.8 ±0.07	0.6 ±0.1	
15	06			
22	07			
33	08			
47	09			
68	11			
100	12			
150	13		0.85 ±0.1	0.6 ±0.1
220	14		1.25 ±0.1	
330	15			
470	16			0.85 ±0.1
680	17		Values in shaded cells indicate thickness classification.	
1000	18			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		0402	0603	0805
	PAPER	BLISTER	PAPER	BLISTER			
0.5 ±0.05	10000	—	50000	—	50000	—	10000
0.6 ±0.1	4000	4000	10000	10000	—	—	10000
0.85 ±0.1	4000	4000	10000	10000	—	—	8000
0.8 ±0.07	4000	4000	15000	15000	—	15000	—
1.25 ±0.1	—	3000	—	10000	—	—	5000
1.15 ±0.1	—	3000	—	10000	—	—	—

Surface mount ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

ORDERING INFORMATION

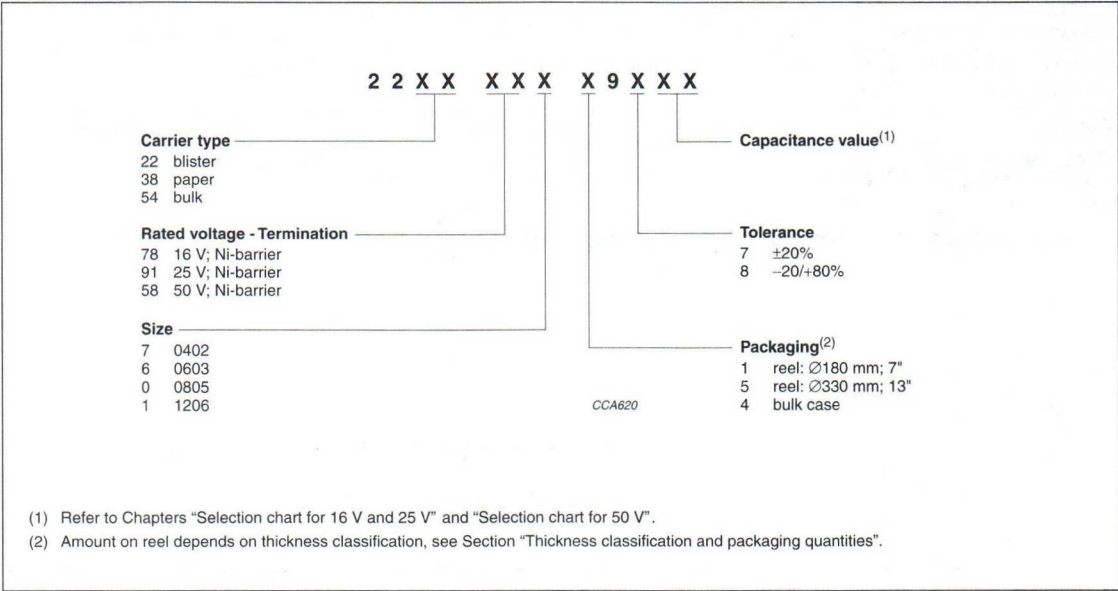
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

Example: 12062F105M8BB0D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206	2F = Y5V	105 = 1 000 000 pF; the third digit signifies the number of zeros	M ±20% Z -20%/+80%	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC



Surface mount ceramic multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Y5V base metal electrode dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 4.7 μ F
Tolerance on capacitance after 1000 hours	-20% (M); -20% to +80% (Z)
Tan δ ; note 1: all 25 V and 50 V (except 1206 and 1 μ F; 0603 and 100 nF; 0805 and 330 nF) sizes 1206 and 1 μ F; 0603 and 100 nF; 0805 and 330 nF all 16 V (except 0402; 0603 and 330 nF, 470 nF; 0805 and 2.2 μ F; 1206 and 3.3 μ F, 4.4 μ F) sizes 0402; 0603 and 330 nF, 470 nF; 0805 and 2.2 μ F; 1206 and 3.3 μ F, 4.4 μ F	$\leq 5\%$ $\leq 7\%$ $\leq 9\%$ $\leq 12.5\%$
Insulation resistance after 1 minute at U_R (DC)	$I_R \times C > 500$ seconds
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	+22% to -82%
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 1 V and 1 kHz, using a four-gauge method.

Surface mount ceramic
multilayer capacitors

Class 2, Y5V 16 V, 25 V and 50 V

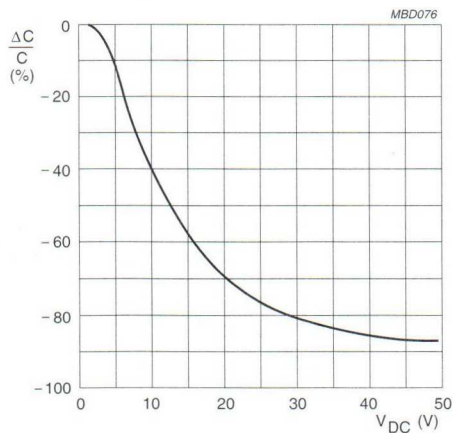


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

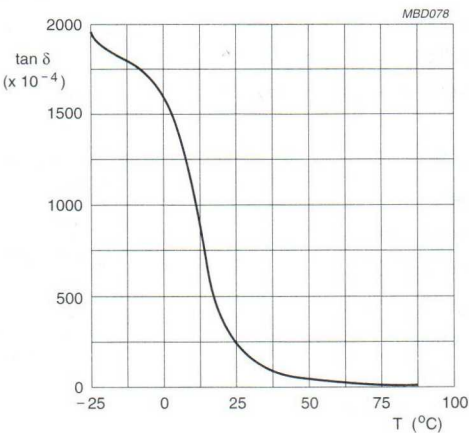


Fig.4 Typical $\tan \delta$ as a function of temperature.

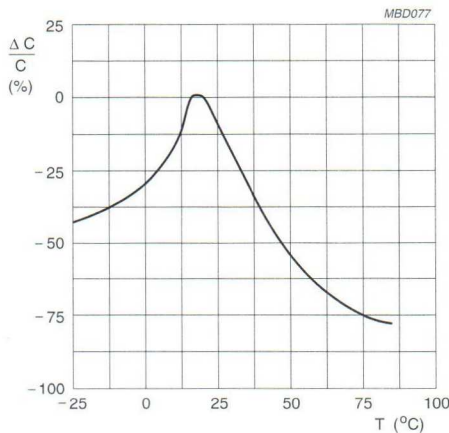


Fig.5 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

FEATURES

- Two standard sizes
- For high frequency applications
- Supplied in tape on reel
- Nickel-barrier end terminations.

APPLICATIONS

- Tuners
- Television receivers
- Video recorders
- All types of cameras
- Telecommunications
- Automotive
- Data processing.

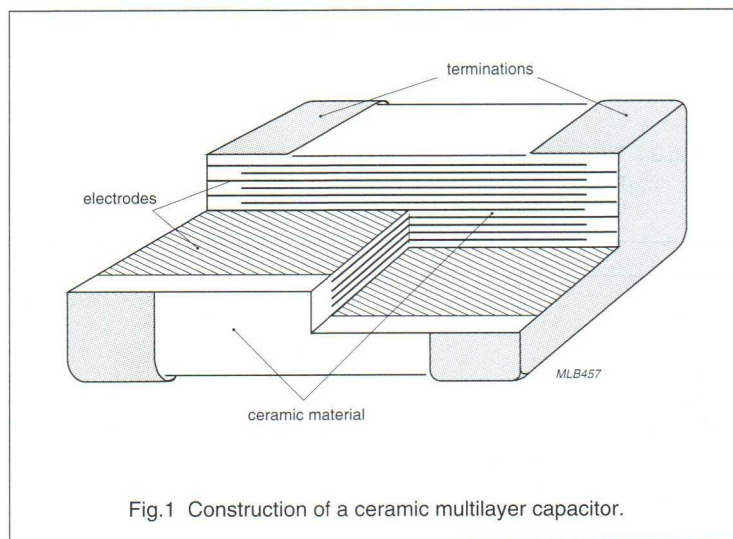
DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

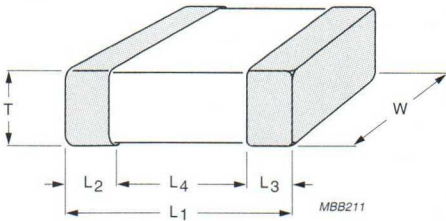
DESCRIPTION	VALUE
Rated voltage U_R (DC)	25 V
Capacitance range (E12 series): case size 0603 case size 1206	10 nF to 100 nF 470 nF to 1 μ F
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $\pm 80\%$ (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	10/085/21



Surface mount ceramic
multilayer capacitors

Class 2, Z5U 25 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
1206	3.2 ±0.15	1.6 ±0.15	0.50	1.75	0.25	0.75	1.40
Dimensions in inches							
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056

Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	25 V	
		0603	1206
10	36	0.80 ±0.07	
12	37		
15	38		
18	39		
22	41		
27	42		
33	43		
39	44		
47	45		
56	46		
68	47		
82	48		
100	49		
120	51		
150	52	Values in shaded cells indicate thickness classification	
180	53		
220	54		
270	55		
330	56		
390	57		
470	58		
560	59		
680	61		
820	62		
1000	63		
			1.15 ±0.1

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE
	Ø180 mm; 7"		Ø330 mm; 13"		0603
	PAPER	BLISTER	PAPER	BLISTER	
0.80 ±0.07	4000	4000	15000	15000	15000
1.15 ±0.1	—	3000	—	10000	—

Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

ORDERING INFORMATION

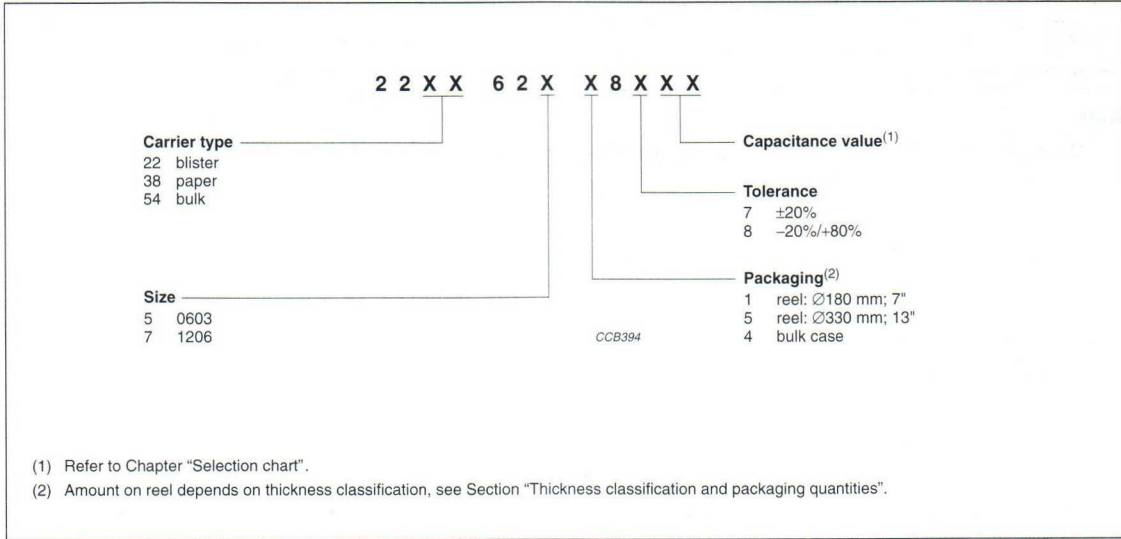
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC number.

Clear text code

Example: 06032E104Z8B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0603 1206	2E = Z5U	104 = 100 000 pF; the third digit signifies the number of zeros	M $\pm 20\%$ Z $-20\%/+80\%$	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC



Surface mount ceramic multilayer capacitors

Class 2, Z5U 25 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Z5U dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ± 1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series): case size 0603 case size 1206	10 nF to 100 nF 470 nF to 1 μ F
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M); -20% to $+80\%$ (Z)
Tan δ ; note 1	$\leq 6\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} > 10 \text{ G}\Omega$ or $R_{ins} \times C > 1000$ seconds, whichever is smaller
Maximum capacitance change with respect to capacitance at 25 °C	$+22\%$ to -56%
Ageing	typical 4% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 0.5 V_{rms} and 1 kHz, using a four-gauge method.

Surface mount ceramic multilayer capacitors

Class 2, Z5U 50 V

FEATURES

- Three standard sizes
- For high frequency applications
- Supplied in tape on reel
- Nickel-barrier end terminations.

APPLICATIONS

- Tuners
- Television receivers
- Video recorders
- All types of cameras
- Telecommunications
- Automotive
- Data processing.

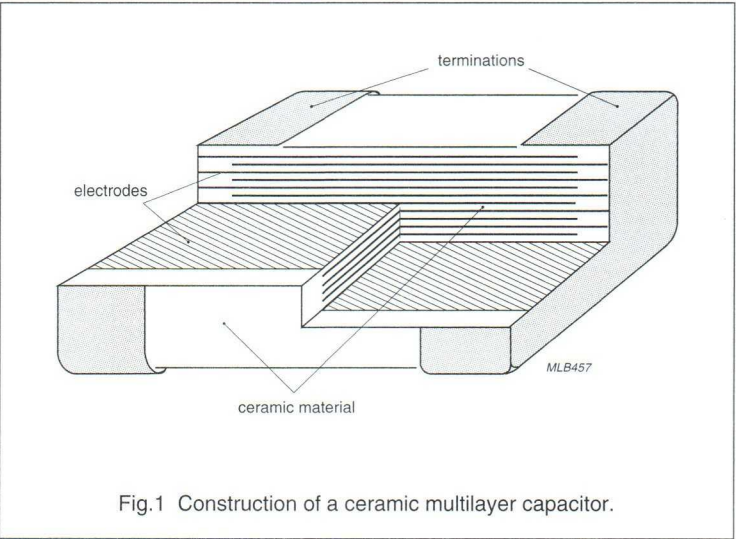
DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

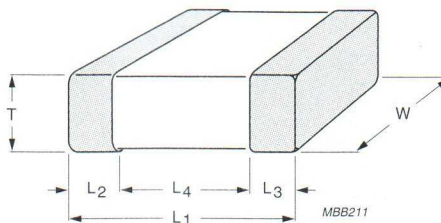
DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V
Capacitance range (E12 series):	
case size 0805	10 nF to 220 nF
case size 1206	10 nF to 470 nF
case size 1210	100 nF to 1 μ F
Tolerance on capacitance after 1000 hours	$\pm 20\%$ (M) -20% to $+80\%$ (Z)
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	10/085/21



Surface mount ceramic multilayer capacitors

Class 2, Z5U 50 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0805	2.0 ±0.1	1.25 ±0.1	0.50	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.50	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.50	1.80	0.25	0.75	1.40
Dimensions in inches							
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056

Surface mount ceramic multilayer capacitors

Class 2, Z5U 50 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	50 V		
		0805	1206	1210
10	36	0.6 ±0.1	0.6 ±0.1	
12	37			
15	38			
18	39			
22	41			
27	42			
33	43			
39	44			
47	45			
56	46			
68	47			
82	48			
100	49			
120	51	0.85 ±0.1	0.5 to 1.0	
150	52	1.25 ±0.1		
180	53			
220	54			
270	55			
330	56			0.85 ±0.1
390	57			1.15 ±0.1
470	58			
560	59			
680	61	Values in shaded cells indicate thickness classification.		
820	62			0.9 to 1.3
1000	63			

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				AMOUNT PER BULK CASE
	Ø180 mm; 7"		Ø330 mm; 13"		0805
	PAPER	BLISTER	PAPER	BLISTER	
0.6 ±0.1	4000	4000	20000	10000	—
0.85 ±0.1	4000	4000	15000	10000	—
0.5 to 1.0	—	4000	—	10000	—
0.9 to 1.3	—	3000	—	10000	—
1.15 ±0.1	—	3000	—	10000	—
1.25 ±0.1	—	3000	—	10000	10000

Surface mount ceramic
multilayer capacitors

Class 2, Z5U 50 V

ORDERING INFORMATION

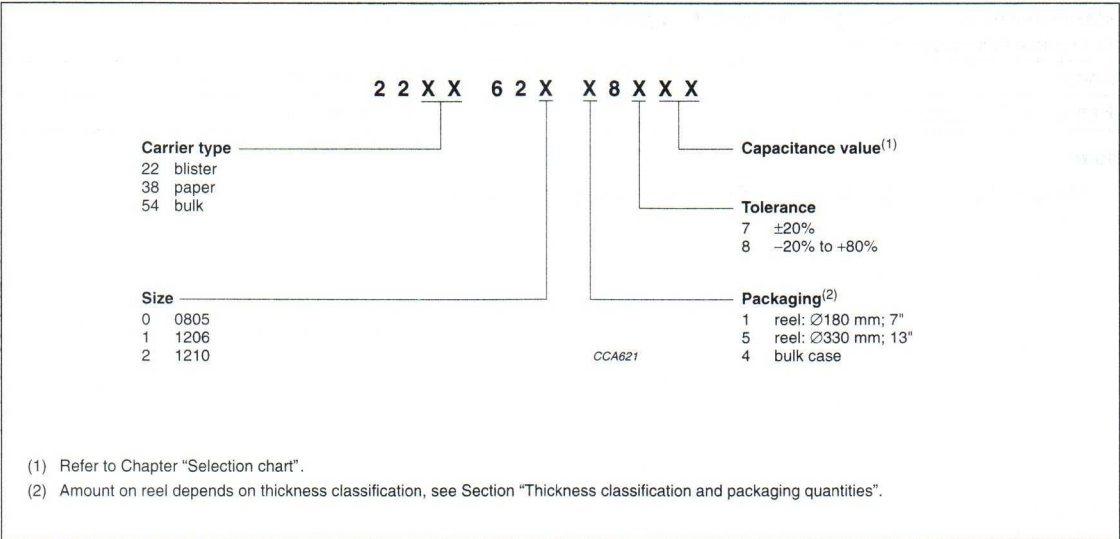
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC number.

Clear text code

Example: 12062E104M9B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210	2E = Z5U	104 = 100 000 pF; the third digit signifies the number of zeros	M ±20%	9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	D = BME

Ordering code 12NC



(1) Refer to Chapter "Selection chart".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

Class 2, Z5U 50 V

ELECTRICAL CHARACTERISTICS

Class 2 capacitors; Z5U dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ±1 °C, an atmospheric pressure of 86 to 105 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	
case size 0805	10 nF to 220 nF
case size 1206	10 nF to 470 nF
case size 1210	100 nF to 1 µF
Tolerance on capacitance after 1000 hours	±20% (M); -20% to +80% (Z)
Tan δ; note 1	≤4%
Insulation resistance after 1 minute at U _R (DC)	R _{ins} > 10 GΩ or R _{ins} × C > 1000 seconds, whichever is smaller
Maximum capacitance change with respect to capacitance at 25 °C (for typical values see Fig.5)	+22% to -56%
Ageing	typical 3% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 25 °C, 0.5 V_{rms} and 1 kHz, using a four-gauge method.

Surface mount ceramic
multilayer capacitors

Class 2, Z5U 50 V

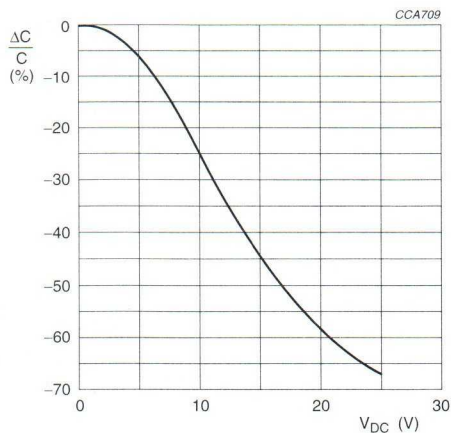


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

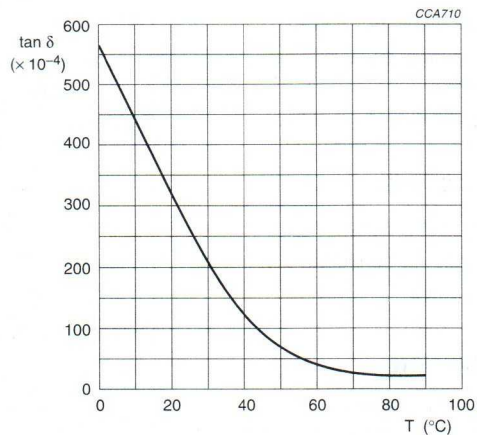


Fig.4 Typical $\tan \delta$ as a function of temperature.

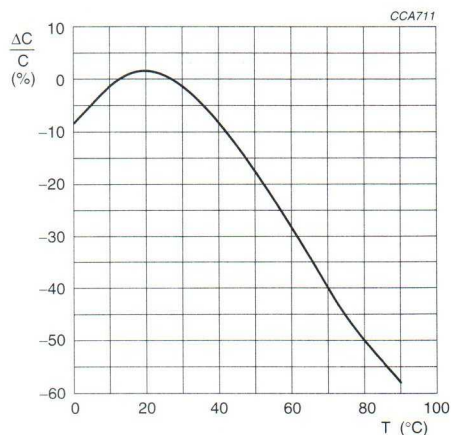


Fig.5 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

Compact series

FEATURES

- Seven standard sizes
- Dense dielectric layers
- Maximum capacitance per unit volume
- Supplied in tape on reel.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, either by silver palladium (AgPd) alloy in the ratio 65 : 35, or silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). A cross section of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	
NP0 dielectric	25 V, 50 V and 63 V (IEC)
X7R dielectric	16 V, 25 V and 63 V (IEC)
Capacitance range (E12 series):	
class 1, NP0 dielectric	220 pF to 100000 pF
class 2, X7R dielectric	12 nF to 4.7 μ F
Tolerance on capacitance:	
class 1, NP0 dielectric	$\pm 10\%$, $\pm 5\%$ and $\pm 2\%$; note 1
class 2, X7R dielectric	$\pm 20\%$, $\pm 10\%$ and $\pm 5\%$
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068):	
class 1, NP0 dielectric	55/125/56
class 2, X7R dielectric	55/125/56

Note

1. Capacitors with a tolerance of $\pm 1\%$ are available on request.

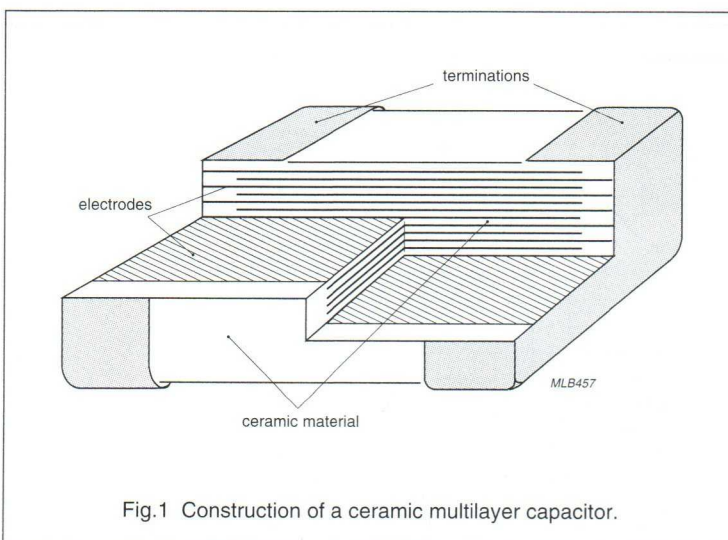
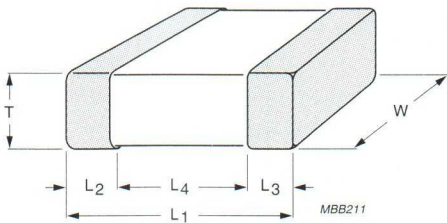


Fig.1 Construction of a ceramic multilayer capacitor.

Surface mount ceramic
multilayer capacitors

Compact series

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Component outline.

Physical dimensions

Table 1 Capacitor dimensions

CASE SIZE	L ₁	W	T		L ₂ and L ₃		L ₄ MIN.
			MIN.	MAX.	MIN.	MAX.	
Dimensions in millimetres							
0402	1.0 ±0.05	0.5 ±0.05	0.45	0.55	0.20	0.30	0.40
0603	1.6 ±0.10	0.8 ±0.07	0.73	0.87	0.25	0.65	0.40
0805	2.0 ±0.10	1.25 ±0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ±0.15	1.6 ±0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ±0.20	2.5 ±0.20	0.51	1.80	0.25	0.75	1.40
1812	4.5 ±0.20	3.2 ±0.20	0.51	1.80	0.25	0.75	2.20
2220	5.7 ±0.20	5.0 ±0.20	0.51	1.80	0.25	0.75	2.90
Dimensions in inches							
0402	0.040 ±0.002	0.020 ±0.002	0.018	0.022	0.008	0.012	0.016
0603	0.063 ±0.004	0.032 ±0.003	0.029	0.035	0.010	0.026	0.016
0805	0.079 ±0.004	0.049 ±0.004	0.020	0.053	0.010	0.030	0.022
1206	0.126 ±0.006	0.063 ±0.006	0.020	0.069	0.010	0.030	0.056
1210	0.126 ±0.008	0.098 ±0.008	0.020	0.072	0.010	0.030	0.056
1812	0.177 ±0.008	0.126 ±0.008	0.020	0.072	0.010	0.030	0.088
2220	0.224 ±0.008	0.197 ±0.008	0.020	0.072	0.010	0.030	0.114

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

SELECTION CHART FOR NP0

C (pF)	LAST TWO DIGITS OF 12NC	25 V	50 V AND 63 V					
		0402	0603	0805	1206	1210	1812	2220
220	41	0.5 ±0.05						
270	42							
330	43							
390	44							
470	45							
560	46							
680	47							
820	48							
1000	49							
1200	51							
1500	52	0.8 ±0.07						
1800	53							
2200	54							
2700	55							
3300	56							
3900	57							
4700	58							
5600	59							
6800	61							
8200	62							
10000	63	0.85 ±0.1			0.85 ±0.1	0.85 ±0.1		
12000	64							
15000	65							
18000	66							
22000	67							
27000	68							
33000	69							
39000	71							
47000	72							
56000	73							
68000	74	1.25 ±0.1					0.9 to 1.3	
82000	75							
100000	76							
		0.9 to 1.3			0.9 to 1.3	0.9 to 1.3	0.85 ±0.1	
		1.2 to 1.75					1.2 to 1.75	0.9 to 1.3
		1.6 to 2.2					1.6 to 2.2	1.2 to 1.75
		Values in shaded cells indicate thickness classification.						0.9 to 1.3
		1.6 to 2.2						1.6 to 2.2

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.5 ±0.05	10000	—	50000	—	—	—	50000	—	—
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.8 ±0.07	4000	4000	15000	15000	—	—	—	15000	—
0.9 to 1.3	—	3000	—	8000	1500	1500	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mount ceramic
multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V
compact series

ORDERING INFORMATION FOR NP0

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0603CG102G9B20C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402 0603 0805 1206 1210 1812 (AgPd only) 2220 (AgPd only)	CG = NP0	102 = 1000 pF; the third digit signifies the number of zeros	F $\pm 1\%$ G $\pm 2\%$ J $\pm 5\%$ K $\pm 10\%$	8 = 25 V 9 = 50 V/63 V	B = Ni-barrier A = AgPd (1812 and 2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

Ordering code 12NC

2 2 X X X X X X 0 X X X

Carrier type

22 blister
38 paper
54 bulk

Rated voltage - Termination

87 25 V; Ni-barrier
89 50 V; 63 V; Ni-barrier
90 50 V; 63 V; AgPd⁽²⁾

Size

7 0402
6 0603
0 0805
1 1206
2 1210
4 1812⁽²⁾
5 2220⁽²⁾

Capacitance value⁽¹⁾

Tolerance

3 $\pm 1\%$
4 $\pm 2\%$
5 $\pm 5\%$
6 $\pm 10\%$

Packaging⁽³⁾

1 reel: $\varnothing$ 180 mm; 7"
8 reel: $\varnothing$ 330 mm; 13"
4 bulk case

CCA619

(1) Refer to Chapter "Selection chart for NP0".
(2) AgPd for case sizes 1812 and 2220 only.
(3) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

1999 Feb 10

145

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V and 25 V compact series

SELECTION CHART FOR X7R 16 V AND 25 V

C (nF)	LAST TWO DIGITS OF 12NC	16 V	25 V				
		1206	0805	1206	1210	1812	2220
12	37						
15	38						
18	39						
22	41						
27	42						
33	43						
39	44						
47	45		0.6 ±0.1				
56	46						
68	47		0.85 ±0.1				
82	48						
100	49		1.25 ±0.1	0.6 ±0.1			
120	51						
150	52						
180	53						
220	54			0.85 ±0.1	0.6 ±0.1		
270	55						
330	56			0.9 to 1.3			
390	57			1.2 to 1.75	0.85 ±0.1		
470	58						
560	59	0.85 ±0.1			0.9 to 1.3		
680	61						
820	62				1.2 to 1.75		
1000	63	0.9 to 1.3			1.6 to 2.2	0.9 to 1.3	
1200	64						
1500	65					1.2 to 1.75	
1800	66						
2200	67						0.9 to 1.3
2700	68						1.2 to 1.75
3300	69						
3900	71						1.6 to 2.2
4700	72						

Values in shaded cells indicate thickness classification.

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.5 ±0.05	10000	—	50000	—	—	—	15000	—	—
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.9 to 1.3	—	3000	—	8000	1500	1500	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V and 25 V compact series

ORDERING INFORMATION FOR X7R 16 V AND 25 V

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 12062R104K8BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0402	2R = X7R	104 = 100 000 pF; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	7 = 16 V 8 = 25 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact
0805								
1206								
1210								
1812								
2220 (AgPd only)								

Ordering code 12NC

2 2 X X X X X X 6 X X X

Carrier type

- 22 blister
- 38 paper
- 54 bulk

Rated voltage - Termination

- 55 10 V; Ni-barrier
- 95 16 V; Ni-barrier
- 96 16 V; AgPd (1812 only)
- 87 25 V; Ni-barrier
- 88 25 V; AgPd (2220 only)

Size

- 7 0402
- 0 0805
- 1 1206
- 2 1210
- 4 1812
- 5 2220

Capacitance value⁽¹⁾

Tolerance

- 5 $\pm 5\%$
- 6 $\pm 10\%$
- 7 $\pm 20\%$

Packaging⁽²⁾

- 1 reel: $\varnothing$ 180 mm; 7"
- 8 reel: $\varnothing$ 330 mm; 13"
- 4 bulk case

CCA618

(1) Refer to Chapter "Selection chart for X7R 16 V and 25 V".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic multilayer capacitors

Class 2, X7R 50 V and 63 V compact series

SELECTION CHART FOR X7R 50 V AND 63 V

C (nF)	LAST TWO DIGITS OF 12NC	50 V AND 63 V						
		0805	1206	1210	1812	2220		
22	41	0.85 ±0.1						
27	42							
33	43							
39	44							
47	45							
56	46							
68	47	1.25 ±0.1						
82	48							
100	49	0.6 ±0.1	0.85 ±0.1					
120	51	0.85 ±0.1						
150	52							
180	53	0.9 to 1.3						
220	54	1.2 to 1.75						
270	55							
330	56		0.9 to 1.3	0.6 ±0.1				
390	57		1.2 to 1.75	0.85 ±0.1				
470	58							
560	59			0.9 to 1.3				
680	61			1.2 to 1.75				
820	62							
1000	63							
1200	64							
1500	65			1.6 to 2.2				
1800	66							
2200	67							

Values in shaded cells indicates thickness classification.

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL				12 mm TAPE WIDTH AMOUNT PER REEL		AMOUNT PER BULK CASE		
	Ø180 mm; 7"		Ø330 mm; 13"		Ø180 mm; 7" BLISTER				
	PAPER	BLISTER	PAPER	BLISTER	1812	2220	0402	0603	0805
0.6 ±0.1	4000	4000	10000	10000	2000	—	—	—	10000
0.85 ±0.1	4000	4000	10000	10000	—	—	—	—	8000
0.9 to 1.3	—	3000	—	8000	1500	1500	—	—	—
1.25 ±0.1	—	3000	—	8000	—	—	—	—	5000
1.2 to 1.75	—	2500	—	7000	1000	1000	—	—	—
1.6 to 2.2	—	—	—	—	1000	1000	—	—	—

Surface mount ceramic
multilayer capacitors

Class 2, X7R 50 V and 63 V
compact series

ORDERING INFORMATION FOR X7R 50 V AND 63 V

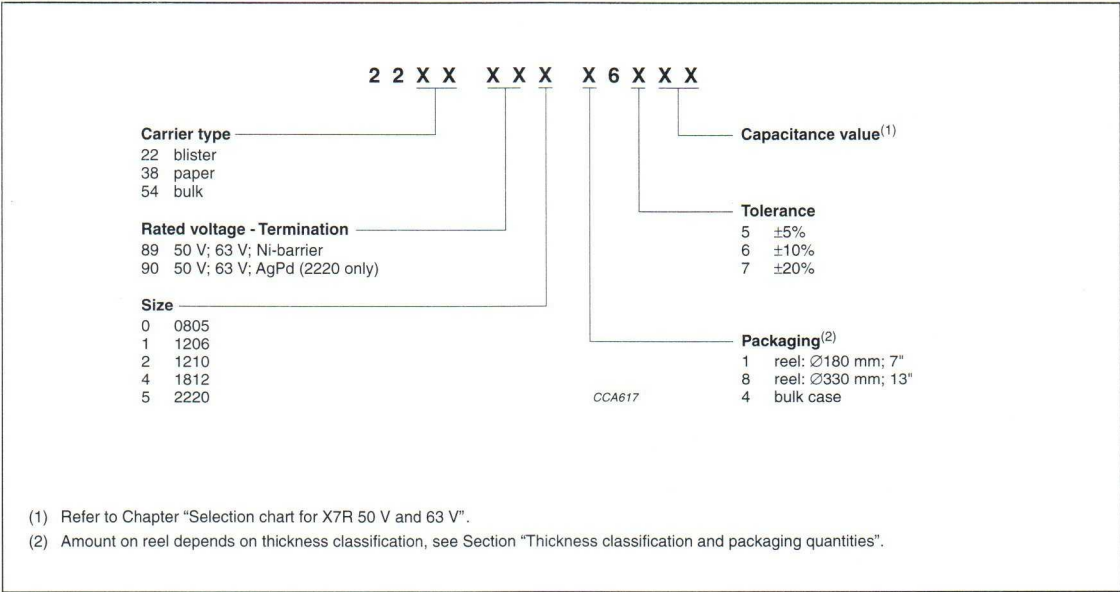
Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 18122R105K9BB0C

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0805 1206 1210 1812 2220 (AgPd only)	2R = X7R	105 = 1000000 pF; the third digit signifies the number of zeros	J $\pm 5\%$ K $\pm 10\%$ M $\pm 20\%$	9 = 50 V/63 V	B = Ni-barrier A = AgPd (2220 only)	2 = 180 mm; 7" paper 3 = 330 mm; 13" paper B = 180 mm; 7" blister F = 330 mm; 13" blister P = bulk case	0 = no marking 2 = 2-character marking in North America only	C = compact

Ordering code 12NC



Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS

Class 1 capacitors; NP0 dielectric; NiSn and AgPd terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

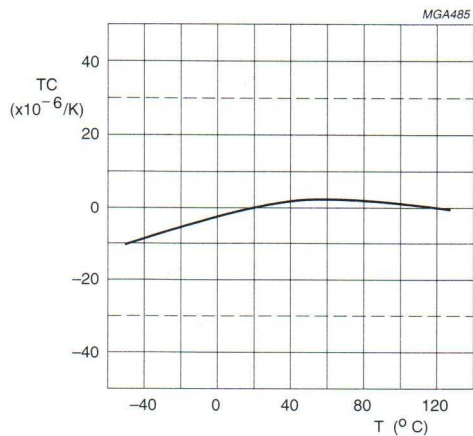
DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	220 pF to 100000 pF
Tolerance on capacitance after 1000 hours	$\pm 10\%$, $\pm 5\%$ and $\pm 2\%$; note 2
Tan δ ; note 1	$\leq 10 \times 10^{-4}$
Insulation resistance after 1 minute at U_R (DC)	$> 1000000 \text{ M}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$

Notes

1. Measured at 1 V, 1 MHz for $C \leq 1000 \text{ pF}$ and at 1 V, 1 kHz for $C > 1000 \text{ pF}$, using a four-gauge method.
2. Capacitors with a tolerance of $\pm 1\%$ are available on request.

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series



Typical values (solid line).
Requirement levels (broken lines).

Fig.3 Typical temperature coefficient as a function of temperature for NP0 dielectric.

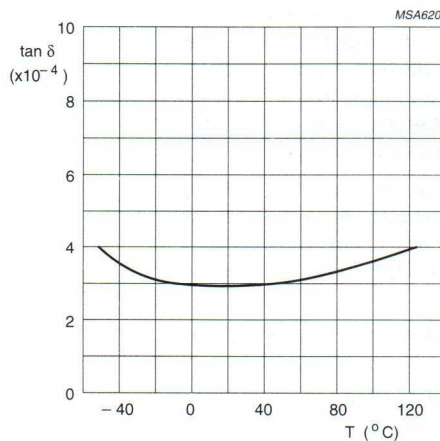


Fig.4 Typical $\tan \delta$ as a function of temperature for NP0 dielectric.

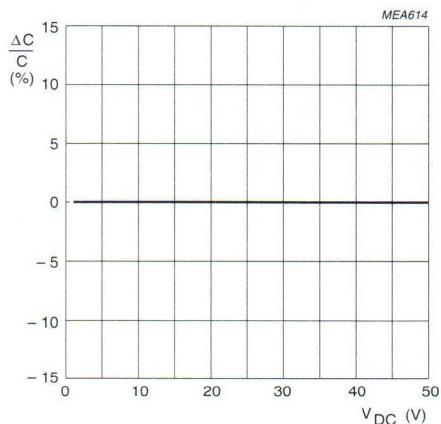


Fig.5 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for NP0 dielectric.

Surface mount ceramic multilayer capacitors

Class 1, NP0 25 V, 50 V and 63 V compact series

HIGH FREQUENCY BEHAVIOUR OF CERAMIC MULTILAYER CAPACITORS

Ceramic multilayer capacitors (CMC) from the high voltage series are suitable for use at high frequencies. At frequencies below the series resonance frequency, the CMC can be represented by an equivalent circuit as shown in Fig.6.

In general, the quantities C, ESR and L are frequency dependent. For most applications, C and L can be regarded as frequency independent below 1 GHz.

The equivalent series self-inductance L is:

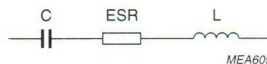
- Independent of the dielectric material.
- Dependent on the size of the capacitor, it increases with increasing length and decreases with increasing width or thickness of the product.
- The value of L is approximately:
 - 0.6 nH for case size 603
 - 1 nH for case sizes 0805, 1206 and 1210
 - 1.5 nH for case sizes 1812 and 2220.

Because of the inductance L, associated with the CMC, there will be a frequency at which the inductive reactance will be equal to the reactance of the capacitor.

This is known as the series resonance frequency (SRF) and is given by:

$$\text{SRF} = \frac{1}{2\pi\sqrt{LC}}$$

At the SRF, the CMC will appear as a small resistor. The transmission loss through the CMC at this series resonance frequency will be low.



C = capacitance.

ESR = equivalent series resistance which is determined by the energy dissipation mechanisms (in the dielectric material as well as in the electrodes).

L = equivalent series self-inductance.

Fig.6 Equivalent series representation of a CMC.

Using the values of C, L (= 1 nH) and the ESR at a specific frequency (f), two often used quantities can be derived.

The impedance (Z) is given by: $Z = \frac{1 - (2\pi f)^2 LC}{2j\pi f C} + \text{ESR}$

The quality factor (Q) is given by: $Q = \frac{|1 - (2\pi f)^2 LC|}{2\pi f \text{ESR} C}$

Table 2 shows maximum Equivalent Series Resistance (ESR) for case sizes 0805 and 1206 at frequencies of 50 MHz and 100 MHz. The measurements were taken using equipment type HP4191A.

Table 2 Maximum ESR for NP0

CASE SIZE	CAPACITANCE (pF)	ESR at 50 MHz (mΩ)	ESR at 100 MHz (mΩ)
0805	470 < C ≤ 2200	80	150
1206	2200 < C ≤ 8200	80	150

Surface mount ceramic multilayer capacitors

Class 2, X7R 16 V, 25 V, 50 V and 63 V compact series

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn and AgPd terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	12 nF to 4.7 μ F
Tolerance on capacitance after 1000 hours	$\pm 20\%$, $\pm 10\%$ and $\pm 5\%$
Tan δ ; note 1	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC): C $\leq$ 10 nF C $>$ 10 nF	$R_{ins} > 100000 \text{ M}\Omega$ $R_{ins} \times C > 1000 \text{ seconds}$
Maximum capacitance change as a function of temperature (for typical values see Fig.9)	$\pm 15\%$

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

Surface mount ceramic
multilayer capacitors

Class 2, X7R 16 V, 25 V, 50 V and 63 V
compact series

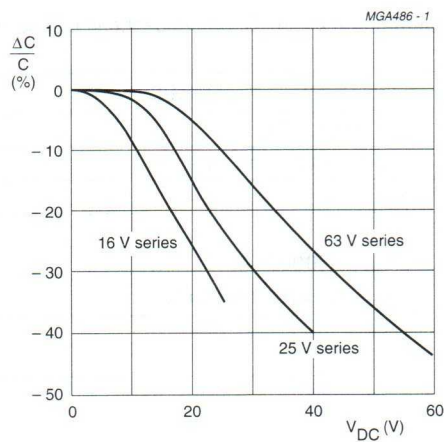


Fig.7 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage for X7R dielectric.

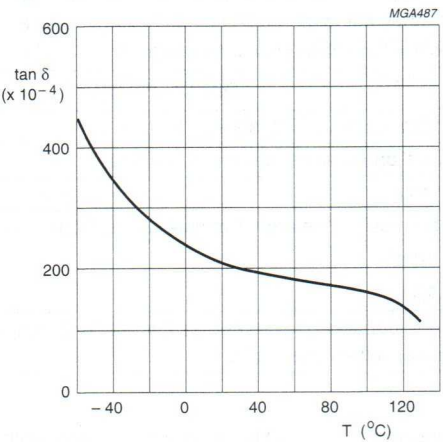
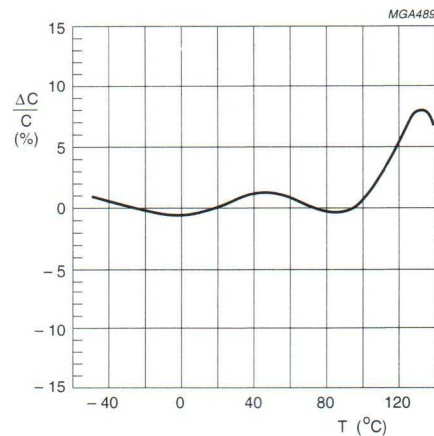
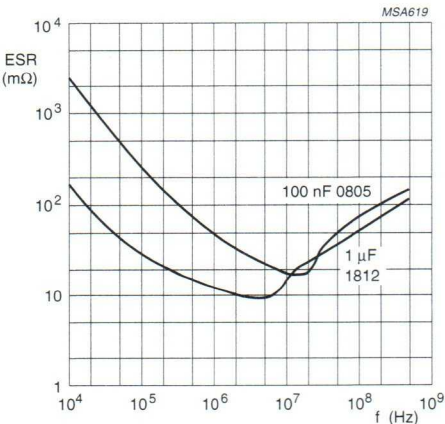


Fig.8 Typical $\tan \delta$ as a function of temperature for X7R dielectric.



$U_{DC} = 0$ V.

Fig.9 Typical capacitance change as a function of temperature for X7R dielectric.



Measuring equipment HP4191A and HP4194A.

Fig.10 Typical equivalent series resistance (ESR) as a function of frequency for X7R dielectric.

Surface mount ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V Noble Metal Electrode

FEATURES

- 4 × 0603 capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

Each capacitor element consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	50 V and 63 V (IEC)
Capacitance range (E12 series)	22 pF to 1 nF
Tolerance on capacitance	±5%, ±10%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

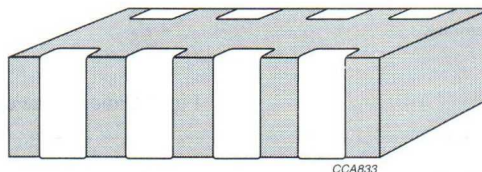
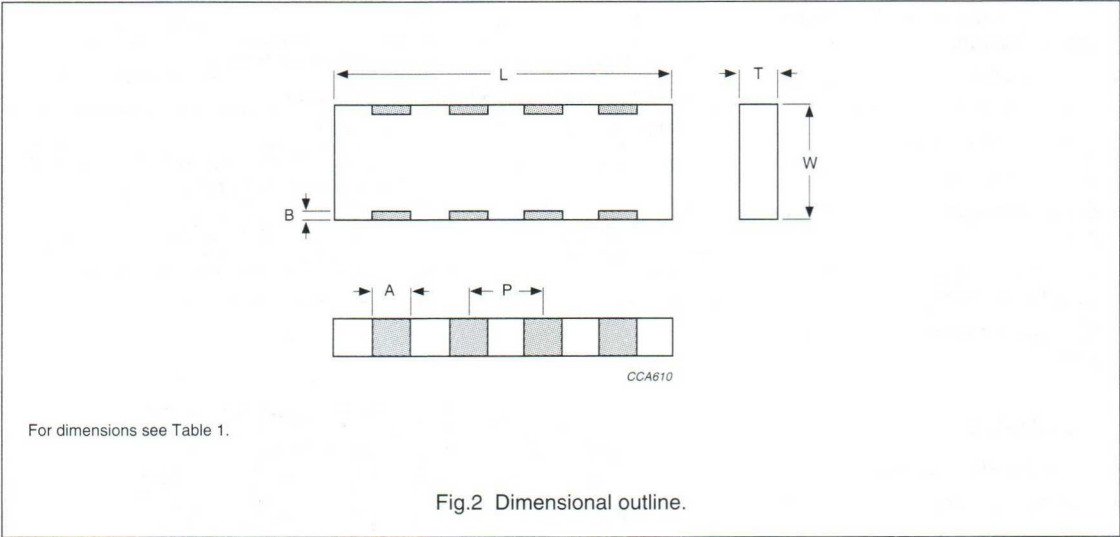


Fig.1 Simplified outline.

Surface mount ceramic
multilayer capacitors

C-Array: Class 1, NP0 50/63 V
Noble Metal Electrode

MECHANICAL DATA



Physical dimensions

Table 1 Capacitor dimensions for product size 0612 (4 × 0603)

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.80	1.20	0.45 ±0.15	0.30 ±0.15	0.80 ±0.15
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.031	0.047	0.018 ±0.006	0.012 ±0.006	0.031 ±0.004

Surface mount ceramic
multilayer capacitors

C-Array: Class 1, NP0 50/63 V
Noble Metal Electrode

SELECTION CHART FOR NP0

C (pF)	LAST TWO DIGITS OF 12NC	50/63 V
		0612 (4 × 0603)
22	27	0.8 ±0.1
27	28	
33	29	
39	31	
47	32	
56	33	
68	34	
82	35	
100	36	
120	37	
150	38	
180	39	
220	41	
270	42	
330	43	

C (pF)	LAST TWO DIGITS OF 12NC	50/63 V
		0612 (4 × 0603)
390	44	0.8 ±0.1
470	45	
560	46	
680	47	
820	48	
1 000	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL	
	Ø180 mm; 7"	
	PAPER	BLISTER
0.8 ±0.1	4000	4000

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 0612CG102J9B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	CG = NP0	102 = 1 000 pF; the third digit signifies the number of zeros	J ±5% K ±10%	9 = 50 /63 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X

Carrier type

50 blister

55 paper

Termination

14 NiSn

Size

6 0612 (4 × 0603)

X 1 X X X

Capacitance value⁽¹⁾

Tolerance

5 ±5%

6 ±10%

Packaging⁽²⁾

1 reel: Ø180 mm; 7" reel

CCA682

(1) Refer to Chapter "Selection chart for NP0".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

**Surface mount ceramic
multilayer capacitors**

**C-Array: Class 1, NP0 50/63 V
Noble Metal Electrode**

ELECTRICAL CHARACTERISTICS FOR CLASS 1, CAPACITORS**Class 1 capacitors; NP0 dielectric; NiSn terminations**

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E12 series); note 1	22 pF to 1 nF
Tolerance on capacitance after 1000 hours	$\pm 5\%$, $\pm 10\%$
Tan δ ; note 1	$\leq 0.1\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Insulation resistance after 1 minute at U_R (DC)	$> 100000 \text{ M}\Omega$
Temperature coefficient	$(0 \pm 30) \times 10^{-6}/\text{K}$

Note

1. Measured at 1 V, 1 MHz for $C \leq 1000 \text{ pF}$ and at 1 V, 1 kHz for $C > 1000 \text{ pF}$, using a four-gauge method.

Surface mount ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V Noble Metal Electrode

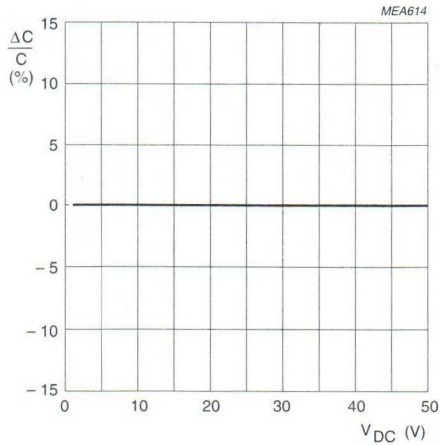


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

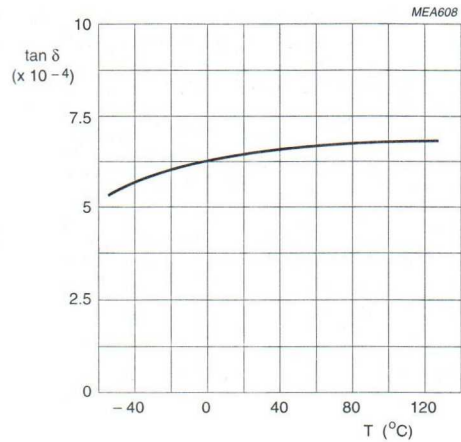


Fig.4 Typical $\tan \delta$ as a function of temperature.

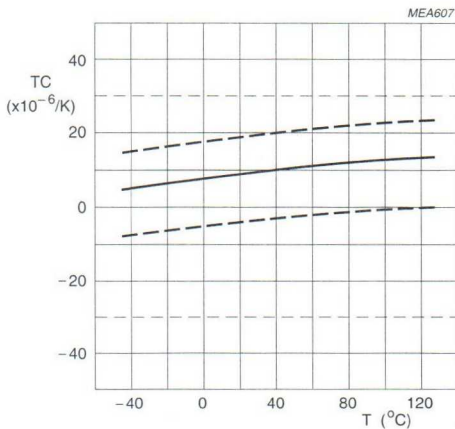
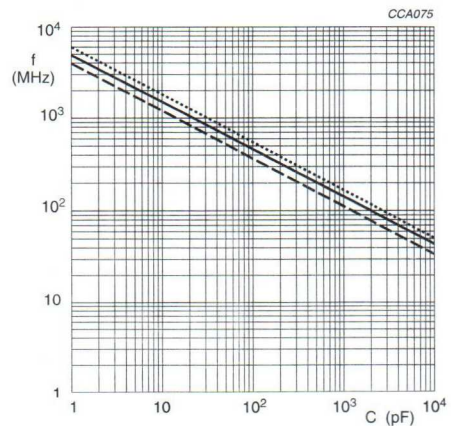


Fig.5 Typical temperature coefficient as a function of temperature.



$L = 0.6 \text{ nH}$ (dotted line).
 $L = 1 \text{ nH}$ (solid line).
 $L = 1.5 \text{ nH}$ (broken line).

Fig.6 Series resonance frequency as a function of capacitance.

Surface mount ceramic multilayer capacitors

C-Array: Class 1, NP0 50/63 V Noble Metal Electrode

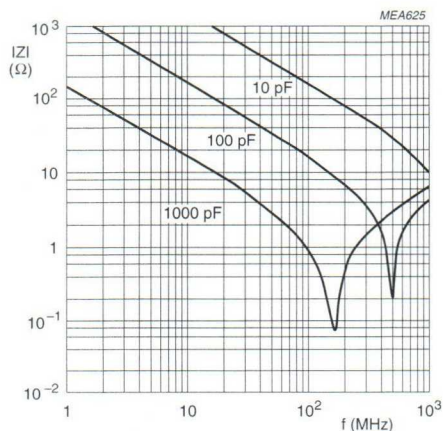
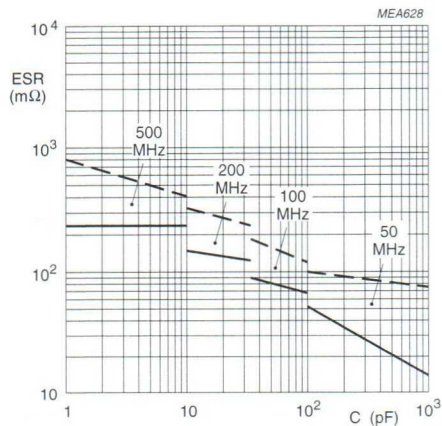
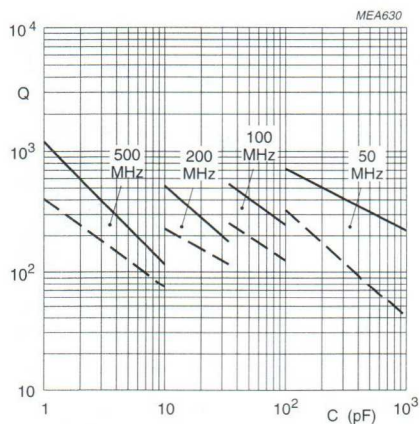


Fig.7 Typical impedance ($|Z|$) as
a function of frequency.



Typical values (solid lines).
Maximum values (broken lines).
Measuring equipment HP4191A.

Fig.8 Equivalent series resistance (ESR) as
a function of capacitance.



Typical values (solid lines).
Minimum values (broken lines).
Measuring equipment HP4191A.

Fig.9 Quality factor (Q) as a function
of the capacitance.

**Surface mount ceramic
multilayer capacitors**

**C-Array: Class 2, X7R 16 V, 25 V and 50 V
Noble Metal Electrode**

FEATURES

- 0612 (4 × 0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

Each capacitor element consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, silver dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V; 25 V; 50 V (IEC)
Capacitance (E12 series):	
16 V	10 nF to 100 nF
25 V	10 nF to 47 nF
50 V	220 pF to 10 nF
Tolerance on capacitance	±5%; ±10%; ±20%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/56

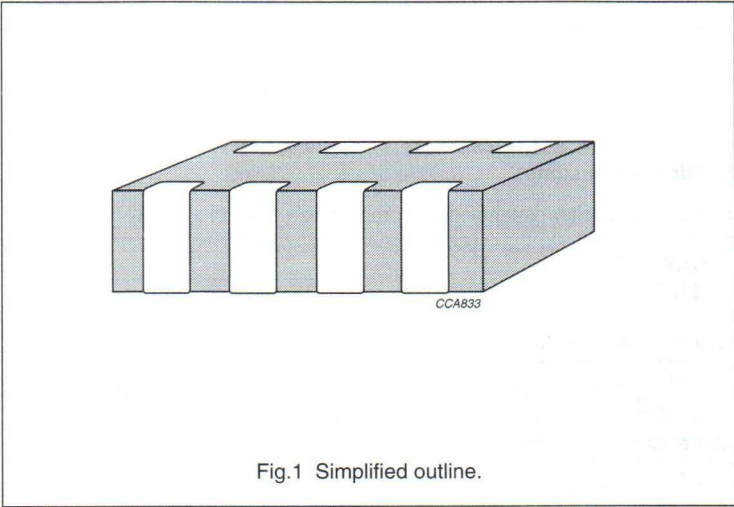
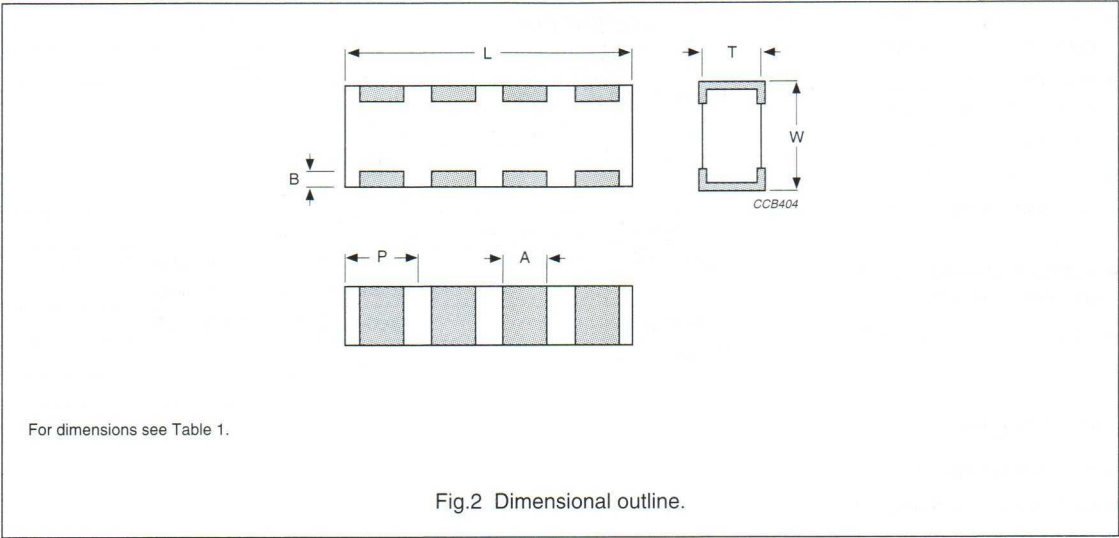


Fig.1 Simplified outline.

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V
Noble Metal Electrode

MECHANICAL DATA



Physical dimensions

Table 1 Capacitor dimensions for product size 0612 (4 × 0603)

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V
Noble Metal Electrode

DIMENSIONS OF SOLDER LANDS

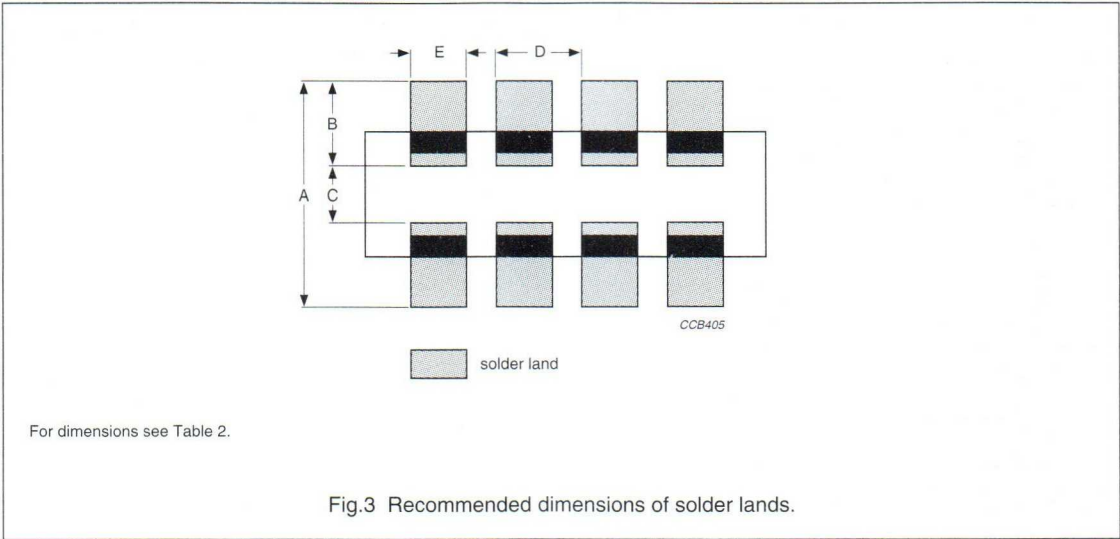


Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V Noble Metal Electrode

SELECTION CHART

C (pF)	LAST TWO DIGITS OF 12NC	16 V	25 V	50 V
		0612 (4 × 0603)		
220	14			0.8 ±0.1
270	15			
330	16			
390	17			
470	18			
560	19			
680	21			
820	22			
1000	23			
1200	24			
1500	25			
1800	26			
2200	27			
2700	28			
3300	29			
3900	31			
4700	32			
5600	33			
6800	34			
8200	35			
10000	36			
12000	37			
15000	38			
18000	39			
22000	41			
27000	42			
33000	43			
39000	44			
47000	45			
56000	46			
68000	47			
82000	48			
100000	49			
		Values in shaded cells indicate thickness classification.		

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	Ø180 mm; 7"		Ø330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.8 ±0.1	4000	4000	10000	10000

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V
Noble Metal Electrode

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122R104K7B200

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2R = X7R	104 = 100000 pF; the third digit signifies the number of zeros	J = ±5% K = ±10% M = ±20%	7 = 16 V 8 = 25 V 9 = 50 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	0 = conv. ceramic

Ordering code 12NC

2 2 X X X X X X 6 X X X

Carrier type

50 blister

55 paper

Rated voltage - Termination

10 16V; Ni-barrier

12 25V; Ni-barrier

14 50/63V; Ni-barrier

Size

6 0612 (4 × 0603)

Capacitance value⁽¹⁾

Tolerance

5 ±5%

6 ±10%

7 ±20%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

CCB549

(1) Refer to Chapter "Selection chart".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

1999 Feb 10

165

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V Noble Metal Electrode

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 20 ± 1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

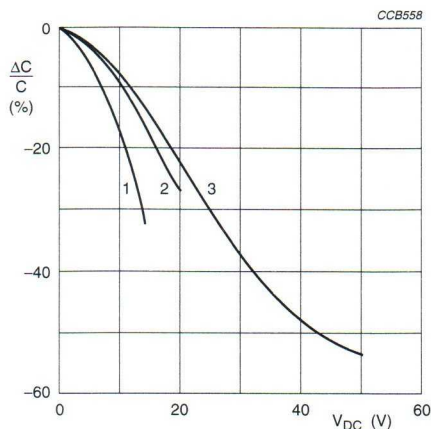
DESCRIPTION	VALUE
Capacitance (E12 series):	
16 V	10 nF to 100 nF
25 V	10 nF to 47 nF
50 V	220 pF to 10 nF
Tolerance on capacitance after 1000 hours	$\pm 5\%$; $\pm 10\%$; $\pm 20\%$
Test voltage (DC) for 1 minute	$2.5 \times U_R$
Tan δ ; note 1	
16 V	$\leq 3.5\%$
25 V and 50 V	$\leq 2.5\%$
Insulation resistance after 1 minute at U_R (DC):	
$C \leq 10$ nF	$R_{ins} \times C \geq 10^5$ M Ω
$C > 10$ nF	$R_{ins} \times C > 1000$ s
Ageing	typical 1% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

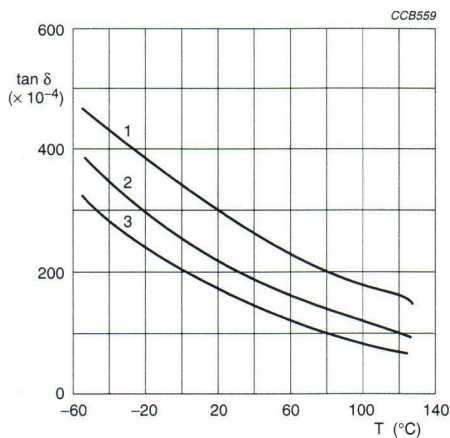
Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V, 25 V and 50 V Noble Metal Electrode



Curve 1 = 16 V product.
Curve 2 = 25 V product.
Curve 3 = 50 V product.

Fig.4 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.



Curve 1 = 16 V product.
Curve 2 = 25 V product.
Curve 3 = 50 V product.

Fig.5 Typical $\tan \delta$ as a function of temperature.

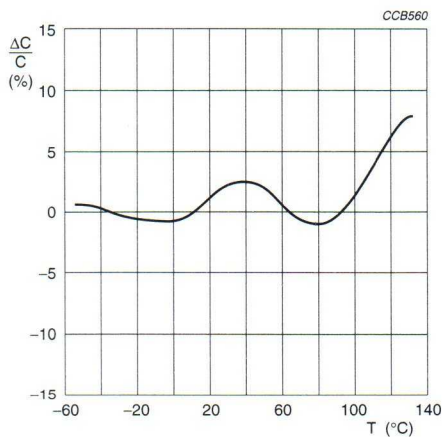


Fig.6 Typical capacitance change as a function of temperature.

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V

FEATURES

- 0612 (4 × 0603) capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

Each capacitor element consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, copper dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC)	16 V (IEC)
Capacitance (E6 series)	10 nF to 100 nF
Tolerance on capacitance	±10%
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	55/125/21

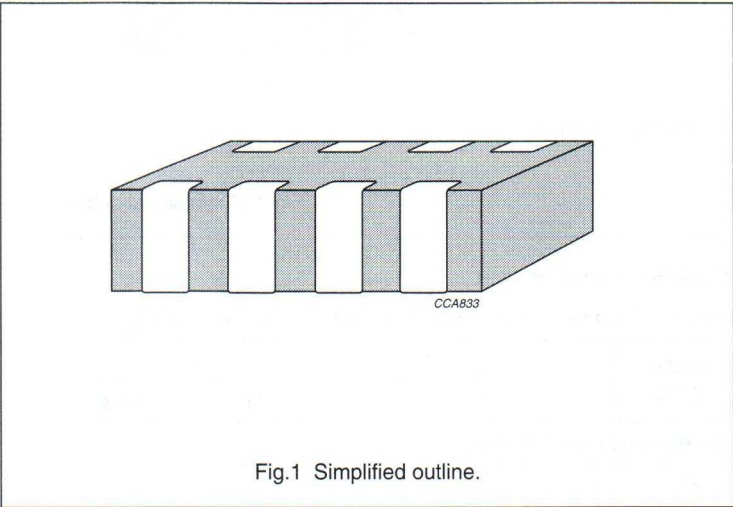
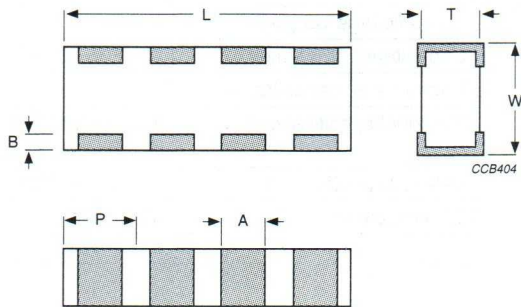


Fig.1 Simplified outline.

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V

MECHANICAL DATA



For dimensions see Table 1.

Fig.2 Dimensional outline.

Physical dimensions

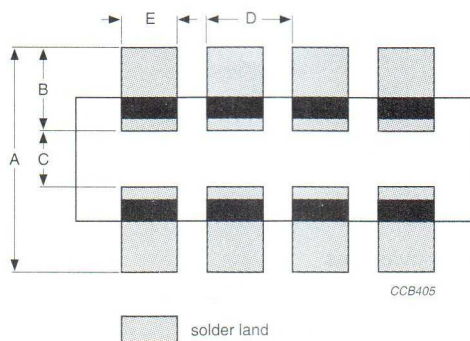
Table 1 Capacitor dimensions for product size 0612 (4 × 0603)

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V

DIMENSIONS OF SOLDER LANDS



For dimensions see Table 2.

Fig.3 Recommended dimensions of solder lands.

Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ± 0.15	0.89 ± 0.10	0.76 ± 0.10	0.80 ± 0.10	0.45 ± 0.10

Surface mount ceramic multilayer capacitors

C-Array: Class 2, X7R 16 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	16 V
		0612 (4 × 0603)
10	36	thickness classification 0.6 ±0.1
15	38	
22	41	
33	43	
39	44	
47	45	
68	47	
100	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	Ø180 mm; 7"		Ø330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.6 ±0.1	4000	4000	10000	10000

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122R104K7B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2R = X7R	104 = 1 00000 pF; the third digit signifies the number of zeros	K = ±10%	7 = 16 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	D = BME

Ordering code 12NC

2 2 X X X X X X X X

Carrier type

50 blister

55 paper

Rated voltage - Termination

10 16 V; Ni-barrier

Size

6 0612 (4 × 0603)

Capacitance value⁽¹⁾

Tolerance

6 ±10%

Packaging⁽²⁾

1 reel: Ø180 mm; 7"

CCB406

(1) Refer to Chapter "Selection chart".

(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, X7R 16 V

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; X7R dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of $20 \pm 1\text{ }^{\circ}\text{C}$, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 100 nF
Tolerance on capacitance after 1000 hours	$\pm 10\%$
Tan δ ; note 1	$\leq 3.5\%$
Insulation resistance after 1 minute at U_R (DC)	$R_{ins} \times C \geq 500\text{ s}$
Ageing	typical 3% per time decade
Resistance to soldering heat	260 $^{\circ}\text{C}$; 10 seconds

Note

1. Measured at 1 V, 1 kHz, using a four-gauge method.

Surface mount ceramic multilayer capacitors

C-Array: Class 2, Y5V 25 V

FEATURES

- 4 × 0603 capacitors (of the same capacitance value) per array
- Less than 50% board space of an equivalent discrete component
- High volumetric efficiency
- Dense dielectric layers
- Supplied in tape on reel or loose in bag
- Increased throughput, by time saved in mounting
- Cost savings on manufacturing time.

APPLICATIONS

- Professional electronics
- High density consumer electronics
- Automotive.

DESCRIPTION

Each capacitor element consists of a rectangular block of ceramic dielectric in which a number of interleaved precious metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two terminations, copper dipped with a barrier layer of plated nickel and finally covered with a layer of plated tin (Nickel-barrier). An outline of the structure is shown in Fig.1.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Rated voltage U_R (DC):	25 V (IEC)
Capacitance (E6 series)	10 nF to 100 nF
Tolerance on capacitance:	-20 to +80% (Z)
Sectional specifications	IEC 60384-10, second edition 1989-04; also based on CECC 32 100
Detailed specification	based on CECC 32 101-801
Climatic category (IEC 60068)	25/85/21

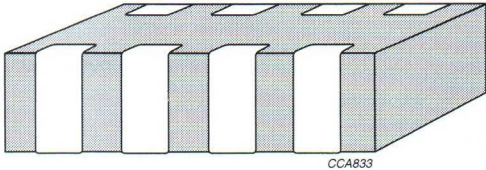
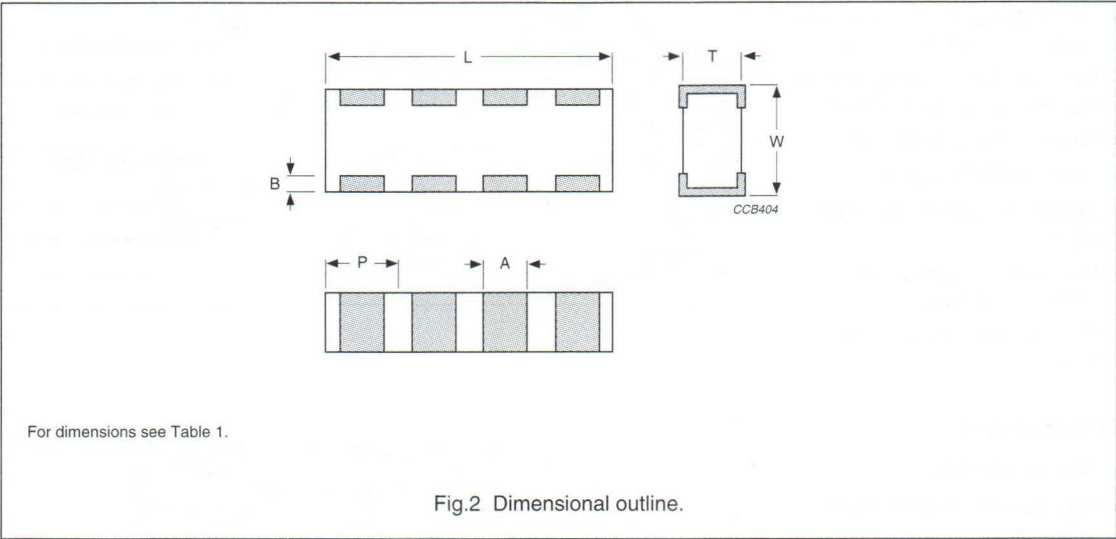


Fig.1 Simplified outline.

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, Y5V 25 V

MECHANICAL DATA



Physical dimensions

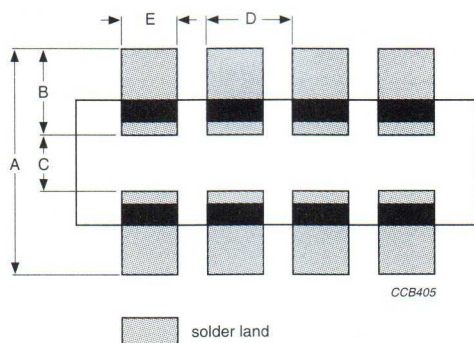
Table 1 Capacitor dimensions for product size 0612 (4 × 0603)

CASE SIZE	L	W	T		A	B	P
			MIN.	MAX.			
Dimensions in millimetres							
0612 (4 × 0603)	3.20 ±0.15	1.60 ±0.15	0.50	1.20	0.40 ±0.1	0.30 ±0.2	0.80 ±0.1
Dimensions in inches							
0612 (4 × 0603)	0.125 ±0.006	0.063 ±0.006	0.020	0.047	0.016 ±0.006	0.012 ±0.006	0.031 ±0.004

Surface mount ceramic multilayer capacitors

C-Array: Class 2, Y5V 25 V

DIMENSIONS OF SOLDER LANDS



For dimensions see Table 2.

Fig.3 Recommended dimensions of solder lands.

Table 2 Solder land dimensions; see Fig.3

CASE SIZE	FOOTPRINT DIMENSIONS (mm)				
	A	B	C	D	E
0612 (4 × 0603)	2.54 ±0.15	0.89 ±0.10	0.76 ±0.10	0.80 ±0.10	0.45 ±0.10

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, Y5V 25 V

SELECTION CHART

C (nF)	LAST TWO DIGITS OF 12NC	25 V
		0612 (4 × 0603)
10	36	thickness classification: 0.6 ±0.1
12	37	
15	38	
18	39	
22	41	
27	42	
33	43	
39	44	
47	45	
56	46	
68	47	
82	48	
100	49	

Thickness classification and packaging quantities

THICKNESS CLASSIFICATION (mm)	8 mm TAPE WIDTH AMOUNT PER REEL			
	Ø180 mm; 7"		Ø330 mm; 13"	
	PAPER	BLISTER	PAPER	BLISTER
0.6 ±0.1	4000	4000	10000	10000

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, Y5V 25 V

ORDERING INFORMATION

Components may be ordered by using either a simple 15-digit clear text code or Philips unique 12NC.

Clear text code

EXAMPLE: 06122F104K7B20D

SIZE CODE	TEMP. CHAR.	CAPACITANCE	TOL.	VOLTAGE	TERMINATION	PACKAGING	MARKING	SERIES
0612 (4 × 0603)	2F = Y5V	104 = 1 00000 pF; the third digit signifies the number of zeros	Z = -20/+80	8 = 25 V	B = Ni-barrier	2 = 180 mm; 7" paper B = 180 mm; 7" blister	0 = no marking	D = BME

Ordering code 12NC

2 2 X X X X X X X X X

Carrier type
50 blister
55 paper

Rated voltage - Termination
12 25 V; Ni-barrier

Size
6 0612 (4 × 0603)

Capacitance value⁽¹⁾

Tolerance
8 -20/+80%

Packaging⁽²⁾
1 reel: Ø180 mm; 7"

CCB407

(1) Refer to Chapter "Selection chart".
(2) Amount on reel depends on thickness classification, see Section "Thickness classification and packaging quantities".

Surface mount ceramic
multilayer capacitors

C-Array: Class 2, Y5V 25 V

ELECTRICAL CHARACTERISTICS FOR CLASS 2, CAPACITORS

Class 2 capacitors; Y5V dielectric; NiSn terminations

Unless otherwise stated all electrical values apply at an ambient temperature of 25 ±1 °C, an atmospheric pressure of 86 to 106 kPa, and a relative humidity of 63 to 67%.

DESCRIPTION	VALUE
Capacitance range (E6 series); note 1	10 nF to 100 nF
Tolerance on capacitance after 1000 hours	−20 to +80% (Z)
Tan δ; note 1	≤7%
Insulation resistance after 1 minute at U _R (DC)	R _{ins} × C ≥ 500 s
Ageing	typical 7% per time decade
Resistance to soldering heat	260 °C; 10 seconds

Note

1. Measured at 1 V, using a four-gauge method.

Surface mount ceramic multilayer capacitors

C-Array: Class 2, Y5V 25 V

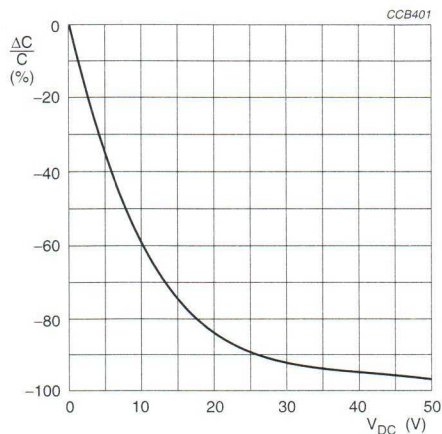


Fig.4 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage at 25 °C.

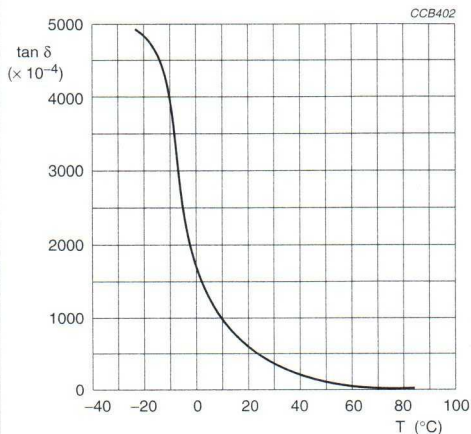


Fig.5 Typical $\tan \delta$ as a function of temperature.

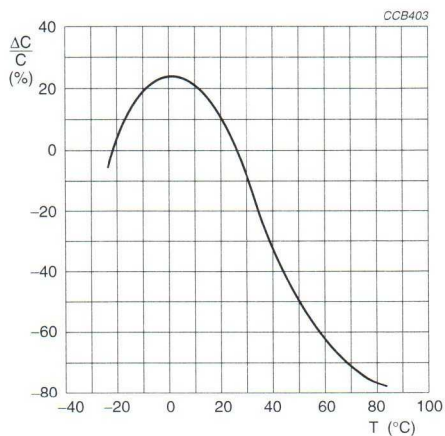


Fig.6 Typical capacitance change as a function of temperature.

RESISTOR INTRODUCTION

Chip resistors

Introduction

INTRODUCTION

Data in data sheets is presented - whenever possible - according to a 'format', in which the following chapters are stated:

- TITLE
- FEATURES
- APPLICATIONS
- DESCRIPTION
- QUICK REFERENCE DATA
- ORDERING INFORMATION
- FUNCTIONAL DESCRIPTION
 - Product characterization
 - Limiting values
- MECHANICAL DATA
 - Mass
 - Marking
 - Outlines
- TESTS AND REQUIREMENTS

The chapters listed above are explained in this section "General introduction Chip resistors", with detailed information in the relevant data sheet. Chapters "Mounting" and "Packaging" are detailed in separate sections.

DESCRIPTION

All types of chip resistors have a rectangular ceramic body. The resistive element is a metal glaze film. The chips have been trimmed to the required ohmic resistance by cutting one or more grooves in the resistive layer. This process is completely computer controlled and yields a high reliability. The terminations are attached using either a silver dipping method or by applying nickel terminations which are covered with lead/tin.

The resistive layer is coated with a coloured protective layer. This protective layer provides electrical, mechanical and/or environmental protection - also against soldering flux and cleaning solvents, in accordance with "MIL-STD-202E", method 215 and "IEC 60068-2-45".

ORDERING INFORMATION

Resistors are ordered by their **ordering code**, a 12-digit number. In general, the packaging method and resistance code are integral parts of this number.

Exceptions to this rule are customer/application specific resistors that are not included in our standard series, such as higher ohmic values and non-standard values.

FUNCTIONAL DESCRIPTION

The functional description includes: nominal resistance range and tolerance, limiting voltage, temperature coefficient, absolute maximum dissipation, climatic category and stability.

The **limiting voltage** (DC or RMS) is the maximum voltage that may be continuously applied to the resistor element, see "IEC publications 60115-8".

The temperature rise in a resistor due to power dissipation, is determined by the laws of heat - conduction, convection and radiation. The maximum body temperature usually occurs in the middle of the resistor and is called the **hot-spot** temperature.

In the normal operating temperature range of chip resistors the temperature rise at the hot-spot, ΔT , is proportional to the power dissipated: $\Delta T = A \times P$. The proportionally constant 'A' gives the temperature rise per Watt of dissipated power and can be interpreted as a thermal resistance in K/W. This thermal resistance is dependent on the heat conductivity of the materials used (including the PCB), the way of mounting and the dimensions of the resistor. The sum of the temperature rise and the ambient temperature is:

$$T_m = T_{amb} + \Delta T$$

where:

T_m = hot-spot temperature

T_{amb} = ambient temperature

ΔT = temperature rise at hot-spot.

The stability of a chip resistor during endurance tests is mainly determined by the hot-spot temperature and the resistive materials used.

Summarizing

DESCRIPTION	RELATIONSHIP
Dimensions, conductance of materials and mounting determine	heat resistance
Heat resistance $\times$ dissipation gives	temperature rise
Temperature rise + ambient temperature give	hot-spot temperature

Chip resistors

Introduction

Performance

When specifying the performance of a resistor, the dissipation is given as a function of the hot-spot temperature, with the ambient temperature as a parameter.

From $\Delta T = A \times P$ and $T_m = T_{amb} + \Delta T$ it follows that:

$$P = \frac{T_m - T_{amb}}{A}$$

If P is plotted against T_m for a constant value of A , parallel straight lines are obtained for different values of the ambient temperature. The slope of these lines,

$$\frac{dP}{dT_m} = \frac{1}{A}$$

is the reciprocal of the heat resistance and is the characteristic for the resistor and its environment.

The temperature coefficient

The temperature coefficient of resistance is a ratio which indicates the rate of increase (decrease) of resistance per Kelvin (K) increase (decrease) of temperature within a specified range, and is expressed in parts per million per K ($\times 10^{-6}/K$).

EXAMPLE

If the temperature coefficient of a resistor of $R_{nom} = 1 \text{ k}\Omega$ between -55°C and $+155^\circ\text{C}$ is $\pm 200 \times 10^{-6}/K$, its resistance will be:

at 25°C :

1000Ω (nominal = rated value)

at $+155^\circ\text{C}$:

$1000 \Omega \pm (130 \times 200 \times 10^{-6}) \times 1000 \Omega$
 $= 1026 \Omega$ or 974Ω

at -55°C :

$1000 \Omega \pm (80 \times 200 \times 10^{-6}) \times 1000 \Omega$
 $= 1016 \Omega$ or 984Ω

If the temperature coefficient is specified as $\leq 200 \times 10^{-6}/K$ the resistance will be within the shaded area as shown in Fig. 1.

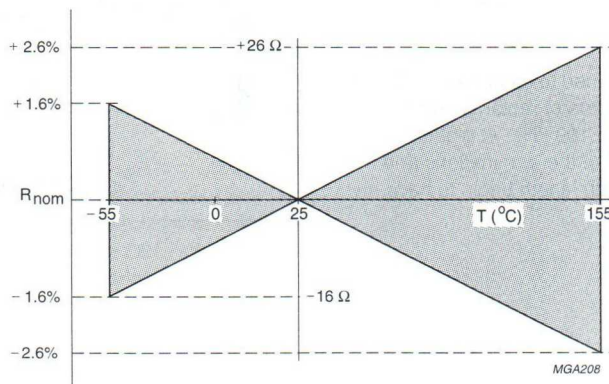


Fig.1 Temperature coefficient.

Chip resistors

Introduction

Noise

Most resistors generate noise due to the passage of current through the resistor. This noise is dependent on the amount of current, the resistive material and the physical construction of the resistor. The physical construction is partly influenced by the laser trimming process which cuts a groove in the resistive material. Typical current noise levels are shown in Fig.2.

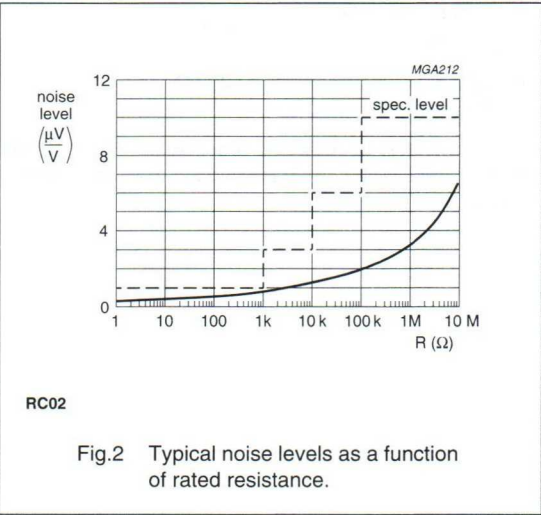


Fig.2 Typical noise levels as a function of rated resistance.

Frequency behaviour

Resistors in general are designed to function according to ohmic laws. This is basically true of rectangular chip resistors for frequencies up to 100 kHz. At higher frequencies, the capacitance of the terminations and the inductance of the resistive path length begin to have an effect.

Basically, chip resistors can be represented by an ideal resistor switched in series with a coil and both switched parallel to a capacitor. The values of the capacitance and inductance are mainly determined by the dimensions of the terminations and the conductive path length. The trimming pattern has a negligible influence on the inductance as the path length is not influenced. Also, its influence on the capacitance is negligible as the total capacitance is largely determined by the terminations.

The environment surrounding chips (e.g. landing paths, nearby tracks and the material of the printed-circuit board) has a large influence on the behaviour of the chip on the printed-circuit board.

Typical values of capacitance and inductance

QUANTITY	CHIP PROPERTIES			
	THIN FILM	THICK FILM		
	1206 R < 1 kΩ	1206	0805	0603
Capacitance	0.05 pF	0.05 pF	0.09 pF	0.05 pF
Inductance	2 nH	2 nH	1 nH	0.4 nH

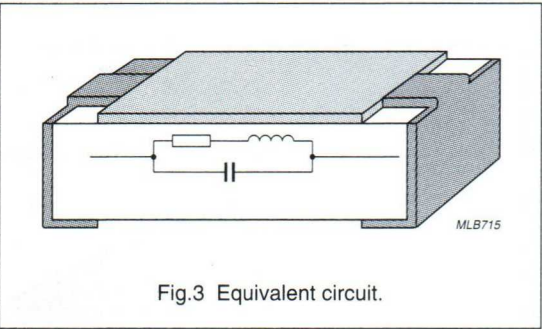
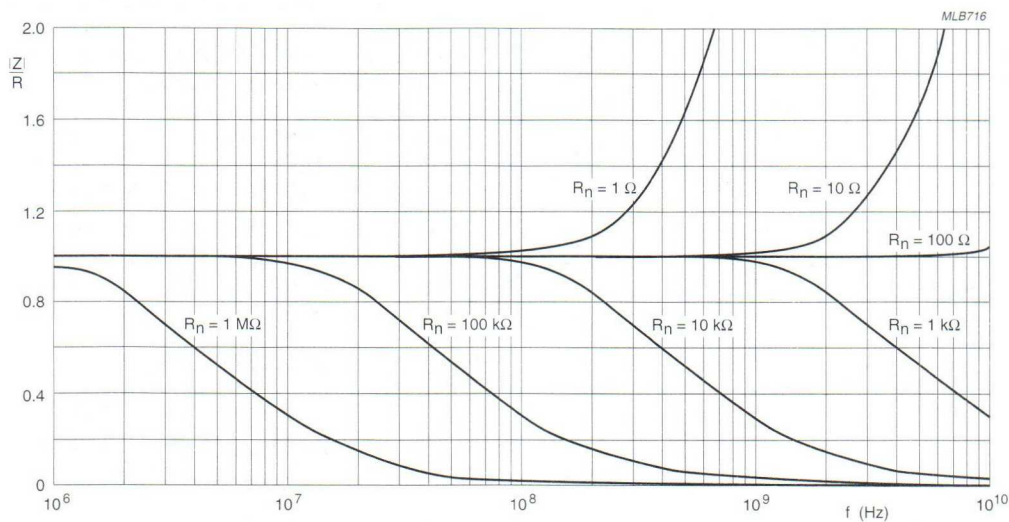


Fig.3 Equivalent circuit.

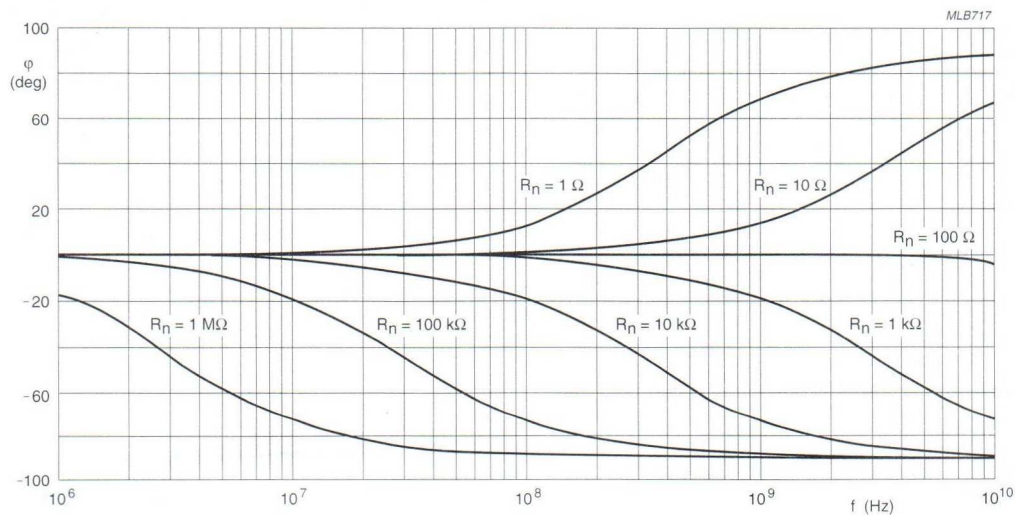
Chip resistors

Introduction



Size 0603

Fig.4 Impedance as a function of frequency for a chip resistor.

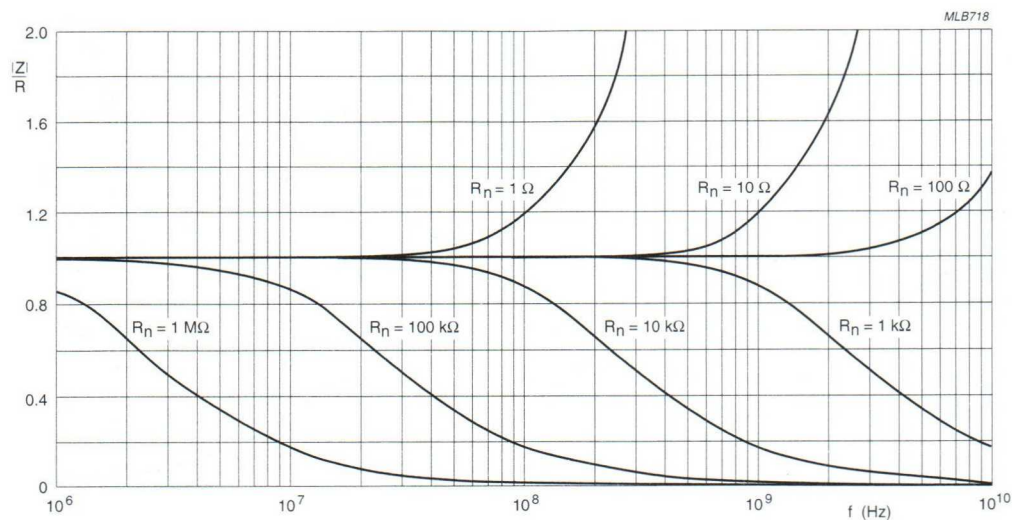


Size 0603

Fig.5 Phase shift as a function of frequency for a chip resistor.

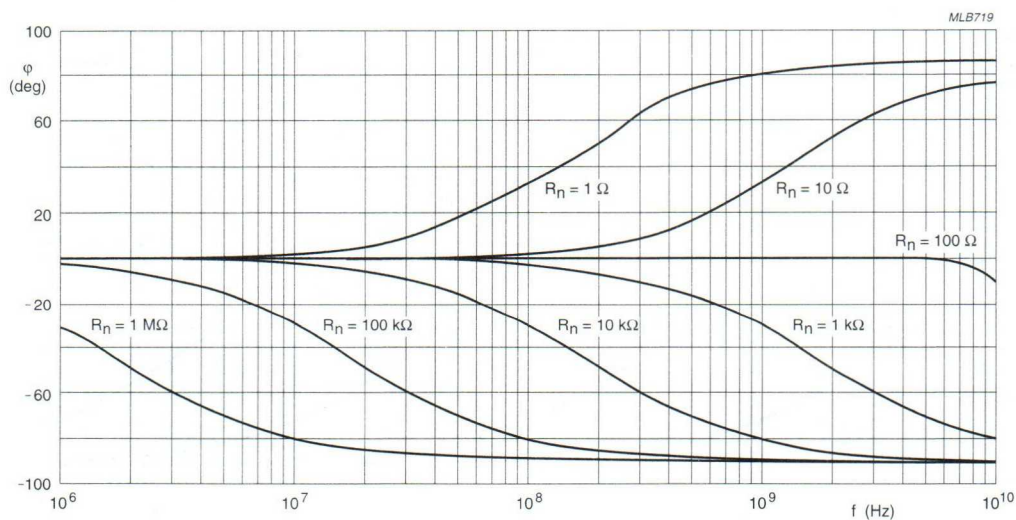
Chip resistors

Introduction



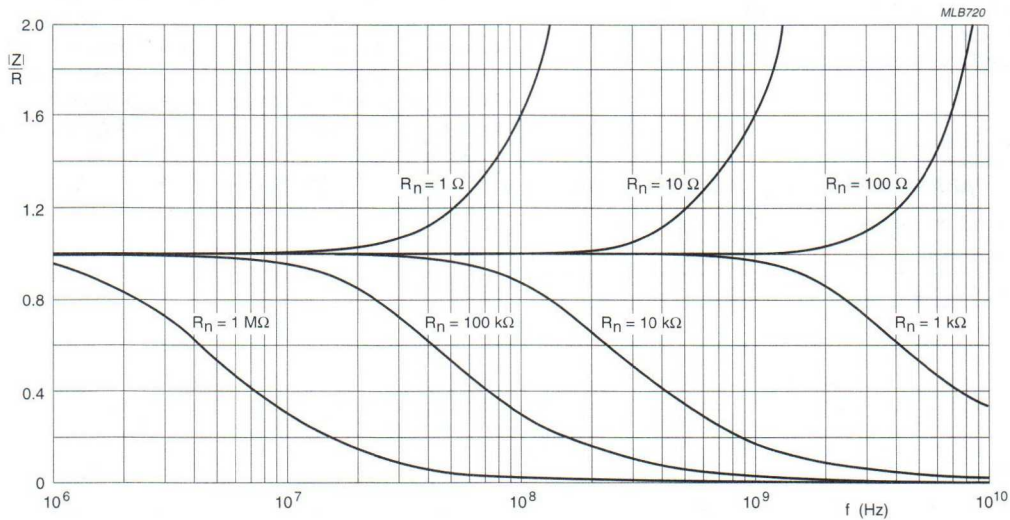
Size 0805

Fig.6 Impedance as a function of frequency for a chip resistor.



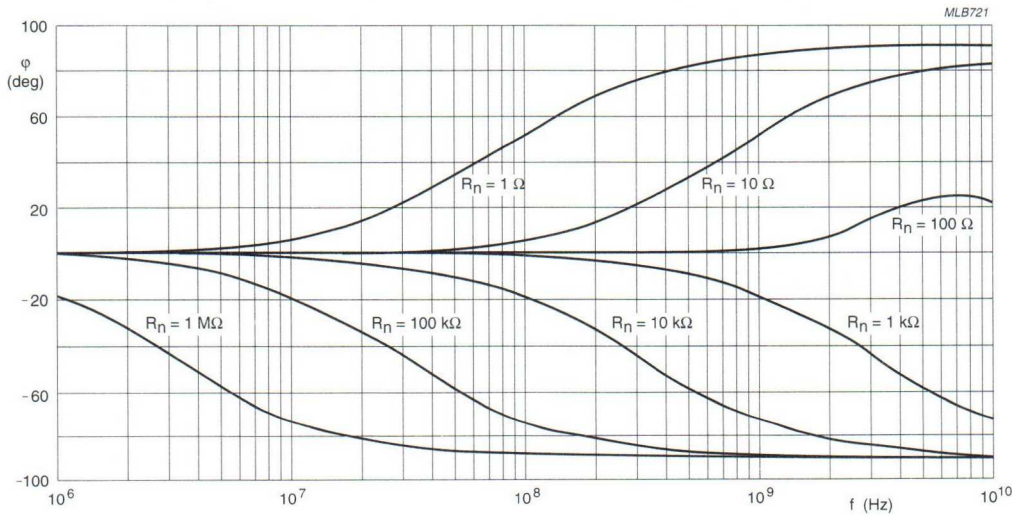
Size 0805

Fig.7 Phase shift as a function of frequency for a chip resistor.



Size 1206

Fig.8 Impedance as a function of frequency for a chip resistor.



Size 1206

Fig.9 Phase shift as a function of frequency for a chip resistor.

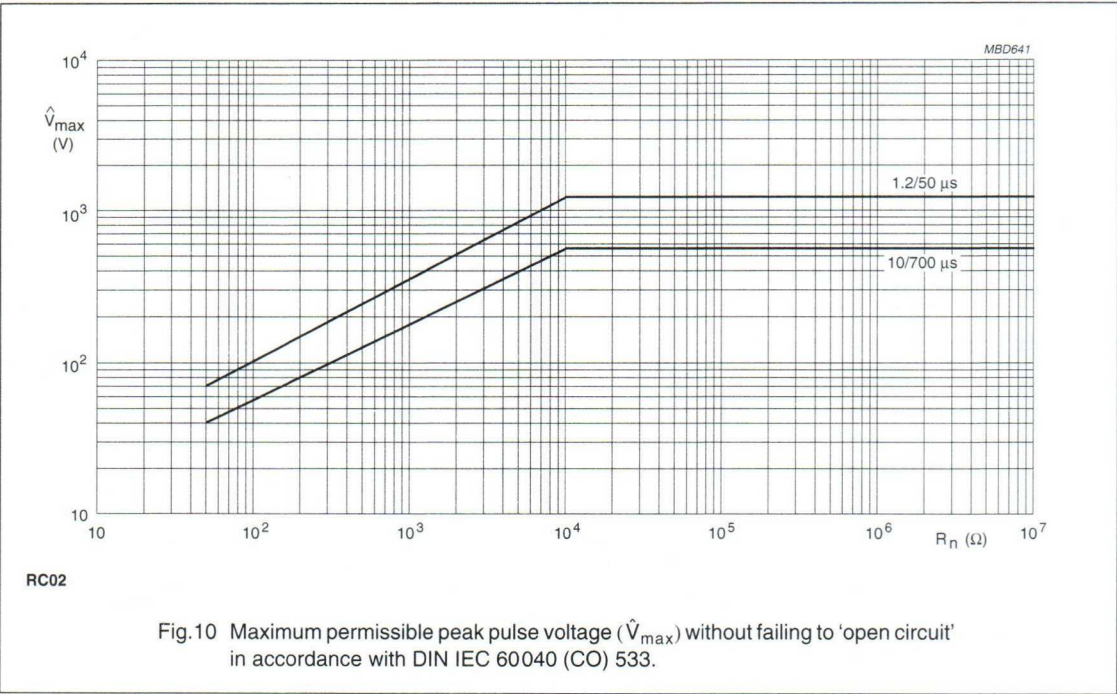
PULSE-LOAD BEHAVIOUR

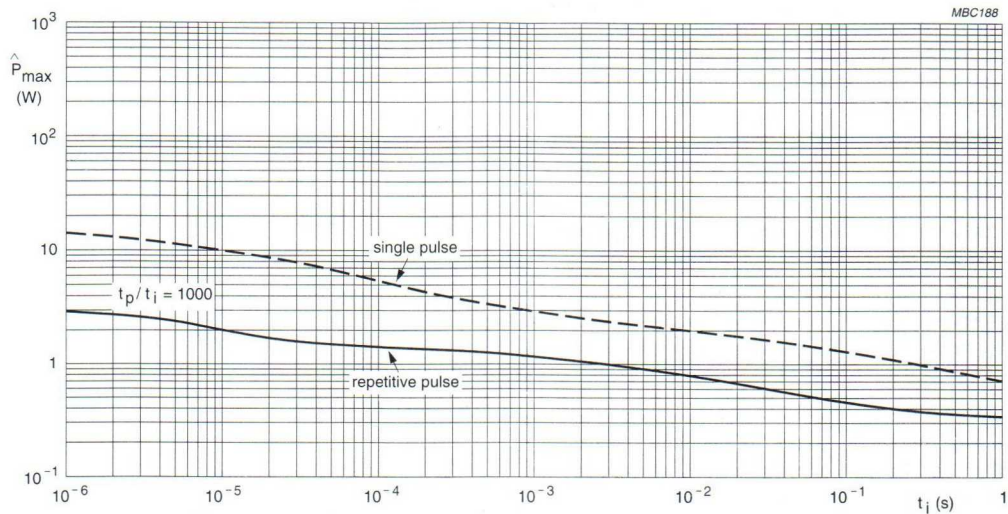
The load, due to a single pulse at which chip resistors fail by going open circuit, is determined by shape and time. A standard way to establish pulse load limits is shown in Table 1.

Table 1 Pulse load limits

PARAMETER	VALUE	UNIT
Exponential time constant	50 to 700	μs
Repetition time	12 to 25	s
Amount of pulses	5 to 10	

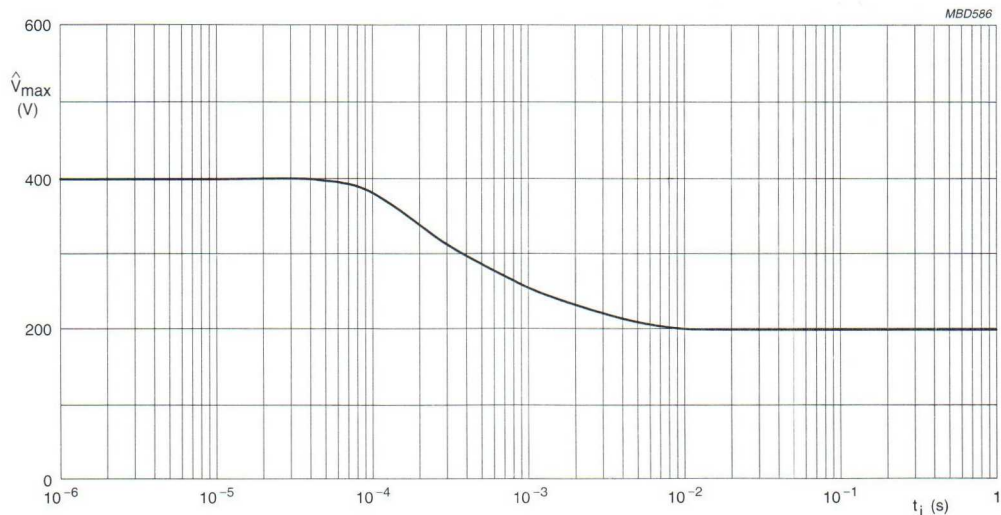
With this test, it can be determined at which applied voltage the resistive value changes about 0.5% of its nominal value under the above mentioned pulse conditions. Figure 10 shows test results for the RC02 chip resistors. If applied regularly the load is destructive, therefore the load must not be applied regularly during the load life of the resistors. However, the magnitude of a pulse at which failure occurs is of little practical value. The maximum 'single-pulse' load that may be applied in a regular way can be determined in a similar manner.





RC02G

Fig. 11 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.



RC02

Fig. 12 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Chip resistors

Introduction

Definitions of pulses

SINGLE PULSE

The resistor is considered to be operating under single pulse conditions if, during its life, it is loaded with a limited number (approximately 1500) of pulses over long time intervals (greater than one hour).

REPETITIVE PULSE

The resistor is operating under repetitive pulse conditions if it is loaded by a continuous train of pulses of similar power.

The dashed line in Fig.11 shows the observed maximum load for the RC02G chip resistors under single-pulse loading.

More usually, the resistor must withstand a continuous train of pulses of repetition time ' t_p ' during which only a small resistance change is acceptable. This resistance change ($\Delta R/R$) is equal to the change permissible under continuous load conditions. The continuous pulse train and small permissible resistance change reduces the maximum handling capability.

The continuous pulse train maximum handling capacity of chip resistors has been determined experimentally.

Measurements have shown that the handling capacity varies with the resistive value applied.

However, maximum peak pulse voltages as indicated in Fig.12, should not be exceeded.

Determination of pulse-load

The graphs in Figs 11 and 12 may be used to determine the maximum pulse-load for a resistor.

- For repetitive rectangular pulses:

- $\frac{\hat{V}_i^2}{R}$ must be lower than the value of $\hat{P}_{max}$ given by the solid lines of Fig.11 for the applicable value of t_i and duty cycle t_p/t_i .

- $\hat{V}_i$ must be lower than the value of $\hat{V}_{max}$ given in Fig.12 for the applicable value of t_i .

- For repetitive exponential pulses:

- As for rectangular pulses, except that $t_i = 0.5 \tau$.

- For single rectangular pulses:

- $\frac{\hat{V}_i^2}{R}$ must be lower than the $\hat{P}_{max}$ given by the dashed line of Fig.11 for the applicable value of t_i .

- $\hat{V}_i$ must be lower than the value of $\hat{V}_{max}$ given in Fig.12 for the applicable value of t_i .

Chip resistors

Definition of symbols (see Figs 11, 12, 13 and 14)

SYMBOL	DESCRIPTION
$\hat{P}$	applied peak pulse power
$\hat{P}_{\max}$	maximum permissible peak pulse power (Fig.11)
$\hat{V}_i$	applied peak pulse voltage (Figs 13 and 14)
$\hat{V}_{\max}$	maximum permissible peak pulse voltage (Fig.12)
R_{nom}	nominal resistance value
t_i	pulse duration (rectangular pulses)
t_p	pulse repetition time
τ	time constant (exponential pulses)
T_{amb}	ambient temperature
$T_{m(\max)}$	maximum hot-spot temperature of the resistor

Examples

Determine the stability of a typical resistor for operation under the following pulse-load conditions.

CONTINUOUS PULSE TRAIN

A 100 Ω resistor is required to operate under the following conditions: $V_i = 10$ V; $t_i = 10^{-5}$ s; $t_p = 10^{-2}$ s.

Therefore:

$$\hat{P} = \frac{10^2}{100} = 1 \text{ W and } \frac{t_p}{t_i} = \frac{10^{-2}}{10^{-5}} = 1000$$

For $t_i = 10^{-5}$ s and $\frac{t_p}{t_i} = 1000$, Fig.11 gives $\hat{P}_{\max} = 2$ W and Fig.12 gives $\hat{V}_{\max} = 400$ V. As the operating conditions $\hat{P} = 1$ W and $\hat{V}_i = 10$ V are lower than these limiting values, this resistor may be safely used.

SINGLE PULSE

A 10 k Ω resistor is required to operate under the following conditions: $\hat{V}_i = 250$ V; $t_i = 10^{-5}$ s.

Therefore:

$$\hat{P}_{\max} = \frac{250^2}{10000} = 6.25 \text{ W}$$

The dashed curve of Fig.11 shows that at $t_i = 10^{-5}$ s, the permissible $\hat{P}_{\max} = 10$ W and Fig.12 shows a permissible $\hat{V}_{\max}$ of 400 V, so this resistor may be used.

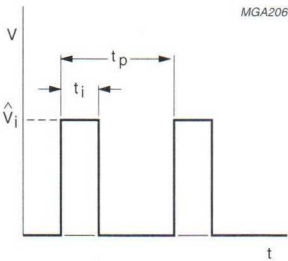


Fig.13 Rectangular pulses.

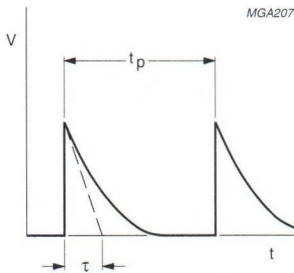


Fig.14 Exponential pulses.

MECHANICAL DATA

Outlines

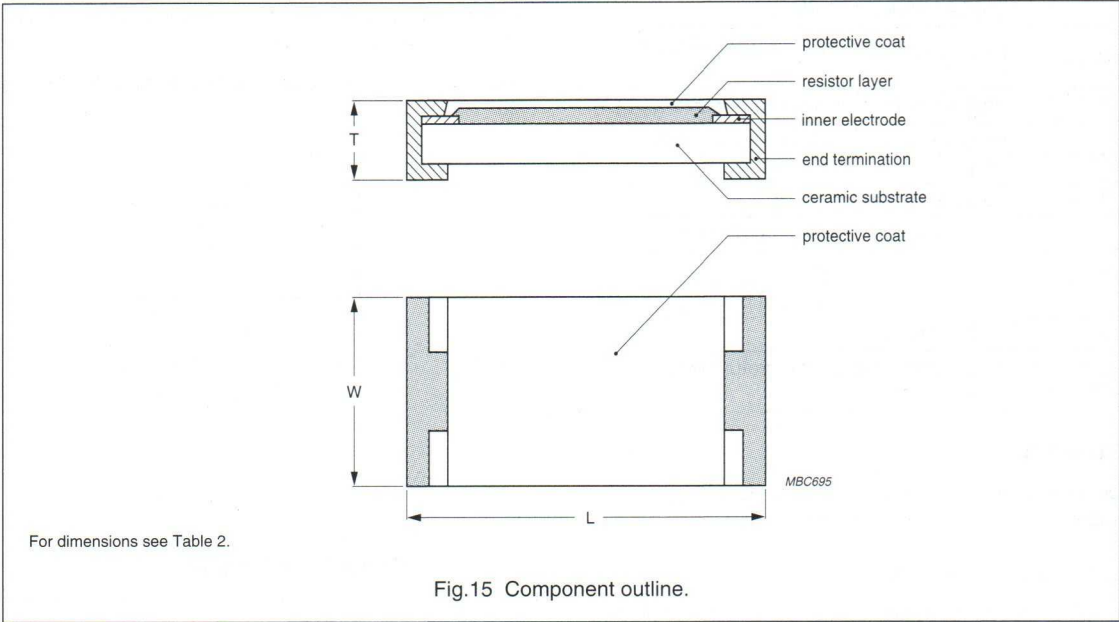


Table 2 Chip resistor type; USA case size code; mass per 100 units and relevant physical dimensions; see Fig.15

TYPE	USA SIZE CODE	L (mm)	W (mm)	T (mm)	MASS (g)
RC0...	1206	3.2	1.6	0.6	1.0
RC1..	0805	2.0	1.25	0.6	0.55
RC2..	0603	1.6	0.8	0.45	0.25
RC3.	0402	1.0	0.5	0.35	0.052

Marking

Wherever possible chip resistors are provided with a **resistance code**; see Table 3. The resistance code includes the first two or three significant digits of the resistance value (in ohms) followed by the number of zeros to follow. Whether two or three significant values are represented depends on the tolerance:

- $\pm 5\%$ requires two digits
- $\pm 2\%$ tolerance may be marked with two or three digits
- $\pm 1\%$ and lower requires three digits.

Table 3 Resistance value indication

INDICATOR	TOL. $\geq \pm 2\%$	TOL. $\leq \pm 1\%$
0	0.0 Ω ; jumper	—
R ⁽¹⁾	1 to 91 Ω	1 to 976 Ω
1	100 to 910 Ω	1 to 97.6 k Ω
2	1 to 9.1 k Ω	10 to 97.6 k Ω
3	10 to 91 k Ω	100 to 976 k Ω
4	100 to 910 k Ω	1 M Ω
5	1 to 9.1 M Ω	—
6	10 M Ω	—

Note

1. R denotes the decimal point.

Chip resistors

Introduction

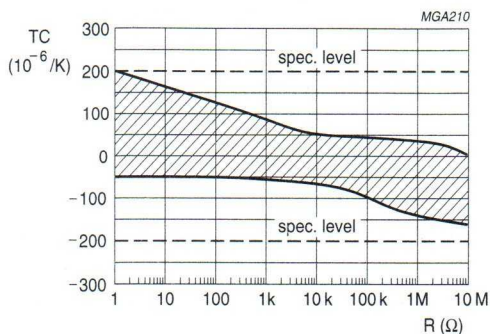
TESTS AND PROCEDURES

To guarantee zero defect production standards, Statistical Process Control is an essential part of our production processes. Furthermore, our production process is operating in accordance with "ISO 9000".

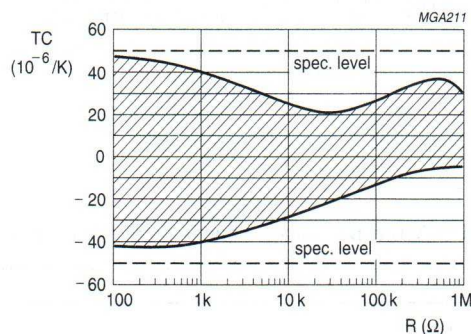
Essentially all tests on resistors are carried out in accordance with the schedule of "IEC publication 60115-1"

in the specified climatic category and in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components". In some instances deviations from the IEC recommendations are made.

Tests and their requirements are described in detail in the data sheets.



a. RC01.

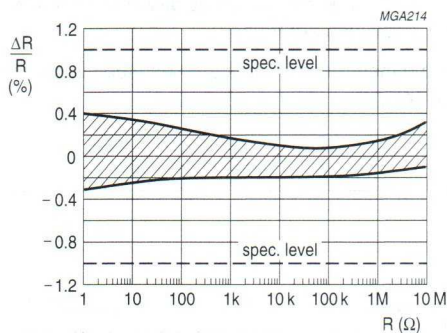


b. RC02G.

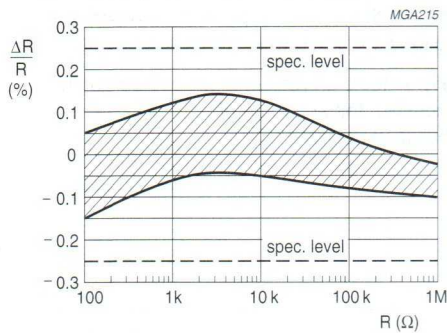
Fig.16 Typical temperature coefficients between the lower and upper category temperatures.

Chip resistors

Introduction

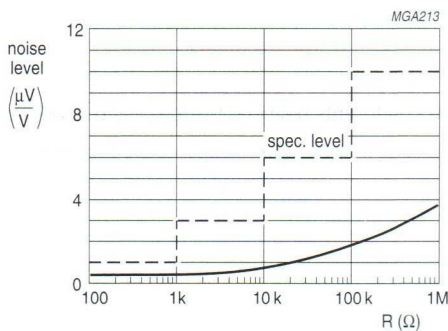


a. RC01.



b. RC02G.

Fig.17 Typical percentage change in resistance after soldering for 10 seconds at 260 °C, completely immersed.

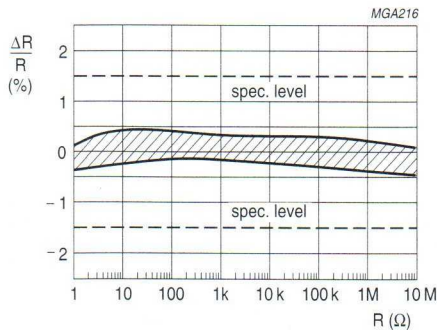


RC02G

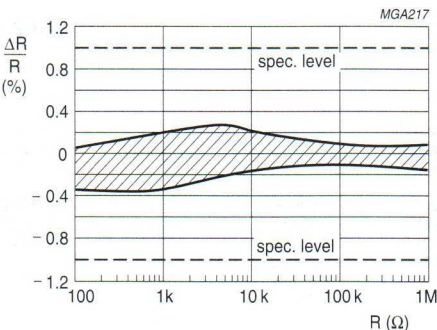
Fig.18 Typical noise level as a function of rated resistance measured using Quantech - equipment.

Chip resistors

Introduction

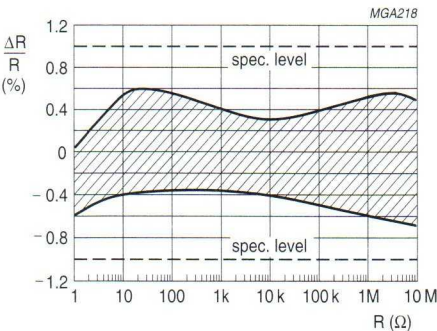


a. RC01.

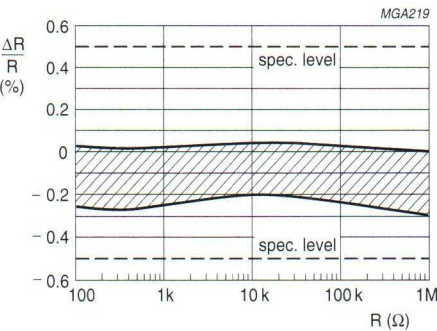


b. RC02G.

Fig.19 Typical percentage change in resistance after 56 days at 40 °C and 90 to 95% relative humidity loaded with P_{nom} .



a. RC01.

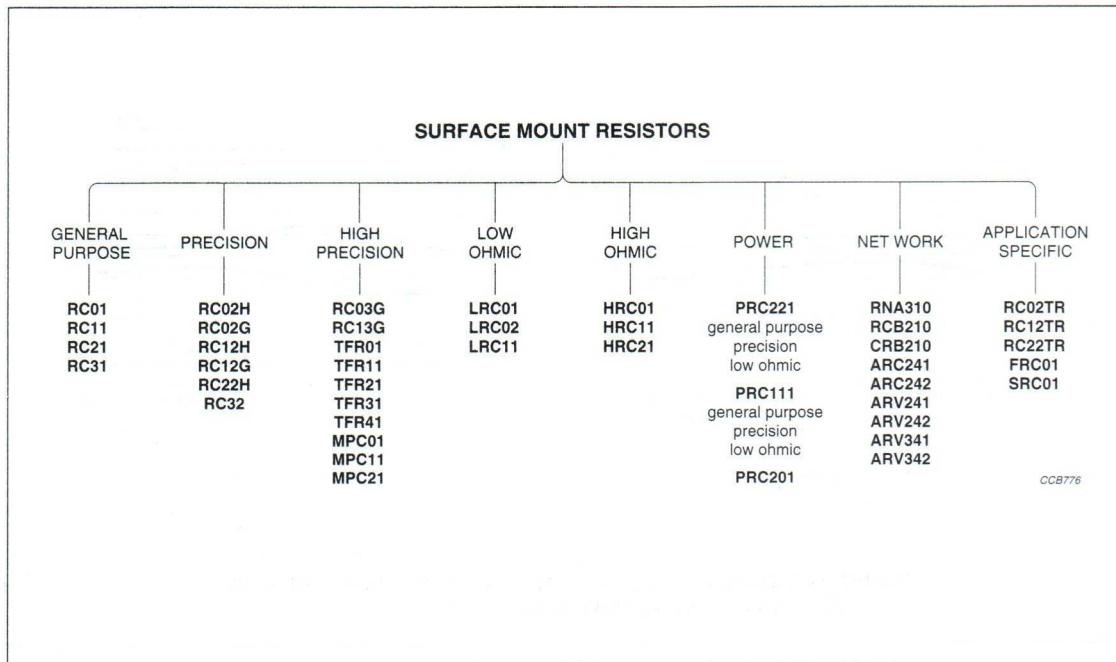


b. RC02G.

Fig.20 Typical percentage change in resistance after 1000 hours loaded with P_{nom} at 70 °C ambient temperature.

Chip resistors

Resistor programme



Chip resistors

Selection guide

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}/K$)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
Thick Film RSMD										
General purpose	RC01	1206	5	1 Ω to 10 M Ω	$\pm 200^{(1)}$	200	0.25	E24	2322 711 61...	214
	RC11	0805		1 Ω to 10 M Ω		150	0.125		2322 730 61...	
	RC21	0603		1 Ω to 10 M Ω		50	0.063		2322 702 60...	
	RC31	0402		6.8 Ω to 2.2 M Ω		50	0.063		2322 705 70...	
	RC01	1206	2	1 Ω to 10 M Ω	$\pm 200^{(1)}$	200	0.25	E24	2322 711 41...	214
	RC11	0805		1 Ω to 10 M Ω		150	0.125		2322 730 31...	
	RC21	0603		1 Ω to 10 M Ω		50	0.063		2322 702 65...	
	RC31	0402		6.8 Ω to 2.2 M Ω		50	0.063		2322 705 75...	
Precision TC100	RC02H	1206	1	1 Ω to 10 M Ω	$\pm 100^{(1)}$	200	0.25	E24/E96	2322 724 6....	227
	RC12H	0805		1 Ω to 10 M Ω		150	0.125		2322 734 6....	
	RC22H	0603		1 Ω to 10 M Ω		50	0.063		2322 704 6....	
	RC32	0402		10 Ω to 1 M Ω		50	0.063		2322 706 7....	
Precision TC50	RC02G	1206	1	90 Ω to 2.74 M Ω	± 50	200	0.25	E24/E96	2322 722 2....	227
	RC12G	0805				150	0.125		2322 732 6....	
High precision TC50	RC03G	1206	0.5	90 Ω to 2.74 M Ω	± 50	200	0.25	E24/E96	2322 725 2....	239
	RC13G	0805				150	0.125		2322 738 2....	
Power chip	PRC221	2512	5	1 Ω to 10 M Ω	$\pm 200^{(1)}$	250	1	E24	2322 762 60...	309
	PRC111	2010		1 Ω to 10 M Ω		200	0.5		2322 760 60...	
	PRC201	1218		1 Ω to 1 M Ω		200	1		2322 735 60...	
Power precision	PRC221	2512	1	1 Ω to 10 M Ω	$\pm 100^{(1)}$	250	1	E96	2322 763 6....	303
	PRC111	2010		1 Ω to 10 M Ω		200	0.5		2322 761 6....	
	PRC201	1218		1 Ω to 1 M Ω		200	1		2322 735 2....	

Chip resistors

Selection guide

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}/K$)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
APPLICATION SPECIFIC										
Power low ohmic	PRC221	2512		0.01 Ω to 0.99 Ω	$\pm 75/\pm 1500$	250	1	E24	2322 762 90.../60...	309
	PRC111	2010	5	0.01 Ω to 0.99 Ω	$\pm 250/\pm 2000$	200	0.5		2322 760 90.../60...	data on request
	PRC201	1218		0.02 Ω to 0.99 Ω		200	1	E96	2322 735 60...	281
	PRC221	2512		0.01 Ω to 0.99 Ω	$\pm 75/\pm 1500$	250	1	E24	2322 762 91.../80...	309
	PRC111	2010	2	0.01 Ω to 0.99 Ω		200	0.5		2322 760 91.../80...	data on request
	PRC221	2512		0.02 Ω to 0.99 Ω	$\pm 75/\pm 1500$	250	1	E24/E96	2322 763 90.../6...	data on request
Low ohmic	PRC111	2010	1	0.02 Ω to 0.99 Ω	$\pm 250/\pm 700$	200	0.5		2322 761 90.../6...	data on request
	PRC201	1218		0.1 Ω to 0.99 Ω		200	1	E96	2322 735 2....	281
	LRC01	1206		0.02 Ω to 0.99 Ω		200	0.25		2350 510 10...	321
	LRC11	0805	5	0.02 Ω to 0.99 Ω	$\pm 75/\pm 1500$	150	0.125	E24	2350 511 10...	331
	LRC11	0805	2	0.02 Ω to 0.99 Ω		150	0.125		2350 511 11...	331
	LRC02	1206	1	0.02 Ω to 0.99 Ω		200	0.25		2350 510 12...	326
High ohmic	HRC01	1206		11 M Ω to 100 M Ω	± 300	200	0.25		2350 520 10...	336
	HRC11	0805	5	11 M Ω to 100 M Ω	$\pm 300^{(1)}$	150	0.125		2350 521 10...	341
	HRC21	0603		11 M Ω to 22 M Ω		50	0.063	E24	2350 522 10...	346
	HRC01	1206		11 M Ω to 100 M Ω	± 300	200	0.25		2350 520 11...	336
	HRC11	0805	2	11 M Ω to 100 M Ω	$\pm 300^{(1)}$	150	0.125		2350 521 11...	341
	HRC21	0603		11 M Ω to 22 M Ω		50	0.063		2350 522 11...	346
Trimmable	RC02TR	1206		1 Ω to 10 M Ω	$\pm 100^{(1)}$	200	0.25		2350 500 11...	351
	RC12TR	0805	0/-20	1 Ω to 10 M Ω		150	0.125	E24	2350 501 11...	351
	RC22TR	0603		1 Ω to 10 M Ω		50	0.063		2350 502 11...	356
	RC02TR	1206		1 Ω to 10 M Ω	$\pm 100^{(1)}$	200	0.25		2350 500 10...	351
	RC12TR	0805	0/-30	1 Ω to 10 M Ω		150	0.125	E24	2350 501 10...	351
	RC22TR	0603		1 Ω to 10 M Ω		50	0.063		2350 502 10...	356
Fusible	FRC01	1206	5	1 Ω to 510 Ω	$\pm 200^{(1)}$	200	0.125	E96	2322 750 6....	361
Surge current	SRC01		5	1 Ω to 100 k Ω	± 200	200	0.25	E24	2350 550 10...	368
	SRC01	1206	2	1 Ω to 100 k Ω		200	0.25		2350 550 11...	368

Chip resistors

Selection guide

APPLICATION	TYPE	SIZE CODE	TOL. (%)	RESISTANCE RANGE	TEMP. COEFF. ($\times 10^{-6}/K$)	MAX. (V)	MAX. (W)	SERIES	CATALOGUE NUMBER	PAGE
Thin Film RSMD										
High precision, high stability	TFR01	1206	0.5	10 Ω to 1 M Ω	$\pm 25/\pm 50$	150	0.125	E24/E96	2350 61. 6....	248
	TFR11	0805		10 Ω to 1 M Ω	$\pm 25/\pm 50$	100	0.1		2350 60. 6....	
	TFR21	0603		10 Ω to 360 k Ω	$\pm 25/\pm 50$	75	0.063		2350 60. 6....	
	TFR31	0402		10 Ω to 100 k Ω	$\pm 25/\pm 100$	25	0.063		2350 60. 6....	
	TFR41	0201		33 Ω to 22 k Ω	± 25	15	0.05		2350 614 6....	
Ultra high precision, high stability	MPC01	1206	0.1	100 Ω to 1 M Ω	$\pm 10/\pm 50$	150	0.125	E24/E96	2322 741 3....	254
	MPC11	0805		100 Ω to 1 M Ω		100	0.1		2322 744 3....	
	MPC21	0603		100 Ω to 332 k Ω		75	0.063		2322 747 3....	
Network and Arrays										
Network 10P8R	RNA310	1206	5	10 Ω to 100 k Ω	± 200	25	0.031	E24/E96	2350 230 10...	263
R-C Network 10P4R4C	RCB210	1608	5	10 Ω to 1 k Ω	± 200	25	0.063	on request	2350 321 2....	374
			30/-20	10 pF to 180 pF						
C-R Network 10P4C4R	CRB210	1608	5; 10; 20	10 Ω to 100 k Ω	± 200	50	0.063	on request	2250 46.	381
			30/-20	15 pF to 22 nF						
Array Concave	ARC241	4 $\times$ 0603	5	10 Ω to 1 M Ω	± 200	50	0.063	E24	2350 034 10...	269
	ARC242		1		± 100			E24/E96	2350 024 1....	
Array Convex	ARV241	4 $\times$ 0603	5	10 Ω to 1 M Ω	± 200	50	0.063	E24	2350 035 10...	269
	ARV242		1					E24/E96	2350 025 1....	
	ARV341	4 $\times$ 0402	5	10 Ω to 1 M Ω	± 300	50	0.063	E24	2350 033 10...	276
	ARV342		1					E24/E96	2350 023 1....	

Note

1. $\leq 10 \Omega$; TCR: 0/+500 ppm
 $> 1 \text{ M}\Omega$; TCR: ± 300 ppm.

Chip resistors

Index of ordering code

12-DIGIT ORDERING CODE

The resistors have a 12-digit ordering code starting with 2350 or 2322.

Subsequent digits indicate style, packaging, resistance value and tolerance.
Refer to individual data sheets for detailed composition of the ordering code.

In Table 1 the 12NC is referenced to the applicable page number where a detailed composition will be found.

Table 1 First 6 or 7 digits of the ordering code

TYPE NAME	ORDERING CODE	PAGE
2350 (first 4 digits followed by next 2 or 3 digits)		
ARC241/ARV241	03	269
ARV341	03	276
ARC242/ARV242	02	269
ARV342	02	276
RNA310	230	263
RCB210	321	374
CRB210	46	381
RC02TR	500	351
RC12TR	501	351
RC22TR	502	356
CRB210	46	381
CRB210	46	381
LRC01	510	321
LRC11	511	331
LRC02	510	326
HRC01	520	336
HRC11	521	341
HRC21	522	346
SRC01	550	368
TFR01	61	248

TYPE NAME	ORDERING CODE	PAGE
2322 (first 4 digits followed by next 2 or 3 digits)		
RC21	702	214
RC22	704	227
RC31	705	214
RC32	706	227
RC01	711	214
RC02	722	227
RC02	724	227
RC03G	725	239
RC11	730	214
RC11	731	214
RC12	732	227
RC12	734	227
PRC201	735	281
RC13G	738	244
MPC01	741	254
MPC11	744	254
MPC21	747	254
PRC111	760	297
PRC111	761	291
PRC221	762	309
PRC221	763	303

Chip resistors

Mounting

MOUNTING

Due to their rectangular shape and small dimensional tolerances, Surface Mounted Resistors are suitable for handling by automatic placement systems. Chip placement can be on ceramic substrates and printed-circuit boards (PCBs). Electrical connection to the circuit is by wave, vapour phase or infrared soldering. The end terminations guarantee a reliable contact and the protective coating enables 'face down' mounting.

The temperature rise in a resistor due to power dissipation, is determined by the laws of heat - conduction, convection and radiation. The maximum body temperature usually occurs in the middle of the resistor and is called the **hot-spot** temperature.

The hot-spot temperature depends on the ambient temperature and the dissipated power. This is described in the data sheets under the chapter heading "Functional description".

The hot-spot temperature is important for mounting because the connections to the chip resistors will reach a temperature close to the hot-spot temperature. Heat conducted by the connections must not reach the melting

point of the solder at the joints. Therefore a maximum solder joint temperature of 110 °C is advised.

The ambient temperature on large or very dense printed-circuit boards (PCBs) is influenced by the dissipated power. The ambient temperature will again influence the hot-spot temperature. Therefore, the packing density that is allowed on the PCB is influenced by the dissipated power.

Example of mounting effects

Assume that the maximum temperature of a PCB is 95 °C and the ambient temperature is 50 °C. In this case the maximum temperature rise that may be allowed is 45 °C. In the graph (see Fig.1), this point is found by drawing the line from point A (PCB = 95 °C) to point B ($T_{\text{amb}} = 50$ °C) and from here to the left axis.

To find the maximum packing density, this horizontal line is extended until it intersects with the curve, 0.125 W (point C). The maximum packing density, 19 units/50 × 50 mm² (point D), is found on the horizontal axis.

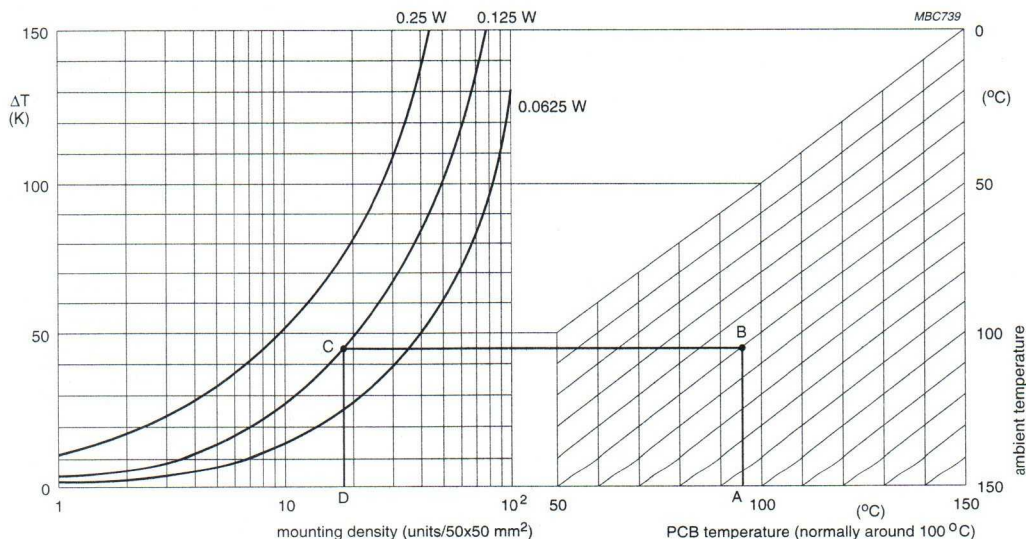


Fig.1 PCB temperature as a function of applied power, mounting density and ambient temperature.

Chip resistors

Mounting

Thermal resistance (R_{th})

Thermal resistance prohibits the release of heat generated within the resistor to the surrounding environment. It is expressed in K/W and defines the surface temperature (T_{HS}) of the resistor in relation to the ambient temperature (T_{amb}) and the load (P) of the resistor, as follows:

$$T_{HS} = T_{amb} + P \times R_{th}$$

Due to their direct contact with the solder spot, chip resistors dissipate over 85% of their heat via conduction to the solder spot and hence to the PCB. Thus the PCB on which the chip resistor is mounted functions as a heat sink. Different PCBs have different heat conductance. Figure 2 shows the different values of heat resistance per material type. Substrates with a higher heat conductance give lower thermal resistance figures; substrates with a lower heat conductance give higher thermal resistance figures.

It should be noted that the temperature of the terminations of the chip resistor is virtually the same as the hot-spot temperature. Therefore the power that may be dissipated by the resistor is dependent on:

T_{amb} (which is also dependent on the packing density)

R_{th} of the PCB

maximum solder spot temperature (generally 110 °C).

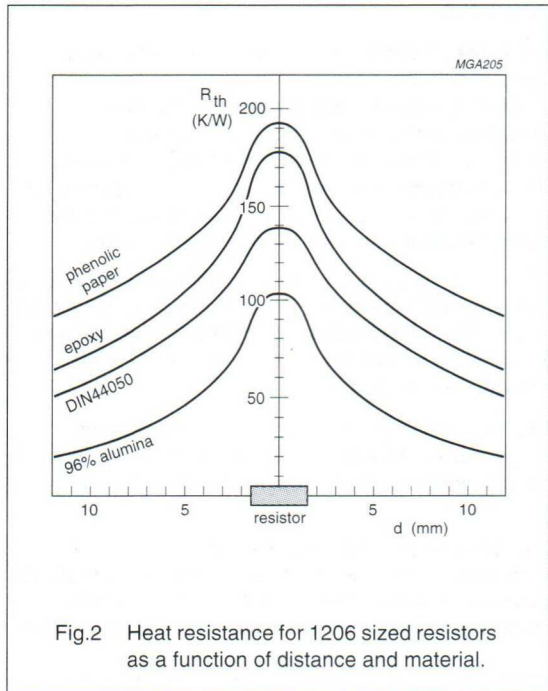


Fig.2 Heat resistance for 1206 sized resistors as a function of distance and material.

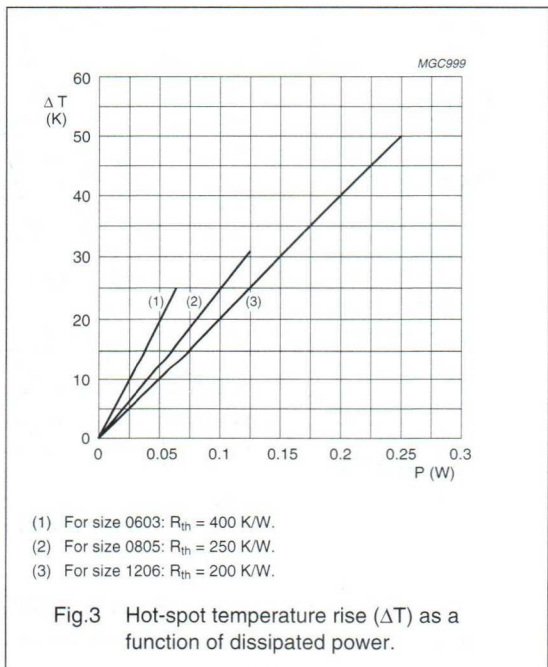


Fig.3 Hot-spot temperature rise (ΔT) as a function of dissipated power.

FOOTPRINT DIMENSIONS

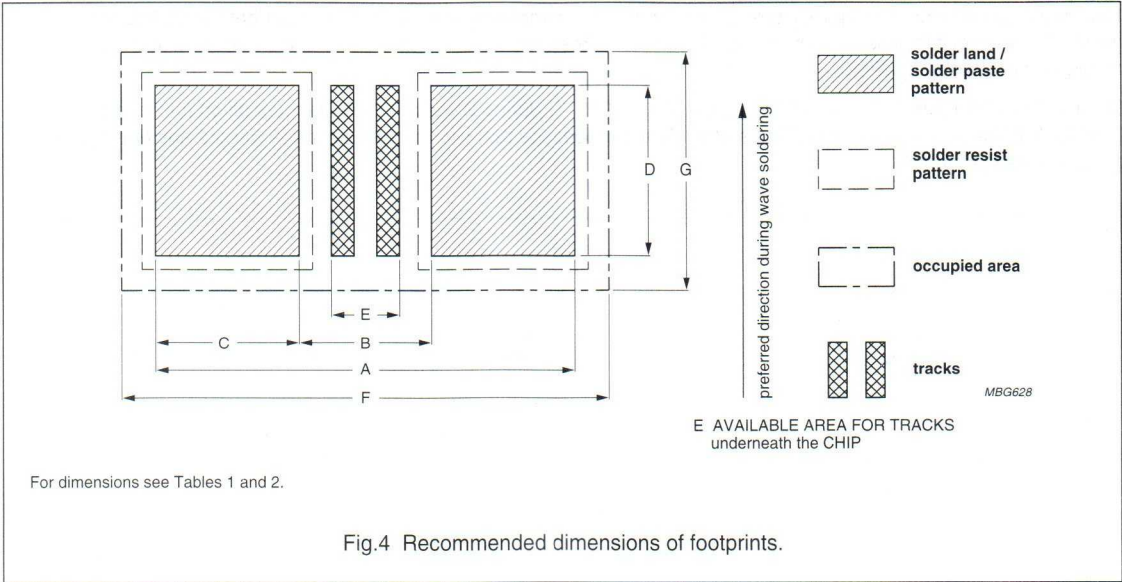


Table 1 Reflow soldering; for dimensions see also Fig.4

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROCESSING REMARKS	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0402	1.5	0.5	0.5	0.6	0.1	1.9	1.0	IR or hot plate soldering	±0.15
0603	2.1	0.5	0.8	0.9	0.0	2.5	1.7		±0.25
0805	2.6	0.9	0.85	1.4	0.5	3.0	2.1		±0.25
1206	3.8	2.0	0.9	1.8	1.4	4.2	2.5		±0.25
1218	3.8	2.0	0.9	1.8	1.4	4.2	2.5		±0.25
2010	5.6	3.8	0.9	2.8	3.4	5.85	3.15		±0.25
2512	7.0	3.8	1.6	3.5	3.4	7.25	3.85		±0.25

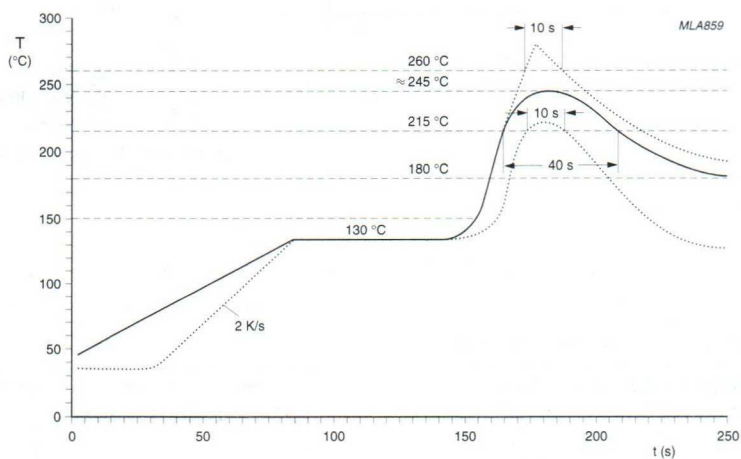
Table 2 Wave soldering (no dummy tracks allowed for the high voltage series); for dimensions see also Fig.4

SIZE CODE	FOOTPRINT DIMENSIONS (mm)							PROPOSED NUMBER AND DIMENSIONS OF DUMMY TRACKS (mm)	PLACEMENT ACCURACY (mm)
	A	B	C	D	E	F	G		
0603	2.7	0.9	0.9	0.8	0.15	3.2	1.9	1 × (0.15 × 0.8)	±0.25
0805	3.3	1.3	1.0	1.3	0.34	3.9	2.4	1 × (0.3 × 1.3)	±0.25
1206	4.5	2.5	1.0	1.7	1.25	3.9	2.4	3 × (0.25 × 1.7)	±0.25
1218	4.5	2.5	1.0	1.7	1.25	4.6	3.6	—	±0.25
2010	6.3	4.3	1.0	2.5	3.00	7.0	3.6	—	±0.25
2512	7.7	5.7	1.0	3.2	3.00	8.4	4.3	—	±0.25

SOLDERING CONDITIONS

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260 °C for one minute. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235 °C during 2 seconds. The test condition for no leaching is 260 °C for 60 seconds. Typical examples of soldering processes that provide reliable joints without any damage, are given in Figs 5, 6 and 7.

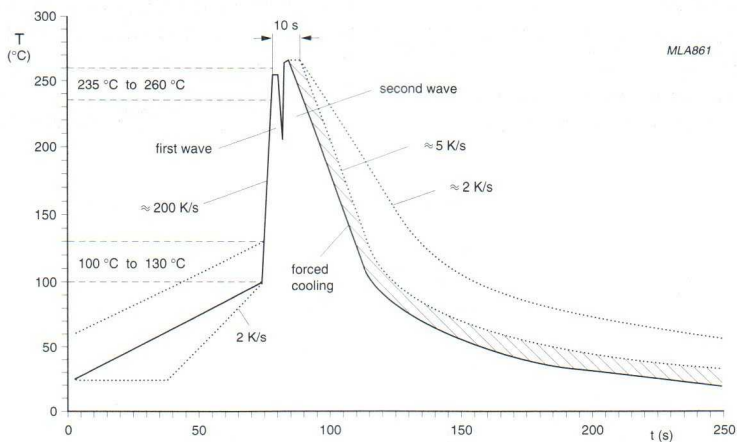


Typical values (solid line).
Process limits (dotted lines).

Fig.5 Infrared soldering.

Chip resistors

Mounting



Typical values (solid line).
Process limits (dotted lines).
The resistors may be soldered twice in accordance with this method if desired.

Fig.6 Double wave soldering.

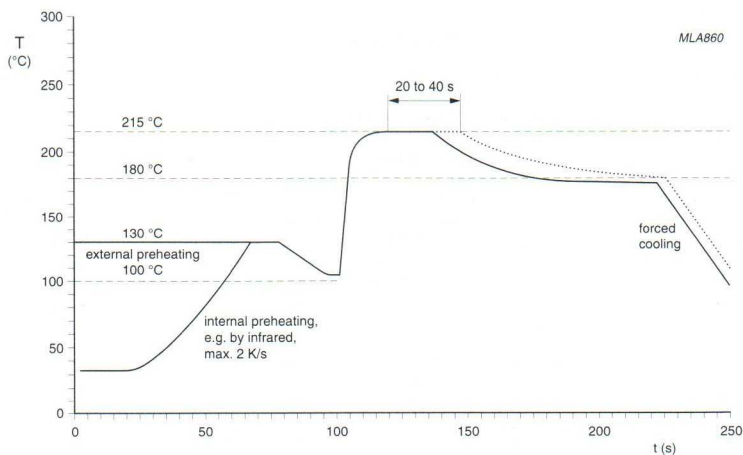


Fig.7 Vapour phase soldering.

Chip resistors

Packaging

PACKAGING

Tape and reel specifications

All tape and reel specifications are in accordance with the second edition of “IEC 60286-3”. Basic dimensions are given in Figs 1, 2 and 5, and Tables 1, 2 and 3.

Peel-off force

Peel-off forces of both paper and blister tapes are in accordance with “IEC 60286-3”; that is, at a peel-off speed of 300 ±10 mm/minute, 0.1 N to 1.0 N for 8 mm tape and 0.1 N to 1.3 N for tape larger than 8 mm. The peel-off angle should be between 165° and 180°.

Paper tape

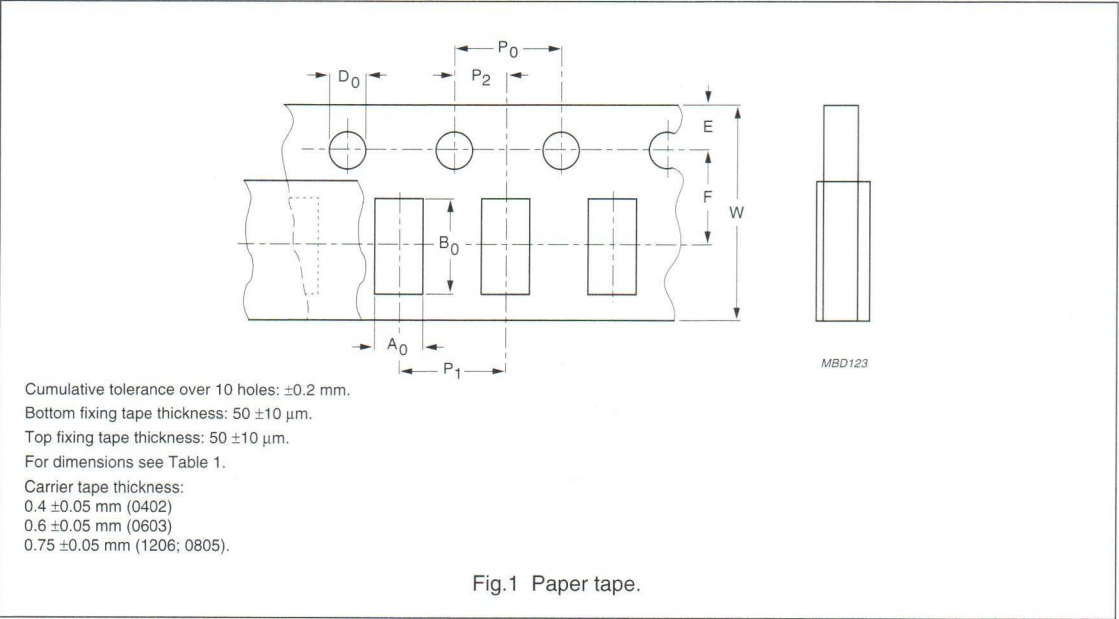


Table 1 Dimensions of paper tape for relevant chip size; see Fig.1

SYMBOL	PRODUCT SIZE CODE								UNIT
	0402		0603		0805		1206		
	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	SIZE	TOL.	
A ₀	0.70	±0.05	1.0	+0.2/−0	1.50	+0.2/−0	1.85	+0.2/−0	mm
B ₀	1.20	±0.05	1.8	+0.2/−0	2.25	+0.2/−0	3.45	+0.2/−0	mm
W	8	±0.2	8	±0.3	8.00	±0.3	8	±0.3	mm
E	1.75	±0.1	1.75	±0.1	1.75	±0.1	1.75	±0.1	mm
F	3.5	±0.05	3.5	±0.05	3.50	±0.05	3.5	±0.05	mm
D ₀	1.5	+0.1/−0	1.5	+0.1/−0	1.50	+0.1/−0	1.5	+0.1/−0	mm
P ₀	4	±0.1	4	±0.1	4.0	±0.1	4	±0.1	mm
P ₁	2	±0.1	4	±0.1	4.0	±0.1	4	±0.1	mm
P ₂	2 or 0	±0.05	2	±0.05	2.0	±0.05	2	±0.05	mm

Chip resistors

Packaging

Blister tape

ENVIRONMENTAL CONSIDERATIONS

- Cover tape, carrier tape and reel do not contain environmentally-harmful PVC materials.
- Tape and reel are antistatic.
- Because the carrier tape is made of polycarbonate, a homogeneous material (mono-plastic), it is ideally suited for recycling.
- Compared to other PVC-free materials polycarbonate shows excellent stiffness and very little deformation with temperature.

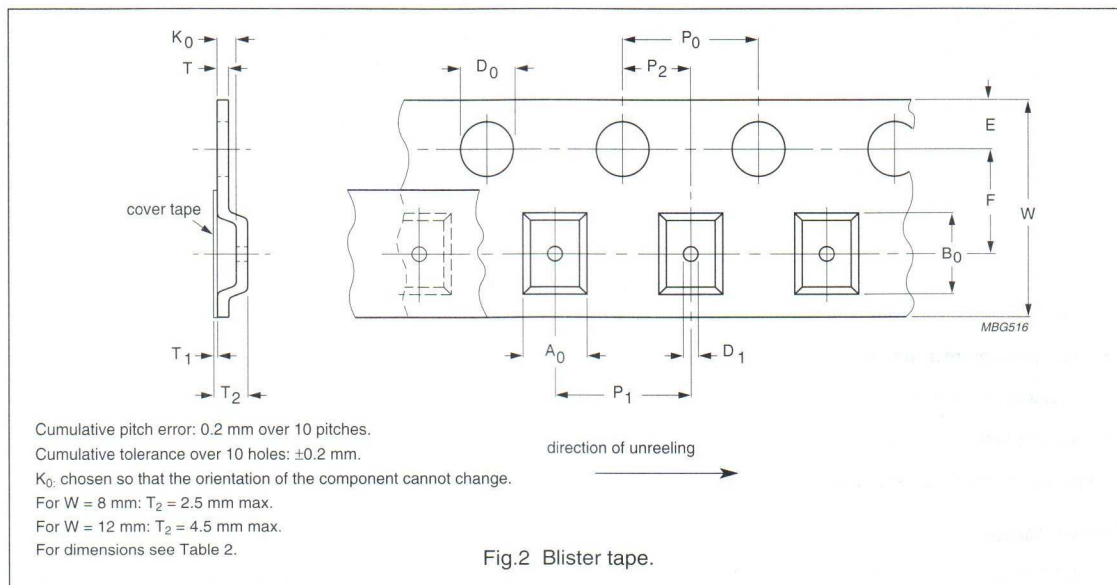


Table 2 Dimensions of blister tape for relevant chip size; see Fig.2

SYMBOL	PRODUCT SIZE CODE				TOL.	UNIT
	1218	1608	2010	2512		
A_0 nominal clearance; note 1	0.30	2.50	2.77	3.6	—	mm
B_0 nominal clearance; note 1	0.20	4.40	5.49	6.9	—	mm
K_0 minimum clearance; note 1	0.10	—	—	—	—	mm
W	12	12.0	12.0	12.0	± 0.2	mm
E	1.75	1.75	1.75	1.75	± 0.1	mm
F	5.5	5.5	5.5	5.5	± 0.05	mm
D_0	1.5	1.5	1.5	1.5	$+0.1/-0.0$	mm
D_1	≥ 1.5	—	—	—	$+0.1/-0.0$	mm
P_0 ; note 2	4	4	4	4	± 0.1	mm
P_1	8	4	4	4	± 0.1	mm
P_2	2	2	2	2	± 0.05	mm
T	1.1	1.15	1.2	1.2	± 0.2	mm

Notes

1. Possible product displacement in pocket.
2. P_0 pitch tolerance over any 10 pitches is ± 0.2 mm.

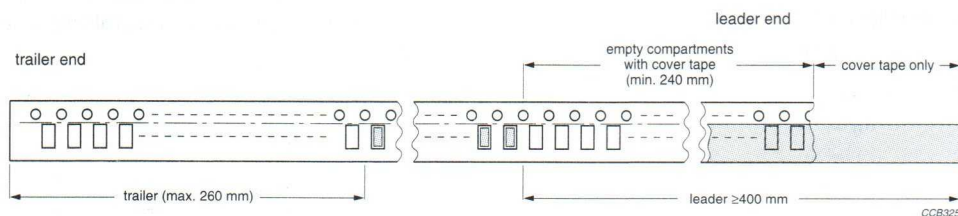
Leader/trailer tape specification

Fig.3 Leader/trailer tape.

Taping package requirements

Resistance side facing up.

Component is free and not sticking to top and/or bottom tape.

Component should be easy to remove from carrier tape and the chip hole should have no mechanical damage.

Peel-off force

Peel-off force of paper and blister tape is in accordance with "IEC 60286-3"; that is, 0.2 to 1.0 N at a peel-off speed of 300 mm/minute.

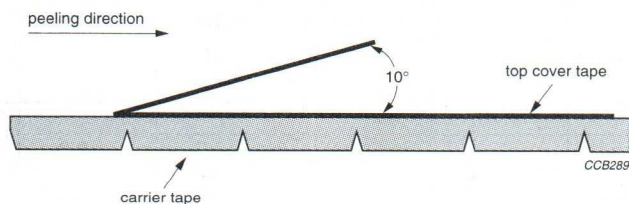


Fig.4 Peel-off force.

REEL SPECIFICATIONS

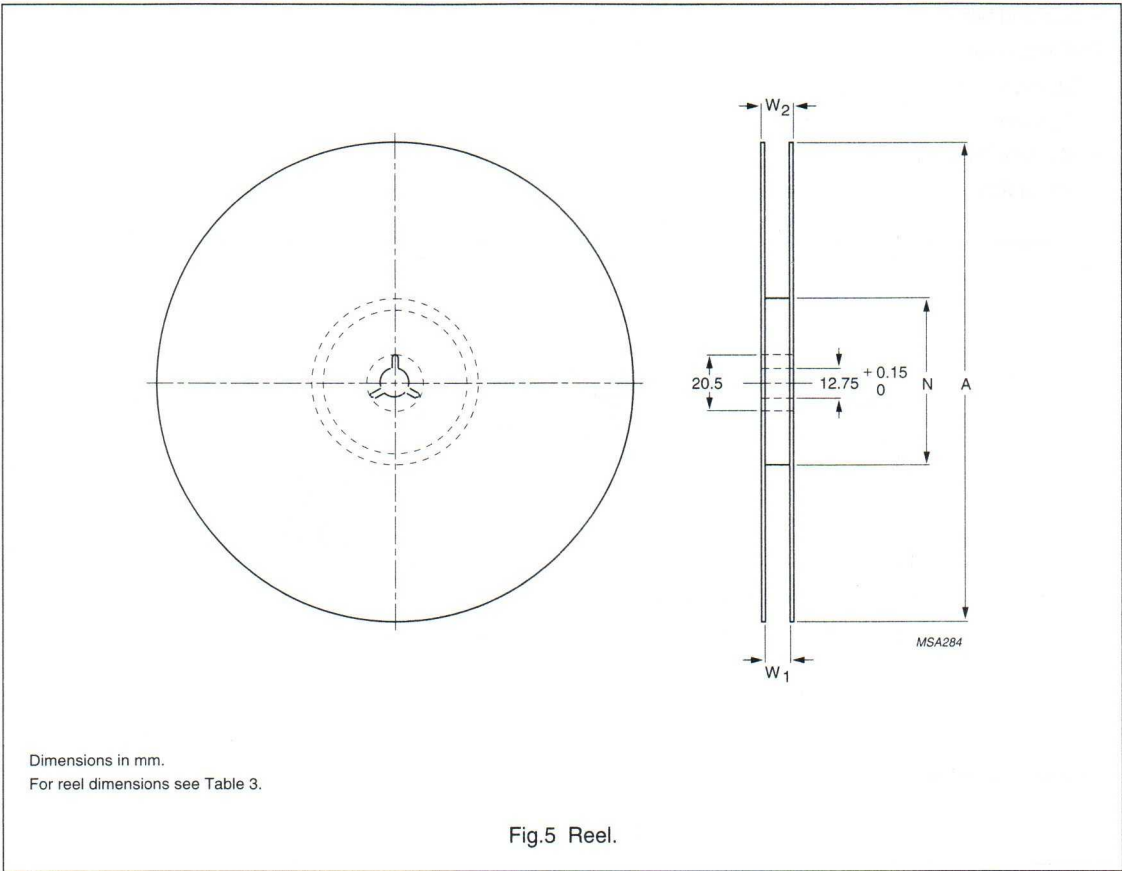


Table 3 Reel dimensions; see Fig.5

PRODUCT SIZE CODE	UNITS PER REEL	TAPE WIDTH (mm)	A (mm)	N (mm)	W ₁ (mm)	W ₂ MAX. (mm)	
0402	10000	8	180	62 ±1.5	8.4 +1.5/−0.0	14.4	
1206; 0603; 0805	20000		330				
	10000		250				
	5000		180				
1608	4000			178 ±2.0	60 ±0.5	13.0 ±0.3	15.7 ±0.5
1218	1000	12	180	12.4 +2/−0.0		18.4	
	5000		286				
2010	4000			178 +0/−0.3	60 ±1.0	14.0 ±0.1	16.7 ±0.5
2512	4000			178 +0/−0.3	60 ±1.0	9.0 ±1	14.4

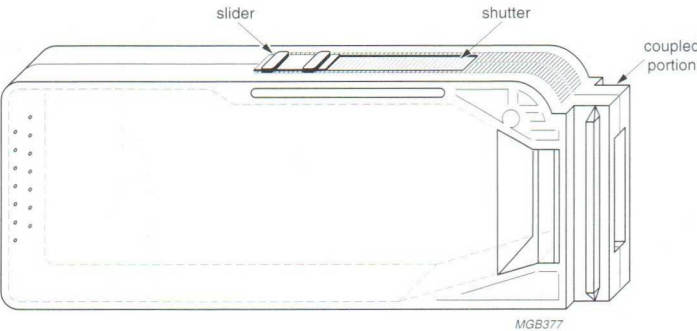
Chip resistors

Packaging

BULK CASE SPECIFICATION

Features and benefits:

- Reduced costs
 - Storage
 - Transport
 - Machine handling
 - Packaging.



For dimensions see Table 4.

Fig.6 Bulk case outline.

Table 4 Bulk case dimensions; see Fig.6

LENGTH (mm)	WIDTH (mm)	THICKNESS (mm)
110	35	12

Table 5 Product size versus packaged quantity

PRODUCT SIZE CODE	UNITS PER CASE
0402	50 000
0603	25 000

RESISTOR PRODUCT DATA

	Page
General purpose 5%; 2%: RC01/11/21/31	214
Precision 1%: RC02/12/22/32	227
High precision 0.5%: RC03G	239
High precision 0.5%: RC13G	244
High precision, high stability 0.5%: TFR01/11/21/31/41	248
Ultra high precision, high stability 0.1%: MPC01/11/21	254
Network 5%: RNA310	263
Array (4x0603) 5%; 1%: ARC241/ARV241/ARC242	269
Array (4x0402) 5%: ARV341	276
Power (1218) 5%; 1%: PRC201	281
Power (2010) 1%: PRC111	291
Power (2010) 5%; 2%: PRC111	297
Power (2512) 1%: PRC221	303
Power (2512) 5%; 2%: PRC221	309
Power, low ohmic (2512) 5%; 2%: PRC221	315
Low ohmic (1206) 5%: LRC01	321
Low ohmic (1206) 1%: LRC02	326
Low ohmic (0805) 5%; 1%: LRC11	331
High ohmic (1206) 5%: HRC01	336
High ohmic (0805) 5%: HRC11	341
High ohmic (0603) 5%: HRC21	346
Trimmable (0805; 1206): RC02/12TR	351
Trimmable (0603): RC22TR	356
Fusible (1206) 5%: FRC01	361
Surge (1206) 5%; 2%: SRC01	368

General purpose chip resistors

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

FEATURES

- Low assembly costs
- High component and equipment reliability
- Excellent performance at high frequency, especially the RC31
- Complete standard SMD family.

APPLICATIONS

- All general purpose applications.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE			
	RC01	RC11	RC21	RC31
Size code	1206 (3216)	0805 (2012)	0603 (1608)	0402(1005)
Resistance range	1 Ω to 10 M Ω			6.8 Ω to 2.2 M Ω
Resistance tolerance and E-series	$\pm 5\%$, $\pm 2\%$; E24 series			
Temperature coefficient: 1 $\Omega \leq R < 10 \Omega$ 10 $\Omega < R \leq 10 \text{ M}\Omega$	$\leq 250 \pm 250 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$			
Maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	0.25 W	0.125 W	0.063 W	0.063 W
Maximum permissible voltage	200 V (DC or RMS)	150 V (DC or RMS)	50 V (DC or RMS)	50 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56			55/125/56
Basic specification	IEC 60115-8			

General purpose chip resistors

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2322					
		PAPER TAPE ON REEL ⁽¹⁾				BULK CASE	
		5000 units	10000 units	20000 units	50000 units	10000 units	25000 units
RC01	±5	711 61...	711 51...	711 81...	—	—	—
	±2	711 41...	—	711 71...	—	—	—
RC11	±5	730 61...	730 71...	730 81...	—	731 81...	—
	±2	730 31...	—	730 41...	—	731 51...	—
RC21	±5	702 60...	702 70...	702 81...	—	—	702 80...
	±2	702 65...	—	702 75...	—	—	702 50...
RC31	±5	—	705 70...	—	705 87...	—	—
	±2	—	705 75...	—	—	—	702 50...
Jumper 0 Ω							
RC01 ⁽¹⁾	—	711 91032	711 91005	711 92004	—	—	—
RC11 ⁽¹⁾	—	730 91002	730 91003	730 92002	—	731 91006	—
RC21 ⁽²⁾	—	702 96001	702 97001	702 92002	—	—	702 91002
RC31 ⁽²⁾	—	—	705 91001	—	705 91007	—	—

Notes

1. The jumper has a maximum resistance $R_{\max} = 50 \text{ m}\Omega$ and a rated current $I_R = 2 \text{ A}$.
2. The jumper has a maximum resistance $R_{\max} = 50 \text{ m}\Omega$ and a rated current $I_R = 1 \text{ A}$.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent 5 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a RC11 resistor, value 4700 Ω with ±2% tolerance, supplied on paper tape of 5000 units per reel is: 2322 730 31472.

General purpose chip resistors

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$ or $\pm 2\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC01	200	0.25
RC11	150	0.125
RC21	50	0.063
RC31		

Note

- This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

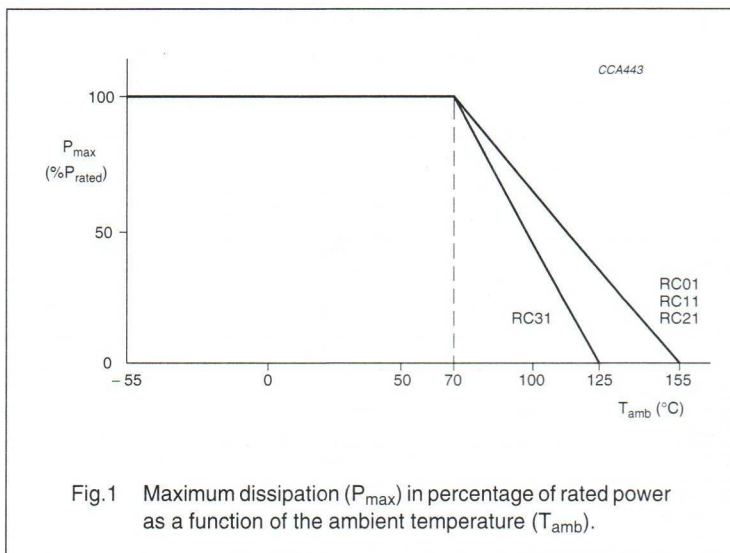
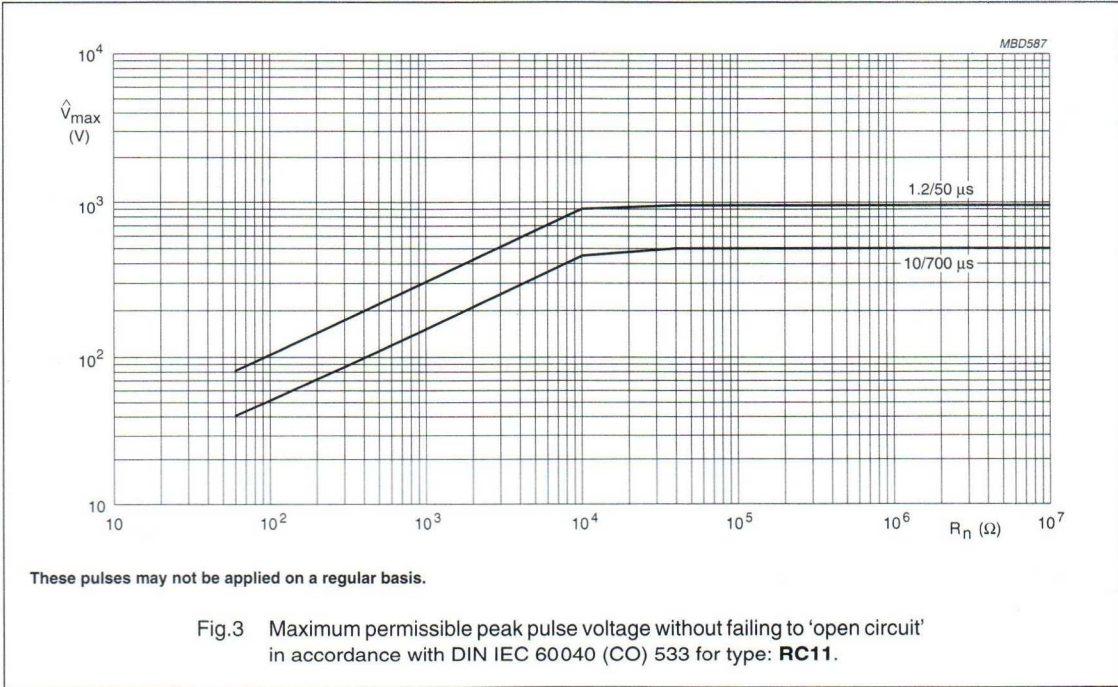
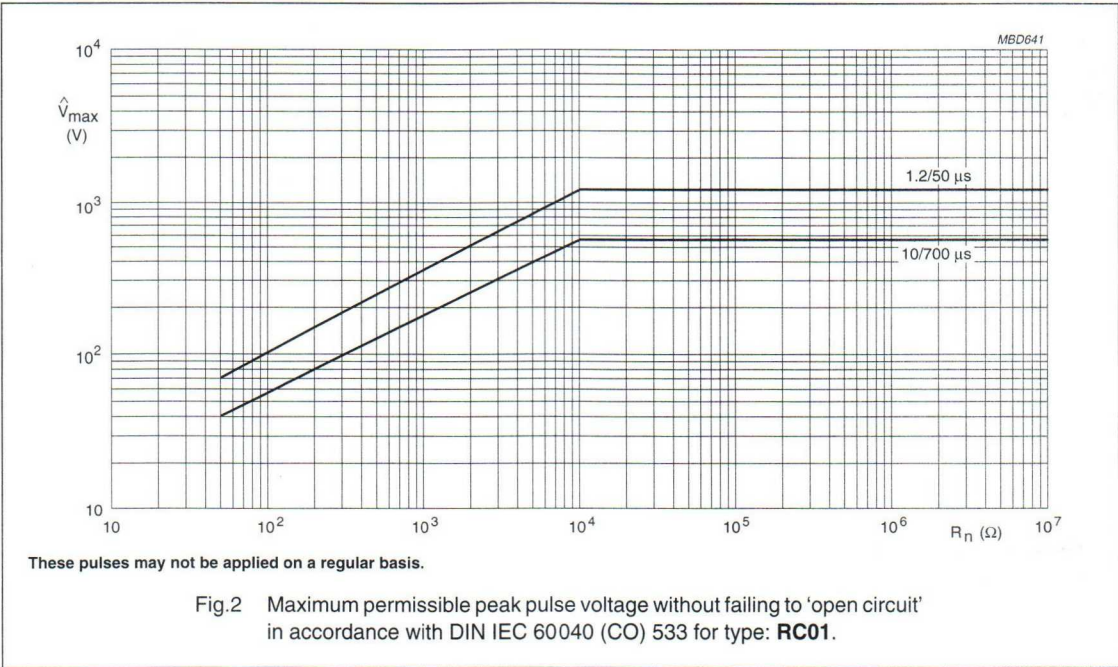


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

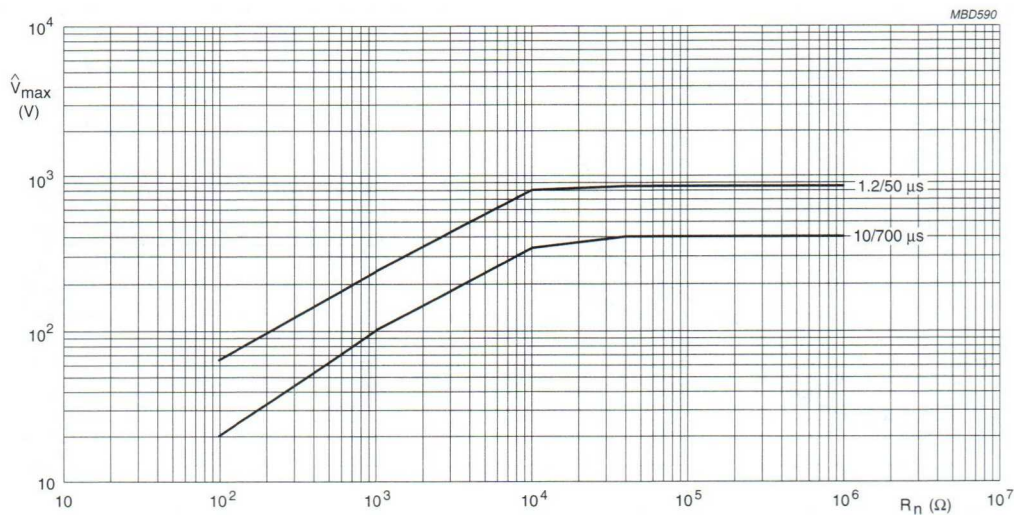
PULSE LOADING CAPABILITIES



General purpose chip resistors

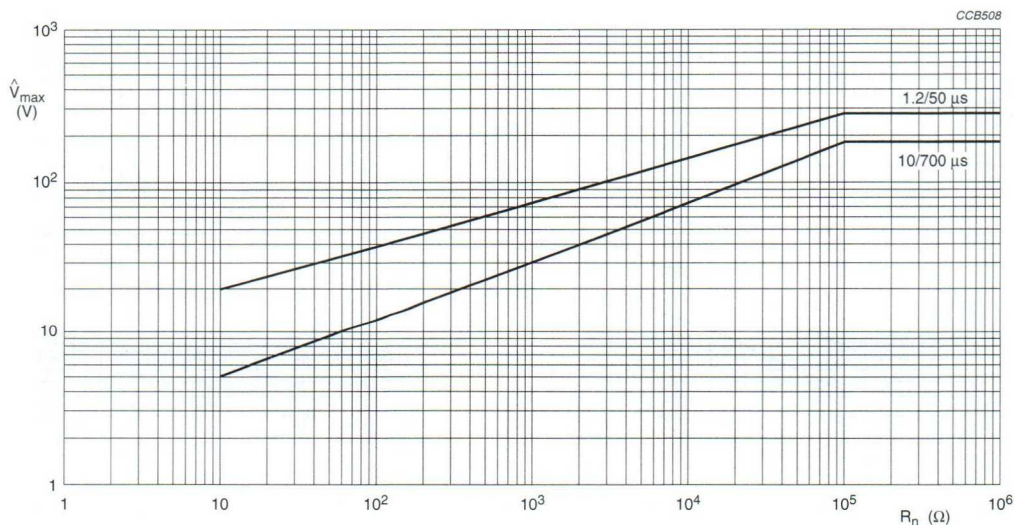
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC21**.



These pulses may not be applied on a regular basis.

Fig.5 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC31**.

General purpose chip resistors

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

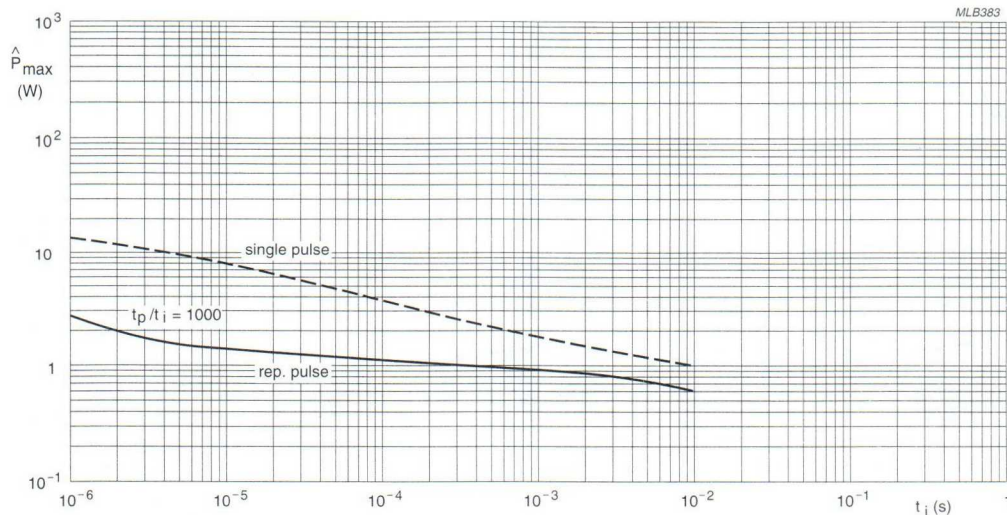


Fig.6 Pulse on a regular basis for type: **RC01**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

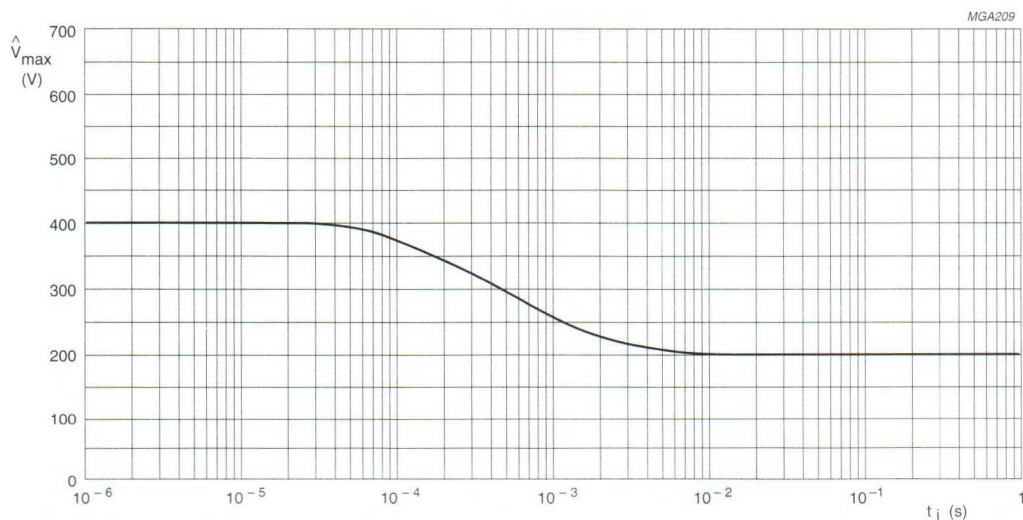


Fig.7 Pulse on a regular basis for type: **RC01**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

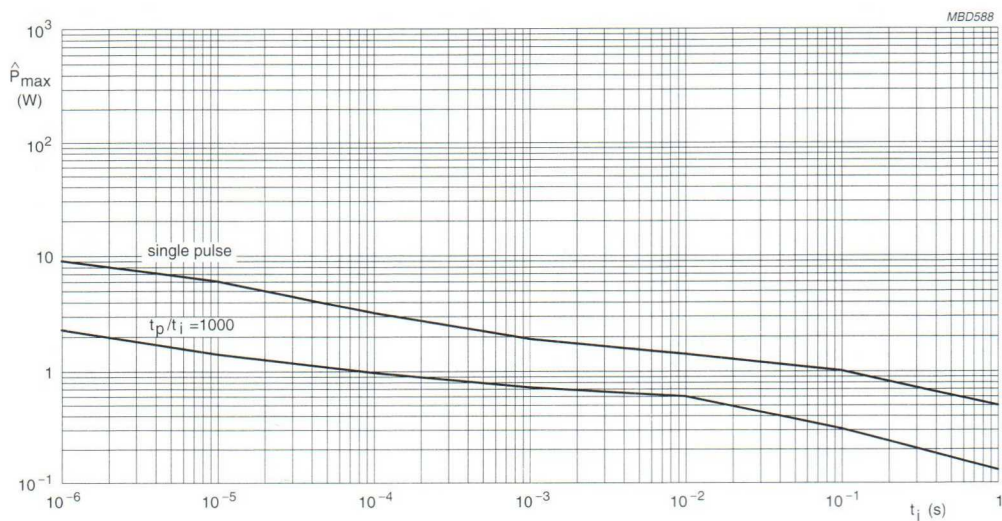


Fig.8 Pulse on a regular basis for type: **RC11**; maximum permissible peak pulse power ($\hat{P}_{\max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

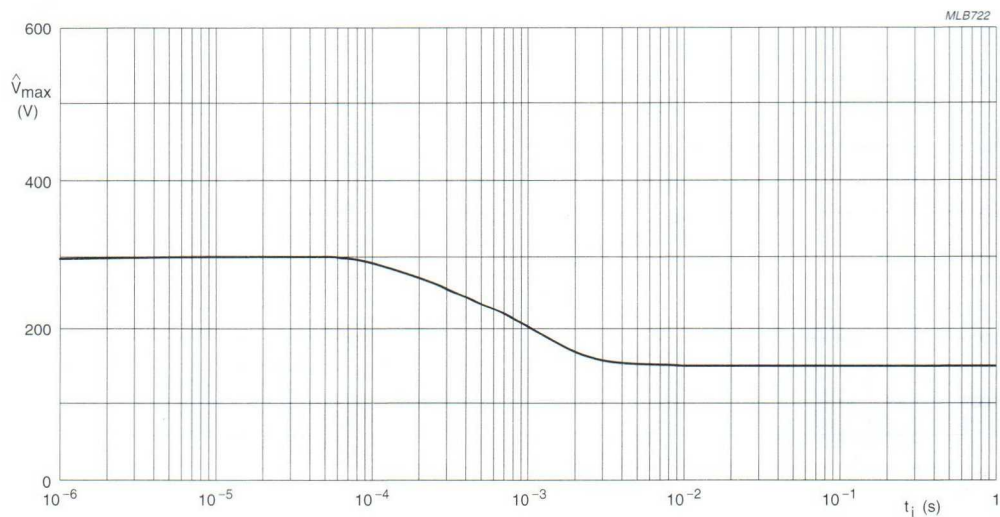


Fig.9 Pulse on a regular basis for type: **RC11**; maximum permissible peak pulse voltage ($\hat{V}_{\max}$) as a function of pulse duration.

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

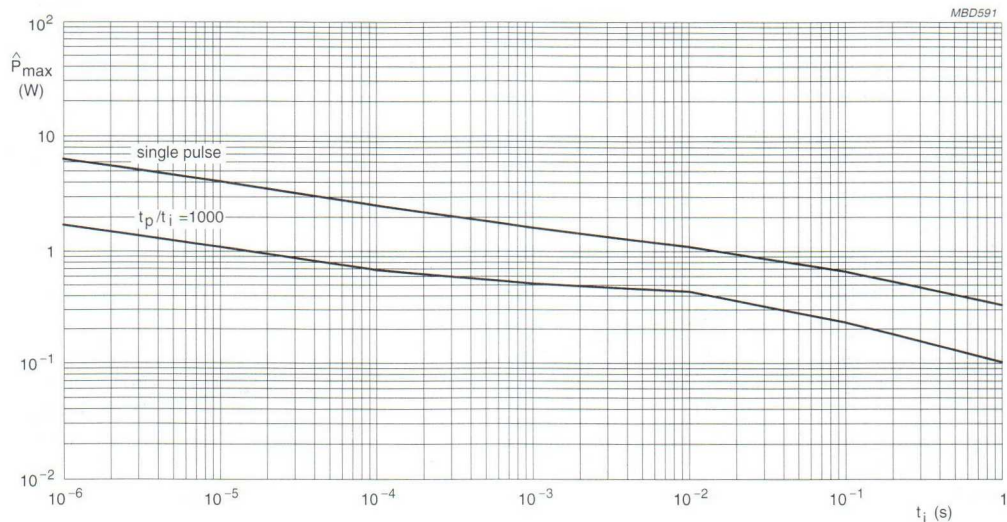


Fig.10 Pulse on a regular basis for type: **RC21**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

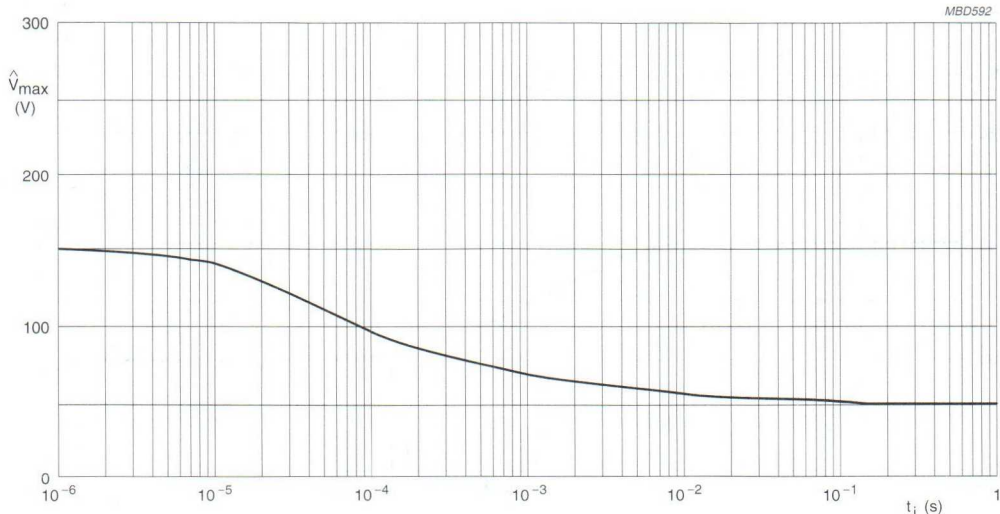


Fig.11 Pulse on a regular basis for type: **RC21**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

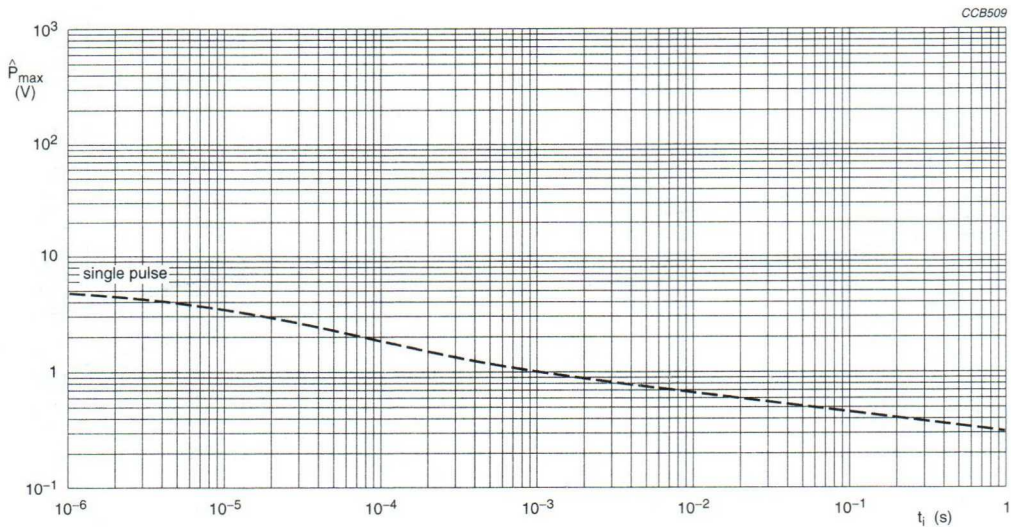


Fig.12 Pulse on a regular basis for type: **RC31**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

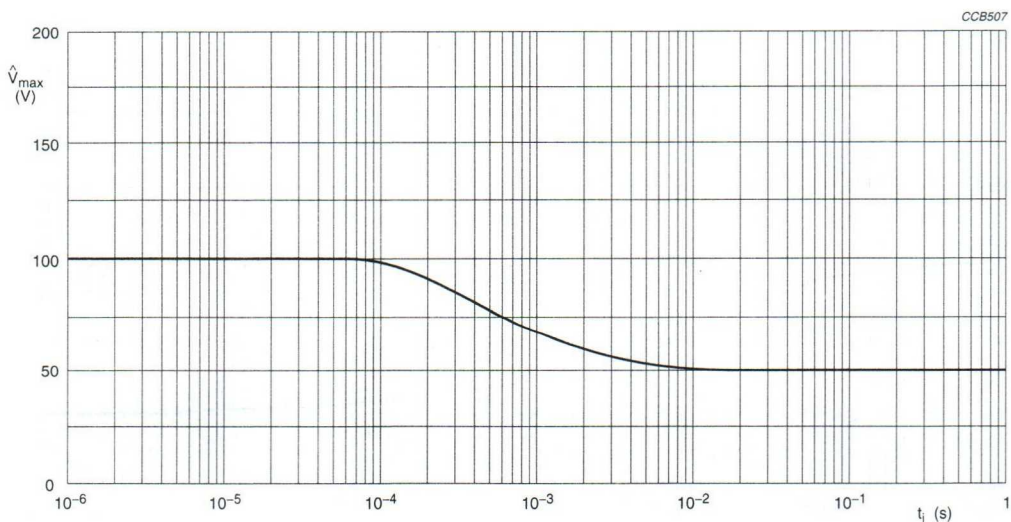


Fig.13 Pulse on a regular basis for type: **RC31**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

General purpose chip resistors sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC01	1.0
RC11	0.55
RC21	0.25
RC31	0.052

Marking

Each resistor, except RC31, is marked with a three digit code (occasionally four digit) on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits are significant, the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R	12 Ω
823	82 k Ω

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 k Ω or greater the first 3 digits are significant, the fourth indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R0	12 Ω
8202	82 k Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

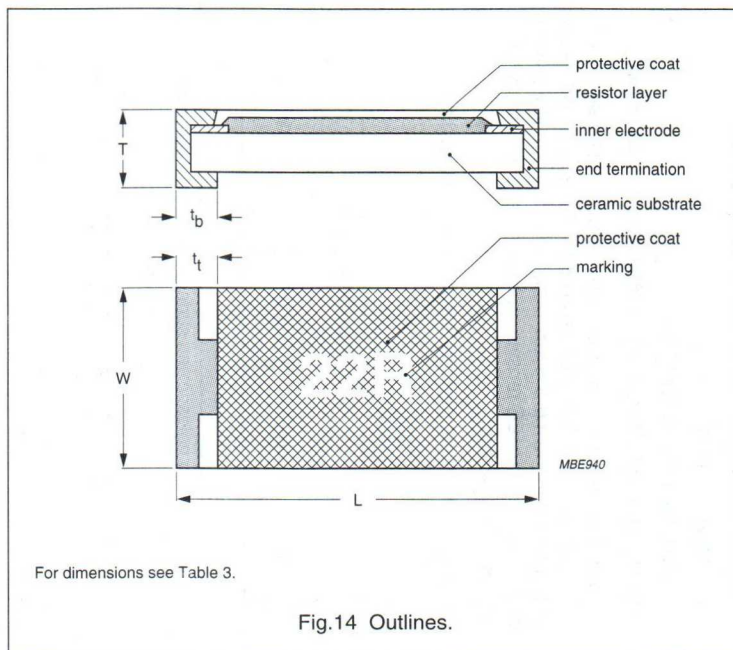


Table 3 Chip resistor types and relevant physical dimensions; see Fig.14

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
RC01	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC11	2.00 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20
RC21	1.60 ±0.10	0.80 +0.15/-0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20
RC31	1.00 ±0.05	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category **LCT/UCT/56** (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, **56** days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE		IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS			
Tests in accordance with the schedule of IEC publication 60115-8					RC01	RC11	RC21	RC31
4.4.1			visual examination		no holes; clean surface; no visible damage			
4.4.2			dimensions (see Fig.14)	gauge (mm)	see Table 3			
4.5			resistance	applied voltage (+0/−10%): R < 10 Ω: 0.1 V 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R < 1 MΩ: 25 V R ≥ 1 MΩ: 50 V	R − R _{nom} : max. ±2% or R − R _{nom} : max. ±5%			
4.18		20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)		no visible damage ΔR/R max.: ±(1% +0.05 Ω)	
4.29		45 (Xa)	component solvent resistance	isopropyl alcohol or H ₂ O followed by brushing in accordance with "MIL 202 F"	no visible damage			

General purpose chip resistors

sizes 1206, 0805, 0603 and 0402

RC01/11/21/31

5%; 2%

		TEST	PROCEDURE	REQUIREMENTS			
IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD			RC01	RC11	RC21	RC31
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage			
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover			
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$			
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for RC01 and 5 mm for RC11, RC21 and RC31	no visible damage; $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$			
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage; $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$ no visible damage; $\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$			
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$: $R \leq 1 M\Omega$ $R > 1 M\Omega$	$\Delta R/R$ max.: $\pm(1.5\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$			
4.25.1		endurance	1000 +48/-0 hours; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off: $R \leq 1 M\Omega$ $R > 1 M\Omega$	$\Delta R/R$ max.: $\pm(1.5\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$			
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; no load: $R \leq 1 M\Omega$ $R > 1 M\Omega$	$\Delta R/R$ max.: $\pm(1.5\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$			
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $R \leq 10 \Omega$ $10 \Omega < R$	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$			
				$\leq 250 \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$			

General purpose chip resistors
sizes 1206, 0805, 0603 and 0402

RC01/11/21/31
5%; 2%

		PROCEDURE		REQUIREMENTS		
		RC01	RC11	RC21	RC31	
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method						
4.17	IEC 60068-2 TEST METHOD 20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage		
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V for RC01 and RC11 , 50 V for RC21 and RC31	R _{ins} min.: 10 ³ MΩ		
4.12		noise	IEC publication 60195 (measured with Quantech - equipment): R ≤ 100 Ω 100 Ω < R ≤ 1 kΩ 1 kΩ < R ≤ 10 kΩ 10 kΩ < R ≤ 100 kΩ 100 kΩ < R ≤ 1 MΩ 1 MΩ < R ≤ 10 MΩ	max. 0.316 μV/V (−10 dB) max. 1 μV/V (0 dB) max. 3 μV/V (9.54 dB) max. 6 μV/V (15.56 dB) max. 10 μV/V (20 dB) max. 32 μV/V (30.10 dB)		
Other applicable tests						
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with P _n or V _{max} : 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(3% +0.1 Ω) ΔR/R max.: ±(5% +0.1 Ω) good tinning; no leaching		
		leaching	unmounted chips; 60 ±1 s; 260 ±5 °C			
		trio damp heat test	1000 +48/−0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.01 P _n or V _{max} R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(3% +0.1 Ω) ΔR/R max.: ±(5% +0.1 Ω)		

Precision chip resistors

sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

FEATURES

- Low assembly costs
- High component and equipment reliability
- Excellent performance at high frequency, especially the RC32.
- TC 50 in thick film technology
- Complete precision SMD family.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value (no printing on RC22H and RC32). Finally, the two external end terminations are added. For ease of soldering the outlayer of these end terminations is a lead/tin alloy.

APPLICATIONS

- All general purpose applications.

QUICK REFERENCE DATA

DESCRIPTION	VALUE					
	RC02H	RC02G	RC12H	RC12G	RC22H	RC32
Size code	1206 (3216)		0805 (2012)		0603 (1608)	0402 (1005)
Resistance range	1 Ω to 10 MΩ	90 Ω to 2.74 MΩ	1 Ω to 10 MΩ	90 Ω to 2.74 MΩ	1 Ω to 10 MΩ	6.8 Ω to 2.2 MΩ
Resistance tolerance and E-series	±1%; E24/E96 series					
Temperature coefficient; note 1:						
1 Ω ≤ R ≤ 10 Ω	≤250 ±250	—	≤250 ±250	—	≤250 ±250	≤250 ±250
10 Ω < R ≤ 10 MΩ	≤±100	≤±50	≤±100	≤±50	≤±100	≤±200
Maximum dissipation at T _{amb} = 70 °C	0.25 W		0.125 W		0.063 W	0.063 W
Maximum permissible voltage	200 V (DC or RMS)		150 V (DC or RMS)		50 V (DC or RMS)	50 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56					55/125/56
Basic specification	IEC 60115-8					

Note

1. All TC values should be multiplied by $10^{-6}/\text{K}$.

Precision chip resistors

RC02/12/22/32

sizes 1206, 0805, 0603 and 0402

1%

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	ORDERING CODE 2322		
	PAPER TAPE ON REEL		
	5000 units	10000 units	20000 units
RC02H	724 6....	724 7....	724 8....
RC02G	722 2....	722 3....	—
RC12H	734 6....	734 7....	734 8....
RC12G	732 6....	732 7....	—
RC22H	704 6....	704 7....	704 8....
RC32	—	706 7....	—
Jumper 0 Ω			
RC02H; note 1	724 92006	724 92007	—
RC12H; note 1	734 92006	734 92007	—
RC22H; note 2	704 92006	704 92007	—
RC32; note 2	—	704 92006	—

Notes

1. The jumper has a maximum resistance $R_{\text{max}} = 50 \text{ m}\Omega$ and a rated current $I_R = 2 \text{ A}$.
2. The jumper has a maximum resistance $R_{\text{max}} = 50 \text{ m}\Omega$ and a rated current $I_R = 1 \text{ A}$.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322.
- The subsequent 4 digits indicate the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a RC02H resistor, value 4750 Ω, supplied on paper tape of 5000 units per reel is: 2322 724 64752.

Precision chip resistors

sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 1\%$. The values of the E24/96 series are in accordance with "IEC publication 60063".

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC02	200	0.25
RC12	150	0.125
RC22	50	0.063
RC32	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

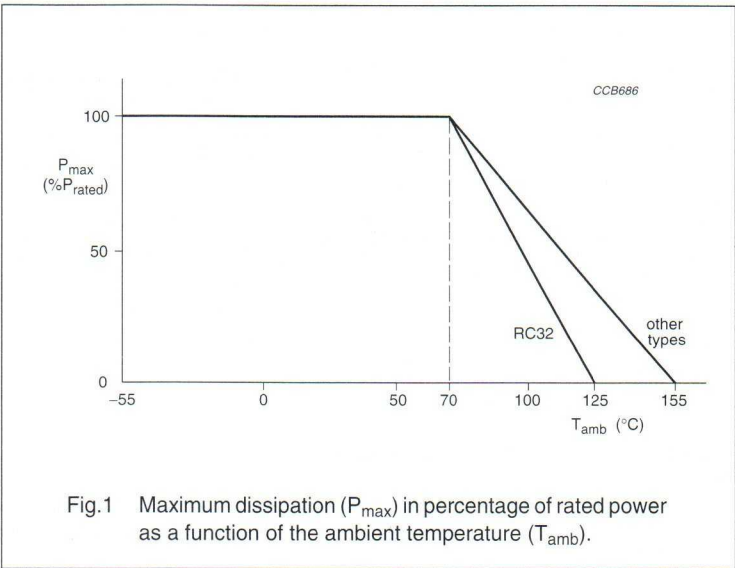


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES

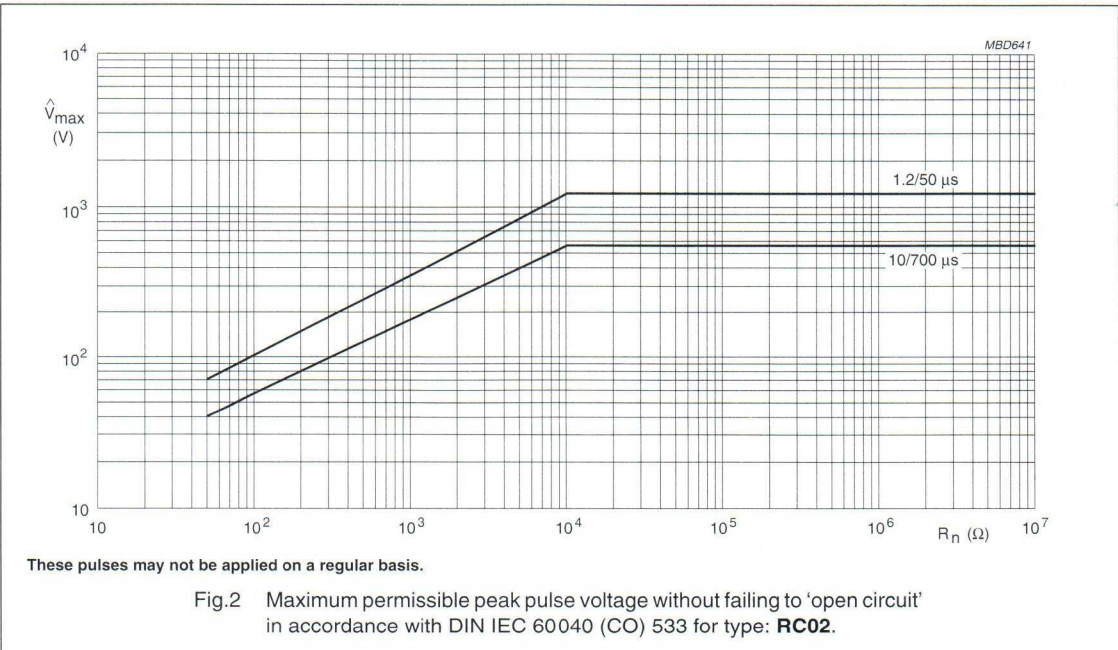
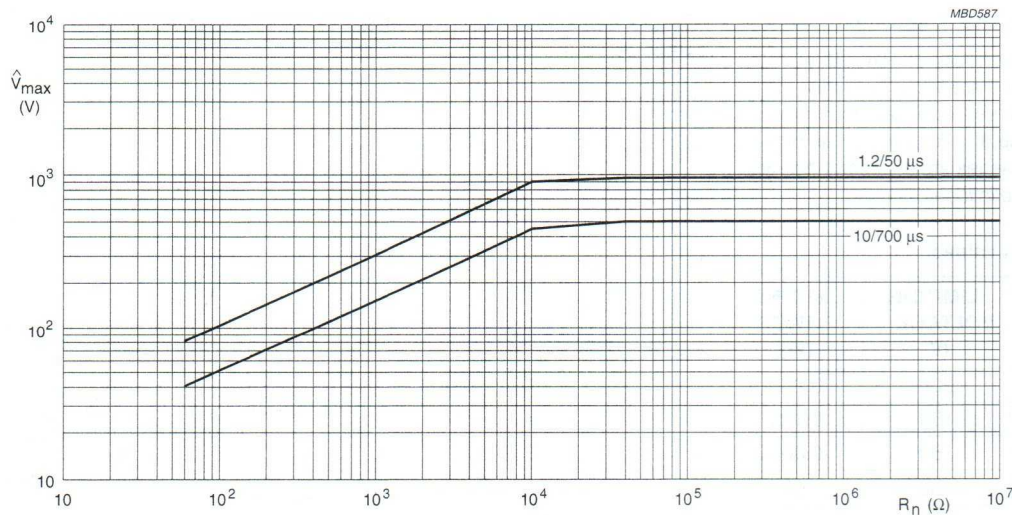


Fig.2 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC02**.

Precision chip resistors

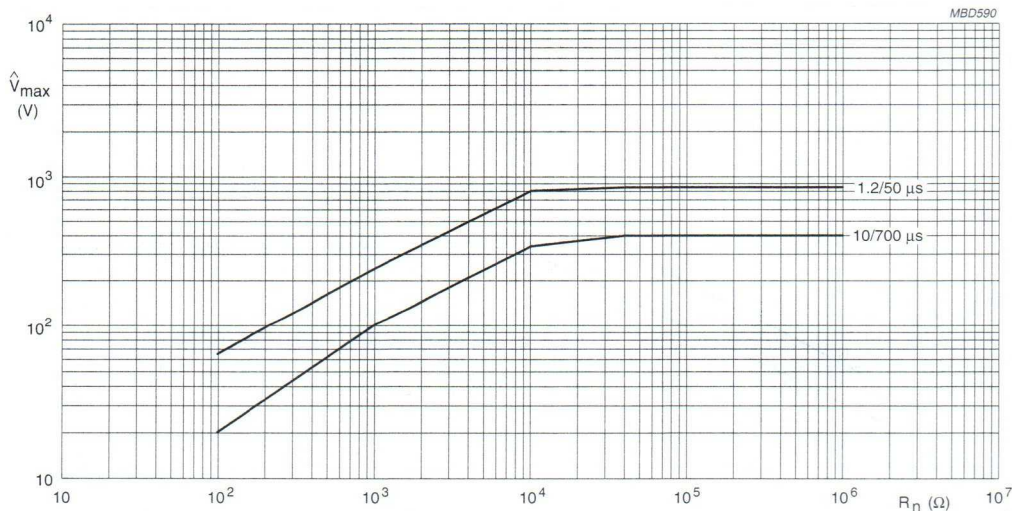
sizes 1206, 0805, 0603 and 0402

RC02/12/22/32
1%



These pulses may not be applied on a regular basis.

Fig.3 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC12**.



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533 for type: **RC22**.

Precision chip resistors

sizes 1206, 0805, 0603 and 0402

RC02/12/22/32
1%

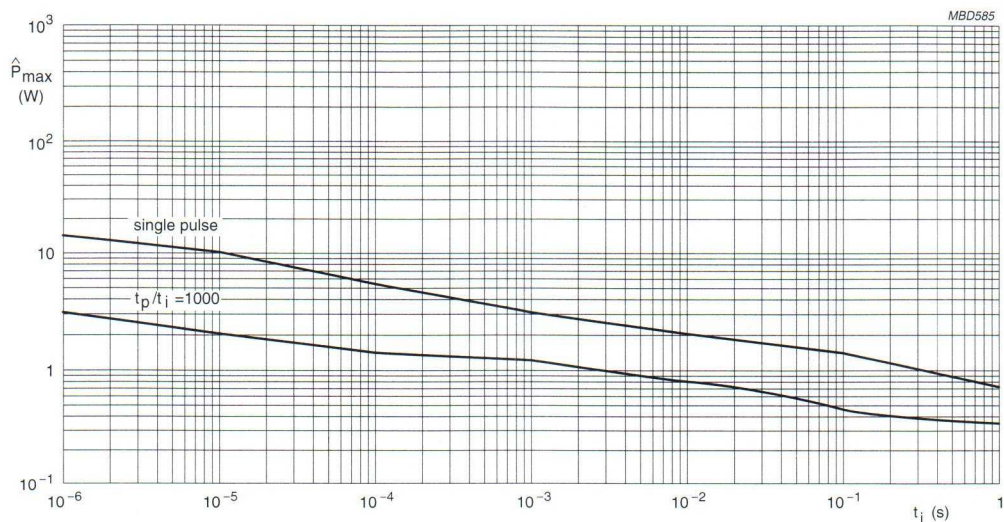


Fig.5 Pulse on a regular basis for type: **RC02**; maximum permissible peak pulse power ($\hat{P}_{\max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

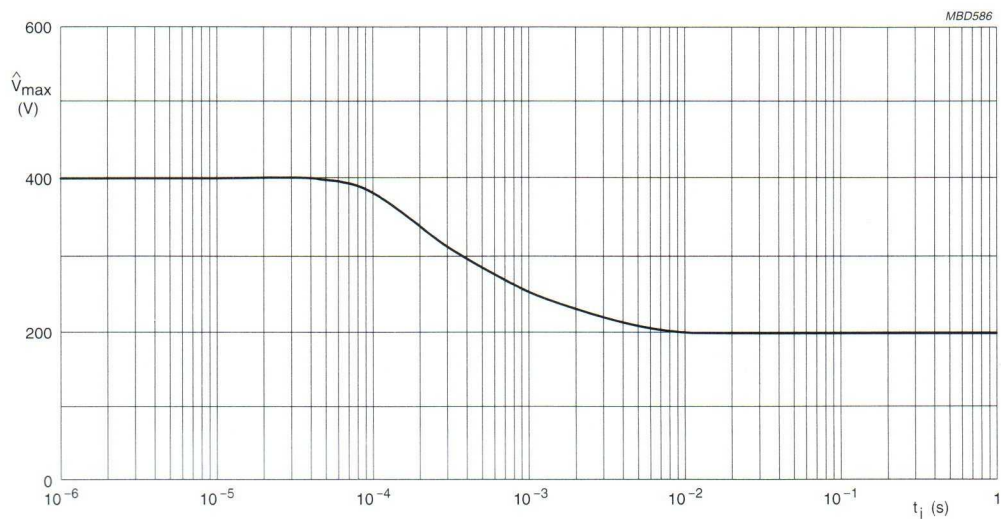


Fig.6 Pulse on a regular basis for type: **RC02**; maximum permissible peak pulse voltage ($\hat{V}_{\max}$) as a function of pulse duration.

Precision chip resistors
sizes 1206, 0805, 0603 and 0402

RC02/12/22/32
1%

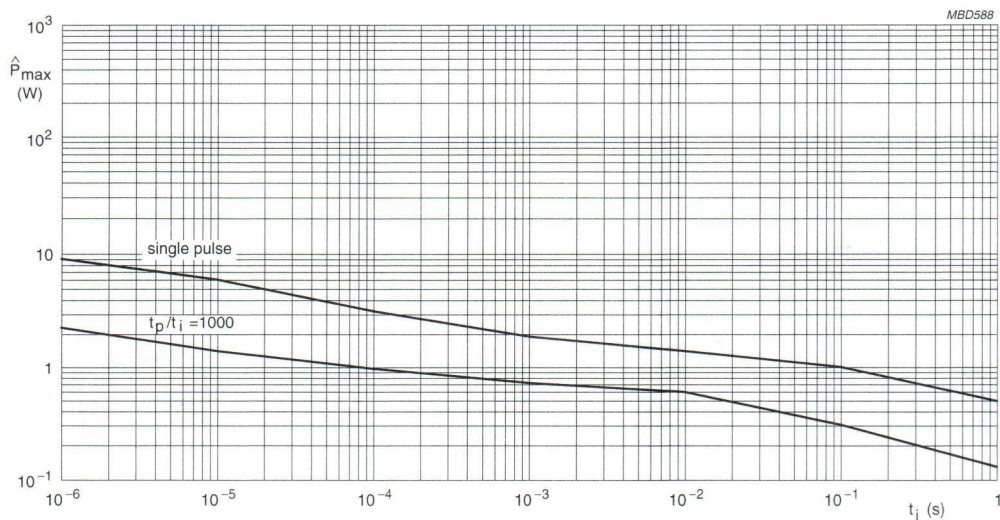


Fig.7 Pulse on a regular basis for type: **RC12**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

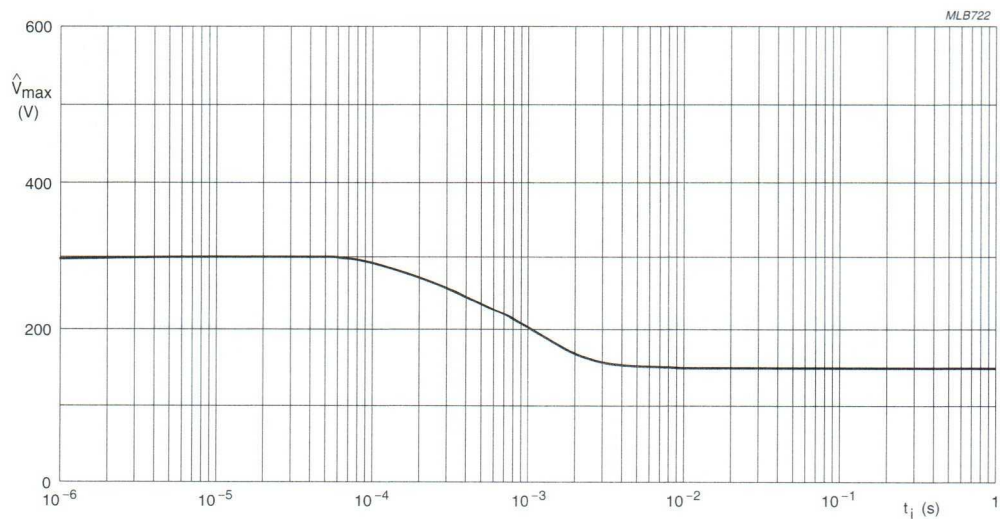


Fig.8 Pulse on a regular basis for type: **RC12**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

Precision chip resistors

sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

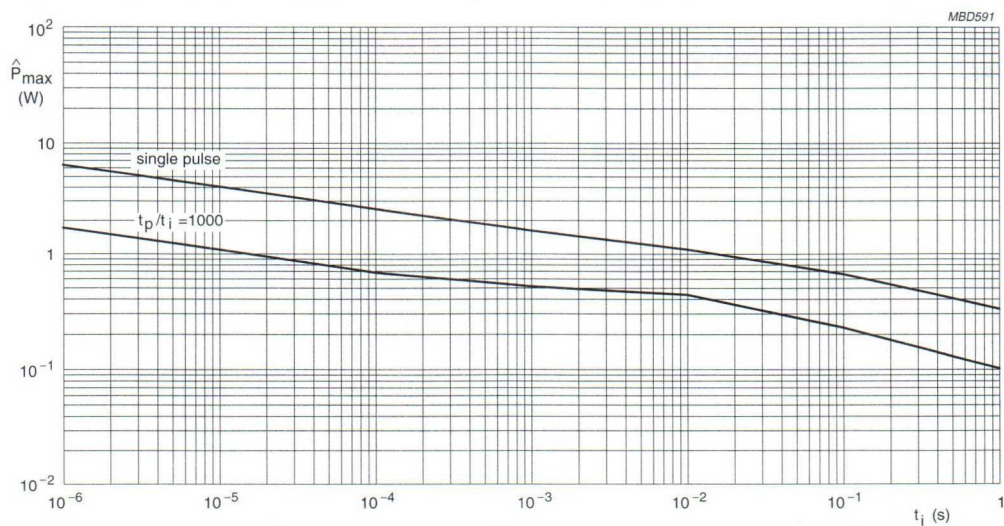


Fig.9 Pulse on a regular basis for type: **RC22**; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

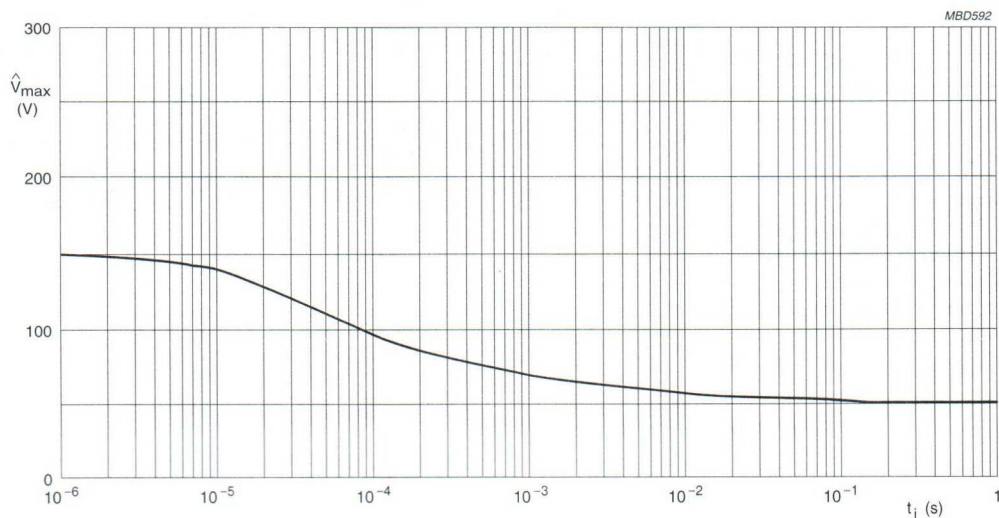


Fig.10 Pulse on a regular basis for type: **RC22**; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

Precision chip resistors sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC02	1.0
RC12	0.55
RC22	0.25
RC32	0.058

Marking

All resistors except RC22 and RC32 are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 k Ω or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

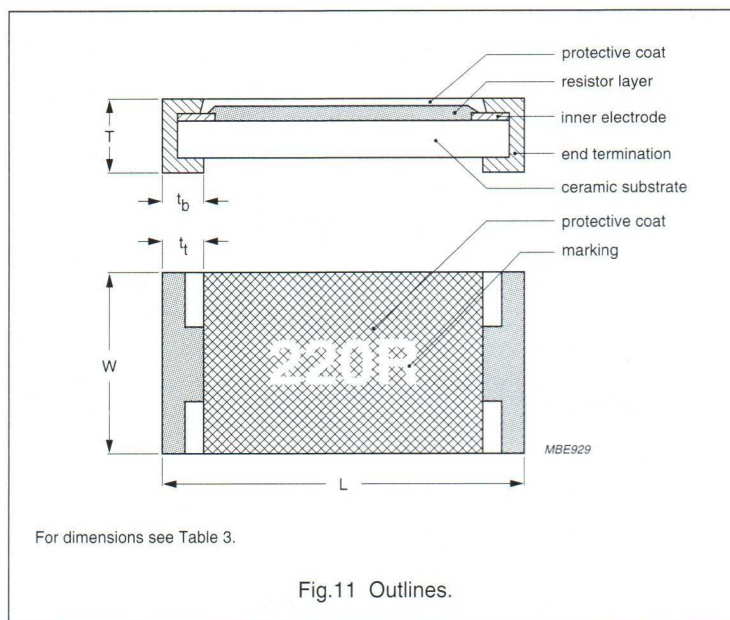
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 k Ω
1503	150 k Ω

PACKAGE MARKING

The packaging of all resistors including RC22 is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Table 3 Chip resistor types and relevant physical dimensions; see Fig.11

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
RC02	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC12	2.00 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20
RC22	1.60 ±0.10	0.80 +0.15/-0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20
RC32	1.00 ±0.05	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10

Precision chip resistors

sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category **LCT/UCT/56** (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	RC02G	RC12H	RC12G	RC22H	RC32
Tests in accordance with the schedule of IEC publication 60115-8									
4.4.1		visual examination		no holes; clean surface; no visible damage					
4.4.2		dimensions (see Fig.11)	gauge (mm)	see Table 3					
4.5		resistance	applied voltage (+0/−10%): R < 10 Ω: 0.1 V 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R < 1 MΩ: 25 V R ≥ 1 MΩ: 50 V	R − R _{nom} : max. ±1%					
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)		no visible damage no visible damage ΔR/R max.: ±(1% +0.05 Ω)			
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H ₂ O followed by brushing in accordance with "MIL 202 F"	no visible damage					

Precision chip resistors
sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

		REQUIREMENTS					PROCEDURE	TEST	IEC 60068-2 TEST METHOD	IEC 60115-8 CLAUSE
		RC02H	RC02G	RC12H	RC12G	RC22H				
4.17		good tinning ($\geq 95\%$ covered); no visible damage					unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	solderability	20 (Ta)	
4.7		no breakdown or flashover					maximum voltage (RMS) during 1 minute, metal block method	voltage proof on insulation		
4.13		$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$					room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	short time overload		
4.33		no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$					resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for RC02H and RC02G ; 5 mm for RC12H , RC12G , RC22H and RC32	bending		
4.19		no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$					30 minutes at LCT and 30 minutes at UCT; 5 cycles	rapid change of temperature	14 (Na)	
4.24.2		$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$					56 days; 40 ± 2 °C; 93 +2/-3% RH; loaded with $0.01 P_n$; $R \leq 1 M\Omega$ $R > 1 M\Omega$	damp heat (steady state)	3 (Ca)	
4.25.1		$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$					1000 +48/-0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off: $R \leq 1 M\Omega$ $R > 1 M\Omega$	endurance		
4.23.2		$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$					1000 +48/-0 hours; no load: $R \leq 1 M\Omega$ $R > 1 M\Omega$	endurance at upper category temperature	27 (Ba)	

Precision chip resistors
sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

		TEST	PROCEDURE	REQUIREMENTS					
IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD			RC02H	RC02G	RC12H	RC12G	RC22H	RC32
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 1 $\Omega \leq R \leq 10 \Omega$ 10 $\Omega < R \leq 10 \text{ M}\Omega$	≤ 250 ± 250 $\leq \pm 100$	– $\leq \pm 50$	≤ 250 ± 250 $\leq \pm 100$	– $\leq \pm 50$	≤ 250 ± 250 $\leq \pm 100$	$\leq 250 \pm 250$ $\leq \pm 200$
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method									
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage					
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V for RC02H, RC02G, RC12H and RC12G, 50 V for RC22H and RC32	R_{ins} min.: 10 ³ M Ω					
4.12		noise	IEC publication 60195 (measured with Quantech - equipment): $R \leq 100 \Omega$ 100 $\Omega < R \leq 1 \text{ k}\Omega$ 1 $\text{k}\Omega < R \leq 10 \text{ k}\Omega$ 10 $\text{k}\Omega < R \leq 100 \text{ k}\Omega$ 100 $\text{k}\Omega < R \leq 1 \text{ M}\Omega$ 1 $\text{M}\Omega < R \leq 10 \text{ M}\Omega$	max. 0.316 $\mu\text{V/V}$ (–10 dB) max. 1 $\mu\text{V/V}$ (0 dB) max. 3 $\mu\text{V/V}$ (9.54 dB) max. 6 $\mu\text{V/V}$ (15.56 dB) max. 10 $\mu\text{V/V}$ (20 dB) max. 32 $\mu\text{V/V}$ (30.10 dB)					

Precision chip resistors
 sizes 1206, 0805, 0603 and 0402

RC02/12/22/32

1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS					
				RC02H	RC02G	RC12H	RC12G	RC22H	RC32
Other applicable tests									
	(JIS) C 5205 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off: R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(2% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)					
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching					
		trio damp heat test	1000 +48/-0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.01 P _n or V _{max} ; R ≤ 1 MΩ R > 1 MΩ	ΔR/R max.: ±(2% +0.1 Ω) ΔR/R max.: ±(3% +0.1 Ω)					

High precision chip resistor size 1206

RC03G 0.5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	90 Ω to 2.74 M Ω
Resistance tolerance and E-series	$\pm 0.5\%$; E24/E96 series
Temperature coefficient: 90 $\Omega \leq R < 250 \Omega$ 250 $\Omega \leq R \leq 2.74 \text{ M}\Omega$	$\leq \pm 100 \times 10^{-6}/\text{K}$ $\leq \pm 50 \times 10^{-6}/\text{K}$
Absolute maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2322 725
			PAPER TAPE ON REEL
			5000 units
RC03G	90 Ω to 2.74 M Ω	± 0.5	1....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 725.
- The subsequent first digit indicates the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
90 to 976 Ω	1
1 to 9.76 k Ω	2
10 to 97.6 k Ω	3
100 to 976 k Ω	4
1 to 2.74 M Ω	5

ORDERING EXAMPLE

The ordering code of a RC03G resistor, value 4750 Ω , supplied on paper tape of 5000 units per reel is: 2322 725 14752.

High precision chip resistor

size 1206

RC03G

0.5%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 0.5\%$. The values of the E24/96 series are in accordance with "IEC publication 60063".

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC03G	200	0.25

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

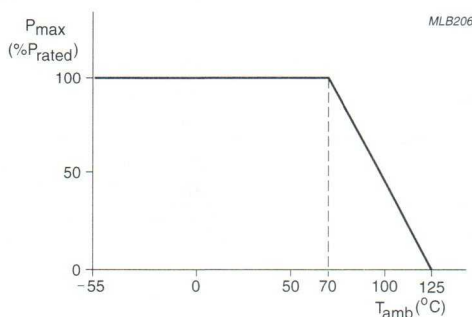
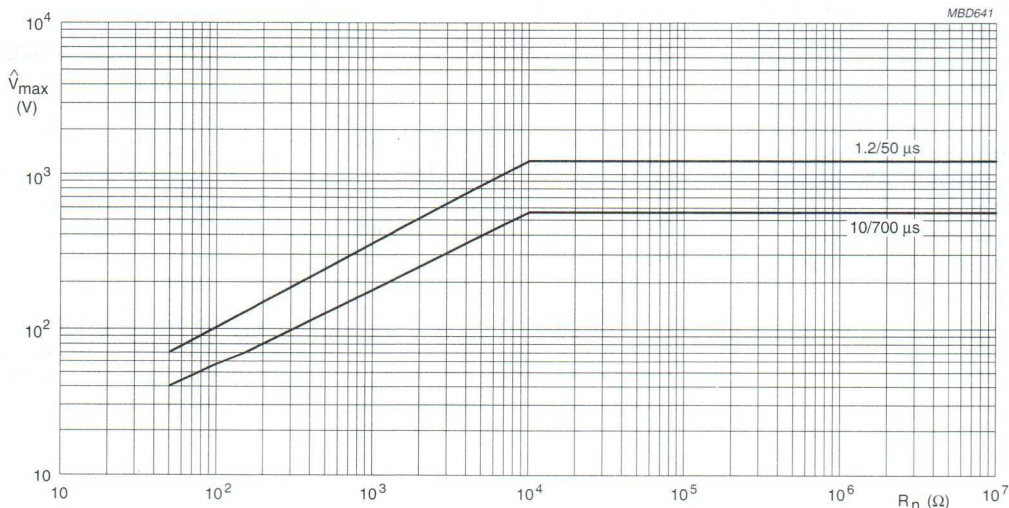


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



These pulses may not be applied on a regular basis.

Fig.2 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

High precision chip resistor size 1206

RC03G
0.5%

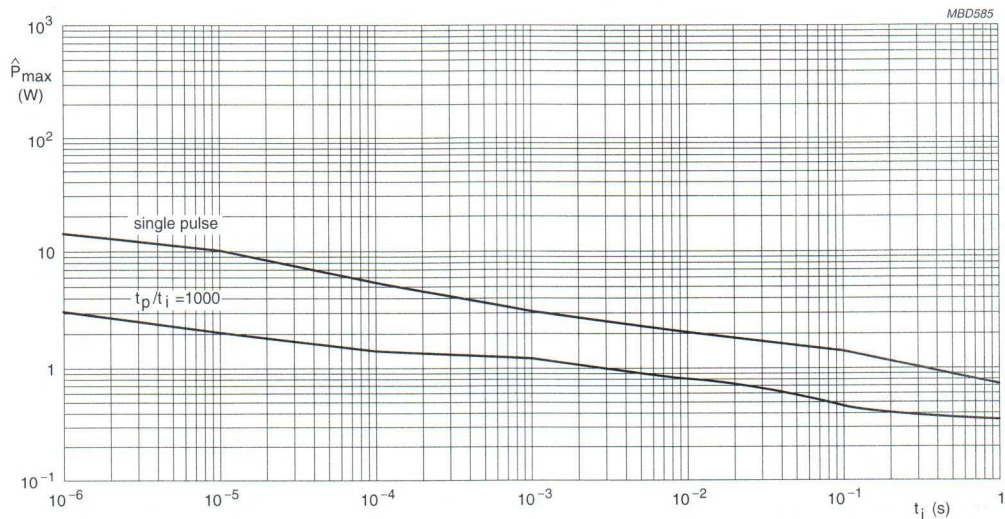


Fig.3 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R \leq 10 \text{ k}\Omega$, single pulse and repetitive pulse $t_p/t_i = 1000$.

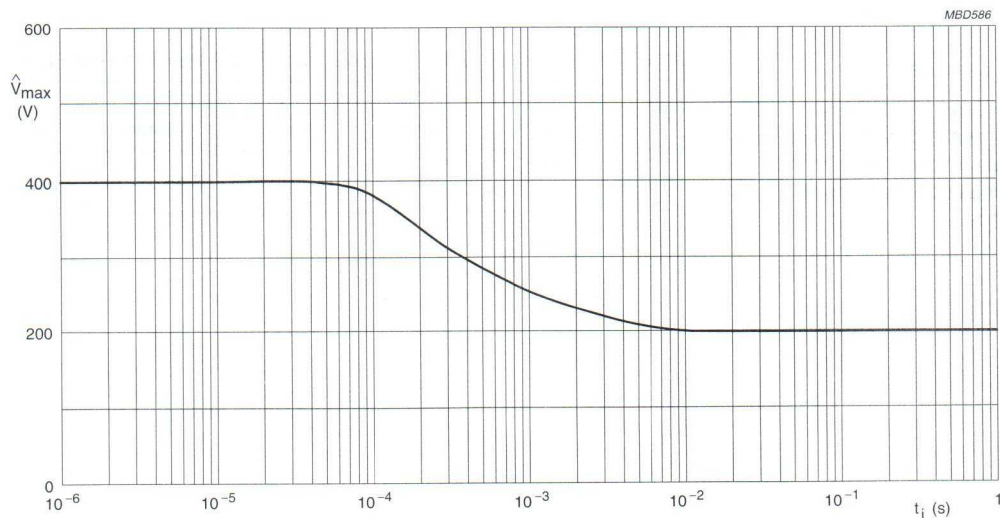


Fig.4 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

High precision chip resistor
size 1206

RC03G
0.5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC03G	1

Marking

All resistors are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

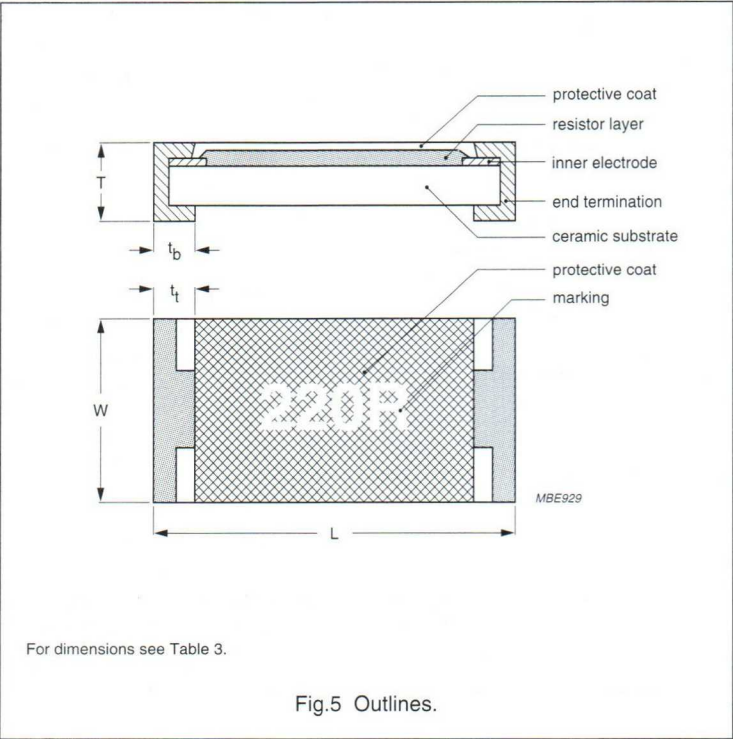


Table 3 Chip resistor type and relevant physical dimensions; see Fig.5

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
RC03G	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

High precision chip resistor size 1206

RC03G

0.5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
		leaching	unmounted chips 60 ± 1 s; 260 ± 5 °C	good tinning; no leaching
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$; dissipation ≤ 1 mW	R_{ins} min.: 1000 M Ω $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.25.1		endurance	$1000 + 48/-0$ hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 M Ω
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at $20/LCT/20$ °C and $20/UCT/20$ °C: $R < 250 \Omega$ $250 \Omega \leq R$	$\leq \pm 100 \times 10^{-6}/K$ $\leq \pm 50 \times 10^{-6}/K$
4.23.2	27 (Ba)	endurance at upper category temperature	$1000 + 48/-0$ hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown

High precision chip resistor size 0805

RC13G 0.5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry
- Computers.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	90 Ω to 2.74 M Ω
Resistance tolerance and E-series	$\pm 0.5\%$; E24/E96 series
Temperature coefficient	$\leq \pm 50 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^{\circ}C$	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2322 738
			PAPER TAPE ON REEL
			5000 units
RC13G	90 Ω to 2.74 M Ω	± 0.5	2

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2338 738.
- The subsequent first digit indicates the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
90 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 k Ω	2
10 to 97.6 k Ω	3
100 to 976 Ω	4
1 to 2.74 M Ω	5

ORDERING EXAMPLE

The ordering code of a RC13G resistor, value 10 k Ω , supplied on paper tape of 5000 units per reel is: 2338 738 21003.

High precision chip resistor size 0805

RC13G
0.5%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24/E96 series for resistors with a tolerance of $\pm 5\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

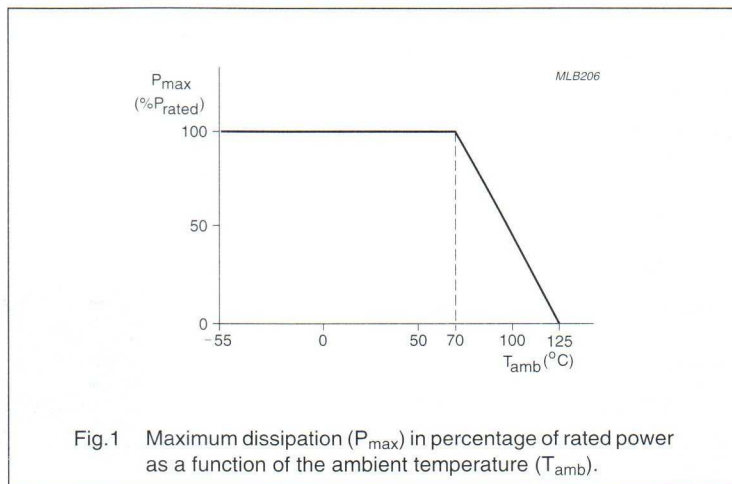
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC13G	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



High precision chip resistor
size 0805

RC13G
0.5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC13G	0.55

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point.

Example

MARKING	RESISTANCE
100R	100 Ω
1001	1 kΩ
1004	1 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

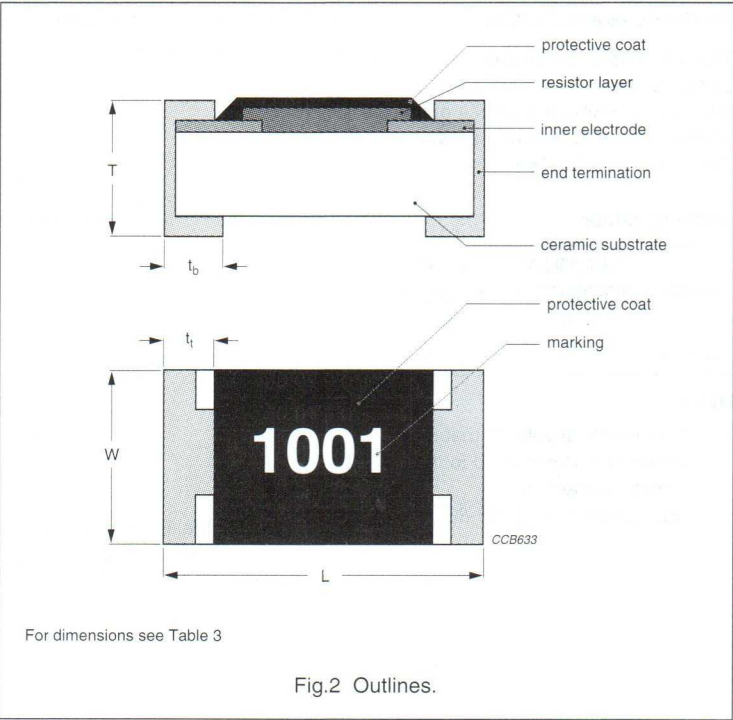


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
RC13G	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

High precision chip resistor

size 0805

RC13G

0.5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068", a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
		leaching	unmounted chips 60 ± 1 s; 260 ± 5 °C	good tinning; no leaching
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$; dissipation ≤ 1 mW	R_{ins} min.: 1000 M Ω $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 M Ω
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(0.25\% + 0.05 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.7		voltage proof on insulation	150 V (RMS) during 1 minute	no breakdown or flashover

Thin film, high precision, high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

FEATURES

- High stability and low temperature coefficient
- Low current noise and high linearity
- Low tolerance: 0.5%.

APPLICATIONS

- Audio and video equipment
- Telecommunication equipment
- Computers
- Automotive.

DESCRIPTION

A metal film layer is deposited on a high grade ceramic body (aluminium oxide). This resistive layer is trimmed to its nominal value and on both ends a contact is made which will guarantee optimum solderability. This is achieved by applying several layers and for ease of soldering the outer layer consists of a lead/tin alloy.

The resistive layer is covered with a protective coating.

QUICK REFERENCE DATA

DESCRIPTION	VALUE				
	TFR01	TFR11	TFR21	TFR31	TFR41
Size code	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)	0201 (0306)
Resistance range	10 Ω to 1 M Ω	10 Ω to 1 M Ω	10 Ω to 360 k Ω	10 Ω to 100 k Ω	33 Ω to 22 k Ω
Resistance tolerance and series	$\pm 0.5\%$; E24 ⁽¹⁾ /E96 series				
Temperature coefficient:					
10 Ω to 91 Ω	$\leq 50 \times 10^{-6}/K$	—	—	—	—
10 Ω to 97.6 Ω	—	$\leq 50 \times 10^{-6}/K$	$\leq 50 \times 10^{-6}/K$	$\leq 100 \times 10^{-6}/K$	—
33 Ω to 22 k Ω	—	—	—	—	$\leq 25 \times 10^{-6}/K$
100 Ω to 100 k Ω	—	—	—	$\leq 25 \times 10^{-6}/K$	—
100 Ω to 360 k Ω	—	—	$\leq 25 \times 10^{-6}/K$	—	—
100 Ω to 1 M Ω	$\leq 25 \times 10^{-6}/K$	$\leq 25 \times 10^{-6}/K$	—	—	—
Maximum dissipation at $T_{amb} = 70^\circ C$	0.125 W	0.1 W	0.063 W	0.063 W	0.05 W
Maximum permissible voltage (DC or RMS)	150 V	100 V	75 V	25 V	15 V
Climatic category (IEC 60068)	55/125/56				
Basic specification	IEC 60115-8 / JIS C 5202				
Stability after: load, 1000 hours at $T_{amb} = 70^\circ C$	$\Delta R/R: \pm(0.5\% + 0.05 \Omega)$				

Note

1. Preferred values are E24.

Thin film, high precision,
high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

ORDERING INFORMATION

The code number can be logically arranged provided that the resistance value may be expressed in three significant digits and an indication of magnitude. Preferred values are E24, E96 values are available.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350
- The subsequent first 4 digits indicate the resistor type, temperature coefficient and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 1 Four digits to indicate resistor type and packaging

TYPE	TC	ORDERING CODE 2350	
		PAPER TAPE ON Ø180 mm REEL	
		5000 units	10000 units
TFR01	25	611 6....	–
	50	610 6....	–
TFR11	25	601 6....	–
	50	600 6....	–
TFR21	25	604 6....	–
	50	603 6....	–
TFR31	25	–	607 6....
	100	–	609 6....
TFR41	25	–	614 6....

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
$10\ \Omega \leq R < 100\ \Omega$	9
$100\ \Omega \leq R < 1\ \text{k}\Omega$	1
$1\ \text{k}\Omega \leq R < 10\ \text{k}\Omega$	2
$10\ \text{k}\Omega \leq R < 100\ \text{k}\Omega$	3
$100\ \text{k}\Omega \leq R < 1\ \text{M}\Omega$	4
$R = 1\ \text{M}\Omega$	5

ORDERING EXAMPLE

The ordering code of a TFR11 resistor, value 153 Ω , TC25, supplied on paper tape of 5 000 units per reel is: 2350 601 61531.

Thin film, high precision,
high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 0.5\%$. The values of the E24/96 series are in accordance with "IEC publication 60063".

Limiting values

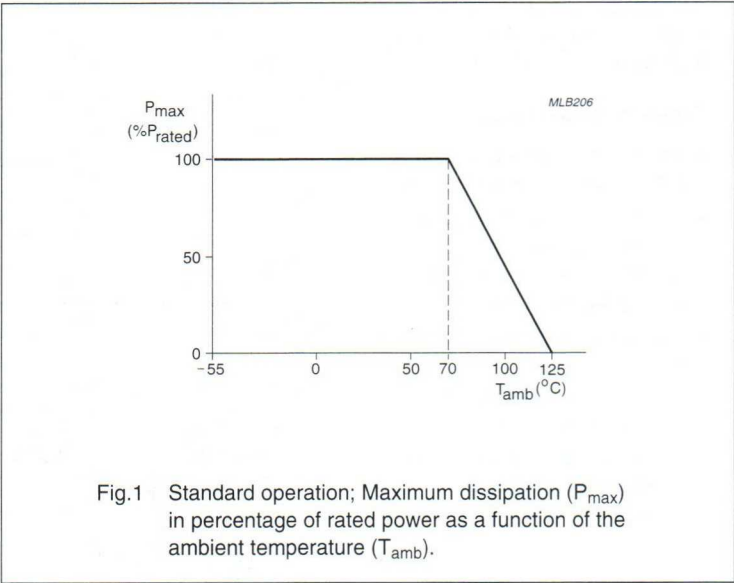
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
TFR01	150	0.125
TFR11	100	0.1
TFR21	75	0.063
TFR31	25	0.063
TFR41	15	0.05

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Thin film, high precision, high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

MECHANICAL DATA

Packaging

The packaging of all resistors is marked and includes resistance value, tolerance, TC value, catalogue number, quantity, production period, batch number and source code.

Outlines

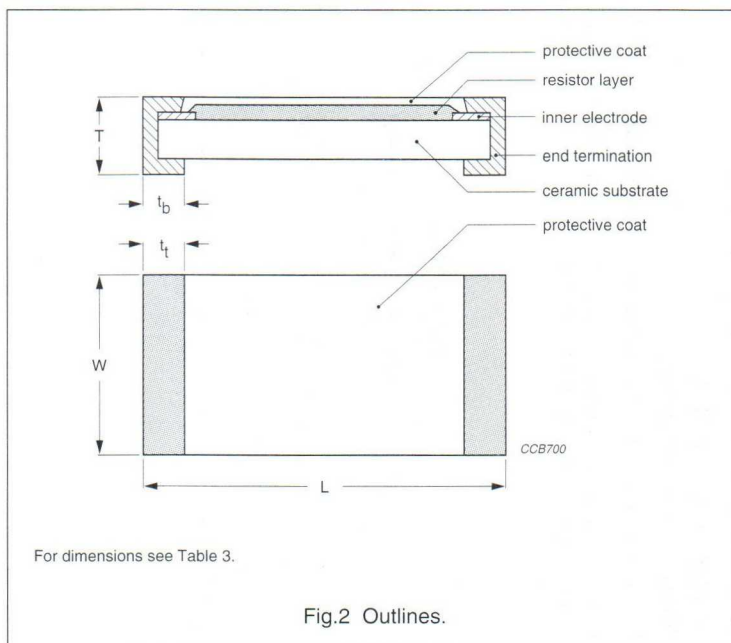


Table 3 Resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
TFR01	3.2 ±0.2	1.6 ±0.2	0.4 ±0.1	0.5 ±0.3	0.50 ±0.3
TFR11	2.0 ±0.2	1.25 ±0.2	0.4 ±0.1	0.4 ±0.2	0.4 ±0.2
TFR21	1.6 ±0.2	0.8 ±0.2	0.4 ±0.1	0.3 ±0.2	0.3 ±0.2
TFR31	1.0 ±0.05	0.5 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.05
TFR41	0.6 ±0.05	0.3 ±0.05	0.23 ±0.03	0.12 ±0.05	0.12 ±0.05

Marking

Resistors of size 0402 are not marked.

In the E24 series, the rated resistance is marked on the protective coating using three digits, which is based on "JIS C 5201 4.2.5":

- The first two digits shall indicate the significant resistance value.
- The last digit indicates the number of zeros to follow the resistance value.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 kΩ

The E96 series is marked with a date code on the protective coating, which is based on "JIS C 5201 10.1.2.(2).(C)".

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "JIS C 5202", "Test method of fixed resistors for electronic equipment". The testing also covers the requirements specified by IEC publication 60115-8 and IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components".

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45% to 75%
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "JIS and IEC"; a short description of the test procedure is also given.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS			
				TFR01	TFR11	TFR21	TFR31
Tests in accordance with the schedule of IEC publication 60115-8							
4.4.1		visual examination		no holes; clean surface; no visible damage			
4.4.2		dimensions (outline)	gauge (mm)	see Table 3			
4.5		resistance	applied voltage (+0/−10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R: 25 V	R − R _{nom} : ±0.5%			
Short term tests							
4.18	IEC 60068-2-20 JIS C 5202 6.4	resistance to soldering heat	unmounted chips; 10 s; 260 ±5 °C	ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.29	IEC 60068-2-45 JIS C 5202 6.9	component solvent resistance	isopropyl alcohol	marking shall be legible; no visible damage			
4.17	IEC 60068-2-20 JIS C 5202 6.5	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±5 °C	good tinning (≥95% covered); no visible damage			
4.7	JIS C 5202 5.7	voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover			

Thin film, high precision,
high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

Thin film, high precision,
high stability, chip resistors

TFR01/11/21/31/41
(1206; 0805; 0603; 0402; 0201)

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS				
				TFR01	TFR11	TFR21	TFR31	TFR41
4.13	JIS C 5202 5.5	short time overload	room temperature; P = 6.25 × P _n ; 5 s (V ≤ 2 × V _{max})		ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.33	JIS C 5202 6.1.4.2 ⁽¹⁾	bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm		no visible damage ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.19	JIS C 5202 7.4	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles		no visible damage ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.6.11	JIS C 5202 5.6	insulation resistance	voltage (DC) after 1 minute metal block method		R _{ins} ≥ 1000 MΩ			
Long term tests								
4.24.2	JIS C 5202 7.9	damp heat steady state	1000 hours; 60 °C; 90 to 95% RH; loaded with P _n or V _{max} for 1.5 hours on and 0.5 hours off		no visible damage ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.25	IEC 60115-8 4.25.1 JIS C 5202 7.10	endurance at 70 °C	1000 hours; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off		no visible damage ΔR/R ≤ ±(0.5% +0.05 Ω)			
4.8.4.2	IEC 60115-8 4.8 JIS C 5202 5.2	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TC × 10 ⁻⁶ /K)		should not exceed the temperature coefficient of resistance as specified in “Quick reference data”			

Note

1. Refer to Table 1 for specific ordering information.

Thin film, ultra high precision, high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

FEATURES

- High stability and low temperature coefficient
- Excellent pulse stability for single pulse conditions
- Low current noise, high linearity and good high frequency performance
- Low tolerance, $\pm 0.1\%$.

APPLICATIONS

- Computers
- Telecommunication equipment
- Test and measuring equipment
- Disk drives
- Automotive.

DESCRIPTION

A metal film layer is deposited on a high grade ceramic body (aluminium oxide). This resistive layer is trimmed to its nominal value and on both ends a contact is made which will guarantee optimum solderability. This is achieved by applying several layers and for ease of soldering the outer layer consists of a lead/tin alloy.

The resistive layer is covered with a protective coating.

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	MPC01	MPC11	MPC21
Size code	1206 (3216)	0805 (2012)	0603 (1608)
Resistance range	10 Ω to 1 M Ω ⁽¹⁾	100 Ω to 1 M Ω ⁽²⁾	100 Ω to 332 k Ω
Resistance tolerance and series	$\pm 0.1\%$; standard values E24 ⁽³⁾ or E96 series		
Temperature coefficient:			
10 Ω to 91 Ω	$\leq \pm 50 \times 10^{-6}/K$	—	—
100 Ω to 249 k Ω	$\leq \pm 10 \times 10^{-6}/K$	—	—
100 Ω to 332 k Ω	—	—	$\leq \pm 25 \times 10^{-6}/K$
100 Ω to 1 M Ω	$\leq \pm 25 \times 10^{-6}/K$	$\leq \pm 25 \times 10^{-6}/K$	—
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.125 W	0.1 W	0.063 W
Maximum permissible voltage (DC or RMS)	150 V	100 V	75 V
Climatic category (IEC 60068)	55/125/56	55/125/56	55/125/56
Basic specification	IEC 60 115-8 / JIS C 5202		
Stability after:			
load, 1000 hours at $T_{amb} = 70^\circ C$	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$
climatic tests	$\Delta R/R \leq \pm 0.25\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$
short term tests	$\Delta R/R \leq \pm 0.1\%$	$\Delta R/R \leq \pm 0.5\%$	$\Delta R/R \leq \pm 0.5\%$

Notes

1. Resistance values for the range 10 Ω to 91 Ω for MPC01 (TC50), are available on request.
2. Resistance values down to 62 Ω for MPC11, are available on request.
3. Preferred range: E24, TC25 and TC50.

Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

ORDERING INFORMATION

The code number can be logically arranged provided that the resistance value may be expressed in three significant digits and an indication of magnitude. Values which cannot be expressed in this way, are available upon request. Preferred values are E24, E96 values are available.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent first 4 digits indicate the resistor type, temperature coefficient and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 1 Four digits to indicate resistor type and packaging

TYPE	TC	ORDERING CODE 2322
		PAPER TAPE ON Ø180 mm REEL
		5000 units
MPC01	50	740 3....
	25	741 3....
	10	781 3....
MPC11	25	744 3....
MPC21	25	747 3....

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
$10\ \Omega \leq R < 100\ \Omega$	9
$100\ \Omega \leq R < 1\ \text{k}\Omega$	1
$1\ \text{k}\Omega \leq R < 10\ \text{k}\Omega$	2
$10\ \text{k}\Omega \leq R < 100\ \text{k}\Omega$	3
$100\ \text{k}\Omega \leq R < 1\ \text{M}\Omega$	4
$R = 1\ \text{M}\Omega$	5

ORDERING EXAMPLE

The ordering code of a MPC01 resistor, value 153 Ω , TC25, supplied on paper tape of 5 000 units per reel is: 2322 741 31531.

Thin film, ultra high precision, high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Limiting values

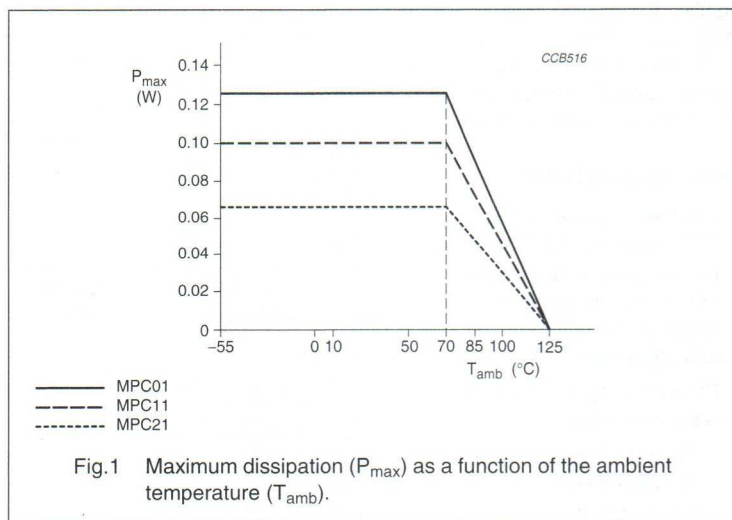
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
MPC01	150	0.125
MPC11	100	0.1
MPC21	75	0.063

Note

- The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

MECHANICAL DATA

Outlines

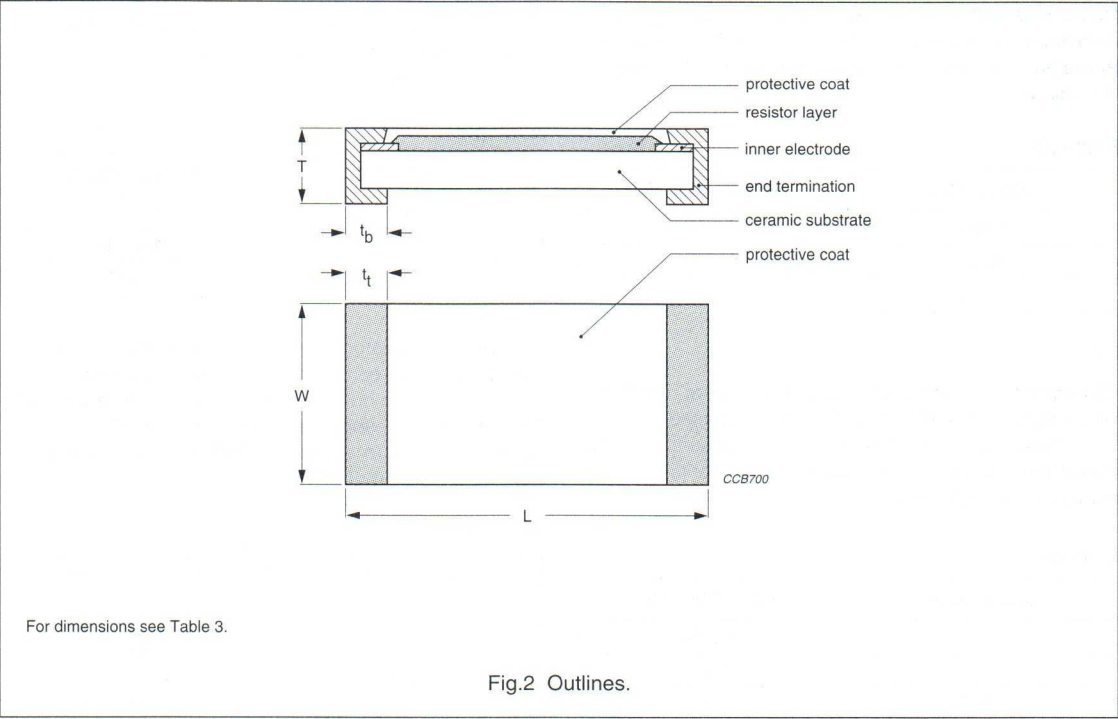


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
MPC01	3.2 ±0.2	1.6 ±0.2	0.4 ±0.1	0.5 ±0.2	0.5 ±0.2
MPC11	2.0 ±0.2	1.25 ±0.2	0.4 ±0.1	0.4 ±0.25	0.4 ±0.2
MPC21	1.6 ±0.2	0.80 ±0.2	0.4 ±0.1	0.3 ±0.2	0.3 ±0.2

Thin film, ultra high precision, high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

Marking

MPC01

Resistors are marked with four digits representing the nominal resistance value. The first three digits represent the value, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
5100	51 Ω
4301	430 Ω
1503	15 k Ω

MPC11

E24 series: Resistors from the E24 series are marked with three digits on the protective coating based on "JIS C 5201 4.2.5". The first two digits represent the value of rated resistance, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 k Ω

E96 series: Resistors from the E96 series are marked with a four digit code number based on "JIS C 5201 4.2.5". The first three digits represent the value of rated resistance, and the last digit represents the number of zeros to follow. The decimal point is represented by 'R'.

Example: 4 digit marking

MARKING	RESISTANCE
5100	51 Ω
4301	430 Ω
1503	15 k Ω

MPC21

E24 series: Resistors from the E24 series are marked with three digits on the protect coating based on "JIS C 5201 4.2.5". The first two digits represent the value of rated resistance, and the last digit represents the number of zeros that follow.

Example

MARKING	RESISTANCE
510	51 Ω
431	430 Ω
153	15 k Ω

E96 series: Resistors from the E96 series are either marked with a three digit manufacturing date code or with a three digit code number. The first two digits are listed in Table 4 and represent the resistance value. The subsequent digit is listed in Table 5 and represents the number of zeros that follow.

Example

MARKING	RESISTANCE
69R	51.1 Ω
62A	432 Ω
18C	15.0 k Ω

PACKAGE MARKING

The packaging of all resistors is marked and includes type designation, quantity, manufacturing date code, manufacturers name and the country of origin.

Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

Two digit resistance code for E96 series

Table 4 First two digits of the resistance code

VALUE	CODE	VALUE	CODE	VALUE	CODE	VALUE	CODE
100	01	178	25	316	49	562	73
102	02	182	26	324	50	576	74
105	03	187	27	332	51	590	75
107	04	191	28	340	52	604	76
110	05	196	29	348	53	619	77
113	06	200	30	357	54	634	78
115	07	205	31	365	55	649	79
118	08	210	32	374	56	665	80
121	09	215	33	383	57	681	81
124	10	221	34	392	58	698	82
127	11	226	35	402	59	715	83
130	12	232	36	412	60	732	84
133	13	237	37	422	61	750	85
137	14	243	38	432	62	768	86
140	15	249	39	442	63	787	87
143	16	255	40	453	64	806	88
147	17	261	41	464	65	825	89
150	18	267	42	475	66	845	90
154	19	274	43	487	67	866	91
158	20	280	44	499	68	887	92
162	21	287	45	511	69	909	93
165	22	294	46	523	70	931	94
169	23	301	47	536	71	953	95
174	24	309	48	549	72	976	96

Table 5 Multiplier codes; see Table 4

CODE	A	H	C	D	E	F	R	S
Multipliers	1	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁻¹	10 ⁻²

Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "JIS C 5202". "Test method of fixed resistors for electronic equipment". The testing also covers the requirements specified by IEC publication 60115-8 and IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components".

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

In Table 6 the tests and requirements are listed with reference to the relevant clauses of "JIS and IEC"; a short description of the test procedure is also given.

Table 6 Test procedures and requirements

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
Tests in accordance with the schedule of IEC publication 60115-8						
4.4.1		visual examination		no holes; clean surface; no visible damage		
4.4.2		dimensions (outline)	gauge (mm)	see Table 3		
4.5		resistance	applied voltage (+0/−10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R: 25 V	R − R _{nom} : max. ±0.1% or ±0.5%		
Short term tests						
4.18	IEC 60068-2-20 JIS C 5202 6.4	resistance to soldering heat	unmounted chips; 10 s; 260 ±5 °C	ΔR/R ≤ ±0.1%	ΔR/R ≤ ±0.5%	
4.29	IEC 60068-2-45 JIS C 5202 6.9	component solvent resistance	isopropyl alcohol	marking shall be legible; no visible damage		

Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
4.17	IEC 60068-2-20 JIS C 5202 6.5	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 5 °C	good tinning ($\geq 95\%$ covered); no visible damage		
4.7	IEC 60115-8 4.7 JIS C 5202 5.7	voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover at 300 V	no breakdown or flashover at 200 V	no breakdown or flashover at 100 V
4.13	IEC 60115-8 4.13 JIS C 5202 5.5	short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R \leq \pm 0.1\%$	$\Delta R/R \leq \pm 0.5\%$	
4.33	IEC 60115-8 4.33 JIS C 5202 6.1.4.2 ⁽¹⁾	bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm	no visible damage $\Delta R/R \leq \pm 0.1\%$	no visible damage $\Delta R/R \leq \pm 0.5\%$	
4.19	IEC 60115-8 4.19 JIS C 5202 7.4	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R \leq \pm 0.1\%$	no visible damage $\Delta R/R \leq \pm 0.5\%$	
4.6.11	JIS C 5202 5.6	Insulation resistance	voltage (DC) after 1 minute metal block method	$R_{ins} \geq 1000 \text{ M}\Omega$ at 300 V	$R_{ins} \geq 1000 \text{ M}\Omega$ at 200 V	$R_{ins} \geq 1000 \text{ M}\Omega$ at 100 V

Thin film, ultra high precision,
high stability, chip resistors

MPC01/11/21
(1206; 0805; 0603)

IEC 60115-8 CLAUSE	TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				MPC01	MPC11	MPC21
Long term tests						
4.24.2	JIS C 5202 7.9	damp heat steady state	1000 hours; 40 °C; 90 to 95% RH; loaded with P _n or V _{max} for 1.5 hours on, 0.5 hours off	ΔR/R ≤ ±0.25%	ΔR/R ≤ ±0.5%	
4.25	IEC 60115-8 4.25.1 JIS C 5202 7.10	endurance at 70 °C	1000 hours; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	ΔR/R ≤ ±0.25%	ΔR/R ≤ ±0.5%	
4.23.2	IEC 60115-8 4.25.3 JIS C 5202 7.11	endurance at upper category temperature	1000 hours; no load	ΔR/R ≤ ±0.25%	ΔR/R ≤ ±0.5%	
4.8.4.2	IEC 60115-8 4.8 JIS C 5202 5.2	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TC × 10 ⁻⁶ /K)	should not exceed the temperature coefficient of resistance as specified in "Quick reference data"		

Note

1. Refer to Table 1 for specific ordering information.

RNA310
5%

Resistor network

FEATURES

- 8 resistors in one 1206 package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

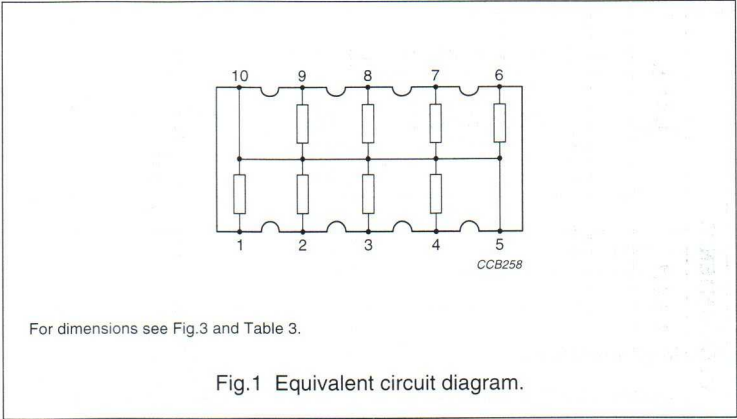
APPLICATIONS

- Motherboards
- Notebook computers
- Printers
- CD-ROM
- PDA
- Camcorders, etc.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	10 Ω to 100 k Ω ; E24 series
Resistance tolerance	$\pm 5\%$
Temperature coefficient: 10 Ω to 100 Ω 100 Ω to 100 k Ω	$\leq 250 \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	$\frac{1}{32}$ W
Maximum permissible voltage	25 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Resistor network

RNA310

5%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE VALUE	TOL. (%)	ORDERING CODE 2350 230
			PAPER TAPE ON REEL
			5000 units
RNA310	10 Ω to 100 k Ω	± 5	10...
Jumper 0 Ω			
RNA310	—	—	91001

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 230
- The subsequent two digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 k Ω	2
10 to 91 k Ω	3
100 to 910 k Ω	4

ORDERING EXAMPLE

The ordering code of an RNA310 chip resistor, value 47 Ω , supplied on paper tape of 5000 units per reel is: 2350 230 10479.

RNA310
5%

Resistor network

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

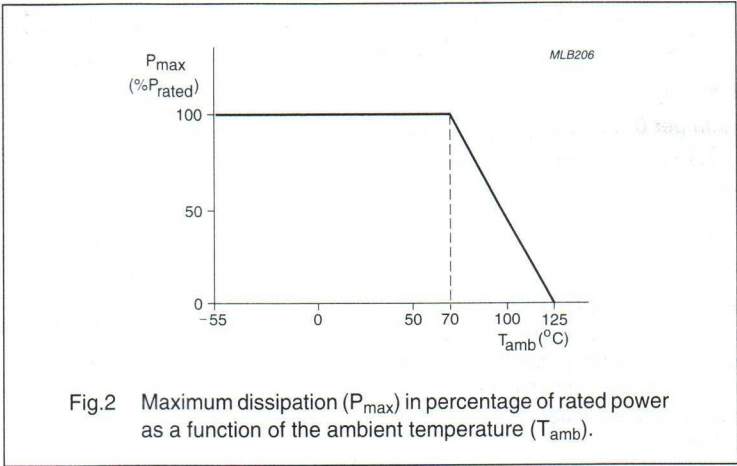
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RNA310	25	$\frac{1}{32}$ W

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.2.



RNA310
5%

Resistor network

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RNA310	1.0

Marking

Each resistor is marked with a 3-digit code on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R	12 Ω
102	1 k Ω
101	100 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

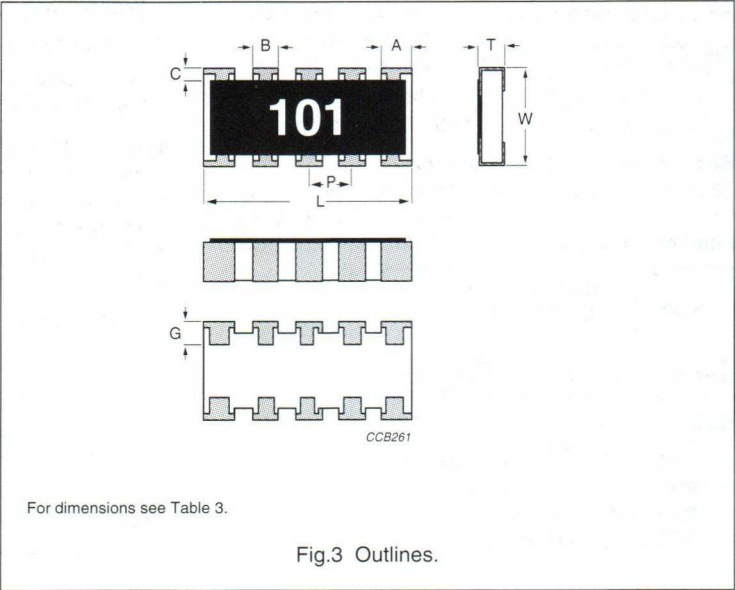


Table 3 Physical dimensions; see Fig.3

SYMBOL	VALUE	TOL.	UNIT
L	3.30	± 0.20	mm
W	1.60	± 0.15	mm
T	0.55	± 0.10	mm
A	0.50	± 0.05	mm
C	0.40	± 0.15	mm
P	0.64	± 0.05	mm
G	0.40	± 0.15	mm
B	0.35	± 0.05	mm

Resistor network

RNA310

5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with "MIL 202 F"	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.7		voltage proof on insulation	25 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 + 2/-3\%$ RH; loaded with $0.01 P_n$	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$

Resistor network

RNA310

5%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 10 Ω $\leq$ R $\leq$ 100 Ω 100 Ω < R $\leq$ 100 k Ω	$\leq 250 \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 $\pm$ 0.5 s in a solder bath at 235 $\pm$ 2 °C	good tinning ($\geq$ 95% covered); no damage
4.6.1.1		insulation resistance	25 V (DC) after 1 minute	R _{ins} min.: 10 ³ M Ω
Other applicable tests				
	(JIS)	resistance to damp heat	1 000 +48/-0 hours; 93 +2/-3% RH; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
		leaching	unmounted chips; 60 $\pm$ 1 s; 260 $\pm$ 5 °C	good tinning; no leaching

Array chip resistors

size 4 × 0603

ARC241/242

ARV241

FEATURES

- 4 × 0603 sized resistors in one 1206-sized package
- Reduced reel exchange time
- Low assembly costs
- Reduced PCB area
- Reduced size of final equipment.

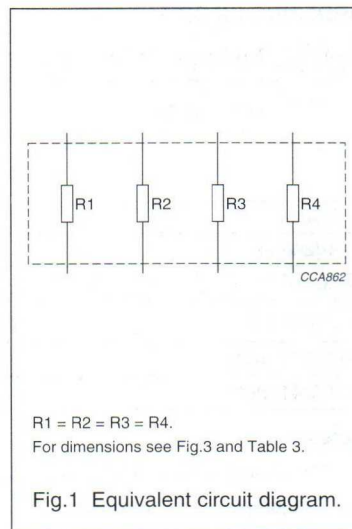
APPLICATIONS

- Computers
- Microcomputer driven applications:
 - Portable radios
 - CD and cassette players
 - Car telephones
 - Camcorders
 - Cordless, cellular phones.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	ARC241	ARV241	ARC242
Resistance range	10 Ω to 1 MΩ		
Resistance tolerance and E-series	±5%; E24 series		±1%; E96 series
Temperature coefficient	≤±200 × 10 ⁻⁶ /K		≤±100 × 10 ⁻⁶ /K
Absolute maximum dissipation per resistive element at T _{amb} = 70 °C	0.063 W		
Maximum permissible voltage	50 V (DC or RMS)		
Climatic category (IEC 60068)	55/155/56		
Basic specification	IEC 60115-8		

R-Array overview

TYPE	TERMINATION TECHNOLOGY	SIZE	TOLERANCE (%)
ARC241	concave	4 × 0603	5
ARC242	concave	4 × 0603	1
ARV241	convex	4 × 0603	5

Array chip resistors size 4 × 0603

ARC241/242 ARV241

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type

TYPE	ORDERING CODE 2350 0.. ⁽¹⁾
	PAPER TAPE ON REEL
	5000 units
ARC241	34 10...
ARV241	35 10...
ARC242	24 1....
Jumper 0 Ω	
ARC241; note 2	34 91001
ARV241; note 2	35 91001

Notes

1. The arrays are supplied in paper tape on reel, 5000 units
2. The jumper has a maximum resistance $R_{\max} = 50 \text{ m}\Omega$ and a rated current $I_R = 1 \text{ A}$.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 0
- The subsequent three or four digits indicate the resistor termination style, tolerance and packaging; see Table 1.
- The remaining digits indicate the resistance value:
 - The first 2 digits for 5% or 3 digits for 1% tolerance products indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

ORDERING EXAMPLE

The ordering code of an ARC241 resistor, value 100 Ω, supplied on paper tape of 5000 units per reel is: 2350 034 10101.

Array chip resistors
size 4 × 0603

ARC241/242
ARV241

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 or E96 series for resistors with a tolerance of $\pm 5\%$ or $\pm 1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Limiting values

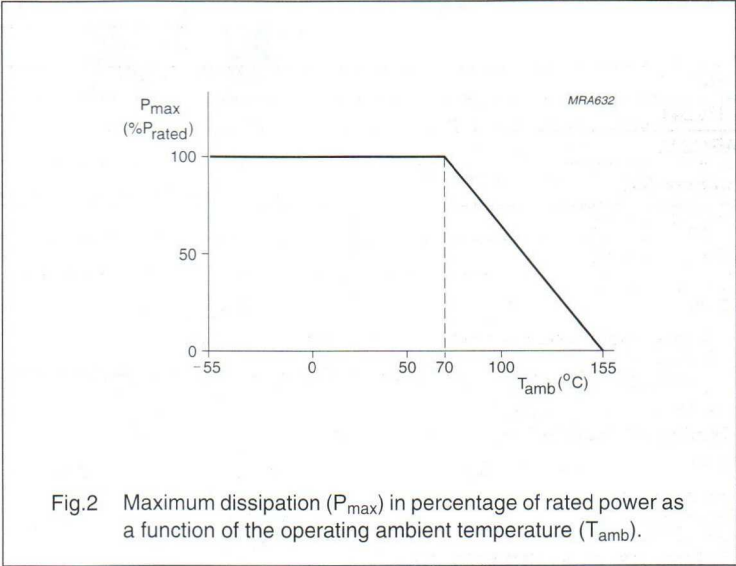
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
ARC241	50	0.063
ARC242		
ARV241		

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating ambient temperature; see Fig.2.



Array chip resistors
size 4 × 0603

ARC241/242
ARV241

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
All types	1.1

Marking

All resistors within the E24 series are marked with a 3-digit code and a 4-digit code for resistors of the E96 series, on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 91 Ω the R is used as a decimal point. For values of 100 Ω or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R	12 Ω
124	120 kΩ
000	jumper

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 K or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R0	12 Ω
1203	120 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

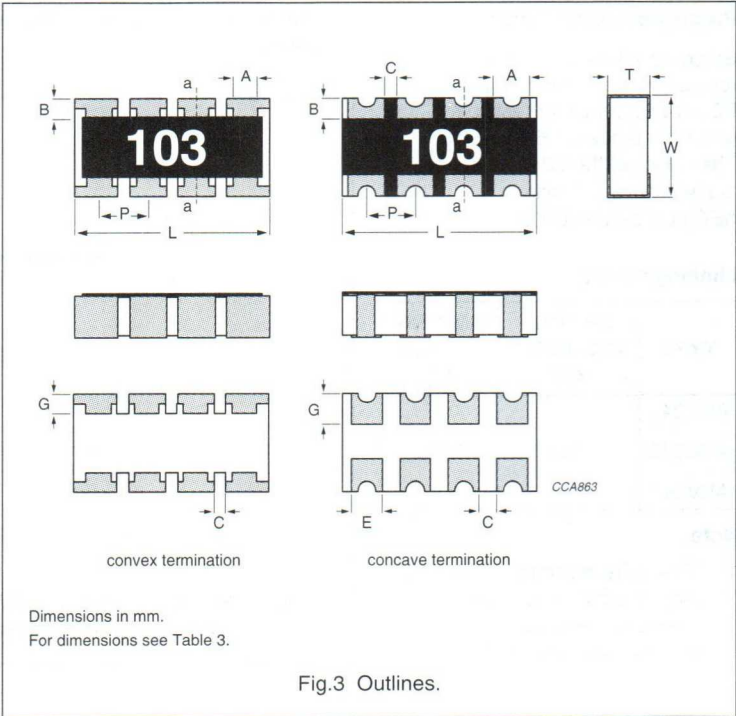


Table 3 Physical dimensions; see Fig.3

SYMBOL	ARC241/242		ARV241		UNIT
	VALUE	TOL.	VALUE	TOL.	
L	3.20	+0.20/-0.10	3.20	±0.15	mm
W	1.60	+0.20/-0.10	1.60	±0.15	mm
T	0.60	±0.20	0.55	±0.10	mm
A	0.60	±0.15	0.40	±0.15	mm
B	0.35	±0.15	0.30	±0.20	mm
P	0.80	±0.15	0.80	±0.15	mm
E	0.50	±0.15	—	—	mm
G	0.50	±0.15	0.30	±0.15	mm
C	0.10	min.	0.10	min.	mm

Array chip resistors size 4 × 0603

ARC241/242
ARV241

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic

climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given.

In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	ARV241	ARC242
Tests in accordance with the schedule of IEC publication 60115-8						
4.4.1		visual examination		no holes; clean surface; no visible damage		
4.4.2		dimensions (outline; see Fig.3)	gauge (mm)	see Table 3		
4.5		resistance	applied voltage (+0/−10%): 10 Ω ≤ R < 100 Ω: 0.3 V 100 Ω ≤ R < 1 kΩ: 1 V 1 kΩ ≤ R < 10 kΩ: 3 V 10 kΩ ≤ R < 100 kΩ: 10 V 100 kΩ ≤ R < 1 MΩ: 25 V R ≥ 1 MΩ: 50 V	R − R _{nom} : max. ±5%	R − R _{nom} : max. ±5%	R − R _{nom} : max. ±1%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ±1 s; 260 ±5 °C	no visible damage ΔR/R max.: ±(0.5% +0.05 Ω)		
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H ₂ O followed by brushing in accordance with “MIL 202 F”	no visible damage		
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage		
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute, metal block method	no breakdown or flashover		
4.13		short time overload	room temperature; P = 6.25 × P _n ; 5 s (V ≤ 2 × V _{max})	ΔR/R max.: ±(1% +0.05 Ω)		

Array chip resistors size 4 × 0603

ARC241/242

ARV241

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	ARV241	ARC242
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage		
				$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$		$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage		
				$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$		
4.24.2	3 (Ca)	damp heat (steady state)	56 days; $40 \pm 2 \text{ }^{\circ}\text{C}$; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$		$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.25.1		endurance	1000 $\pm 48/-0$ hours; $70 \pm 2 \text{ }^{\circ}\text{C}$; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$		$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 $\pm 48/-0$ hours; no load	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$		$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/ $20 \text{ }^{\circ}\text{C}$ and 20/UCT/ $20 \text{ }^{\circ}\text{C}$	$\leq 200 \times 10^{-6}/\text{K}$		$\leq 100 \times 10^{-6}/\text{K}$
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method						
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours $155 \text{ }^{\circ}\text{C}$; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at $235 \pm 2 \text{ }^{\circ}\text{C}$	good tinning ($\geq 95\%$ covered); no damage		
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 10 V	R_{ins} min.: $10^3 \text{ M}\Omega$		
4.12		noise	IEC publication 60195 (measured with Quantech-equipment) $R \leq 100 \Omega$ $100 \Omega < R \leq 1 \text{ k}\Omega$ $1 \text{ k}\Omega < R \leq 10 \text{ k}\Omega$ $10 \text{ k}\Omega < R \leq 100 \text{ k}\Omega$ $100 \text{ k}\Omega < R \leq 1 \text{ M}\Omega$	max. $0.316 \mu\text{V/V}$ (-10 dB) max. $1 \mu\text{V/V}$ (0 dB) max. $3 \mu\text{V/V}$ (9.54 dB) max. $6 \mu\text{V/V}$ (15.56 dB) max. $10 \mu\text{V/V}$ (20 dB)		

Array chip resistors
size 4 × 0603

ARC241/242
ARV241

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS		
				ARC241	ARV241	ARC242
Other applicable tests						
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/−0 hours; 40 ±2 °C; 93 +2/−3% RH; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)	ΔR/R max.: ±(2% +0.1 Ω)	
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching		

Array chip resistor size 4 × 0402

ARV341

5%

FEATURES

- 4 × 0402 sized resistors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Motherboards
- Notebook computers
- Add-on cards
- Mobile phones
- PDA
- Dual In line Memory Module (DIMM).

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	10 Ω to 1 MΩ; E24 series
Resistance tolerance	±5%
Temperature coefficient	≤±300 × 10 ⁻⁶ /K
Absolute maximum dissipation at T _{amb} = 70 °C	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Operating temperature range	-55 to +125 °C
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	ORDERING CODE 2350 033	
	PAPER TAPE ON REEL	
	5000 units	10000 units
ARV341	10...	11...
Jumper 0 Ω		
ARV341; see note 1	91002	91001

Note

1. The jumper has a maximum resistance R_{max} = 50 mΩ and a rated current I_R = 1 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 033
- The subsequent two digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE	LAST DIGIT
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

ORDERING EXAMPLE

The ordering code of an ARV341 resistor, value 100 Ω, supplied on paper tape of 5000 units per reel is: 2350 033 10101.

Array chip resistor size 4 × 0402

ARV341
5%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

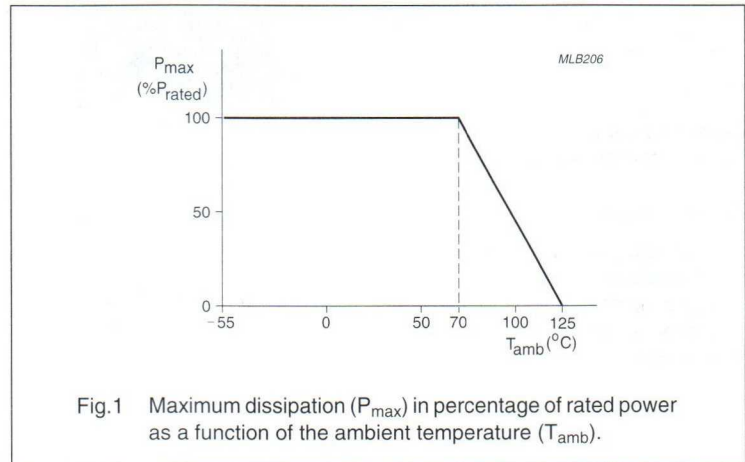
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
ARV341	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Array chip resistor size 4 × 0402

ARV341 5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
ARV341	0.20

Marking

There is no marking on the product;
the product is marked on request.

PACKAGE MARKING

The packaging is marked and
includes resistance value, tolerance,
catalogue number, quantity,
production period, batch number and
source code.

Outlines

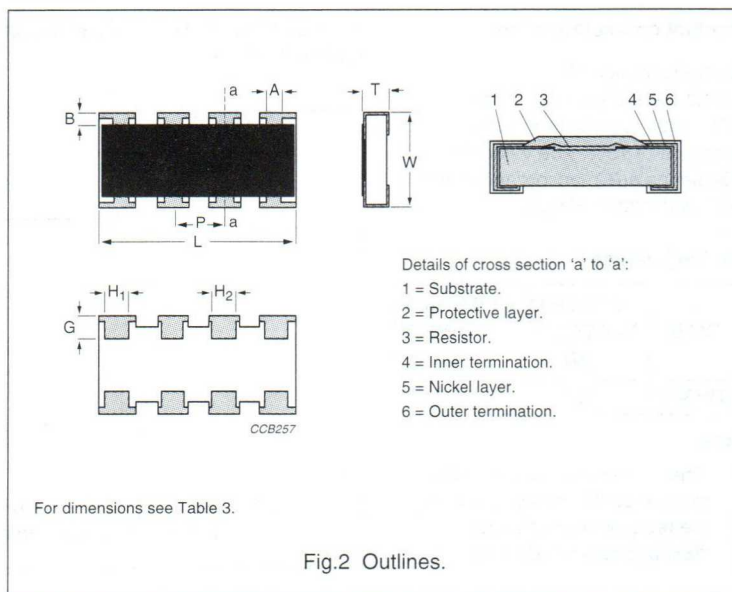


Table 3 Physical dimensions; see Fig.2

SYMBOL	VALUE	TOL.	UNIT
L	2.0	±0.10	mm
W	1.0	±0.10	mm
T	0.5	±0.10	mm
A	0.2	±0.15	mm
B	0.2	±0.10	mm
P	0.5	±0.10	mm
G	0.3	±0.10	mm
H ₁	0.3	±0.10	mm
H ₂	0.2	±0.05	mm

Array chip resistor

size 4 × 0402

ARV341

5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H ₂ O followed by brushing in accordance with "MIL 202 F"	no visible damage
4.7		voltage proof on insulation	50 V (DC or RMS) during 1 minute metal block method	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\leq \pm 300 \times 10^{-6}/K$

Array chip resistor
size 4 × 0402

ARV341
5%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	16 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.6.1.1		insulation resistance	50 V (DC) after 1 minute, metal block method: 10 V	R_{ins} min.: 10 ³ MΩ
4.12		noise	IEC publication 60195 (measured with Quantech-equipment): R ≤ 100 Ω 100 Ω < R ≤ 1 kΩ 1 kΩ < R ≤ 10 kΩ 10 kΩ < R ≤ 100 kΩ 100 kΩ < R ≤ 1 MΩ	 max. 0.316 μV/V (−10 dB) max. 1 μV/V (0 dB) max. 3 μV/V (9.54 dB) max. 6 μV/V (15.56 dB) max. 10 μV/V (20 dB)
Other applicable tests				
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	40 ±2 °C; 93 +2/−3% RH; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±(3% +0.1 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

Power chip resistor size 1218

PRC201
5%; 1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supplies in small sized equipment
- Camcorders
- Portable radio, CD and cassette players
- Automotive.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 1 M Ω
Resistance tolerance and series: 0.02 $\Omega \leq R \leq 1$ M Ω 0.1 $\Omega \leq R \leq 1$ M Ω	$\pm 5\%$, E24 series $\pm 1\%$, E24/E96 series
Temperature coefficient: 0.020 $\Omega \leq R < 0.033$ Ω 0.033 $\Omega \leq R < 0.060$ Ω 0.060 $\Omega \leq R < 0.2$ Ω 0.2 $\Omega \leq R < 1$ Ω 1 $\Omega \leq R < 10$ Ω 10 $\Omega \leq R \leq 1$ M Ω	$\leq \pm 2000 \times 10^{-6}/K$ $\leq \pm 1000 \times 10^{-6}/K$ $\leq \pm 700 \times 10^{-6}/K$ $\leq \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$ $\leq \pm 100 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70$ $^{\circ}C$	1 W
Maximum permissible voltage	200 V (DC or RMS)
Maximum permissible current	6 A (DC or RMS)
Operating temperature range	-55 $^{\circ}C$ to $+155$ $^{\circ}C$
Basic specification	IEC 60115-8

Power chip resistor size 1218

PRC201
5%; 1%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2322 735
		BLISTER TAPE ON REEL
		5000 units
PRC201	±5; note 1	60...
	±1	2....
Jumper 0 Ω		
PRC201; note 2	—	90006

Notes

- Code numbers for values less than 0.1 Ω are available on request
- The jumper has a maximum resistance $R_{\max} = 20 \text{ m}\Omega$ and a rated current $I_R = 6 \text{ A}$.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322.
- The subsequent four or five digits indicate the resistor type and packaging; see Table 1.
- The remaining digits indicate the resistance value:
 - The first 2 digits for 5% or 3 digits for 1% tolerance products indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.02 to 0.091 Ω	note 1
0.1 to 0.91 Ω	7
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 MΩ	5

Note

- Code numbers for values less than 0.1 Ω are available on request.

ORDERING EXAMPLE

The ordering code of a PRC201 resistor, value 470 Ω with 5% tolerance, supplied on blister tape of 5000 units per reel is: 2322 735 60471.

Power chip resistor	PRC201
size 1218	5%; 1%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 or E96 series for resistors with a tolerance of $\pm 5\%$ or $\pm 1\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

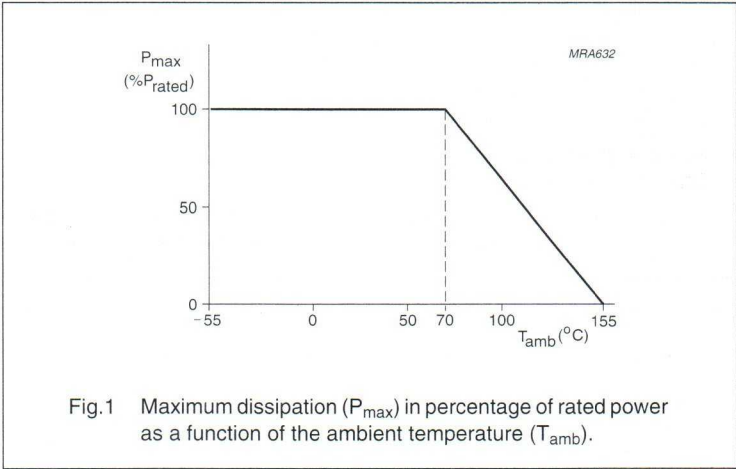
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING CURRENT (A)	LIMITING POWER (W)
PRC201	200	6	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

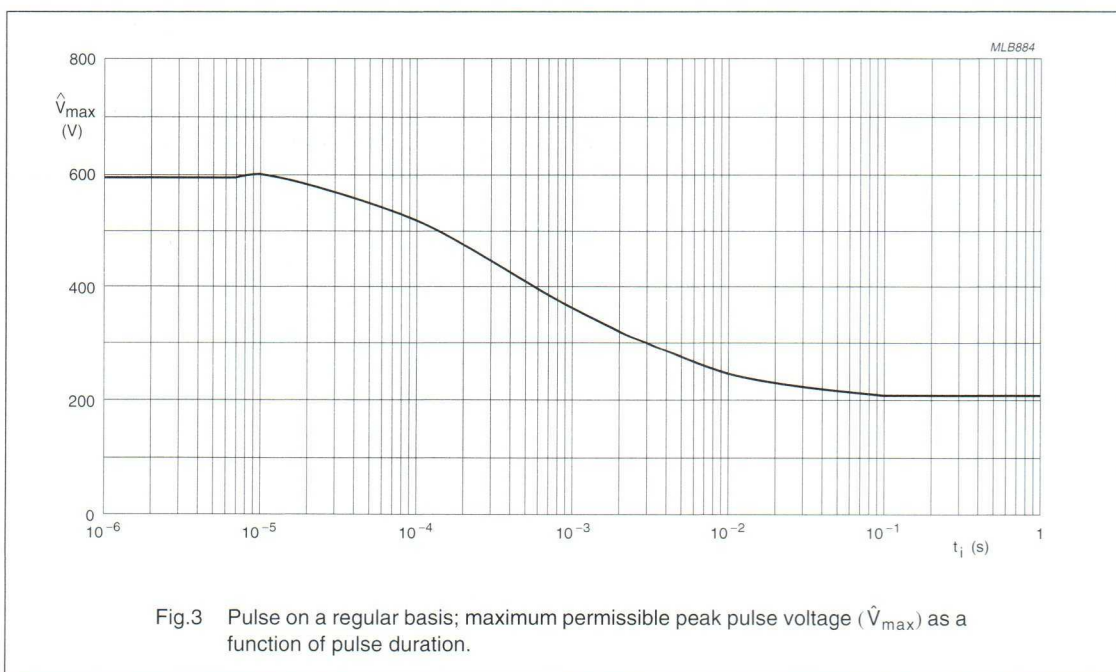
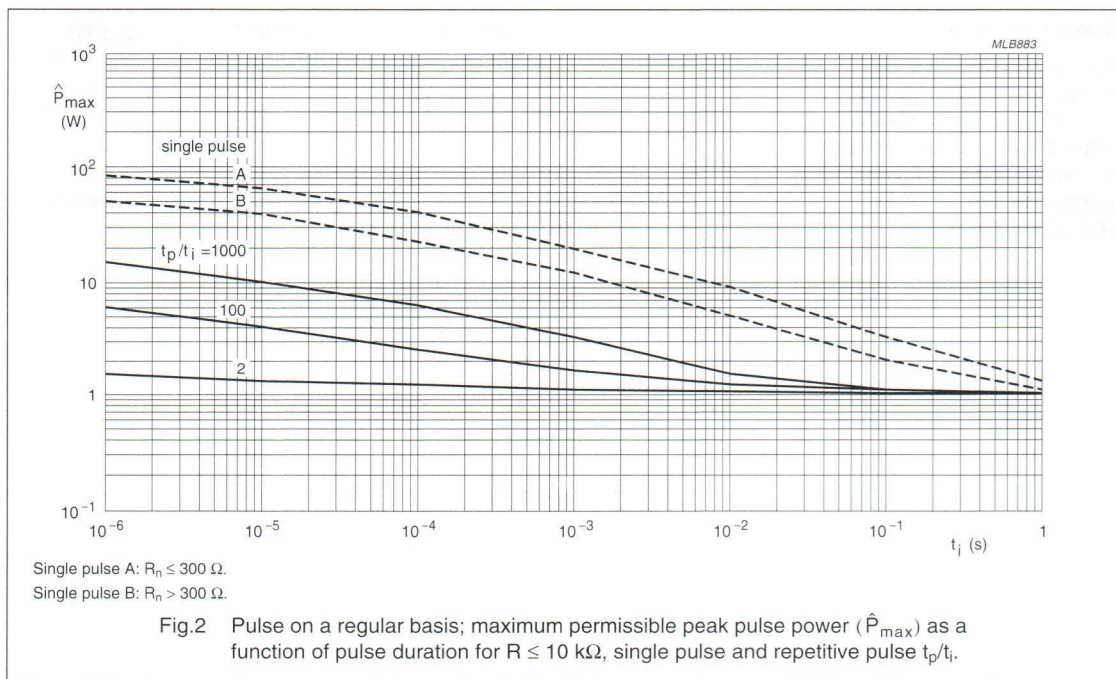
The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Power chip resistor size 1218

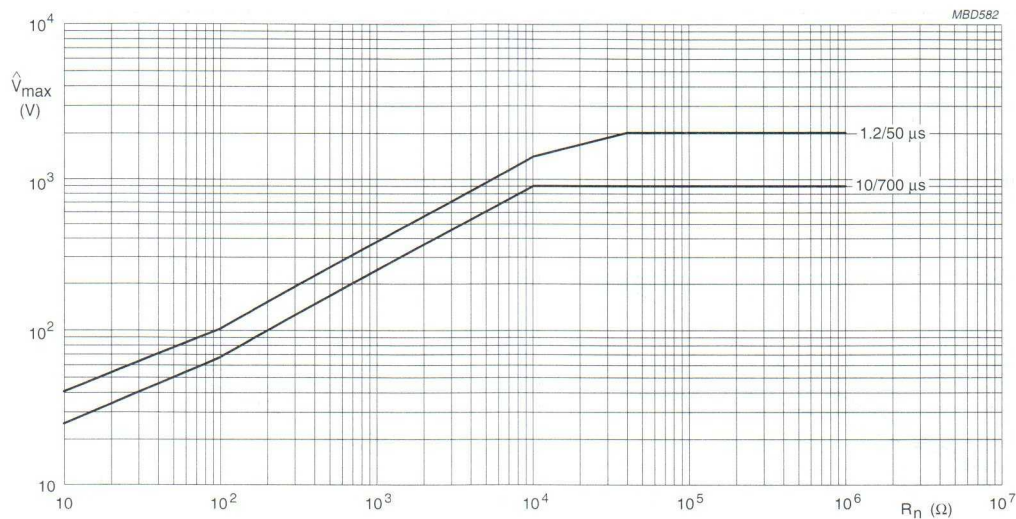
PRC201
5%; 1%

PULSE LOADING CAPABILITIES



Power chip resistor size 1218

PRC201
5%; 1%



These pulses may not be applied on a regular basis.

Fig.4 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

Power chip resistor size 1218

PRC201

5%; 1%

Application information

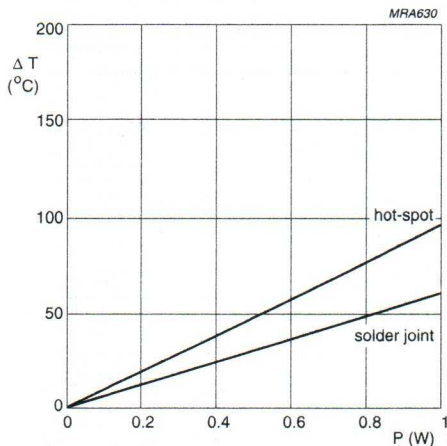


Fig.5 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor mounted horizontally on ceramic PCB.

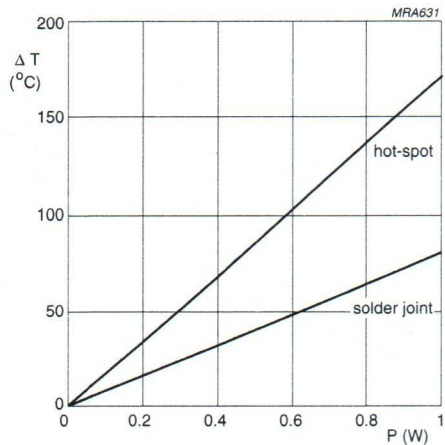


Fig.6 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor mounted horizontally on a FR4 PCB.

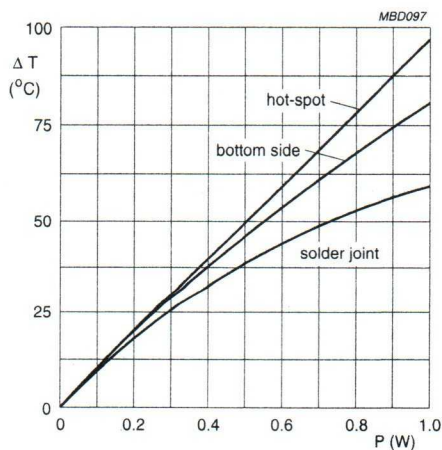
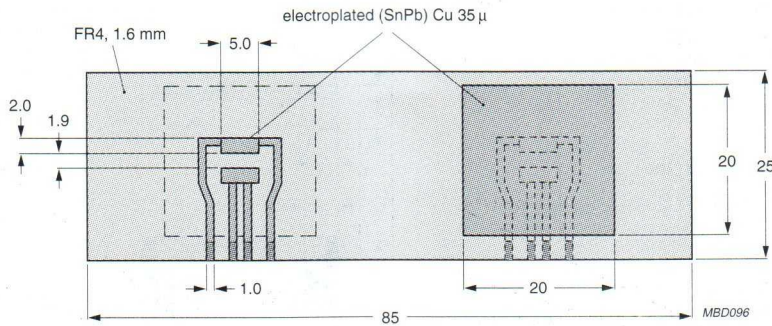


Fig.7 Temperature rise at hot-spot and solder joint as a function of dissipated power, for a resistor horizontally mounted on the test substrate; see Fig.8.

Power chip resistor size 1218

PRC201

5%; 1%



Dimensions in mm.

Fig.8 Test substrate layout. The tracks on the substrate for values below $33 \text{ m}\Omega$ are wider. With this substrate, the resistance of the tracks becomes significant compared to the resistor tested. Due to the current loading required for resistor testing these tracks may be damaged.

Power chip resistor
size 1218

PRC201
5%; 1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC201	3

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 910 Ω the R is used as a decimal point. For values of 1 kΩ or greater the letter K or M is used as the decimal point for the kΩ or MΩ indication.

Magnitude indicators

RESISTANCE	INDICATOR
0.02 to 910 Ω	R
1 to 910 kΩ	K
1 MΩ	M

Example

MARKING	RESISTANCE
120R	120 Ω
4K70	4.70 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

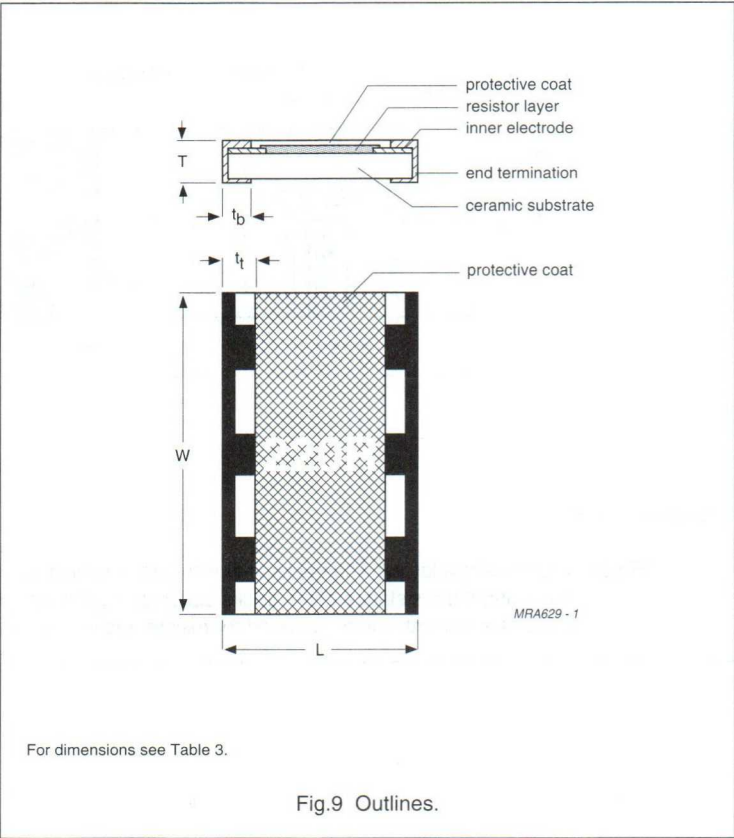


Table 3 Chip resistor type and relevant physical dimensions; see Fig.9

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC201	3.05 ±0.15	4.60 ±0.20	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

Power chip resistor size 1218

PRC201
5%; 1%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to +155 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge	$0.45 \text{ mm} \leq T \leq 0.65 \text{ mm}$ $4.4 \text{ mm} \leq W \leq 4.8 \text{ mm}$ $2.9 \text{ mm} \leq L \leq 3.2 \text{ mm}$
4.5		resistance	applied voltage (+0/-10%): $R < 10 \Omega$: 0.1 V $10 \Omega \leq R < 100 \Omega$: 0.3 V $100 \Omega \leq R < 1 \text{ k}\Omega$: 1 V $1 \text{ k}\Omega \leq R < 10 \text{ k}\Omega$: 3 V $10 \text{ k}\Omega \leq R < 100 \text{ k}\Omega$: 10 V $100 \text{ k}\Omega \leq R < 1 \text{ M}\Omega$: 25 V $1 \text{ M}\Omega$: 50 V	$R - R_{\text{nom}}$: max. $\pm 5\%$ or 1%
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; $10 \pm 1 \text{ s}$; $260 \pm 5 \text{ }^\circ\text{C}$: $0.020 \Omega \leq R < 0.1 \Omega$ $0.1 \Omega \leq R \leq 1 \text{ M}\Omega$	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for $2 \pm 0.5 \text{ s}$ in a solder bath at $235 \pm 2 \text{ }^\circ\text{C}$	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover

Power chip resistor
size 1218

PRC201
5%; 1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; 93 ± 2 –3% RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.25.1		endurance	1000 ± 48 –0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off: $0.020 \Omega \leq R < 0.1 \Omega$ $0.1 \Omega \leq R \leq 1 M\Omega$	no visible damage $\Delta R/R$ max.: $\pm(5\% + 0.1 \Omega)$ $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 ± 48 –0 hours; no load	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.8.4.2s'		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $0.020 \Omega \leq R < 0.033 \Omega$ $0.033 \Omega \leq R < 0.060 \Omega$ $0.060 \Omega \leq R < 0.2 \Omega$ $0.2 \Omega \leq R < 1 \Omega$ $1 \Omega \leq R < 10 \Omega$ $10 \Omega \leq R$	$\Delta R/R$ max.: $\pm 2000 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 1000 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 700 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 250 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 100 \times 10^{-6}/K$
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	16 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
Other applicable tests				
		leaching	unmounted chips 60 ± 1 s; 260 ± 5 °C	good tinning; no leaching

Power chip resistor size 2010

PRC111
1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printer equipment
- Computers
- Battery chargers
- Automotive
- Power supplies.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 M Ω , E96 series
Resistance tolerance	$\pm 1\%$
Temperature coefficient: 1 $\Omega \leq R < 4.99 \Omega$ 5.1 $\Omega \leq R < 9.76 \Omega$ 10 $\Omega \leq R < 1 \text{ M}\Omega$ 1 M $\Omega \leq R < 10 \text{ M}\Omega$	$\leq \pm 300 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$
Absolute maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	0.5 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	-55°C to $+125^\circ\text{C}$
Basic specification	IEC 60115-8

Power chip resistor
size 2010

PRC111
1%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	SERIES	ORDERING CODE 2322 761
				BLISTER TAPE ON REEL
				4000 units
PRC111	1 Ω to 10 MΩ	±1	E96	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 761; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC111 resistor, value 4.02 kΩ with 1% tolerance, supplied on blister tape of 4 000 units per reel is:
2322 761 64022.

Power chip resistor size 2010

PRC111
1%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 series for resistors with a tolerance of $\pm 1\%$. The values of the E96 series are in accordance with "IEC publication 60063".

Limiting values

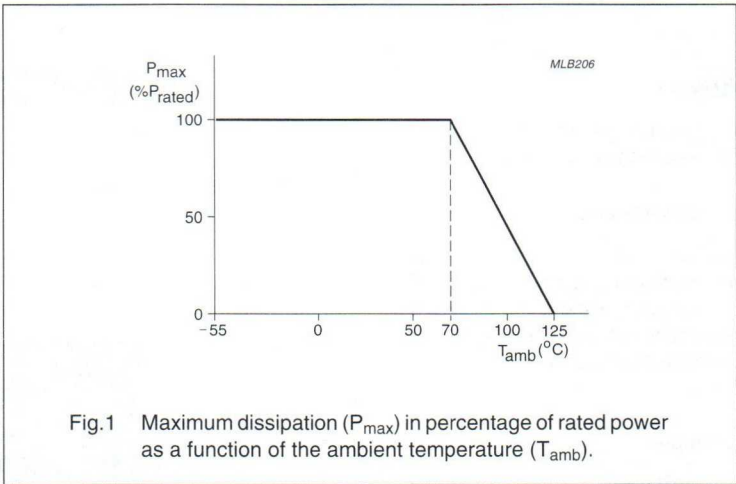
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
PRC111	200	0.5

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Power chip resistor
size 2010

PRC111
1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC111	2.50

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

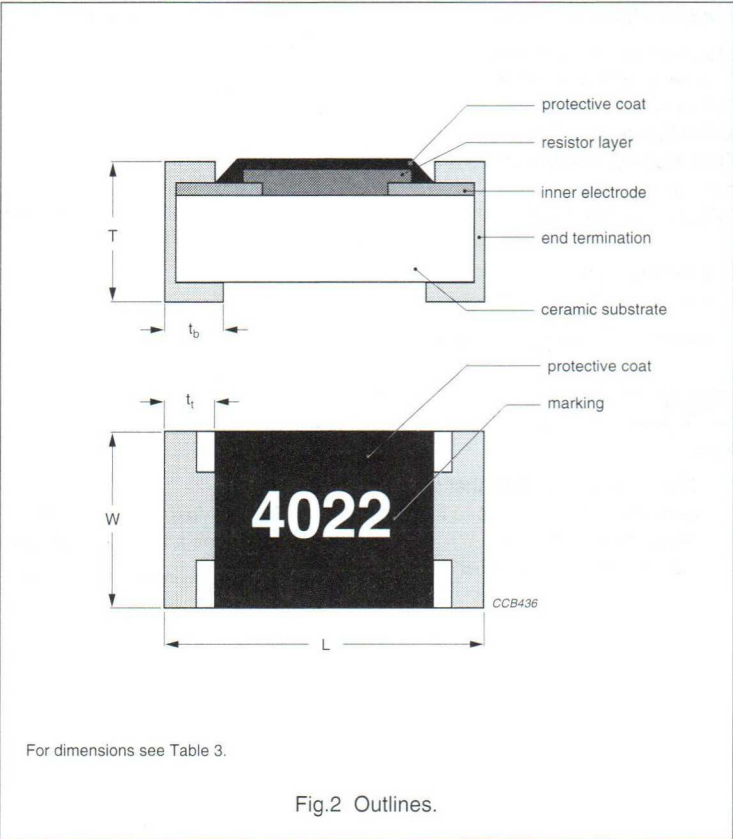
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 kΩ
1503	150 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC111	5.0 ±0.2	2.5 ±0.2	0.55 ±0.10	0.65 ±0.25	0.90 ±0.25

Power chip resistor size 2010

PRC111
1%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.13		short time overload	room temperature; dissipation 6.25×0.5 W; 5 s (voltage not more than $2 \times V_{\max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	200 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.25.1		endurance	1000 $\pm 48/-0$ hours; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $1 \Omega \leq R < 4.99 \Omega$ $5.1 \Omega \leq R < 9.76 \Omega$ $10 \Omega \leq R < 1 \text{ M}\Omega$ $1 \text{ M}\Omega \leq R < 10 \text{ M}\Omega$	$\Delta R/R$ max.: $\pm 300 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 100 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/\text{K}$

Power chip resistor
size 2010

PRC111
1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with 1 W or $V_{\max}$; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)

Power chip resistor size 2010

PRC111
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printer equipment
- Computers
- Battery chargers
- Automotive
- Power supplies.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 M Ω , jumper; E24 series
Resistance tolerance	$\pm 5\%$; $\pm 2\%$
Temperature coefficient: 1 $\Omega \leq R < 4.99 \Omega$ 5.1 $\Omega \leq R < 9.76 \Omega$ 10 $\Omega \leq R < 1 \text{ M}\Omega$ 1 M $\Omega \leq R < 10 \text{ M}\Omega$	$\leq \pm 300 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$
Absolute maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	0.5 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	-55°C to $+125^\circ\text{C}$
Basic specification	IEC 60115-8

Power chip resistor	PRC111
size 2010	5%; 2%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	SERIES	ORDERING CODE 2322 760
				BLISTER TAPE ON REEL
				4000 units
PRC111	1 Ω to 10 MΩ	±5	E24	60...
		±2		80...
Jumper 0 Ω				
PRC111	—	—	—	90003

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 760; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 to 9.76 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC111 resistor, value 47 Ω with 5% tolerance, supplied on blister tape of 4 000 units per reel is: 2322 760 60479.

Power chip resistor
size 2010

PRC111
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 2\%$ or $\pm 5\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

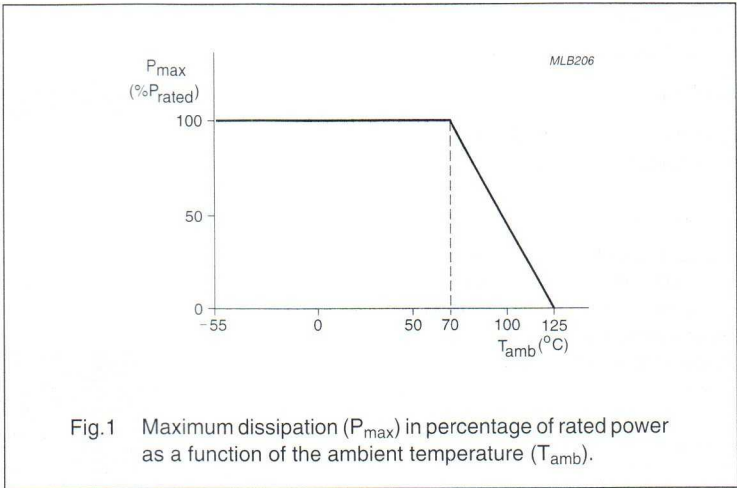
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
PRC111	200	0.5

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Power chip resistor
size 2010

PRC111
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC111	2.50

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
120R	120 Ω
1202	12 kΩ
1203	120 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

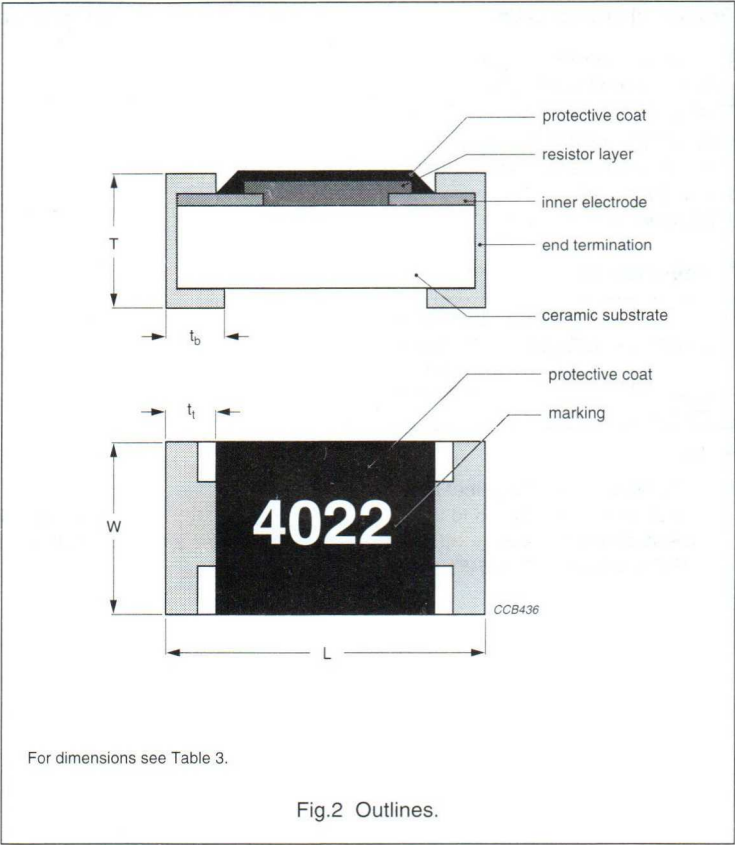


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC111	5.0 ±0.2	2.5 ±0.2	0.55 ±0.10	0.65 ±0.25	0.90 ±0.25

Power chip resistor size 2010

PRC111
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.13		short time overload	room temperature; dissipation 6.25×0.5 W; 5 s (voltage not more than $2 \times V_{\max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage $\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	200 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.25.1		endurance	1000 $\pm 48/-0$ hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $1 \Omega \leq R < 4.99 \Omega$ $5.1 \Omega \leq R < 9.76 \Omega$ $10 \Omega \leq R < 1 \text{ M}\Omega$ $1 \text{ M}\Omega \leq R < 10 \text{ M}\Omega$	$\Delta R/R$ max.: $\pm 300 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 100 \times 10^{-6}/\text{K}$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/\text{K}$

Power chip resistor
size 2010

PRC111
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with 1 W or V _{max} ; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(1% +0.05 Ω)

Power chip resistor

size 2512

PRC221
1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies
- Printers
- Computers
- Battery chargers
- Automotive
- Converters
- CD-ROM.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 M Ω ; E96 series
Resistance tolerance	$\pm 1\%$
Temperature coefficient:	
1 $\Omega \leq R < 4.99 \Omega$	$\leq \pm 300 \times 10^{-6}/K$
5.1 $\Omega \leq R < 9.76 \Omega$	$\leq \pm 200 \times 10^{-6}/K$
10 $\Omega \leq R < 1 \text{ M}\Omega$	$\leq \pm 100 \times 10^{-6}/K$
1 M $\Omega \leq R < 10 \text{ M}\Omega$	$\leq \pm 200 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	1 W
Maximum permissible voltage	250 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	-55°C to $+125^\circ\text{C}$
Basic specification	IEC 60115-8

Power chip resistor
size 2512

PRC221
1%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	SERIES	ORDERING CODE 2322 763
			BLISTER TAPE ON REEL
			4000 units
PRC221	±1	E96	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 763; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 k Ω	2
10 to 97.6 k Ω	3
100 to 976 k Ω	4
1 to 9.76 M Ω	5
10 M Ω	6

ORDERING EXAMPLE

The ordering code of a PRC221 resistor, value 4.02 k Ω with 1% tolerance, supplied on blister tape of 4 000 units per reel is:
2322 763 64022.

Power chip resistor
size 2512

PRC221
1%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 series for resistors with a tolerance of $\pm 1\%$. The values of the E96 series are in accordance with "IEC publication 60063".

Limiting values

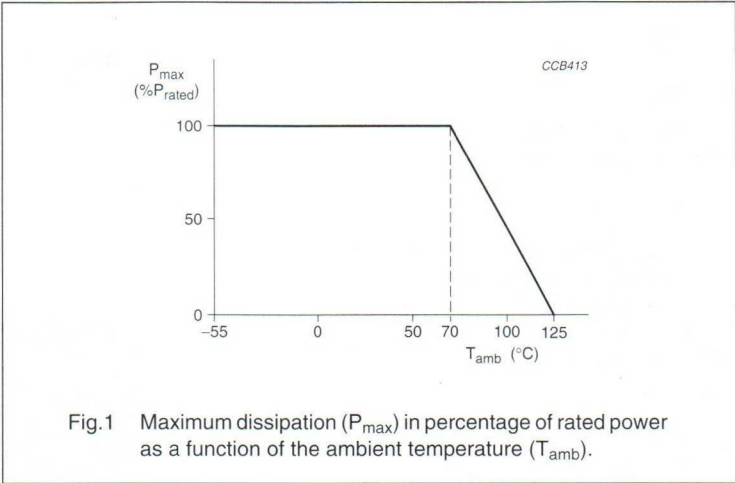
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
PRC221	250	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Power chip resistor size 2512

PRC221
1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	4.25

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 976 Ω the R is used as a decimal point. For values of 1 k Ω or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

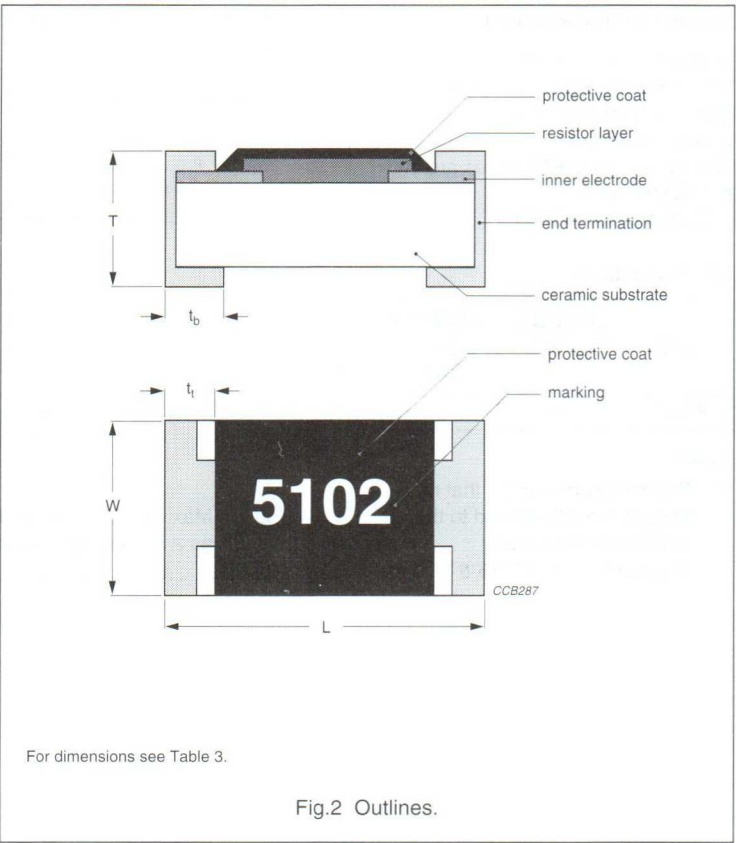
Example

MARKING	RESISTANCE
121R	121 Ω
4021	4.02 k Ω
1503	150 k Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC221	6.4 $\pm$ 0.2	3.1 $\pm$ 0.2	0.55 $\pm$ 0.10	0.65 $\pm$ 0.25	1.3 $\pm$ 0.25

Power chip resistor size 2512

PRC221

1%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $1 \Omega \leq R < 4.99 \Omega$ $5.1 \Omega \leq R < 9.76 \Omega$ $10 \Omega \leq R < 1 \text{ M}\Omega$ $1 \text{ M}\Omega \leq R < 10 \text{ M}\Omega$	$\Delta R/R$ max.: $\pm 300 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 100 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/K$

Power chip resistor
size 2512

PRC221
1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/-3% RH loaded with 1 W or $V_{\max}$; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: ±(1% + 0.05 Ω)

Power chip resistor size 2512

PRC221
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies
- Printers
- Computers
- Battery chargers
- Automotive
- Converters
- CD-ROM.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. To guarantee optimum solderability the outer layer consists of a lead-tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 M Ω ; jumper E24 series
Resistance tolerance	5%; 2%
Temperature coefficient:	
1 $\Omega \leq R < 4.99 \Omega$	$\leq \pm 300 \times 10^{-6}/K$
5.1 $\Omega \leq R < 9.76 \Omega$	$\leq \pm 200 \times 10^{-6}/K$
10 $\Omega \leq R < 1 M\Omega$	$\leq \pm 100 \times 10^{-6}/K$
1 M $\Omega \leq R < 10 M\Omega$	$\leq \pm 200 \times 10^{-6}/K$
Absolute maximum dissipation at T _{amb} = 70 °C	1 W
Maximum permissible voltage	250 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Operating temperature range	-55 °C to +125 °C
Basic specification	IEC 60115-8

Power chip resistor	PRC221
size 2512	5%; 2%

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	SERIES	ORDERING CODE 2322 762
			BLISTER TAPE ON REEL
			4000 units
PRC221	±5	E24	60...
	±2		80...
Jumper			
PRC221	—	—	90 000

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 762; see Table 1.
- The subsequent 2 digits indicates the resistor type and packaging
- The remaining digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 to 9.1 MΩ	5
10 MΩ	6

ORDERING EXAMPLE

The ordering code of a PRC221 resistor, value 47 Ω with 5% tolerance, supplied on blister tape of 4 000 units per reel is:
2322 762 60479.

Power chip resistor size 2512

PRC221
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$ and $\pm 2\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

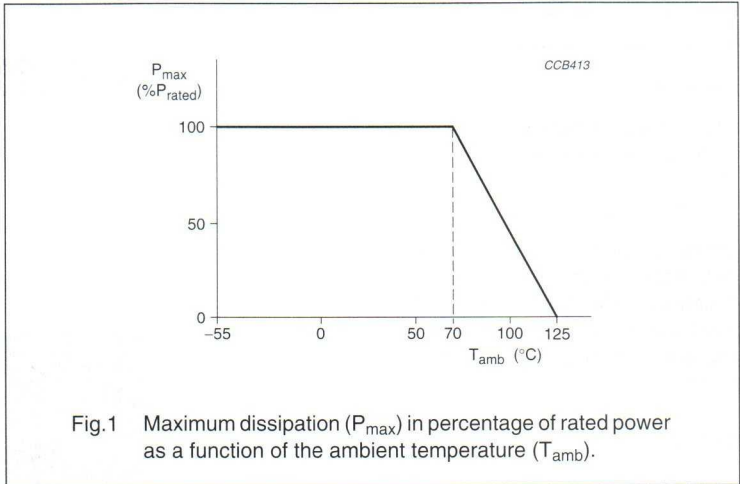
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
PRC221	250	1

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Power chip resistor
size 2512

PRC221
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	4.25

Marking

Each resistor is marked with the nominal resistance value.

4-DIGIT MARKING

For values up to 910 Ω the R is used as a decimal point. For values of 1 kΩ or greater the first 3 digits apply to the resistance value and the fourth indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
12R0	12 Ω
8202	82 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

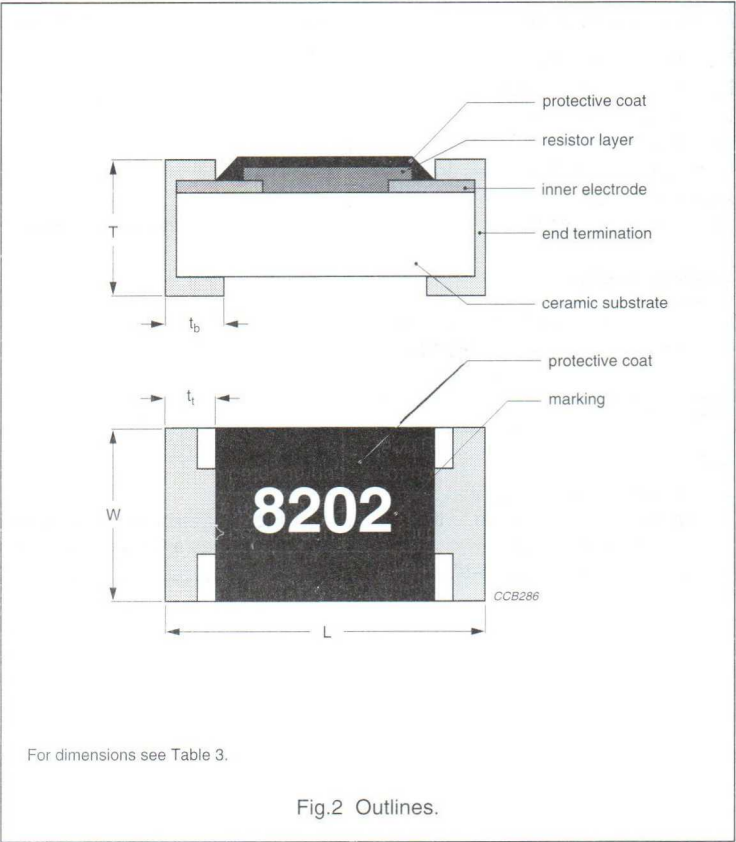


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC221	6.4 ±0.2	3.1 ±0.2	0.55 ±0.10	0.65 ±0.25	1.3 ±0.25

Power chip resistor size 2512

PRC221
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 2 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.05 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on, 0.5 hour off	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $1 \Omega \leq R < 4.99 \Omega$ $5.1 \Omega \leq R < 9.76 \Omega$ $10 \Omega \leq R < 1 \text{ M}\Omega$ $1 \text{ M}\Omega \leq R < 10 \text{ M}\Omega$	$\Delta R/R$ max.: $\pm 300 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 100 \times 10^{-6}/K$ $\Delta R/R$ max.: $\pm 200 \times 10^{-6}/K$

Power chip resistor
size 2512

PRC221
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no visible damage
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	56 days; 40 ±2 °C; 93 +2/-3% RH; loaded with 1 W or V _{max} ; 1.5 hours on, 0.5 hour off	no visible damage ΔR/R max.: ±(2% + 0.05 Ω)

Low ohmic power chip resistors size 2512

PRC221
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Converters
- Printers
- Computers
- Battery chargers
- Power supplies
- Automotive.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range; note 1	0.01 Ω to 0.99 Ω ; E24
Resistance tolerance; note 1	$\pm 5\%$; $\pm 2\%$
Temperature coefficient:	
0.01 $\Omega \leq R < 0.04 \Omega$	$\pm 1500 \times 10^{-6}/K$
0.04 $\Omega \leq R < 0.10 \Omega$	$\pm 600 \times 10^{-6}/K$
0.10 $\Omega \leq R < 0.20 \Omega$	$\pm 300 \times 10^{-6}/K$
0.20 $\Omega \leq R < 0.50 \Omega$	$\pm 150 \times 10^{-6}/K$
0.50 $\Omega \leq R < 0.99 \Omega$	$\pm 75 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	1 W
Maximum permissible voltage	250 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non-E24 values and special tolerances are available on request.

Low ohmic power chip resistors size 2512

PRC221
5%; 2%

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2322 762
			BLISTER TAPE ON REEL
			4000 units
PRC221	0.01 to 0.099 Ω	± 5	90...
	0.1 to 0.99 Ω		60...
	0.01 to 0.099 Ω	± 2	91...
	0.1 to 0.99 Ω		80...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322 762
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.01 to 0.099 Ω	0
0.1 to 0.99 Ω	7

ORDERING EXAMPLE

The ordering code of a PRC221 low ohmic power chip resistor, value 0.51 Ω with a tolerance of 5%, supplied on blister tape of 4000 units per reel is: 2322 762 60517.

Low ohmic power chip resistors
size 2512

PRC221
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 5% or 2%. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

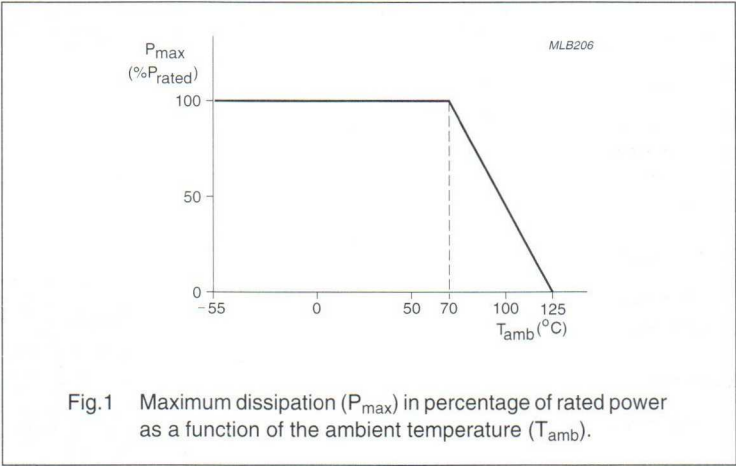
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
PRC221	250	1.0

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Low ohmic power chip resistors size 2512

PRC221
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
PRC221	1.0

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point, the other 3 digits are significant

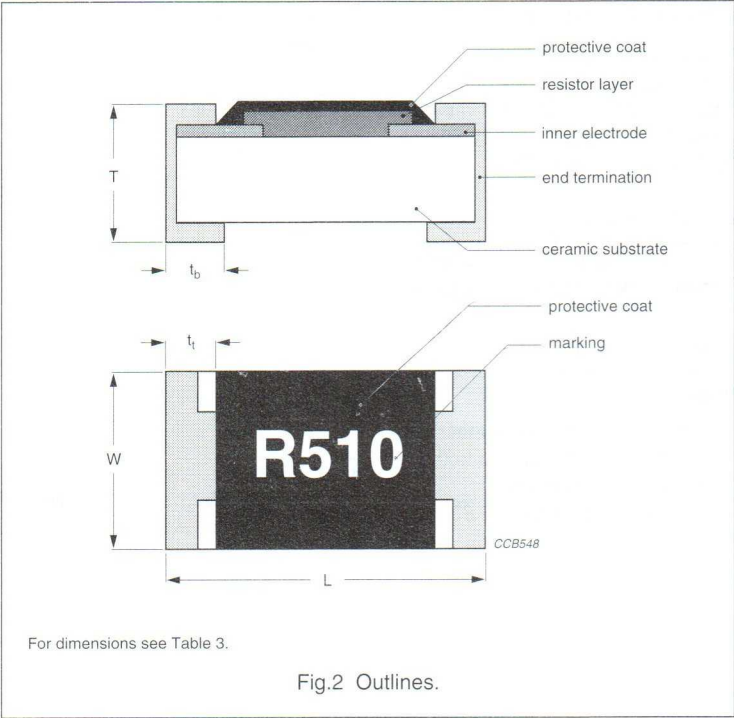
Example

MARKING	RESISTANCE
R010	0.01 Ω
R510	0.51 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3.

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
PRC221	6.4 ±0.20	3.2 ±0.20	0.55 ±0.10	0.65 ±0.25	1.3 ±0.25

Low ohmic power chip resistors size 2512

PRC221
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/-10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H ₂ O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	200 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm 2\%$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 2 mm	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.6.1.1		insulation resistance	250 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm 3\%$

Low ohmic power chip resistors size 2512

PRC221
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1 000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R$ max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1 000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $0.01 \Omega \leq R < 0.04 \Omega$ $0.04 \Omega \leq R < 0.10 \Omega$ $0.10 \Omega \leq R < 0.20 \Omega$ $0.20 \Omega \leq R < 0.50 \Omega$ $0.50 \Omega \leq R < 0.99 \Omega$	$\pm 1500 \times 10^{-6}/K$ $\pm 600 \times 10^{-6}/K$ $\pm 300 \times 10^{-6}/K$ $\pm 150 \times 10^{-6}/K$ $\pm 75 \times 10^{-6}/K$
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1 000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±3%

Low ohmic chip resistors

size 1206

LRC01
5%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Battery loaders
- Power supplies in small sized equipment
- Car telephones
- Portable stereo equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range; note 1	0.02 Ω to 0.99 Ω ; E24 series
Resistance tolerance	$\pm 5\%$
Temperature coefficient:	
0.02 $\Omega \leq R < 0.04 \Omega$	$\leq \pm 1500 \times 10^{-6}/K$
0.04 $\Omega \leq R < 0.10 \Omega$	$\leq \pm 600 \times 10^{-6}/K$
0.10 $\Omega \leq R < 0.20 \Omega$	$\leq \pm 300 \times 10^{-6}/K$
0.20 $\Omega \leq R < 0.50 \Omega$	$\leq \pm 150 \times 10^{-6}/K$
0.50 $\Omega \leq R < 0.99 \Omega$	$\leq \pm 75 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non E24 values are available on request.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 510
			PAPER TAPE ON REEL
			5000 units
LRC01	20 m Ω to 990 m Ω	± 5	10...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 510
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.01 to 0.099 Ω	0
0.1 to 0.99 Ω	7

Ordering example

The ordering code of a LRC01 resistor, value 0.47 Ω , supplied on paper tape of 5000 units per reel is: 2350 510 10477.

Low ohmic chip resistors size 1206

LRC01
5%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of $\pm 5\%$. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
LRC01	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

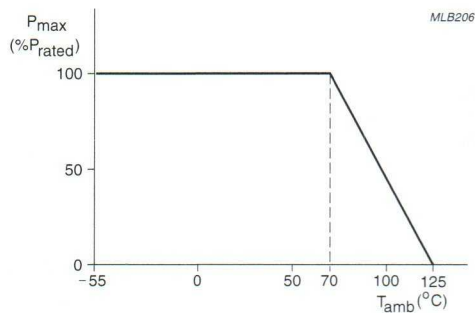


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Temperature coefficient

Figure 2 shows the typical temperature coefficient of the resistor.

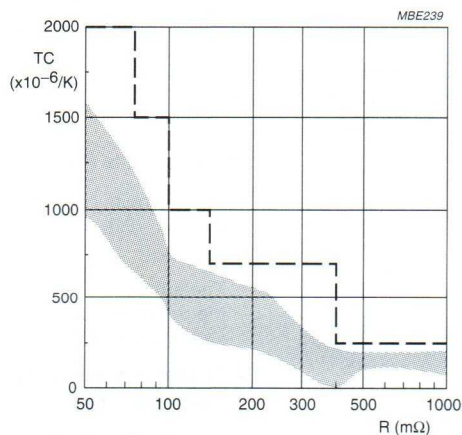


Fig.2 Typical TC as a function of resistance.

Low ohmic chip resistors size 1206

LRC01
5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC01	1

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

The R is used as a decimal point.

Magnitude indicators

RESISTANCE	INDICATOR
20 mΩ to 990 mΩ	R

Example

MARKING	RESISTANCE
R210	0.210 Ω
R560	0.560 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

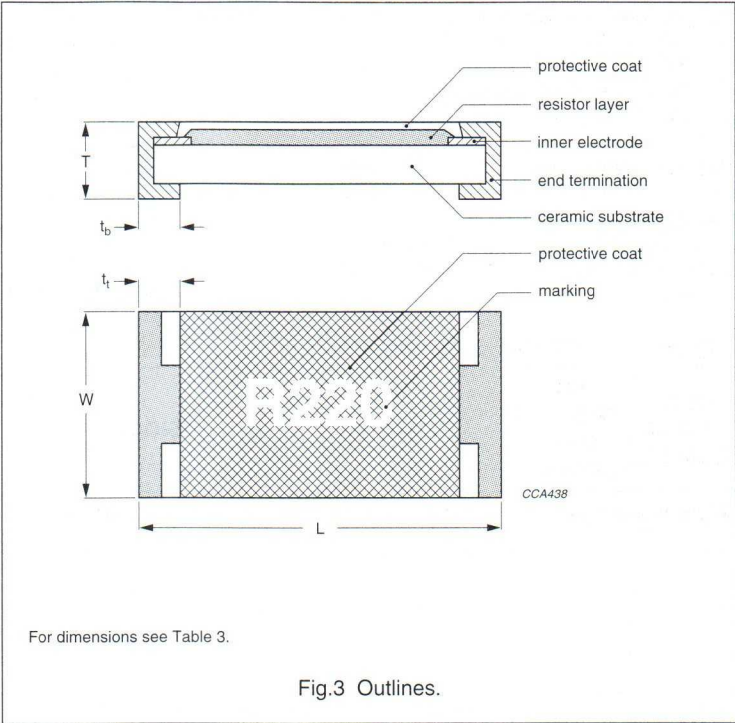


Table 3 Chip resistor type and relevant physical dimensions; see Fig.3

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
LRC01	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

Low ohmic chip resistors size 1206

LRC01
5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge	$0.45 \text{ mm} \leq T \leq 0.65 \text{ mm}$ $1.45 \text{ mm} \leq W \leq 1.75 \text{ mm}$ $3.0 \text{ mm} \leq L \leq 3.3 \text{ mm}$
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{\text{nom}}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	$\Delta R/R$ max.: $\pm 1\%$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H ₂ O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{\text{max}}$)	$\Delta R/R$ max.: $\pm 1\%$
	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm 1\%$

Low ohmic chip resistors size 1206

LRC01 5%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 $\pm$ 2 $^{\circ}$ C; 93 +2/-3% RH; loaded with 0.01 P _n	no visible damage $\Delta R/R$ max.: $\pm$ 3%
4.25.1		endurance	1000 +48/-0 hours; 70 $\pm$ 2 $^{\circ}$ C; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R$ max.: $\pm$ 3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 $^{\circ}$ C; no load	no visible damage $\Delta R/R$ max.: $\pm$ 3%
4.8.4.2		temperature coefficient	at 20/LCT/20 $^{\circ}$ C and 20/UCT/20 $^{\circ}$ C: 0.02 $\Omega \leq R < 0.04 \Omega$ 0.04 $\Omega \leq R < 0.10 \Omega$ 0.10 $\Omega \leq R < 0.20 \Omega$ 0.20 $\Omega \leq R < 0.50 \Omega$ 0.50 $\Omega \leq R < 0.99 \Omega$	$\leq \pm 1500 \times 10^{-6}/K$ $\leq \pm 600 \times 10^{-6}/K$ $\leq \pm 300 \times 10^{-6}/K$ $\leq \pm 150 \times 10^{-6}/K$ $\leq \pm 75 \times 10^{-6}/K$
Other applicable tests				
		leaching	unmounted chips 60 $\pm$ 1 s; 260 $\pm$ 5 $^{\circ}$ C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 $\pm$ 2 $^{\circ}$ C; 93 +2/-3% RH; loaded with P _n or V _{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm$ 3%

Low ohmic chip resistors size 1206

LRC02

1%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Low inductance design for current sensing applications.

APPLICATIONS

- Television
- Telecommunication
- Portable computers
- Battery chargers
- Lighting.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 0.99 Ω ; E96 series
Resistance tolerance	$\pm 1\%$
Temperature coefficient: 0.02 $\Omega \leq R < 0.04 \Omega$ 0.04 $\Omega \leq R < 0.10 \Omega$ 0.10 $\Omega \leq R < 0.20 \Omega$ 0.20 $\Omega \leq R < 0.50 \Omega$ 0.50 $\Omega \leq R < 0.99 \Omega$	$\pm 1500 \times 10^{-6}/K$ $\pm 600 \times 10^{-6}/K$ $\pm 300 \times 10^{-6}/K$ $\pm 150 \times 10^{-6}/K$ $\pm 75 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 510
			PAPER TAPE ON REEL
			5000 units
LRC02	0.02 to 0.99 Ω	± 1	12...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 510
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.02 to 0.099 Ω	0
0.1 to 0.99 Ω	7

Ordering example

The ordering code of a LRC02 resistor, value 0.47 Ω , supplied on paper tape of 5000 units per reel is: 2350 510 12477.

Low ohmic chip resistors
size 1206

LRC02
1%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E96 series for resistors with a tolerance of 1%. The values of the E96 series are in accordance with "IEC publication 60063".

Limiting values

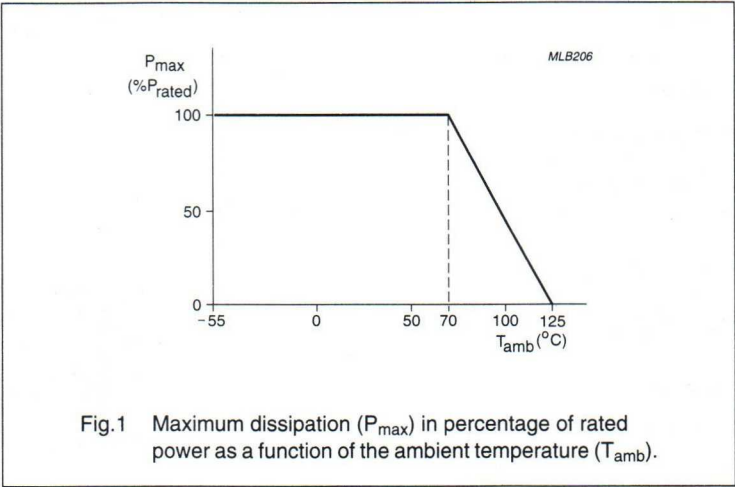
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
LRC02	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Low ohmic chip resistors
size 1206

LRC02
1%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC02	1.0

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

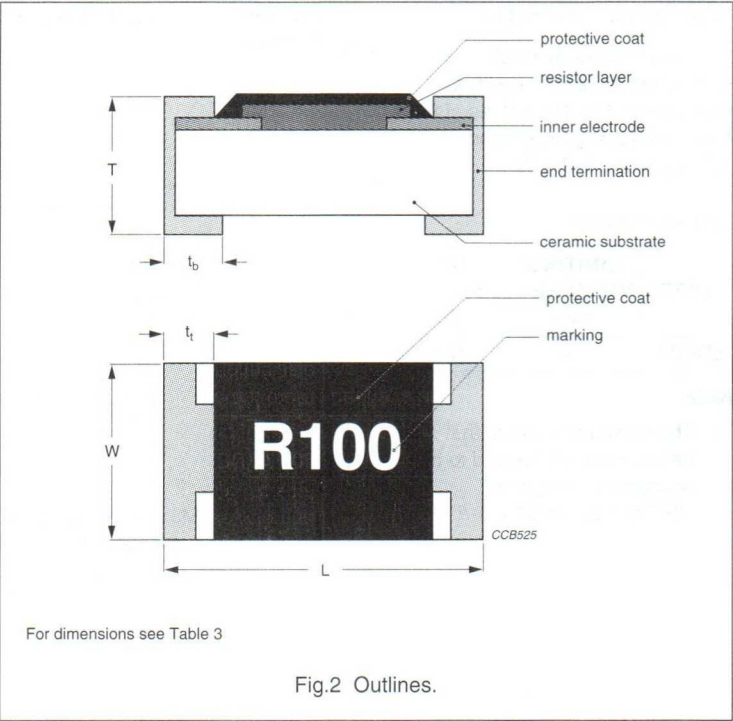
The R is used as a decimal point, the other 3 digits are significant

Example

MARKING	RESISTANCE
R220	0.220 Ω
R100	0.100 Ω
R040	0.040 Ω

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
LRC02	3.2 +0.1/-0.2	1.6 ±0.15	0.60 ±0.10	0.45 ±0.25	0.50 ±0.25

Low ohmic chip resistors size 1206

LRC02
1%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/-10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H ₂ O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	200 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm 1\%$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm 3\%$

Low ohmic chip resistors size 1206

LRC02 1%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R$ max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.02 Ω ≤ R < 0.04 Ω 0.04 Ω ≤ R < 0.10 Ω 0.10 Ω ≤ R < 0.20 Ω 0.20 Ω ≤ R < 0.50 Ω 0.50 Ω ≤ R < 0.99 Ω	 ±1500 × 10 ⁻⁶ /K ±600 × 10 ⁻⁶ /K ±300 × 10 ⁻⁶ /K ±150 × 10 ⁻⁶ /K ±75 × 10 ⁻⁶ /K
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±3%

Low ohmic chip resistors

size 0805

LRC11
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Low inductance design for current sensing applications.

APPLICATIONS

- Television
- Telecommunication equipment
- Portable computers
- Battery chargers
- Lighting.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	0.02 Ω to 0.99 Ω ; E24 series
Resistance tolerance	$\pm 5\%$; $\pm 2\%$
Temperature coefficient:	
0.02 $\Omega \leq R < 0.04 \Omega$	$\pm 1500 \times 10^{-6}/K$
0.04 $\Omega \leq R < 0.10 \Omega$	$\pm 600 \times 10^{-6}/K$
0.10 $\Omega \leq R < 0.20 \Omega$	$\pm 300 \times 10^{-6}/K$
0.20 $\Omega \leq R < 0.50 \Omega$	$\pm 150 \times 10^{-6}/K$
0.50 $\Omega \leq R < 0.99 \Omega$	$\pm 75 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

Note

1. Non-E24 values and special tolerances are available on request.

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 511
			PAPER TAPE ON REEL
			5000 units
LRC11	$0.02 \Omega \leq R < 1 \Omega$	± 5	10...
		± 2	11...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 511
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.020 to 0.099 Ω	0
0.10 to 0.99 Ω	7

Ordering example

The ordering code of a LRC11 low ohmic resistor, value 0.47 Ω with a 2% tolerance, supplied on paper tape of 5000 units per reel is: 2350 511 11477.

Low ohmic chip resistors
size 0805

LRC11
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of $\pm 5\%$ or 2% . The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

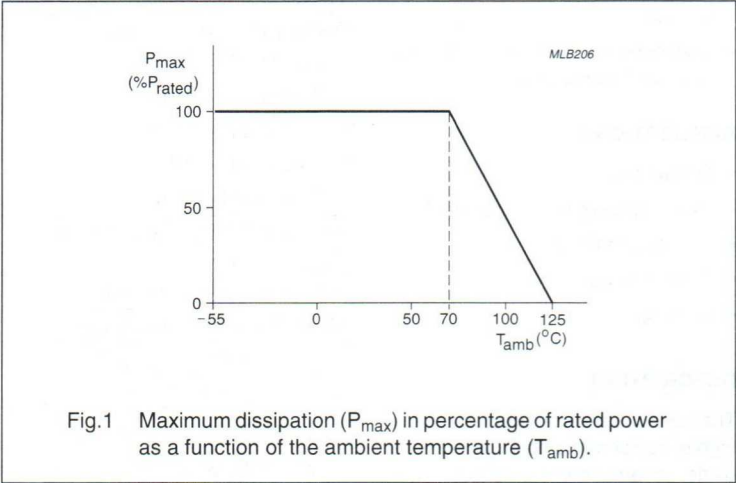
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
LRC11	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Low ohmic chip resistors size 0805

LRC11

5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
LRC01	0.55

Marking

Each resistor is marked with a 4-digit code on the protective coating to designate the nominal resistance value.

4-DIGIT MARKING

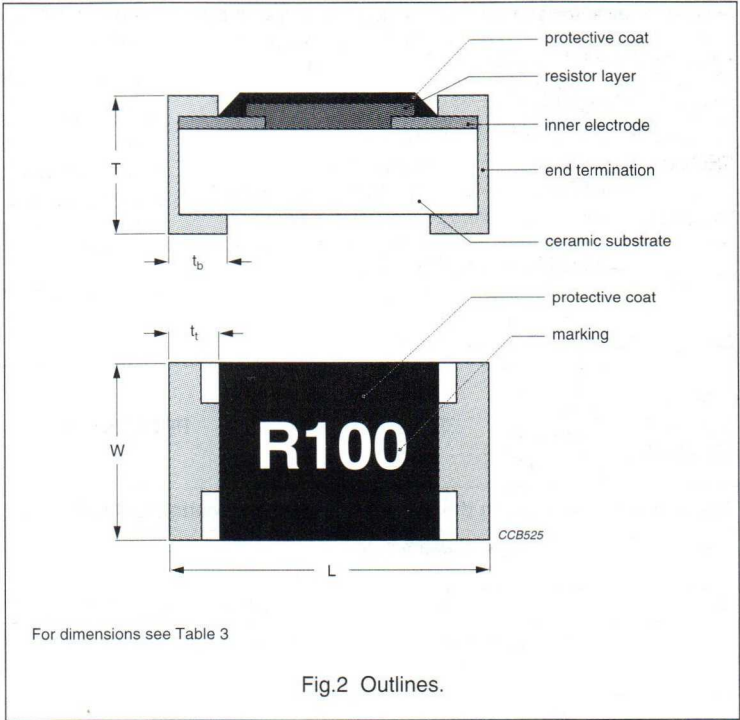
The R is used as a decimal point.

Example

MARKING	RESISTANCE
R220	0.220 Ω
R100	0.100 Ω
R040	0.040 Ω

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines



For dimensions see Table 3

Fig.2 Outlines.

Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
LRC11	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

Low ohmic chip resistors size 0805

LRC11
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage (+0/-10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H ₂ O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	150 V (DC or RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm 1\%$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm 1\%$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm 3\%$

Low ohmic chip resistors
size 0805

LRC11
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	no visible damage $\Delta R/R$ max.: ±3%
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: ±3%
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: 0.02 $\Omega \leq R < 0.04 \Omega$ 0.04 $\Omega \leq R < 0.10 \Omega$ 0.10 $\Omega \leq R < 0.20 \Omega$ 0.20 $\Omega \leq R < 0.50 \Omega$ 0.50 $\Omega \leq R < 0.99 \Omega$	$\pm 1500 \times 10^{-6}/K$ $\pm 600 \times 10^{-6}/K$ $\pm 300 \times 10^{-6}/K$ $\pm 150 \times 10^{-6}/K$ $\pm 75 \times 10^{-6}/K$
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

High ohmic chip resistors size 1206

HRC01
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- High maximum permissible voltage.

APPLICATIONS

- Measuring equipment
- Telecommunication
- Computers
- Television.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 100 M Ω ; E24 series
Resistance tolerance	$\pm 2\%$; $\pm 5\%$
Temperature coefficient	$\pm 250 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 520
			PAPER TAPE ON REEL
			5000 units
HRC01	11 to 100 M Ω	± 5	10... (91001 for 100 M Ω)
		± 2	11... (92001 for 100 M Ω)

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 520
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 100 M Ω	6

Ordering example

The ordering code of a HRC01 high ohmic resistor, value 30 M Ω , supplied on paper tape of 5000 units per reel is: 2350 520 10306.

High ohmic chip resistors
size 1206

HRC01
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

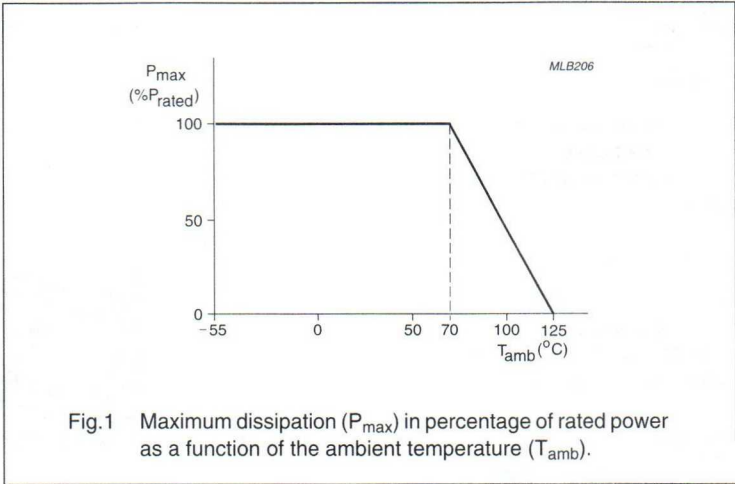
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
HRC01	200	0.25

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



High ohmic chip resistors
size 1206

HRC01
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC01	1.0

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6, as an indication of magnitude.

Example

MARKING	RESISTANCE
306	30 MΩ
107	100 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

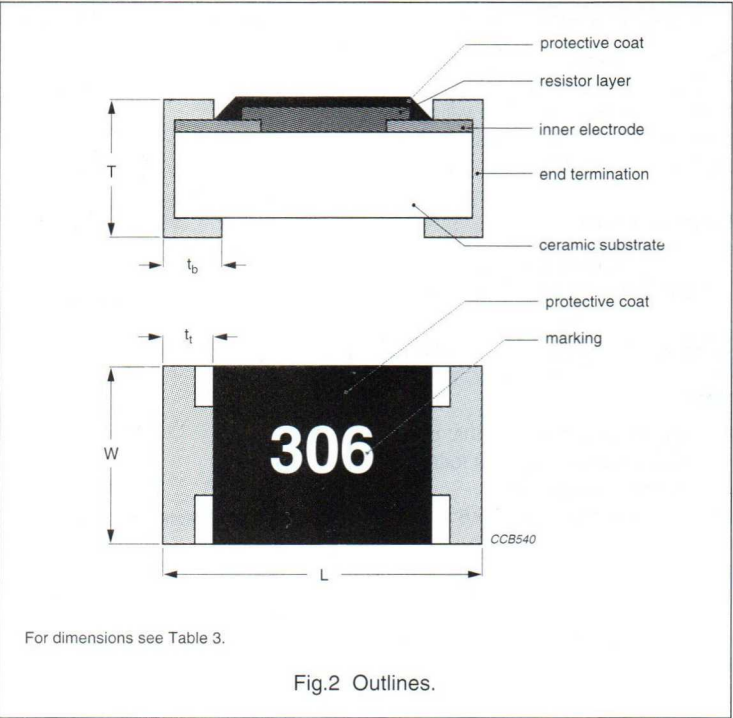


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
HRC01	3.2 +0.1/-0.2	1.60 ±0.15	0.60 ±0.10	0.45 ±0.25	0.50 ±0.25

High ohmic chip resistors

size 1206

HRC01
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to +125 °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/-10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.2\% + 0.1 \Omega)$
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 125 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	500 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than 400 V)	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 3 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(3.0\% + 0.1 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(5\% + 0.1 \Omega)$
4.25.1		endurance	1000 +48/-0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$

High ohmic chip resistors size 1206

HRC01 5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 250 \times 10^{-6}/K$
		leaching	unmounted chips 60 $\pm$ 1 s; 260 $\pm$ 5 °C	good tinning ($\geq 95\%$ covered); no leaching

High ohmic chip resistors size 0805

HRC11
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small equipment
- Digital multimeter
- Telecommunication
- Computers
- Automotive industry
- Medical and military equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 100 M Ω ; E24 series
Resistance tolerance	$\pm 5\%$; $\pm 2\%$;
Temperature coefficient	$\pm 300 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.125 W
Maximum permissible voltage	150 V (DC or RMS)
Operating temperature range	-55 to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 521
			PAPER TAPE ON REEL
			5000 units
HRC11	11 to 100 M Ω	± 5	10... (91001 for 100 M Ω)
		± 2	11... (92001 for 100 M Ω)

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 521
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 100 M Ω	6

ORDERING EXAMPLE

The ordering code of a HRC11 high ohmic resistor, value 30 M Ω with a tolerance of $\pm 5\%$, supplied on paper tape of 5000 units per reel is: 2350 521 10306.

High ohmic chip resistors
size 0805

HRC11
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

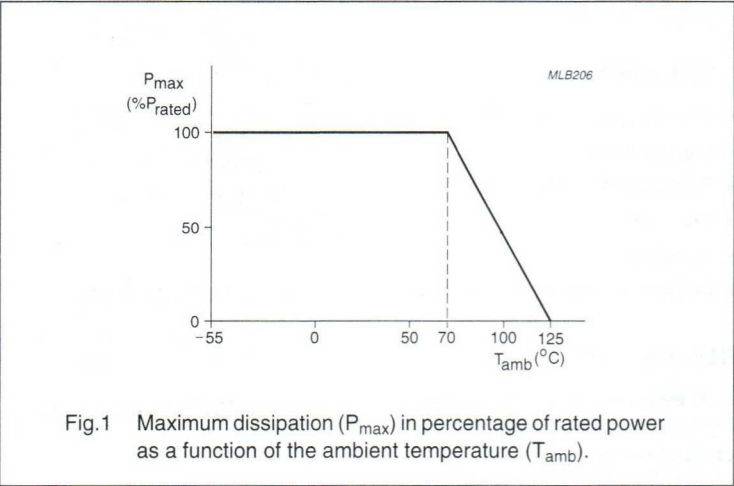
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
HRC11	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



High ohmic chip resistors
size 0805

HRC11
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC11	0.55

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6 or 7, as an indication of magnitude.

Example

MARKING	RESISTANCE
306	30 MΩ
107	100 MΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

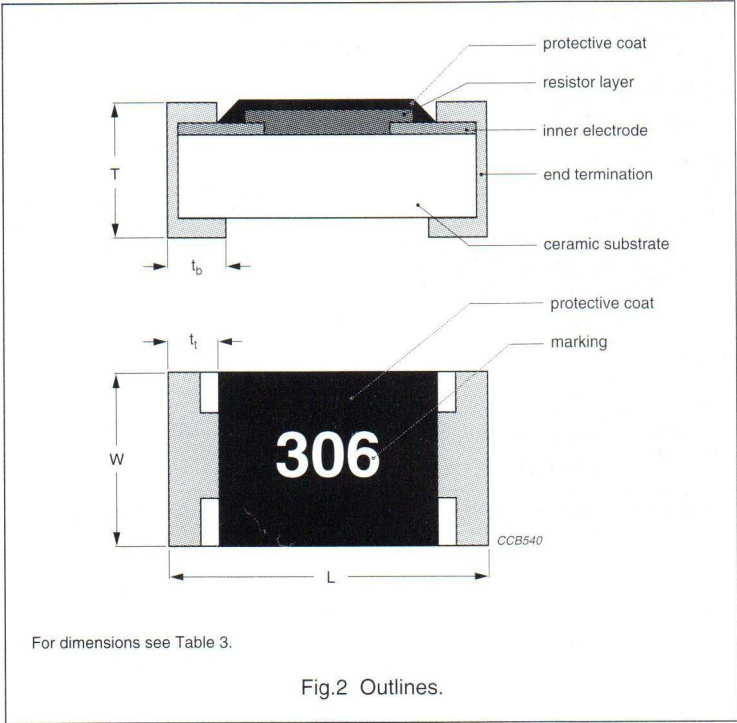


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
HRC11	2.0 ±0.15	1.25 ±0.15	0.55 ±0.10	0.40 ±0.20	0.40 ±0.20

High ohmic chip resistors size 0805

HRC11
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/125/56 (rated temperature range -55 to $+125$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage ($+0/-10\%$): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	150 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$

High ohmic chip resistors size 0805

HRC11
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% +0.1 \Omega)$
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(1.5\% +0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$300 \times 10^{-6}/K$
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching

High ohmic chip resistors

size 0603

HRC21
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small equipment
- Telecommunication
- Computers
- Automotive industry
- Medical and military equipment.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	11 to 22 M Ω ; E24 series
Resistance tolerance	$\pm 5\%$; $\pm 2\%$
Temperature coefficient	$\pm 300 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Operating temperature range	-55 to $+155^\circ C$
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 522
			PAPER TAPE ON REEL
			5000 units
HRC21	11 to 22 M Ω	± 5	10...
		± 2	11...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 522
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
11 to 22 M Ω	6

Ordering example

The ordering code of a HRC21 high ohmic resistor, value 12 M Ω , supplied on paper tape of 5000 units per reel is: 2350 522 10126.

High ohmic chip resistors
size 0603

HRC21
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

The resistors are available in the E24 series for resistors with a tolerance of 2% or 5%. The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

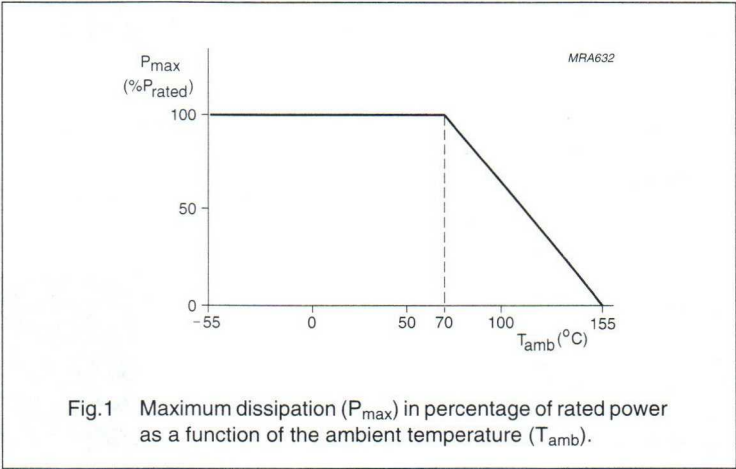
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
HRC21	50	0.063

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



High ohmic chip resistors
size 0603

HRC21
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
HRC21	0.25

Marking

Each resistor is marked with a 3-digit code on the protective coating to designate the nominal resistance value.

3-DIGIT MARKING

For values of 11 MΩ or greater the first 2 digits apply to the resistance value and the third is a 6, as an indication of magnitude.

Example

MARKING	RESISTANCE
116	11 MΩ
156	15 MΩ

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

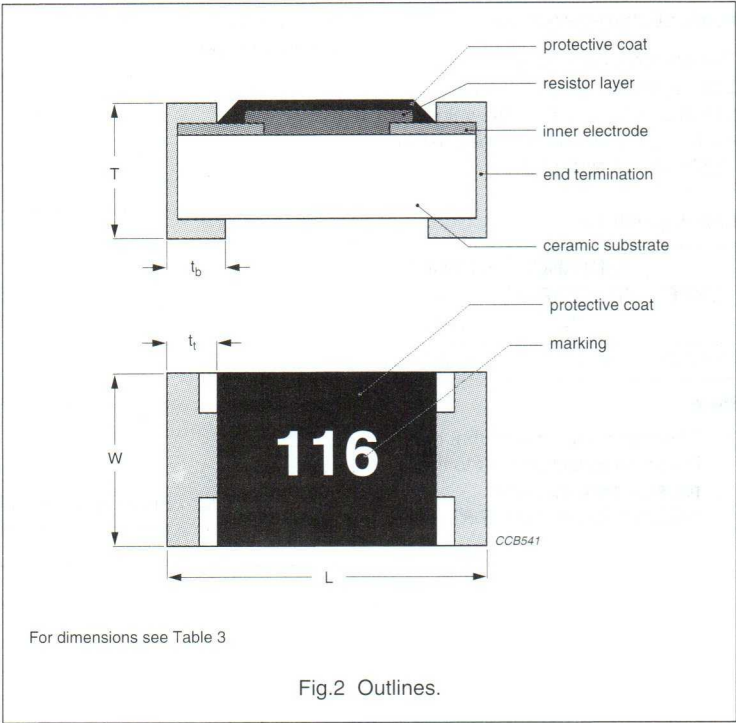


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
HRC21	1.6 ±0.10	0.8 +0.15/-0.05	0.45 ±0.10	0.30 ±0.20	0.30 ±0.20

High ohmic chip resistors size 0603

HRC21
5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to $+155$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	100 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; 93 ± 2 –3% RH; loaded with $0.01 P_n$	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.25.1		endurance	1000 ± 48 –0 hours; 70 ± 2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$

High ohmic chip resistors
size 0603

HRC21
5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.23.2	27 (Ba)	endurance at upper category temperature	1 000 +48/-0 hours; 155 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 300 \times 10^{-6}/K$
		leaching	unmounted chips 60 $\pm$ 1 s; 260 $\pm$ 5 °C	good tinning; no leaching

Trimmable chip resistors sizes 1206 and 0805

RC02TR RC12TR

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Specific electrical requirements (such as HF characteristics).

APPLICATIONS

This trimmable chip-resistor is suitable for the whole electronic industry and can replace trimmer resistors in several applications.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and a connection is made between them using a resistive metal glaze; the approximate resistor values are dependent on the composition of the glaze.

The resistive layer is covered with a translucent protective coat. Finally, two end electrodes are added, the composition of which has been designed to provide ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	RC02TR	RC12TR
Resistance range	1 Ω to 10 M Ω ; E24 series	
Resistance tolerance	0/-20% and 0/-30%	
Temperature coefficient: 1 $\Omega \leq R < 10 \Omega$ 10 $\Omega \leq R \leq 1 \text{ M}\Omega$ 1 M $\Omega < R$	$\leq 250 \pm 250 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$	
Absolute maximum dissipation at $T_{\text{amb}} = 70^\circ\text{C}$	0.25 W	0.125 W
Maximum permissible voltage	200 V (RMS)	150 V (RMS)
Climatic category (IEC 60068)	55/155/56	
Basic specification	IEC 60115-8	

ORDERING INFORMATION

Ordering code (12NC)

The resistors have a 12-digit catalogue number starting with 2350 50. The subsequent digits indicate the packaging and resistance value; see Table 1.

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	ORDERING CODE 2350 50. 1....	
		RC02TR	RC12TR
		PAPER TAPE ON REEL	
		5000 units	5000 units
RC02TR/RC12TR	+0/-30	500 11...	501 11...
	+0/-20	500 10...	501 10...

Trimmable chip resistors
sizes 1206 and 0805

RC02TR
RC12TR

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of 0/-20% and 0/-30%.

Limiting values

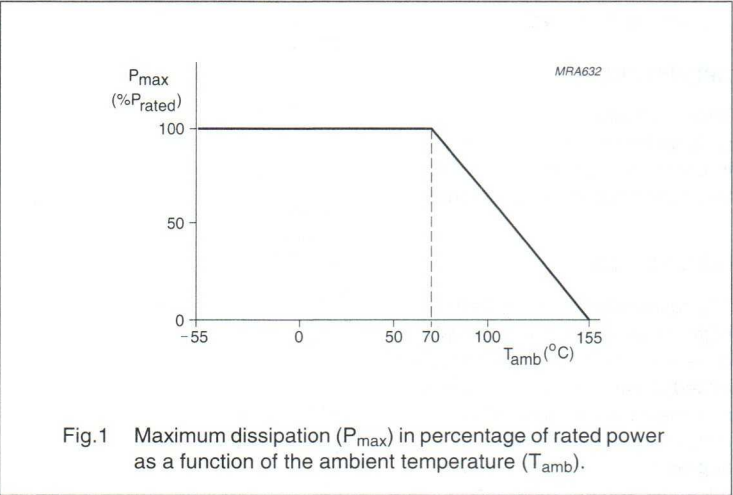
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC02TR	200	0.25
RC12TR	150	0.125

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Application information

TRIMMING INSTRUCTIONS WITH YAG-LASER

Typical values for:

- Cutting speed = 10 to 300 mm/s
- Laser power = 1 to 6 W
- Maximum trimming length = 60% of resistor film width
- Minimum distance between end termination and trimming cut = 0.50 mm.

PROTECTION OF LASER CUT

With epoxy-phenol lacquers, epoxy resins or silicon alkyd-resins. This is necessary for humidity tests and stability at load.

Trimmable chip resistors
sizes 1206 and 0805

RC02TR
RC12TR

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC02TR	1
RC12TR	0.55

Marking

The resistor is not marked. The packaging is marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

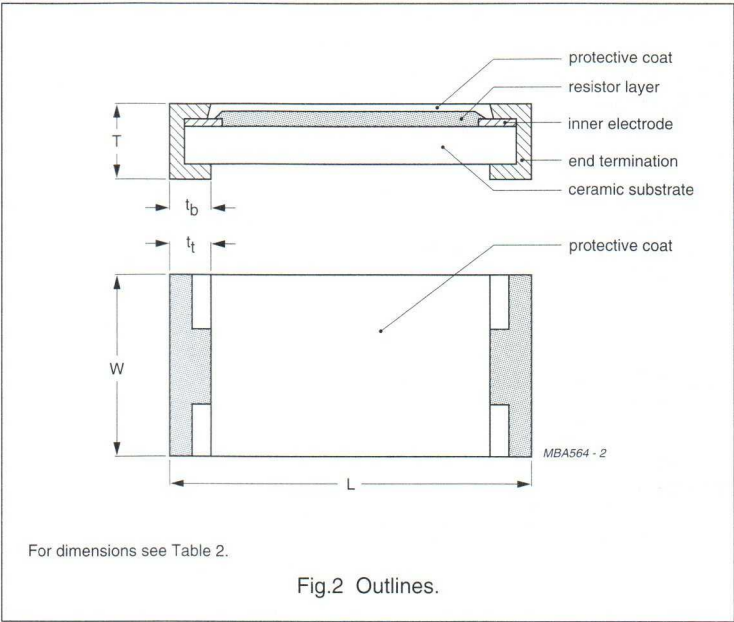


Table 2 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
RC02TR	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RC12TR	3.20 ±0.15	1.25 ±0.15	0.55 ±0.10	0.45 ±0.20	0.50 ±0.20

Trimable chip resistors sizes 1206 and 0805

RC02TR
RC12TR

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to $+155$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 3 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 3 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	10 ± 1 s; 260 ± 5 °C	$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	$\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm for RC02TR , 5 mm for RC12TR	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_N$: $R \leq 1 M\Omega$ $R > 1 M\Omega$	$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.25.1		endurance	$1000 + 48/-0$ hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off: $R \leq 1 M\Omega$ $R > 1 M\Omega$	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute, metal block method	R_{ins} min.: $10^3 M\Omega$
4.13		short time overload	room temperature; $P = 6.25 \times P_N$; 5 s ($V \leq 2 \times V_{max}$ for RC02TR , $V \leq 200$ V for RC12TR)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $1 \Omega \leq R \leq 10 \Omega$ $10 \Omega \leq R \leq 1 M\Omega$ $1 M\Omega < R$	$\leq 250 \pm 250 \times 10^{-6}/K$ $\leq \pm 100 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$

Trimmable chip resistors
sizes 1206 and 0805

RC02TR
RC12TR

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		noise	IEC publication 60195 (measured with Quantech-equipment): $R \leq 100 \Omega$ $R \leq 1 \text{ k}\Omega$ $R \leq 10 \text{ k}\Omega$ $R \leq 100 \text{ k}\Omega$ $R \leq 1 \text{ M}\Omega$ $R \leq 10 \text{ M}\Omega$	max. $0.316 \mu\text{V/V}$ (-10 dB) max. $1 \mu\text{V/V}$ (0 dB) max. $3 \mu\text{V/V}$ (9.54 dB) max. $6 \mu\text{V/V}$ (15.56 dB) max. $10 \mu\text{V/V}$ (20 dB) max. $32 \mu\text{V/V}$ (30.10 dB)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; no load: $R \leq 1 \text{ M}\Omega$ $R > 1 \text{ M}\Omega$	$\Delta R/R \text{ max.: } \pm(1\% + 0.05 \Omega)$ $\Delta R/R \text{ max.: } \pm(1.5\% + 0.05 \Omega)$
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown

Trimable chip resistor size 0603

RC22TR

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Improved performance at high frequency
- Low noise, when not trimmed.

APPLICATIONS

- Hand-held measuring equipment
- Mobile phones
- Camcorders
- Portable radios, CD and cassette players
- Tuners
- Photo sensors.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and a connection is made between them using a resistive metal glaze; the approximate resistor values are dependent on the composition of the glaze.

The resistive layer is covered with a translucent protective coat. Finally, two end electrodes are added, the composition of which has been designed to provide ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 10 M Ω ; E24 series
Resistance tolerance	0/-20% and 0/-30%
Temperature coefficient: R $\leq$ 10 Ω 10 Ω < R $\leq$ 1 M Ω 1 M Ω < R	0 to 500 $\times 10^{-6}$ /K $\leq \pm 100 \times 10^{-6}$ /K $\leq \pm 200 \times 10^{-6}$ /K
Absolute maximum dissipation at T _{amb} = 70 °C	0.063 W
Maximum permissible voltage	50 V (DC or RMS)
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60 115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	TOL. (%)	RESISTANCE VALUE	ORDERING CODE 2350 502
			PAPER TAPE ON REEL
			5000 units
RC22TR	0/-20	1 Ω to 10 M Ω	11...
	0/-30		10...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 502; see Table 1.
- The subsequent digit indicates the resistor type and packaging.
- The remaining digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 k Ω	2
10 to 91 k Ω	3
100 to 910 k Ω	4
1 to 9.1 M Ω	5
10 M Ω	6

Ordering example

The ordering code of a RC22TR resistor, value 330 Ω , 0/-30%, supplied on paper tape of 5000 units per reel is: 2350 502 10331

Trimmable chip resistor
size 0603

RC22TR

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of 0/-20% and 0/-30%.

Limiting values

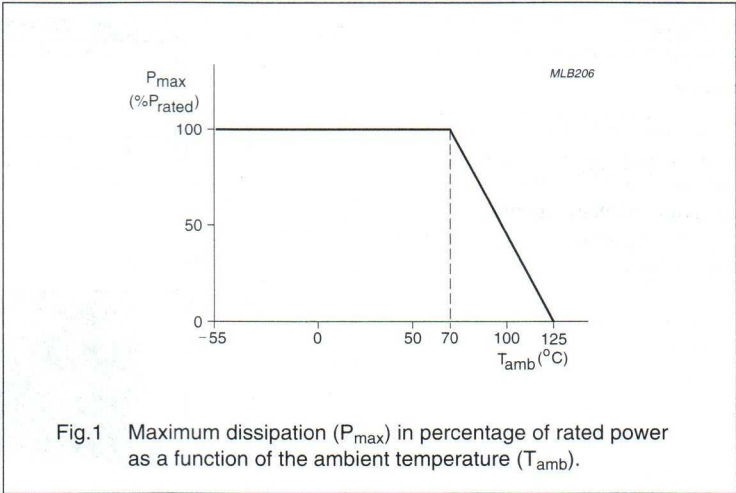
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RC22TR	50	0.063

Note

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.



Application information

TRIMMING INSTRUCTIONS WITH YAG-LASER

Typical values for:

- Cutting speed = 10 to 300 mm/s
- Laser power = 1 to 6 W
- Maximum trimming length = 60% of resistor film width
- Minimum distance between end termination and trimming cut = 0.20 mm.

PROTECTION OF LASER CUT

With epoxy-phenol lacquers, epoxy resins or silicon alkyd-resins. This is necessary for humidity tests and stability at load.

Trimable chip resistor
size 0603

RC22TR

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RC22TR	0.25

Marking

The resistor is not marked. The packaging is marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

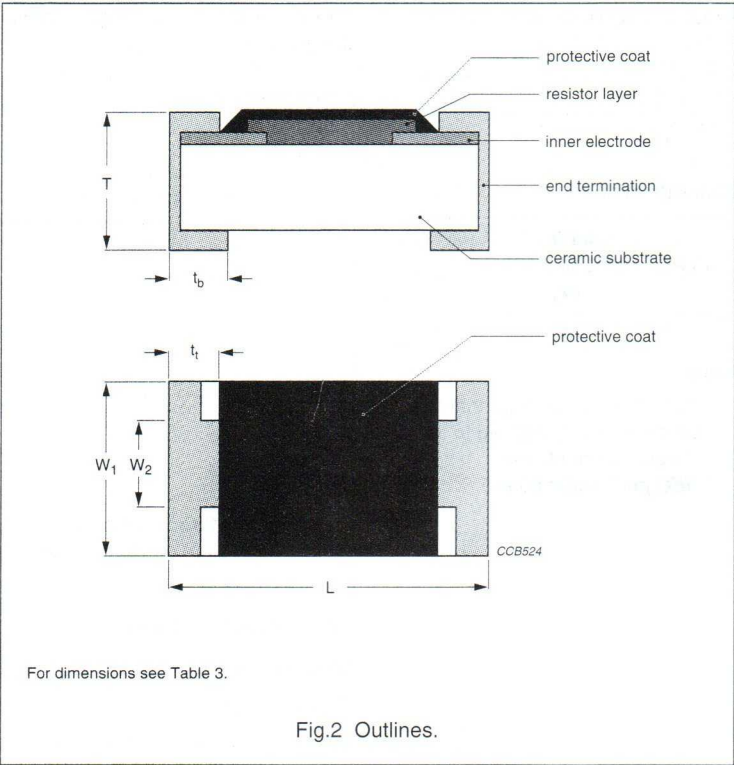


Table 3 Chip resistor type and relevant physical dimensions; see Fig.2

TYPE	L (mm)	W ₁ (mm)	W ₂ (mm)	T (mm)	t _t (mm)	t _b (mm)
RC22TR	1.6 ±0.10	0.8 +0.15/-0.05	0.7	0.45 ±0.10	0.30 ±0.15	0.30 ±0.15

Trimmable chip resistor size 0603

RC22TR

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to $+155$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions in accordance with "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; 93 ± 2 –3% RH; loaded with $0.01 P_n$ $R < 1 M\Omega$ $R > 1 M\Omega$	R_{ins} min.: 10000 M Ω $\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$ $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.25.1		endurance	1000 ± 48 –0 hours; 70 ± 2 °C; nominal dissipation; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	50 V (DC) after 1 minute	R_{ins} min.: 10000 M Ω
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.8.4.2		temperature coefficient	at 20/LCT/20 and 20/UCT/20 $R \leq 10 \Omega$ $10 \Omega < R \leq 1 M\Omega$ $1 M\Omega < R$	0 to $500 \times 10^{-6}/K$ $\leq \pm 100 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$

Trimmable chip resistor
size 0603

RC22TR

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.12		noise	IEC publication 60195 (measured with Quantech-equipment) $R \leq 100 \Omega$ $100 \Omega < R \leq 1 \text{ k}\Omega$ $1 \text{ k}\Omega < R \leq 10 \text{ k}\Omega$ $10 \text{ k}\Omega < R \leq 100 \text{ k}\Omega$ $100 \text{ k}\Omega < R \leq 1 \text{ M}\Omega$ $1 \text{ M}\Omega < R$	max. $0.316 \mu\text{V/V}$ (-10 dB) max. $1 \mu\text{V/V}$ (0 dB) max. $3 \mu\text{V/V}$ (9.54 dB) max. $6 \mu\text{V/V}$ (15.56 dB) max. $10 \mu\text{V/V}$ (20 dB) max. $32 \mu\text{V/V}$ (30.10 dB)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 125 °C; no load	no visible damage $\Delta R/R$ max.: $\pm(1.0\% + 0.05 \Omega)$
4.7		voltage proof on insulation	50 V (DC or RMS) during 1 minute	no breakdown

Fusible chip resistor size 1206

FRC01
5%

FEATURES

- Overload protection without the risk of fire
- Grey coating for ease of recognition
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Power supplies in small sized equipment
- Car telephones
- Portable radio, CD and cassette players.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

To enable recognition of a fusible device, the resistor should be mounted face up.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 to 510 Ω ; E24/E96 series
Resistance tolerance	$\pm 5\%$
Temperature coefficient: 1 to 4.7 Ω 5.1 to 510 Ω	$\leq \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.125 W
Maximum permissible voltage	200 V (DC or RMS)
Operating temperature range	$-55^\circ C$ to $+125^\circ C$
Climatic category (IEC 60068)	55/125/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating type and packaging

TYPE	ORDERING CODE 2322 750
	PAPER TAPE ON REEL
	5000 units
FRC01	6....

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2322
- The subsequent 4 digits indicate the resistor type and packaging; see Table 1.
- The remaining 4 digits indicate the resistance value:
 - The first 3 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 240 Ω	1

ORDERING EXAMPLE

The ordering code of a FRC01 resistor, value 200 Ω , packed in paper tape and supplied on a reel of 5000 units is: 2322 750 62001.

Fusible chip resistor size 1206

FRC01

5%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$. The values of the E24/E96

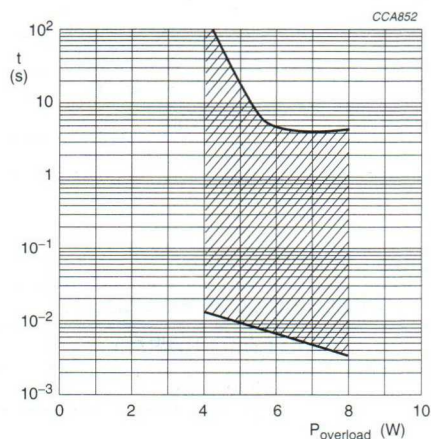
series are in accordance with "IEC publication 60063".

Fusing characteristics

The resistors will fuse without the risk of fire and within an indicated range of overload. Fusing means that the

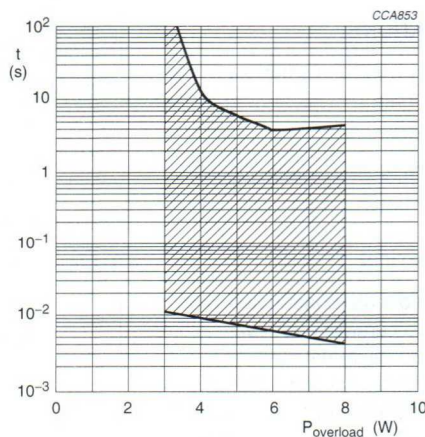
resistive value of the resistor increases at least 100 times; see Figs 1 and 2.

The fusing characteristic is measured under constant voltage with resistors mounted on a ceramic or glass epoxy (FR4) substrate; see Fig.3.



This graph is based on measured data which may deviate according to the application.

Fig.1 Fusing characteristic: $10 \Omega \leq R < 240 \Omega$, measured using ceramic board material.



This graph is based on measured data which may deviate according to the application.

Fig.2 Fusing characteristic: $1 \Omega \leq R < 240 \Omega$, measured using glass epoxy (FR4) board material.

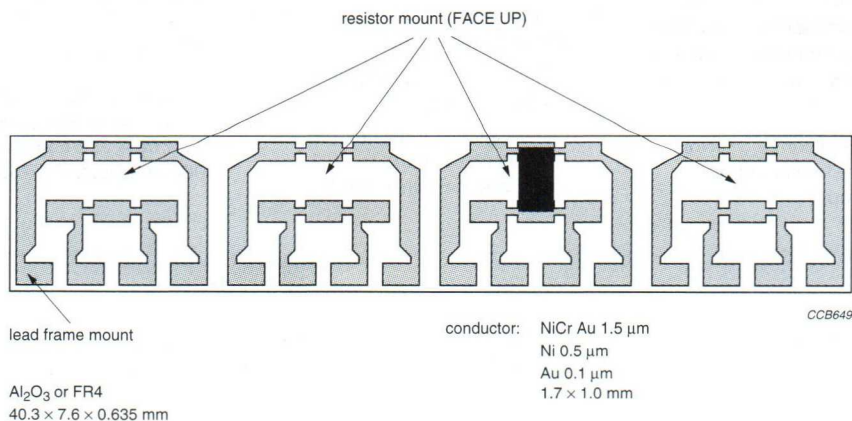


Fig.3 Test substrate layout.

Fusible chip resistor size 1206

FRC01
5%

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
FRC01	200 ⁽²⁾	0.125

Notes

1. The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".
2. The maximum voltage that may be applied after fusing is shown in Fig.4.

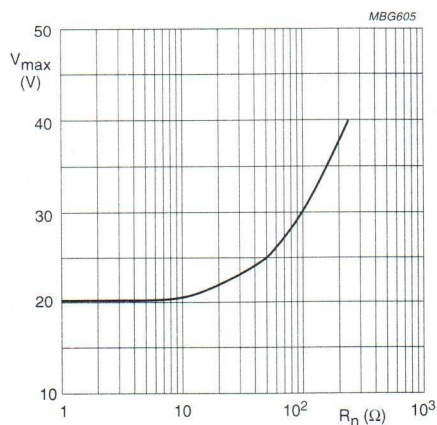


Fig.4 Maximum applied voltage after fusing.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.5.

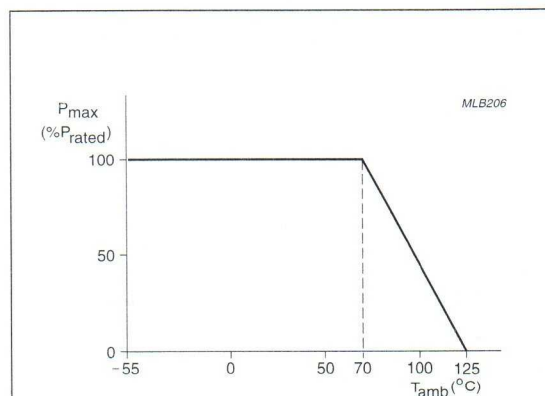
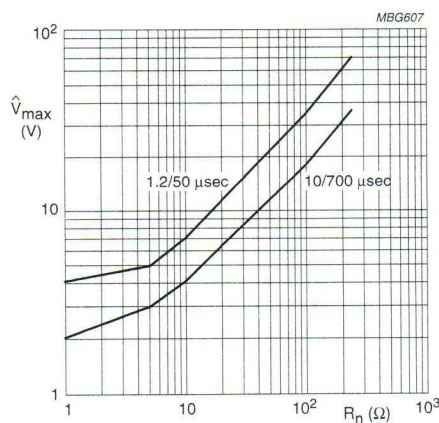


Fig.5 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



These pulses may not be applied on a regular basis.

Fig.6 Maximum permissible peak pulse voltage without failing to 'open circuit' in accordance with DIN IEC 60040 (CO) 533.

Fusible chip resistor size 1206

FRC01 5%

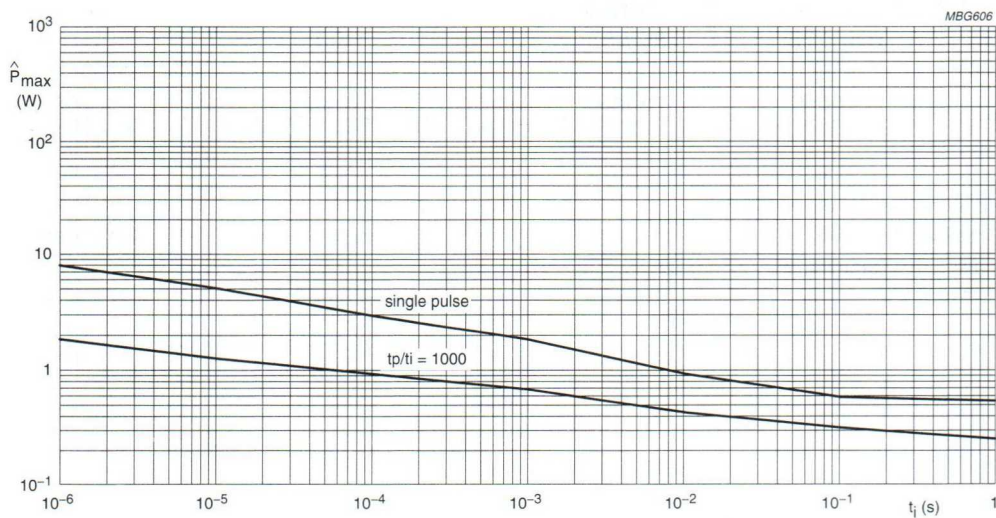


Fig.7 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration, single pulse and repetitive pulse $t_p/t_i = 1000$.

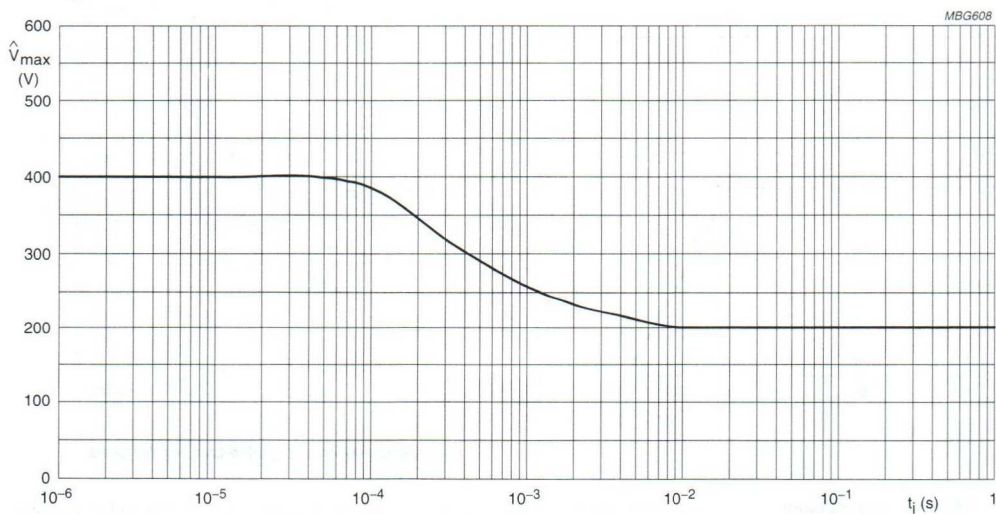


Fig.8 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration.

Fusible chip resistor size 1206

FRC01
5%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
FRC01	1.0

Marking

All resistors are marked with a four digit code on the protective coat to designate the nominal resistance value.

4-DIGIT MARKING

For all values, the R is used as a decimal point.

Example

MARKING	RESISTANCE
120R	120 Ω

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

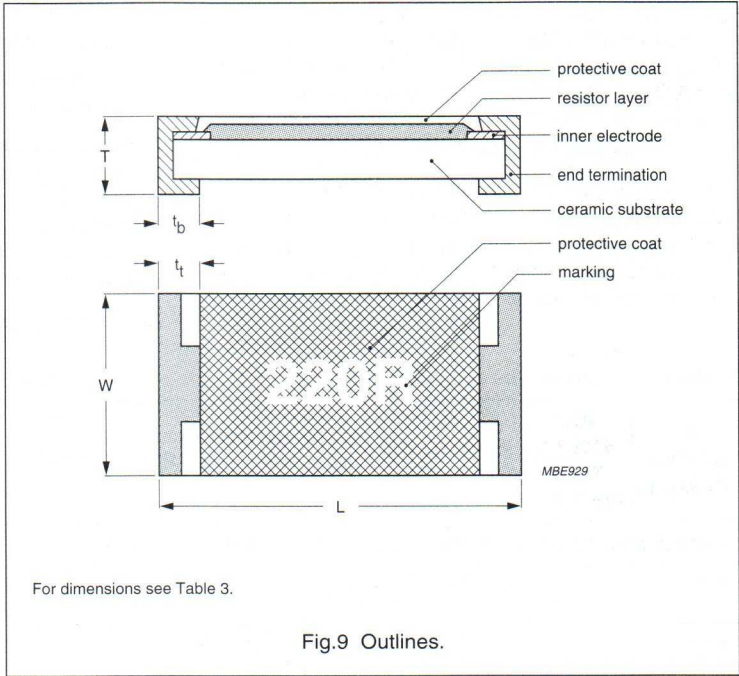


Table 3 Chip resistor type and relevant physical dimensions; see Fig.9

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
FRC01	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

Fusible chip resistor size 1206

FRC01 5%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category **LCT/UCT/56** (rated temperature range: **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, **56** days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa
(860 mbar to 1060 mbar).

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge (mm)	$0.45 \leq T \leq 0.65$ $1.45 \leq W \leq 1.75$ $3.0 \leq L \leq 3.3$
4.5		resistance	applied voltage (+0/-10%): $R < 10 \Omega$: 0.1 V $10 \Omega \leq R < 100 \Omega$: 0.3 V $100 \Omega \leq R < 240 \Omega$: 1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H ₂ O followed by brushing in accordance with "MIL 202 F"	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no visible damage
4.7		voltage proof on insulation	maximum voltage (RMS) during 1 minute metal block method	no breakdown or flashover
4.13		short time overload	room temperature; $P = 6.25 \times P_n$; 5 s ($V \leq 2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.33		bending	resistors mounted on a 90 mm glass epoxy resin PCB (FR4), bending: 3 mm	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	$\Delta R/R$ max.: $\pm(3\% + 0.1 \Omega)$

Fusible chip resistor size 1206

FRC01
5%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1 000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±(3% +0.1 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1 000 +48/-0 hours; no load	$\Delta R/R$ max.: ±(3% +0.1 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C: $R < 5 \Omega$ $R \leq 510 \Omega$	$\leq \pm 250 \times 10^{-6}/K$ $\leq \pm 200 \times 10^{-6}/K$
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours 155 °C; unmounted chips completely immersed for 2 ±0.5 s in a solder bath at 235 ±2 °C	good tinning (≥95% covered); no damage
4.6.1.1		insulation resistance	voltage (DC) after 1 minute, metal block method: 100 V	R_{ins} min.: 10 ³ MΩ
4.12		noise	IEC publication 60195 (measured with Quantech-equipment)	max. 2 μV/V
Other applicable tests				
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1 000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±(5% +0.1 Ω)
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
		trio damp heat test	1 000 +48/-0 hours; 85 ±2 °C; 85 ±5% RH; loaded with 0.1 P_n or V_{max}	$\Delta R/R$ max.: ±(5% +0.1 Ω)

Surge chip resistor size 1206

SRC01
5%; 2%

FEATURES

- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability
- Excellent performance at high frequency.

APPLICATIONS

- Power supply in small sized equipment
- Telecommunication
- Medical and Military
- Automotive industry.

DESCRIPTION

The resistors are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive layer is covered with a protective coating and printed with the resistance value. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance range	1 Ω to 100 k Ω
Resistance tolerance	$\pm 5\%$; $\pm 2\%$ E24 series
Temperature coefficient	$\leq \pm 200 \times 10^{-6}/K$
Absolute maximum dissipation at $T_{amb} = 70^{\circ}C$	0.25 W
Maximum permissible voltage	200 V (DC or RMS)
Climatic category (IEC 60068)	55/155/56
Basic specification	IEC 60115-8

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging

TYPE	RESISTANCE RANGE	TOL. (%)	ORDERING CODE 2350 550
			PAPER TAPE ON REEL
			5000 units
SRC01	1 Ω to 100 k Ω	5	10 ...
		2	11 ...

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 2350 550.
- The subsequent 2 digits indicate the resistor type and packaging; see Table 1.
- The remaining 3 digits indicate the resistance value:
 - The first 2 digits indicate the resistance value.
 - The last digit indicates the resistance decade in accordance with Table 2.

Table 2 Last digit of 12 NC

RESISTANCE	LAST DIGIT
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 k Ω	2
10 to 97.6 k Ω	3
100 k Ω	4

ORDERING EXAMPLE

The ordering code of a SRC01 resistor, value 750 Ω with a tolerance of 5%, supplied on paper tape of 5000 units per reel is: 2350 550 10751.

Surge chip resistor size 1206

SRC01
5%; 2%

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$ or 2% . The values of the E24 series are in accordance with "IEC publication 60063".

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
SRC01	200	0.25

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.1.

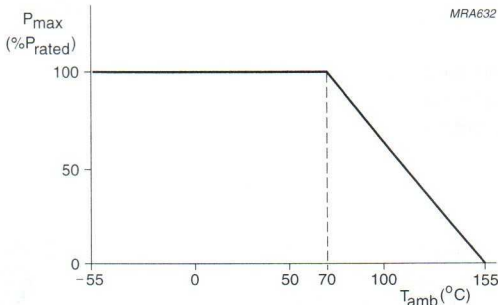


Fig.1 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES

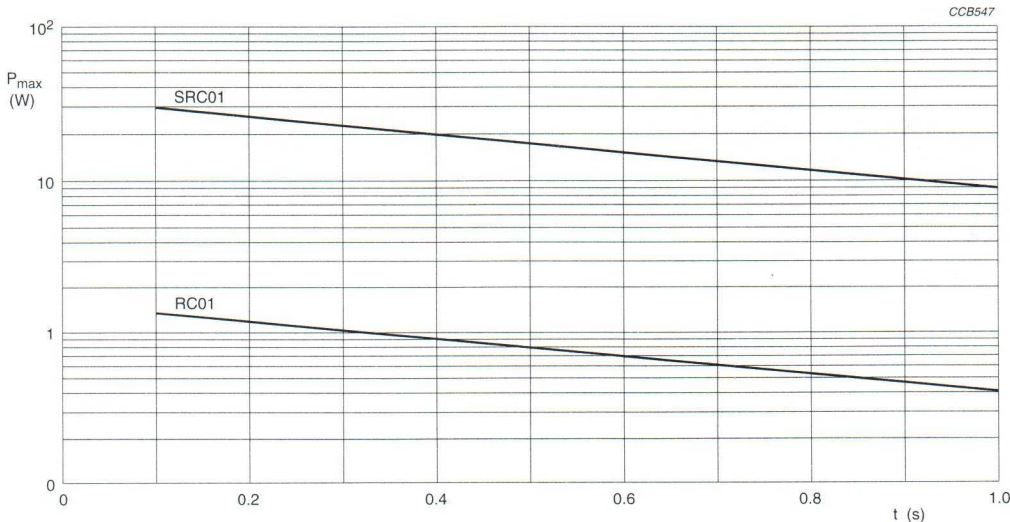


Fig.2 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration for $R = 1 \Omega$, single pulse.

Surge chip resistor
size 1206

SRC01
5%; 2%

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
SRC01	1.0

Marking

All resistors are marked with a 3-digit code on the protective coat to designate the nominal resistance value.

3-DIGIT MARKING

For values up to 1 kΩ the R is used as a decimal point. For values of 1 kΩ or greater the first 2 digits apply to the resistance value and the third indicates the number of zeros to follow.

Example

MARKING	RESISTANCE
10R	10 Ω
102	1 kΩ
104	100 kΩ

PACKAGE MARKING

The packaging is also marked and includes resistance value, tolerance, catalogue number, quantity, production period, batch number and source code.

Outlines

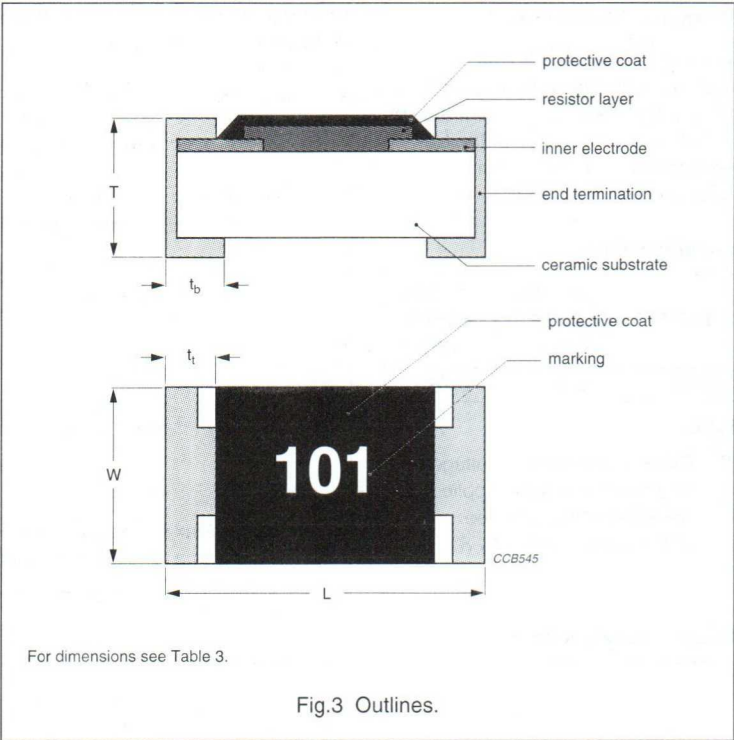


Table 3 Chip resistor type and relevant physical dimensions; see Fig.3

TYPE	L (mm)	W (mm)	T (mm)	t _t (mm)	t _b (mm)
SRC01	3.20 +0.10/-0.20	1.60 ±0.15	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25

Surge chip resistor size 1206

SRC01 5%; 2%

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-8", category 55/155/56 (rated temperature range -55 to $+155$ °C; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

Air pressure: 86 kPa to 106 kPa.

In Table 4 the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-8 and 60068", a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying.

All soldering tests are performed with mildly activated flux.

Table 4 Test procedures and requirements

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-8				
4.4.1		visual examination		no holes; clean surface; no visible damage
4.5		resistance	applied voltage (+0/−10%): 0.1 V	$R - R_{nom}$: max. $\pm 5\%$
4.18	20 (Tb)	resistance to soldering heat	unmounted chips; 10 ± 1 s; 260 ± 5 °C	no visible damage $\Delta R/R$ max.: $\pm(1\% + 0.05 \Omega)$
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol; H_2O	no visible damage
4.17	20 (Ta)	solderability	unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.17	20 (Ta)	solderability (after ageing)	8 hours steam or 16 hours at 155 °C; unmounted chips completely immersed for 2 ± 0.5 s in a solder bath at 235 ± 2 °C	good tinning ($\geq 95\%$ covered); no damage
4.7		voltage proof on insulation	200 V (RMS) during 1 minute	no breakdown or flashover
4.13		short time overload	room temperature; dissipation $6.25 \times P_n$; 5 s (voltage not more than $2 \times V_{max}$)	$\Delta R/R$ max.: $\pm(2\% + 0.1 \Omega)$
4.33	(JIS) C 5200	bending	resistors mounted on a 90 mm glass epoxy resin printed-circuit board; bending: 5 mm	no visible damage $\Delta R/R$ max.: $\pm(0.5\% + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visible damage $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$
4.6.1.1		insulation resistance	100 V (DC) after 1 minute	R_{ins} min.: 1000 M Ω
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 ± 2 °C; $93 \pm 2/-3\%$ RH; loaded with $0.01 P_n$	R_{ins} min.: 1000 M Ω $\Delta R/R$ max.: $\pm(1.5\% + 0.05 \Omega)$

Surge chip resistor size 1206

SRC01 5%; 2%

IEC 60115-8 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.25.1		endurance	1000 +48/-0 hours; 70 ±2 °C; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±(1% +0.05 Ω)
4.23.2	27 (Ba)	endurance at upper category temperature	1000 +48/-0 hours; 155 °C; no load	no visible damage $\Delta R/R$ max.: ±(1% +0.05 Ω)
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\leq \pm 200 \times 10^{-6}/K$
Other applicable tests				
		leaching	unmounted chips 60 ±1 s; 260 ±5 °C	good tinning; no leaching
	(JIS) C 5202 7.5	resistance to damp heat (steady state)	1000 +48/-0 hours; 40 ±2 °C; 93 +2/-3% RH; loaded with P_n or V_{max} ; 1.5 hours on and 0.5 hours off	$\Delta R/R$ max.: ±3%

RC NETWORKS PRODUCT DATA

	Page
Mono-layer RC network (10P4R4C, 1608): RCB210	374
Multilayer CR network (10P4R4C, 1608): CRB210	381

Resistor-Capacitor network size 1608

RCB210

FEATURES

- 4 resistors and 4 capacitors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

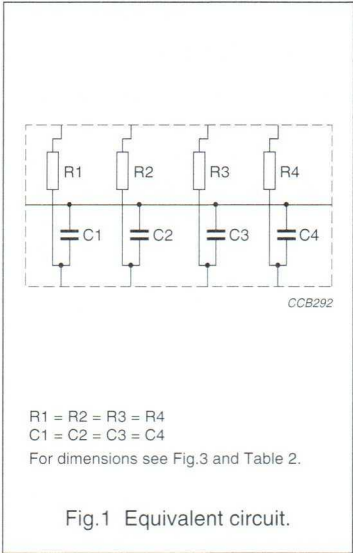
APPLICATIONS

- Motherboards
- Notebook computers
- LCD displays
- Mobile phones.

DESCRIPTION

The components are constructed on a high grade ceramic body (aluminium oxide). Internal metal electrodes are added at each end and connected by a resistive paste which is applied to the bottom surface of the substrate; a dielectric material is applied to the top surface. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance, by laser cutting of this resistive layer.

The resistive and dielectric layers are covered with a protective coating and the marking bar is printed on the capacitor side. Finally, external end terminations are added. For ease of soldering the outer layer of these end terminations is a lead/tin alloy.



QUICK REFERENCE DATA

DESCRIPTION	VALUE
Resistance: range tolerance temperature coefficient	10 Ω to 1 k Ω ; E6 series $\pm 5\%$ $\pm 200 \times 10^{-6}/K$
Capacitance: range tolerance temperature coefficient	10 to 180 pF; E3 series +30 to -20% $\Delta C/C$: +20% to -55%
Dissipation factor at 25 $^{\circ}C$, 1 kHz, 1 V_{rms}	$\leq 3.0\%$
Number of: resistors capacitors terminals	4 4 10
Absolute maximum dissipation at $T_{amb} = 70^{\circ}C$	0.063 W/element
Maximum permissible voltage	25 V (DC or RMS)
Operating temperature range	-25 to +85 $^{\circ}C$
Climatic category (IEC 60068)	55/85/56

Resistor-Capacitor network size 1608

RCB210

ORDERING INFORMATION

Ordering code (12NC)

The R-C network has a 12-digit ordering code starting with 2350 321

The last 5 digits indicate the resistance/capacitance combination; see Table 1.

ORDERING EXAMPLE

The ordering code of an RCB210, 1608 concave type R-C network, value 22 Ω /100 pF, supplied on blister tape of 4000 units per reel is: 2350 321 20002.

Table 1 Ordering code indicating network type, packaging and marking code

ORDERING CODE 2350 321			
BLISTER TAPE ON REEL			
4000 units			
R (Ω)	C (pF)	LAST FIVE DIGITS	MARKING CODE
33	180	20001	702
22	100	20002	13
100	47	20003	32
22	10	20004	515
47	22	20005	21
22	22	20006	11
22	47	20007	12
47	47	20008	22
47	100	20009	23
100	22	20010	31
100	100	20011	33
220	22	20012	41
220	47	20013	42
220	100	20014	43
470	22	20015	51
470	47	20016	52
470	100	20017	53
1000	22	20018	61
1000	47	20019	62
1000	100	20020	63
100000	22	20021	502
33	47	20022	503
33	33	20023	504
100	33	20024	505
1000	33	20025	506
47	33	20026	507
2200	47	20027	508

ORDERING CODE 2350 321			
BLISTER TAPE ON REEL			
4000 units			
R (Ω)	C (pF)	LAST FIVE DIGITS	MARKING CODE
82000	33	20028	509
22	33	20029	510
47000	100	20030	511
15000	47	20031	512
33	10	20032	513
47	10	20033	514
330	100	20034	516
10	10	20035	517
15	15	20036	518
10	15	20037	519
15	10	20038	520
27	47	20039	521
33	100	20040	522
100	10	20041	523
10	100	20042	524
10	22	20043	525
10	47	20044	526
1000	10	20045	527
220	10	20046	528
470	10	20047	529
22	180	20048	701
47	180	20049	703
68	180	20050	704
4700	180	20051	705
100	180	20052	706
82	100	20053	530

Resistor-Capacitor network
size 1608

RCB210

FUNCTIONAL DESCRIPTION

Limiting values

TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
RCB210	25	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8".

DERATING

The power that the component can dissipate depends on the operating temperature; see Fig.2.

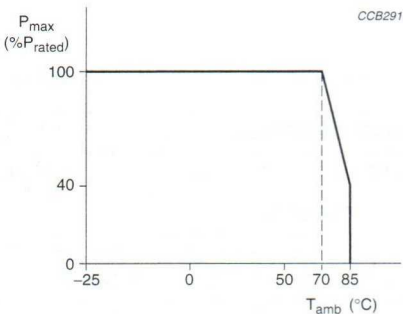


Fig.2 Maximum dissipation ($P_{\max}$) in percentage of rated power as a function of the ambient temperature (T_{amb}).

Resistor-Capacitor network
size 1608

RCB210

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
RCB210	1.8

Marking

Marking codes for capacitance and
resistance

RESISTANCE		CAPACITANCE	
VALUE (Ω)	CODE	VALUE (pF)	CODE
22	1	22	1
47	2	47	2
100	3	100	3
220	4	—	—
470	5	—	—
1000	6	—	—

MARKING EXAMPLES

Typical capacitance/resistance
marking codes

C (pF)	R (Ω)			
	22	47	100	220
22	11	21	31	41
47	12	22	32	42
100	13	23	33	43

Outlines

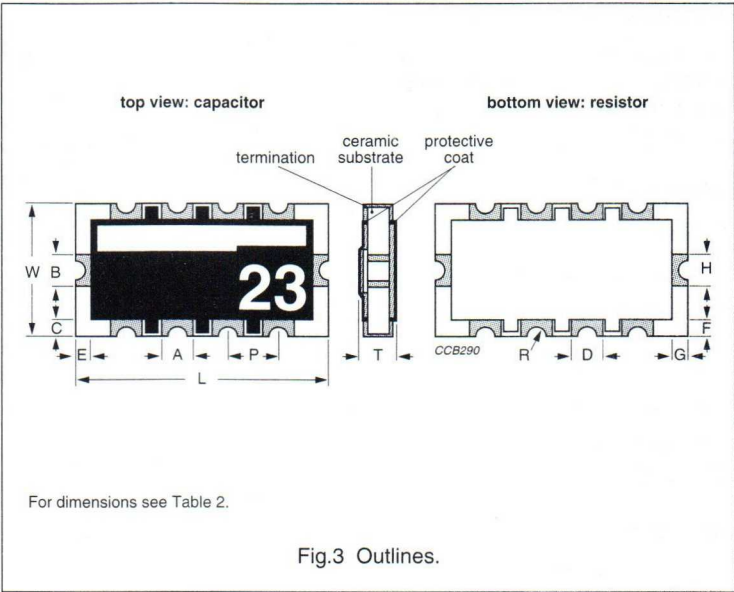


Table 2 Physical dimensions; see Fig.3

SYMBOL	VALUE	TOL.	UNIT
L	4.00	+0.30/-0.10	mm
W	2.10	± 0.20	mm
A and B	0.50	± 0.20	mm
C and E	0.25	± 0.20	mm
H	0.50	± 0.20	mm
R	0.15	+0.05/-0.10	mm
T	0.65	+0.20/-0.10	mm
D	0.45	± 0.20	mm
F and G	0.40	± 0.20	mm
P	0.80	± 0.10	mm

Resistor-Capacitor network
size 1608

RCB210

HANDLING

Recommended land patterns

The GND pattern should be as large as possible as high frequency noise is removed through this terminal, see Fig.4 and Table 3.

Reflow soldering

SOLDER PASTE

Refer to Fig.5 for pattern.

Thickness: 150 to 200 μm .

FLUX AND SOLDER

Use rosin -based flux only.

Sn/Pb solder composition ratio:
63/37 or 60/40.

Wave soldering

Not recommended.

Component replacement

SOLDERING GUN (<30 W)

The temperature of the tip must be less than 280 $^{\circ}\text{C}$ for a period within 3 seconds and should not come in direct contact with the product.

Substrate

MOUNTING

The mounting place on the printed-circuit board (PCB) should be as far as possible from the position which is close to the break line or on the line of large holes.

BENDING

Excessive bending of the PCB after soldering is not recommended. When mounting other components use support pins; see Fig.5.

BREAKING

Any breaking of the PCB should only be done by machine or jig.

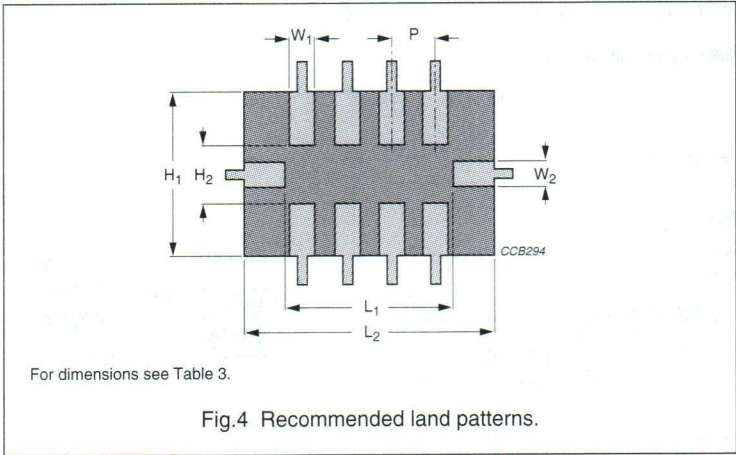


Fig.4 Recommended land patterns.

Table 3 Recommended land pattern dimensions; see Fig.4

SYMBOL	SIZE	TOL.	UNIT
H ₁	3.10	± 0.4	mm
H ₂	1.60	± 0.5	mm
L ₁	3.50	± 0.1	mm
L ₂	5.10	± 0.3	mm
W ₁	0.40	± 0.05	mm
W ₂	0.45	± 0.05	mm
P	0.80	± 0.05	mm

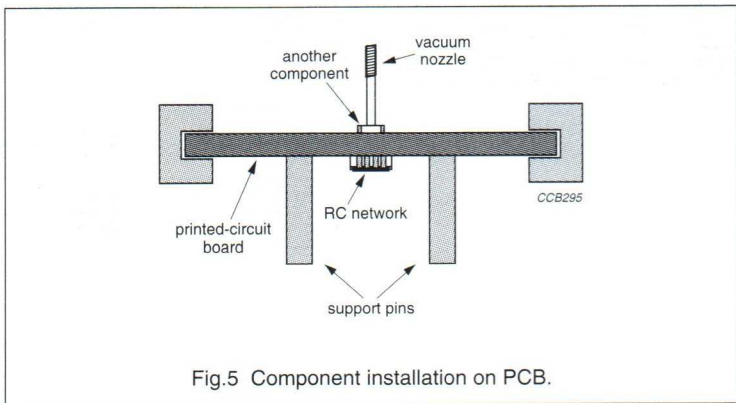


Fig.5 Component installation on PCB.

CAUTION

Rapid heating or cooling will damage this product.
Avoid an initial heat shock over 100 $^{\circ}\text{C}$.

Preheating and gradual cooling is recommended.

Resistor-Capacitor network

size 1608

RCB210

TESTS AND REQUIREMENTS

Unless otherwise specified the following values apply:

Temperature: 25 ± 2 °C

Relative humidity: 45% to 55%

Air pressure: 86 kPa to 107 kPa
(860 mbar to 1070 mbar).

In Table 4 the tests and requirements are listed.

The description of the test procedure is also given.

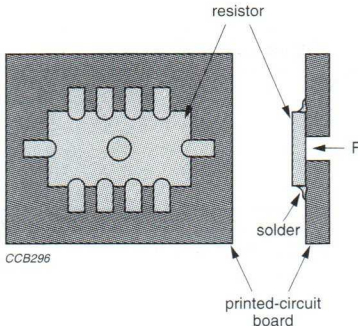
All soldering tests are performed with rosin -based flux.

Table 4 Test procedures and requirements

TEST METHOD	PROCEDURE	REQUIREMENTS
Electrical characteristics of resistor		
DC resistance	$R \leq 100 \Omega$: 0.3 V $100 \Omega < R \leq 999 \Omega$: 1 V	within the specified tolerance $\pm 5\%$
Temperature coefficient	between -55 °C to $+125$ °C	$\leq \pm 200 \times 10^{-6}/K$
Electrical characteristics of capacitor		
Capacitance	capacitance value shall be measured according to: frequency: 1 kHz $\pm 10\%$ voltage: $1 \pm 0.2 V_{rms}$ temperature: 25 ± 2 °C	within the specified tolerance $+30$ to -20%
Dissipation factor	dissipation factor shall be measured according to: frequency: 1 kHz $\pm 10\%$ voltage: $1 \pm 0.2 V_{rms}$ temperature: 25 ± 2 °C	3.0% max.
Temperature characteristic	between -25 °C to $+85$ °C	$\Delta C/C$: -55% to $+20\%$
Insulation resistance	25 V (DC) during 1 minute	R_{ins} min.: 1000 M Ω
Withstanding voltage	$2.5 \times U_R$ applied between I/O terminal and GND for 1 to 5 s	no mechanical damage, arcing or breakdown
Environmental characteristics of resistor and capacitor		
Temperature cycling	30 minutes at -25 °C 30 minutes at $+85$ °C; 5 cycles	no mechanical damage $\Delta C/C$: $\pm 20\%$ D_F max.: 5.0% R_{ins} min.: 100 M Ω $\Delta R/R$: $\pm 5.0\%$
Capacitor load life in humidity	U_R for 500 $\pm 24/-0$ hours in a controlled humidity test chamber at: 40 ± 2 °C and 90 to 95% RH; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C$: $\pm 20\%$ D_F max.: 5.0% R_{ins} min.: 100 M Ω $\Delta R/R$: $\pm 5.0\%$
Resistor load life in humidity	U_R for 500 $\pm 24/-0$ hours (1.5 hours on, 0.5 hours off) in a controlled humidity test chamber at: 40 ± 2 °C and 90 to 95% RH; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C$: $\pm 20\%$ D_F max.: 5.0% R_{ins} min.: 100 M Ω $\Delta R/R$: $\pm 5.0\%$

Resistor-Capacitor network size 1608

RCB210

TEST METHOD	PROCEDURE	REQUIREMENTS
Capacitor load life	$2 \times U_R$ for 1000 +24/-0 hours at $T_{amb} = 85 \pm 2 \text{ }^\circ\text{C}$; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C: \pm 20\%$ $D_F \text{ max.: } 5.0\%$ $R_{ins} \text{ min.: } 100 \text{ M}\Omega$ $\Delta R/R: \pm 5.0\%$
Resistor load life	U_R for 1000 +24/-0 hours at $T_{amb} = 70 \pm 2 \text{ }^\circ\text{C}$; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C: \pm 20\%$ $D_F \text{ max.: } 5.0\%$ $R_{ins} \text{ min.: } 100 \text{ M}\Omega$ $\Delta R/R: \pm 5.0\%$
Resistance to soldering heat	unmounted chips completely immersed for 5 ± 1 s in a solder bath at $260 \pm 5 \text{ }^\circ\text{C}$, after $150 \pm 5 \text{ }^\circ\text{C}$ preheat for 1 minute; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C: \pm 20\%$ $D_F \text{ max.: } 5.0\%$ $R_{ins} \text{ min.: } 100 \text{ M}\Omega$ $\Delta R/R: \pm 5.0\%$
Bending	Products shall be soldered to a testing board. The substrate shall be supported at two points 45 mm from its centre. The middle of the substrate shall be pressed by a pressing rod at a rate of 1.0 mm per second until the deflection reaches 3 mm. The pressure shall be maintained for 30 s. Testing board: $100 \times 40 \times 1.6$ mm glass epoxy-rosin printed-circuit board. Pressing rod: 20×50 mm wide cylindrical metal rod with a radius of 340 mm.	no mechanical damage $\Delta C/C: \pm 20\%$ $D_F \text{ max.: } 5.0\%$ $R_{ins} \text{ min.: } 100 \text{ M}\Omega$ $\Delta R/R: \pm 5.0\%$
Terminal strength	Products shall be soldered to a testing board, as shown below and a pressing force (9.8 N, 1 Kgf) applied in the direction F, for 5 ± 1 s.  The diagram illustrates the terminal strength test setup. It shows a rectangular component labeled 'RCB298' with multiple terminals. The component is soldered to a 'printed-circuit board'. A 'resistor' is indicated on one of the terminals. A 'solder' joint is shown where the terminal meets the board. A pressing rod, represented by a vertical bar, is shown applying a force 'F' to the solder joint.	no mechanical damage
Terminal solderability	in accordance with "MIL-STD-202F" method 208; solder temperature: $230 \pm 5 \text{ }^\circ\text{C}$, during 5 ± 0.5 s	95% min. coverage

Capacitor-Resistor network size 1608

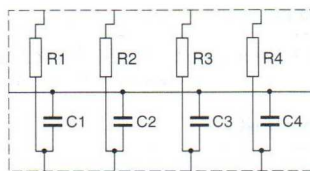
CRB210

FEATURES

- 4 capacitors and 4 resistors in one package
- Reduced size of final equipment
- Low assembly costs
- Higher component and equipment reliability.

APPLICATIONS

- Motherboards
- Notebook computers
- LCD displays
- Mobile phones.


 $R1 = R2 = R3 = R4$
 $C1 = C2 = C3 = C4$

For dimensions see Fig.9 and Table 2.

Fig.1 Equivalent circuit.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	CLASS 1 NP0	CLASS 2 X7R
Capacitance: range tolerance	15 to 470 pF; E12 series $\pm 5\%$ (J); $\pm 10\%$ (K)	560 pF to 22 nF; E12 series $\pm 10\%$ (K); $\pm 20\%$ (M)
Resistance: range tolerance temperature coefficient	10 Ω to 100 k Ω ; E12 series $\pm 20\%$ $\pm 200 \times 10^{-6}/K$	
Absolute maximum dissipation at $T_{amb} = 70^\circ C$	0.063 W/element	
Rated voltage	50 V	
Tan δ	$\leq 0.1\%$	$\leq 2.5\%$
Number of:		
capacitors	4	
resistors	4	
terminals	10	
Operating temperature range	-55 to $+125^\circ C$	

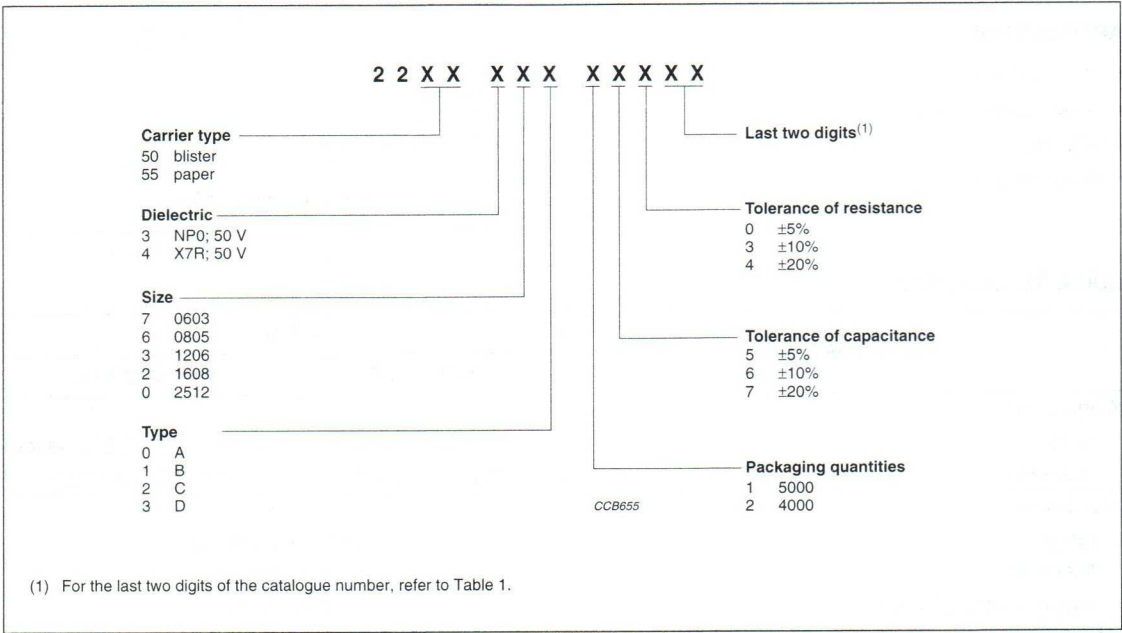
Capacitor-Resistor network
size 1608

CRB210

ORDERING INFORMATION

- The C-R network has a 12-digit ordering code starting with 22; see "Ordering code 12NC".
- The last 2 digits indicate the capacitance/resistance combination; see Table 1.

Ordering code 12NC



Capacitor-Resistor network size 1608

CRB210

Table 1 Composition of the last two digits of the 12NC

LAST TWO DIGITS OF 12NC	CLASS 1	
	C _R (pF)	RESISTANCE (Ω)
01	180	33
02	100	22
03	47	100
04	10	22
05	22	47
06	22	22
07	47	22
08	47	47
09	100	47
10	22	100
11	100	100
12	22	220
13	47	220
14	100	220
15	22	470
16	47	470
17	100	470
18	22	1000
19	47	1000
20	100	1000
21	22	100000
22	47	33
23	33	33
24	33	100
25	33	1000
26	33	47
27	47	2200
28	33	82000
29	33	22

LAST TWO DIGITS OF 12NC	CLASS 1	
	C _R (pF)	RESISTANCE (Ω)
30	100	47000
31	47	15000
32	10	33
33	10	47
34	100	330
35	10	10
36	15	15
37	15	10
38	10	15
39	47	27
40	100	33
41	10	100
42	100	10
43	22	10
44	47	10
45	10	1000
46	10	220
47	10	470
48	180	22
49	180	47
50	180	68
51	180	4700
52	52	100

ORDERING EXAMPLE

The ordering code of an 1608 type C-R network, NP0 dielectric material, value 180 pF/33 Ω and a 5% tolerance, supplied on blister tape of 4000 units per reel is: 2250 321 25001.

Capacitor-Resistor network
size 1608

CRB210

FUNCTIONAL DESCRIPTION

Limiting values

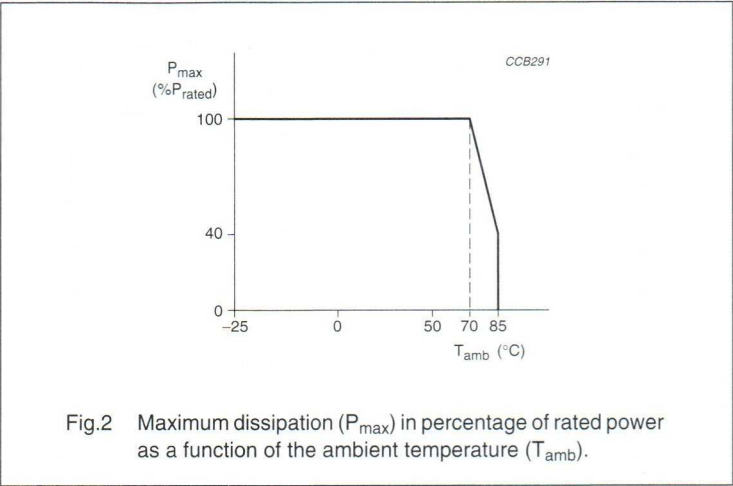
TYPE	LIMITING VOLTAGE ⁽¹⁾ (V)	LIMITING POWER (W)
CRB210	50	0.063

Note

1. This is the maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60 115-8".

DERATING

The power that the component can dissipate depends on the operating temperature; see Fig.2.



Capacitor-Resistor network size 1608

CRB210

ELECTRICAL CHARACTERISTICS

DESCRIPTION	VALUE	
	CLASS 1 NP0	CLASS 2 X7R
Capacitance: range tolerance	15 to 470 pF; E12 series $\pm 5\%$ (J); $\pm 10\%$ (K)	560 pF to 22 nF; E12 series $\pm 10\%$ (K); $\pm 20\%$ (M)
Resistance: range tolerance temperature coefficient	10 Ω to 100 k Ω ; E12 series 20% $\pm 200 \times 10^{-6}/K$	
Absolute maximum dissipation at $T_{amb} = 70\text{ }^{\circ}\text{C}$	0.063 W	
Rated voltage	50 V	
Tan δ	$\leq 0.1\%$	$\leq 2.5\%$
Number of: capacitors resistors terminals	4 4 10	
Operating temperature range	-55 to $+125\text{ }^{\circ}\text{C}$	

Capacitor-Resistor network size 1608

CRB210

NP0 capacitor electrical data

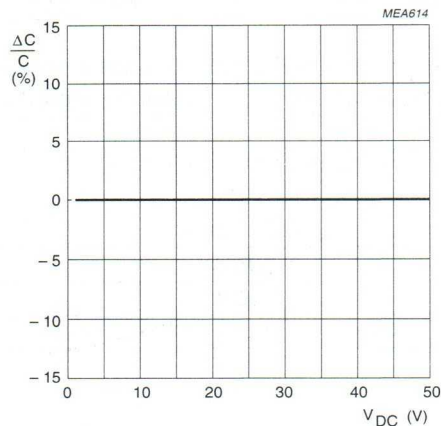


Fig.3 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

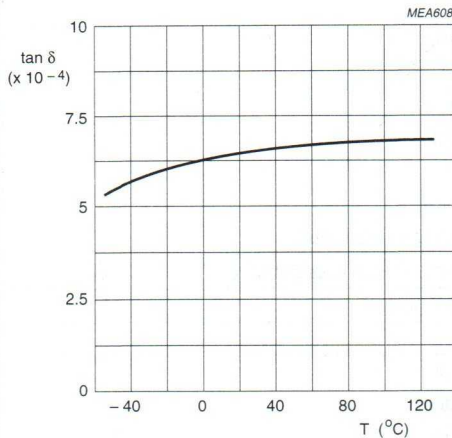
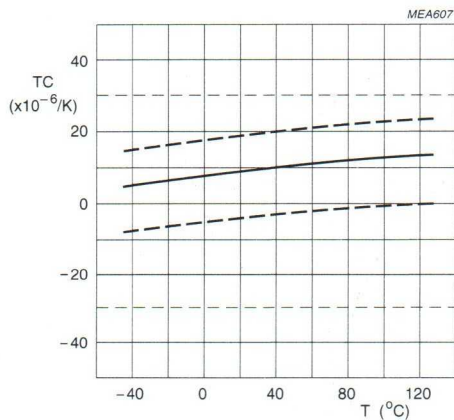


Fig.4 Typical $\tan \delta$ as a function of temperature.



Sample limits (broken lines).

Requirement levels (dotted lines).

Fig.5 Typical temperature coefficient as a function of temperature.

Capacitor-Resistor network size 1608

CRB210

X7R capacitor electrical data

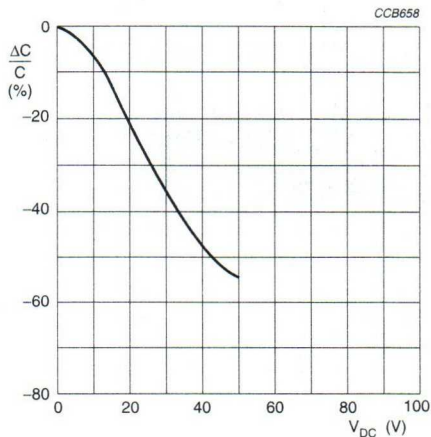


Fig.6 Typical capacitance change with respect to the capacitance at 1 V as a function of DC voltage.

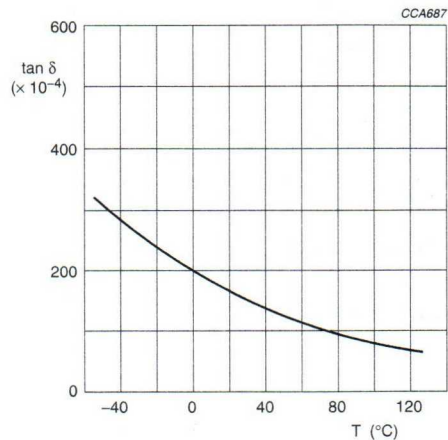


Fig.7 Typical $\tan \delta$ as a function of temperature.

Attenuation of C-R network: NP0 180 pF/33 Ω and NP0 15 pF/22 Ω

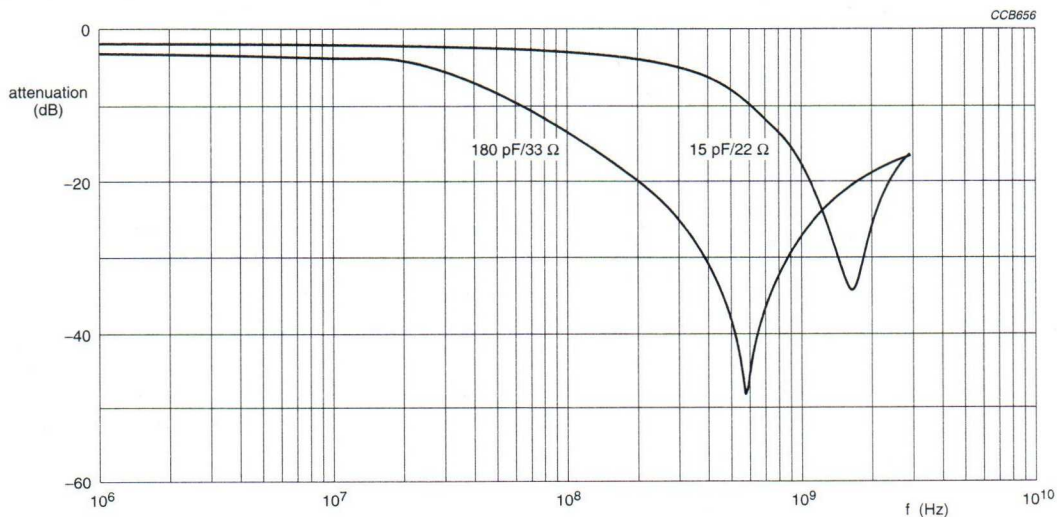


Fig.8 Typical attenuation of C-R network.

Capacitor-Resistor network size 1608

CRB210

MECHANICAL DATA

Mass per 100 units

TYPE	MASS (g)
CRB210	≈4

Outlines

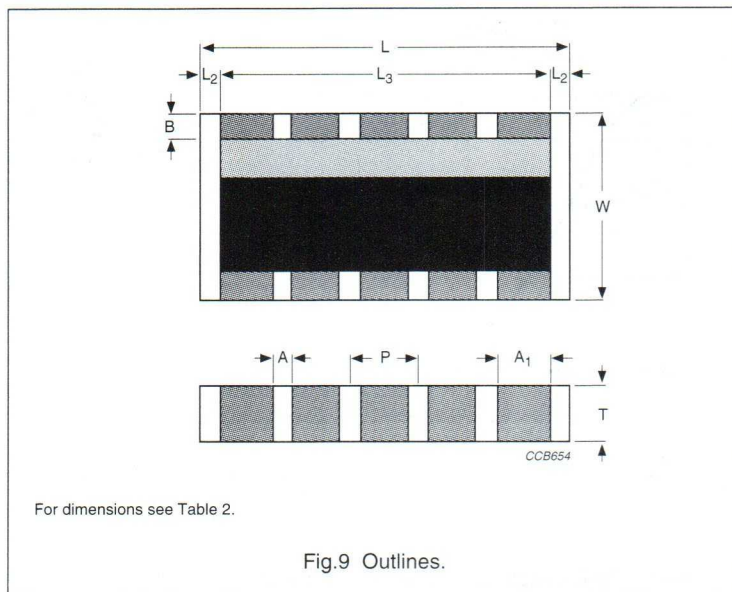


Table 2 Physical dimensions; see Fig.9

SYMBOL	VALUE	TOL.	UNIT
L	4.00	±0.20	mm
W	2.10	±0.20	mm
T	0.80	±0.10	mm
L ₂	0.20	±0.10	mm
L ₃	3.60	±0.20	mm
A	0.40	±0.10	mm
B	0.25	±0.20	mm
P	0.80	±0.10	mm
A ₁	0.40	±0.10	mm

Capacitor-Resistor network size 1608

CRB210

HANDLING

Recommended land patterns

The GND pattern should be as large as possible as high frequency noise is removed through this terminal, see Fig.10 and Table 3.

Reflow soldering

SOLDER PASTE

Refer to Fig.10 for pattern.

Thickness: 150 to 200 μm .

FLUX AND SOLDER

Use rosin-based flux only.

Sn/Pb solder composition ratio:
63/37 or 60/40.

Wave soldering

Not recommended.

Component replacement

SOLDERING GUN (<30 W)

The temperature of the tip must be less than 280 $^{\circ}\text{C}$ for a period within 3 seconds and should not come in direct contact with the product.

Substrate

MOUNTING

The mounting place on the printed-circuit board (PCB) should be as far as possible from the position which is close to the break line or on the line of large holes.

BENDING

Excessive bending of the PCB after soldering is not recommended. When mounting other components use support pins; see Fig.11.

BREAKING

Any breaking of the PCB should only be done by machine or jig.

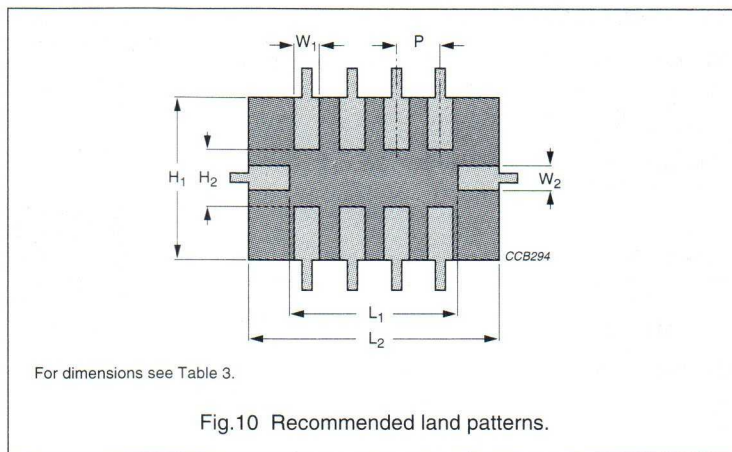


Fig.10 Recommended land patterns.

Table 3 Recommended land pattern dimensions; see Fig.10

SYMBOL	SIZE	TOL.	UNIT
H ₁	3.10	± 0.4	mm
H ₂	1.65	± 0.05	mm
L ₁	3.50	± 0.1	mm
L ₂	5.10	± 0.3	mm
W ₁	0.45	± 0.05	mm
W ₂	0.45	± 0.05	mm
P	0.80	± 0.05	mm

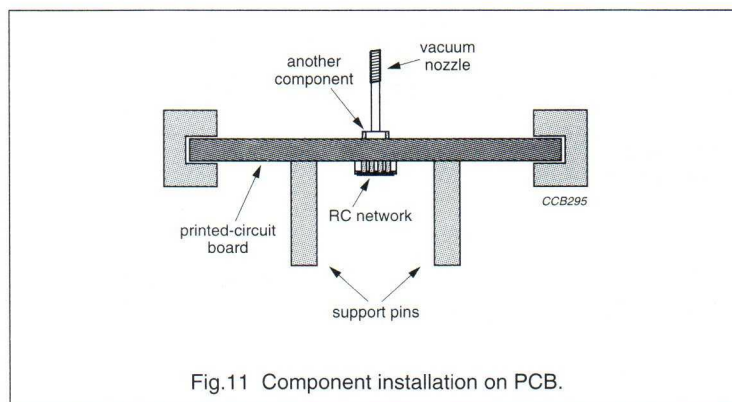


Fig.11 Component installation on PCB.

CAUTION

Rapid heating or cooling will damage this product.
Avoid an initial heat shock over 100 $^{\circ}\text{C}$.

Preheating and gradual cooling is recommended.

Capacitor-Resistor network size 1608

CRB210

TESTS AND REQUIREMENTS

Unless otherwise specified the following values apply:

Temperature: 25 ± 2 °C

Relative humidity: 45% to 55%

Air pressure: 86 kPa to 107 kPa
(860 mbar to 1070 mbar).

In Table 4 the tests and requirements are listed.

The description of the test procedure is also given.

All soldering tests are performed with rosin-based flux.

Table 4 Test procedures and requirements

TEST METHOD	PROCEDURE	REQUIREMENTS
Electrical characteristics of resistor		
DC resistance	$R < 100 \Omega$: 0.3 V $100 \Omega \leq R < 1 \text{ k}\Omega$: 1 V $1 \text{ k}\Omega \leq R < 10 \text{ k}\Omega$: 3 V $10 \text{ k}\Omega \leq R \leq 100 \text{ k}\Omega$: 10 V	within the specified tolerance: 20%
Temperature coefficient	at $20/-55/20$ °C and $20/-125/20$ °C	$\leq \pm 200 \times 10^{-6}/\text{K}$
Electrical characteristics of capacitor		
Capacitance	capacitance value shall be measured as: NP0 : frequency: 1 MHz voltage: 1 V _{rms} temperature: 20 °C; X7R : frequency: 1 kHz voltage: 1 V _{rms} temperature: 20 °C	within the specified tolerance: NP0 : $\pm 5\%$; $\pm 10\%$; X7R : $\pm 20\%$
Dissipation factor	dissipation factor, measured as 6.2.1	NP0 : 0.1% max. X7R : 2.5% max.
Temperature characteristic	$TC = \frac{C_2 - C_1}{C_1} \times 10^2$ $C_1 = C \text{ at } 20 \text{ °C}$ $C_2 = C \text{ at test temperature } (-55 \text{ to } +125 \text{ °C})$	$\Delta C/C$: NP0 : $\pm 30 \times 10^{-6}/\text{K}$ X7R : $\pm 15\%$ max.
Insulation resistance	U_R for 1 minute	$\Delta C/C$: NP0 : $> 10^5 \text{ M}\Omega$ X7R : $C \leq 10 \text{ nF}$: $> 10^5 \text{ M}\Omega$; $C > 10 \text{ nF}$: $R_{ins} C > 1000 \text{ s}$
Withstanding voltage	$2.5 \times U_R$ applied between I/O terminal and GND for 1 minute	no mechanical damage, arcing or breakdown

Capacitor-Resistor network

size 1608

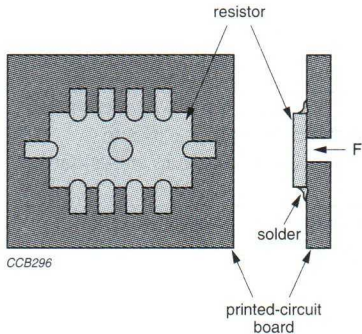
CRB210

TEST METHOD	PROCEDURE	REQUIREMENTS
Environmental characteristics of resistor and capacitor		
Rapid change of temperature	preconditioning, class 2 only; NP0/X7R: -55 to $+125$ °C; 5 cycles	no visible damage after 48 hours recovery $\Delta C/C$: NP0 : $\leq 1\%$ or 1 pF X7R : $\leq 15\%$ $\Delta R/R$: NP0/X7R : $\pm 5.0\%$
Capacitor load damp heat	preconditioning class 2 only; 56 days at 40 °C and 90 to 95% RH; U_R applied; measurement after recovery: class 1: 1 to 2 hours class 2: 48 hours	no visible damage $\Delta C/C$: NP0 : 2% or 1 pF, whichever is greater X7R : $\leq 15\%$ D_F : NP0 : $\leq 2 \times$ specified value X7R : $\leq 7\%$ I_R : NP0 : 2500 M Ω or $R_{ins} C \geq 25$ s, whichever is less X7R : 1000 M Ω or $R_{ins} C \geq 25$ s, whichever is less
Resistor load life in humidity	U_R for 500 $+24/-0$ hours (1.5 hours on, 0.5 hours off) in a controlled humidity test chamber at: 40 ± 2 °C and 90 to 95% RH; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta R/R$: $\pm 5.0\%$
Capacitor load endurance	preconditioning class 2 only; 1000 hours, 125 °C at $2 \times U_R$ for $U_R = 50$ V; measurement after 48 hours recovery	no visible damage $\Delta C/C$: NP0 : 2% or 1 pF, whichever is greater X7R : $\leq 20\%$ D_F : NP0 : $\leq 2 \times$ specified value X7R : $\leq 7\%$ I_R : NP0 : 4000 M Ω or $R_{ins} C \geq 405$ s, whichever is less X7R : 2000 M Ω or $R_{ins} C \geq 25$ s, whichever is less
Resistor load life	U_R for 1000 $+24/-0$ hours at $T_{amb} = 70 \pm 2$ °C; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta R/R$: $\pm 5.0\%$

Capacitor-Resistor network

size 1608

CRB210

TEST METHOD	PROCEDURE	REQUIREMENTS
Resistance to soldering heat	unmounted chips completely immersed for 10 ± 0.5 s in a solder bath at 260 ± 5 °C, after 150 ± 5 °C preheat for 1 minute; measurement in 48 ± 4 hours at standard condition after test	no mechanical damage $\Delta C/C$: NP0 : $\leq 0.5\%$ or 0.5 pF, whichever is greater X7R : $> -5\%$ and $\leq 10\%$ $\Delta R/R$: $\pm 5.0\%$
Machinery performance		
Bending	1 mm at a rate of 1 mm/s, radius jig 340 mm.	no visible damage $\Delta C/C$: NP0 : $\leq 1\%$ X7R : $\leq 10\%$ $\Delta R/R$: NP0/X7R : $\pm 5.0\%$
Terminal strength	Products shall be soldered to a testing board, as shown below and a pressing force (5 N) applied in the direction F, for 10 s 	no mechanical damage
Terminal solderability	in accordance with "MIL-STD-202F" method 208; solder temperature: 215 ± 5 °C, during 3 ± 0.5 s	95% min. coverage

MULTILAYER SUPPRESSORS AND INDUCTORS PRODUCT DATA

	Page
Multilayer suppressors (0603; 0805; 1206; 1808): MLS	394
Thin film, high frequency inductors (0402; 0603): THL	400

Soft Ferrites

Multilayer suppressors

MULTILAYER SUPPRESSORS

Multilayer suppressors are a powerful solution for EMI/RFI attenuation for electronic equipment. Supplied in four standard sizes (0603, 0805, 1206 and 1806), they have impedances between 30 and 1 000 Ω at 100 MHz.

When installed in series with signal and/or power circuits, high frequency noise is suppressed. There is no need for ground termination, which makes these devices very suitable for circuits with difficult ground. Typical suppression frequencies range from 10 MHz to 1 000 MHz and rated currents are between 0.1 and 0.6 A.

Multilayer suppressors are specially designed to reduce noise in low impedance circuits while keeping the signal free from distortion. This is because at the interfering frequencies these components behave as a resistor. The high frequency noise is converted into heat rather than reflected to the source. This dissipation prevents ringing and parasitic oscillations.

These characteristics can be used for many different purposes:

- Absorption of generated noise.
- Filtering and wave-shape correction of digital signals from high speed clock oscillators.
- Prevention of high frequency interference entering circuit electronics.

Product construction

The use of silver for electrodes and terminations in multilayer suppressors ensures high electrical conductivity, which minimizes heat generation and crosstalk.

The internal construction can be single layer or multilayer, depending on impedance requirements. Single layer products have a meander design and are suitable for lower impedances, while multilayer types have alternating layers of ferrite and conductor stacked up to achieve higher impedance levels.

The terminal electrode forms a conductive connection to the circuit. It is formed by three layers:

- Silver: for good conductivity
- Nickel: to protect silver termination against leaching
- Tin-lead: applied to ensure good solderability.

The products are suitable for both reflow and wave soldering.

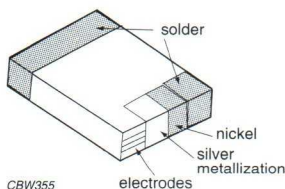


Fig.1 Structure of electrodes.

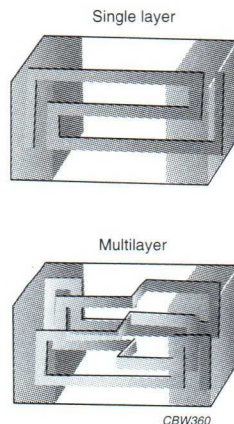


Fig.2 Internal structure of multilayer suppressors..

Soft Ferrites

Multilayer suppressors

TYPE NUMBER STRUCTURE

Type numbers for these products consist of the following:

- Product type
- Size
- Material
- Impedance.

Product type

MLS: multilayer suppressor.

Size

0603: 1.6×0.80 mm

0805: 2.0×1.25 mm

1206: 3.2×1.60 mm

1806: 4.5×1.60 mm.

Material

4S4

4S7

Impedance value

Expressed in ohms (Ω)

First two digits are significant figures

Last digit is the number of zeros to follow.

EXAMPLES

600: 60 Ω

101: 100 Ω

121: 120 Ω

151: 150 Ω

301: 300 Ω

102: 1000 Ω

Example of the ordering code: MLS0603-4S7-600

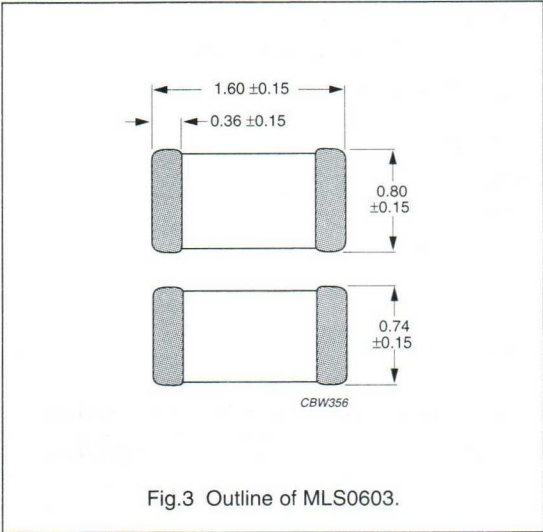
TYPE	SIZE	MATERIAL	IMPEDANCE
MLS	0603	4S7	600

Standard products are delivered taped on reel and have a tolerance on impedance of 25%. For different specifications a fifth group is added to the type number.

Soft Ferrites

MLS0603

MULTILAYER SUPPRESSORS MLS0603



Mass

Approximately 5 mg.

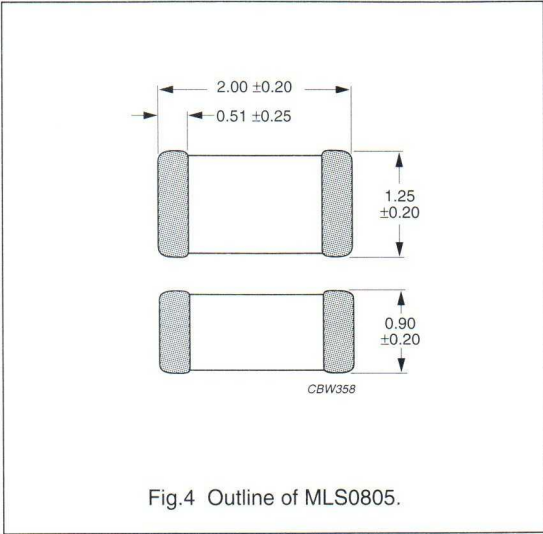
Product specifications

GRADE	SIZE	Z at 100 MHz (Ω)	R _{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S7	0603	60	0.4	300	MLS0603-4S7-600
		100	0.7	200	MLS0603-4S7-101
		120	0.8	200	MLS0603-4S7-121
		150	0.9	200	MLS0603-4S7-151
		300	1.2	150	MLS0603-4S7-301
		600	1.8	150	MLS0603-4S7-601
		1000	2.0	100	MLS0603-4S7-102

Soft Ferrites

MLS0805

MULTILAYER SUPPRESSORS MLS0805



Mass

Approximately 11 mg.

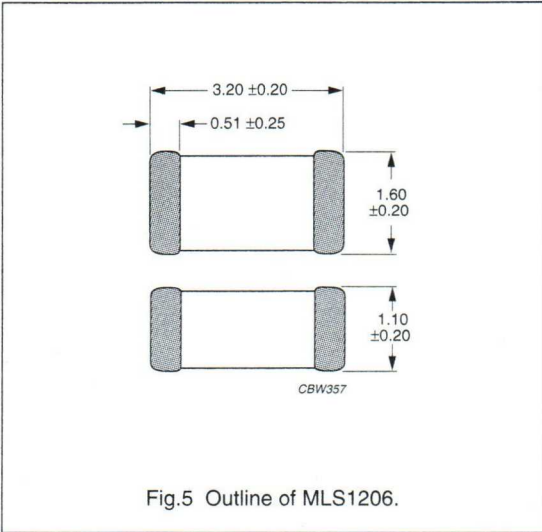
Product specifications

GRADE	SIZE	Z at 100 MHz (Ω)	R _{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	0805	30	0.1	600	MLS0805-4S4-300
		60	0.2	400	MLS0805-4S4-600
4S7	0805	120	0.3	200	MLS0805-4S7-121
		300	0.3	200	MLS0805-4S7-301
		600	0.6	200	MLS0805-4S7-601
		1000	0.8	150	MLS0805-4S7-102

Soft Ferrites

MLS1206

MULTILAYER SUPPRESSORS MLS1206



Mass

Approximately 28 mg.

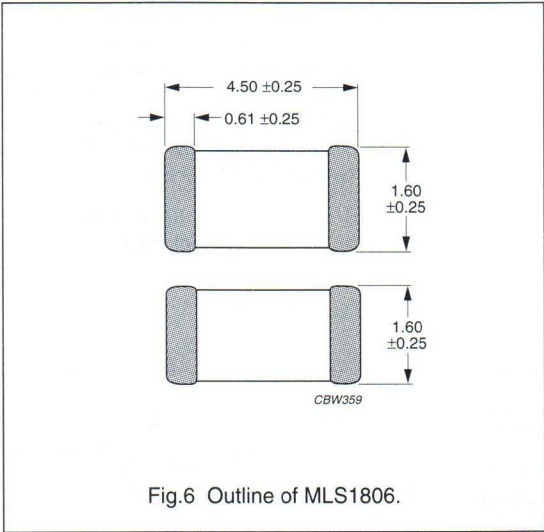
Product specifications

GRADE	SIZE	$ Z $ at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	1206	30	0.1	600	MLS1206-4S4-300
		70	0.2	400	MLS1206-4S4-700
		90	0.2	400	MLS1206-4S4-900
		120	0.2	300	MLS1206-4S4-121
		600	0.4	200	MLS1206-4S4-601
4S7	1206	1000	0.6	150	MLS1206-4S7-102

Soft Ferrites

MLS1806

MULTILAYER SUPPRESSORS MLS1806



Mass

Approximately 55 mg.

Product specifications

GRADE	SIZE	$ Z $ at 100 MHz (Ω)	R_{DC} MAX. (Ω)	I MAX. (mA)	TYPE NUMBER
4S4	1806	80	0.1	600	MLS1806-4S4-800
		150	0.2	500	MLS1806-4S4-151

Thin film, high frequency inductors

THL (0402; 0603)

FEATURES

- High tolerance, ± 0.2 nH and $\pm 2\%$
- High Q
- High SRF
- Low DC resistance
- Excellent RF stability
- Low profile.

APPLICATIONS

- Cellular handsets
- Cordless telephones
- Base stations
- W-LAN
- GPS
- Tuners
- Satellite TV
- CATV.

DESCRIPTION

The body of the inductor consists of a ceramic substrate on which a low resistive planar inductor is grown. The inductor is patterned very accurately by means of photolithography. Thin-film terminations are added and connected to the inductor.

The terminations are covered with a tin layer for ease of soldering.

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	THL0603	THL0402
Size code	0603 (1608)	0402 (1005)
Inductance range	1.0 to 100 nH	1.0 to 39 nH
Tolerance on inductance (E12 series):		
1.0 $\leq$ L $\leq$ 8.2 nH	± 0.2 nH	± 0.2 nH
10 < L $\leq$ 15 nH	$\pm 2\%$	$\pm 2\%$
L > 15 nH	$\pm 2\%$	$\pm 3\%$
Temperature coefficient	0 to $+125 \times 10^{-6}/K$	
Operating temperature	-55 °C to +125 °C	

Thin film, high frequency inductors

THL (0402; 0603)

ORDERING INFORMATION

Components may be ordered by using a simple 13-digit clear text code or Philips unique 12NC.

Clear text code (preferred)

Composition of the clear text code

TYPE	SIZE	VALUE ⁽¹⁾	TOL.	PACKAGING ⁽²⁾
				PAPER TAPE ON Ø180 mm REEL
THL	0603	1N0 = 1 nH	C = ±0.2 nH	B1 = 5 000 units
	0402		G = ±2%	B2 = 10 000 units
			H = ±3%	

Notes

1. For values up to 8.2 nH the letter N is used as a decimal point. For values of 10 nH or greater the first 2 digits apply to the inductance value and the third indicates the number of zeros to follow.
2. Inductors in size 0603 are available only in quantities of 5000 units per reel. Inductors in size 0402 are available only in quantities of 10000 units per reel.

EXAMPLE

The ordering code of a thin film 0603 inductor, value 4.7 nH with a tolerance of 0.2 nH, supplied on paper tape of 5000 units per reel is: THL06034N7CB1.

Thin film, high frequency inductors

THL (0402; 0603)

Ordering code (12NC)

The inductors have a 12-digit ordering code that can be logically constructed using Tables 1 and 2. Case size 0603 is only available in 5000 units per reel. Case size 0402 is available in 10000 units per reel.

- The code starts with 9365
- The subsequent 3 digits indicate case size and packaging quantity; see Table 1.
- The following 3 digits are always 122
- The last 2 digits indicate the inductance value in accordance with Table 2.

Table 1 Three digits to indicate case size and packaging quantity

TYPE	ORDERING CODE 9365	
	PAPER TAPE ON Ø180 mm REEL	
	5 000 UNITS	10 000 UNITS
THL0603	006 122..	—
THL0402	—	007 122..

Table 2 Last digits of 12NC

ORDERING CODE 9365			
INDUCTANCE VALUE (nH)	LAST TWO DIGITS	RANGE	
		0603	0402
1.0	11		
1.2	13		
1.5	15		
1.8	17		
2.2	19		
2.7	22		
3.3	24		
3.9	26		
4.7	28		
5.6	31		
6.8	33		
8.2	35	Shaded cells indicate product range.	
10	37		
12	39		
15	42		
18	44		
22	46		
27	48		
33	51		
39	53		
47	55		
56	57		
68	59		
82	62		
100	64		

ORDERING EXAMPLE

The ordering code of a thin film 0603 inductor, value 4.7 nH with a tolerance of 0.2 nH, on paper tape of 5000 units per reel is: 9365 00 6 122 28.

Thin film, high frequency inductors

THL (0402; 0603)

FUNCTIONAL DESCRIPTION

Product characterization

Table 3 Available range and relevant electrical data for 0603 size

L (nH)	TOL.	Q			SRF (GHz)	R _{DC} (Ω)	I _R (mA)	
		MIN. at 300 MHz	TYPICAL at 800 MHz	TYPICAL at 1.5 GHz	MIN.	MIN.		
1.0	±0.2 nH	20	34	38	6.0	0.10	1000	
1.2						0.15	800	
1.5								
1.8			30	35		5.0	0.20	700
2.2							0.25	600
2.7		4.0			0.50	400		
3.3								
3.9							15	
4.7								
5.6		2.0	1.50	250				
6.8	±2%		25	30		2.00	200	
8.2				1.5	3.00	180		
10				1.0	4.00	150		
12	15 ⁽¹⁾				4.50	140		
15					6.00	120		
18					8.50	100		
22								
27	15	—						
33								
39	10 ⁽¹⁾	15	—					

Note

1. Measured at 200 MHz

Thin film, high frequency inductors

THL (0402; 0603)

Table 4 Available range and relevant electrical data for 0402 size

L (nH)	TOL.	Q			SRF (GHz)	R _{DC} (Ω)	I _R (mA)		
		MIN. at 300 MHz	TYPICAL at 800 MHz	TYPICAL at 1.5 GHz	MIN.	MIN.			
1.0	±0.2 nH	10	21	25	7.0	0.10	1200		
1.2						0.15	930		
1.5							730		
1.8						0.20	600		
2.2							580		
2.7						0.30	500		
3.3						0.40	420		
3.9						0.60	340		
4.7				22	5.5	0.70	320		
5.6						0.80	290		
6.8						1.30	230		
8.2						1.50	210		
10	±2%	10 ⁽¹⁾	21	20	4.0	1.80	190		
12						2.55	160		
15									
18	±3%			10 ⁽¹⁾	21	20	2.0	2.70	150
22								3.60	130
27								4.00	120
33									
39									

Note

1. Measured at 200 MHz.

Thin film, high frequency inductors

THL (0402; 0603)

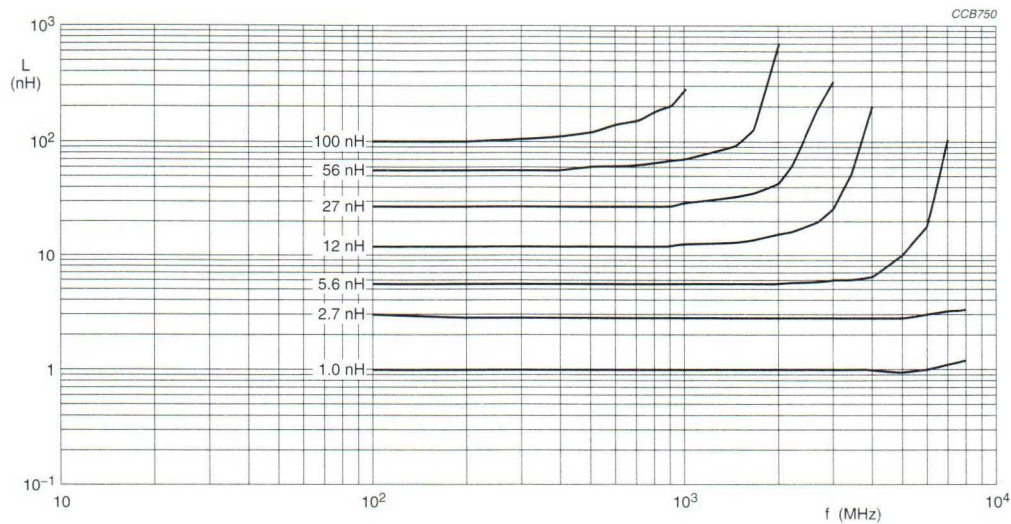
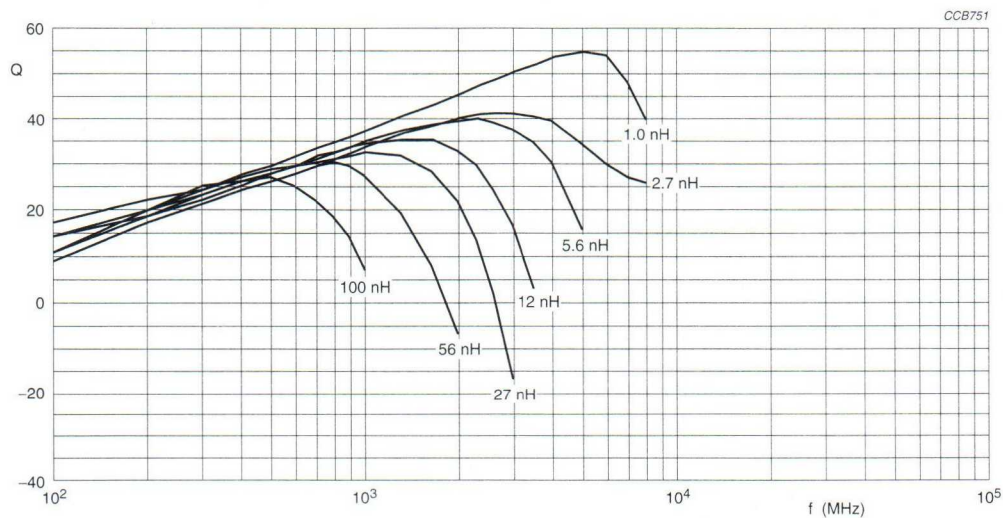
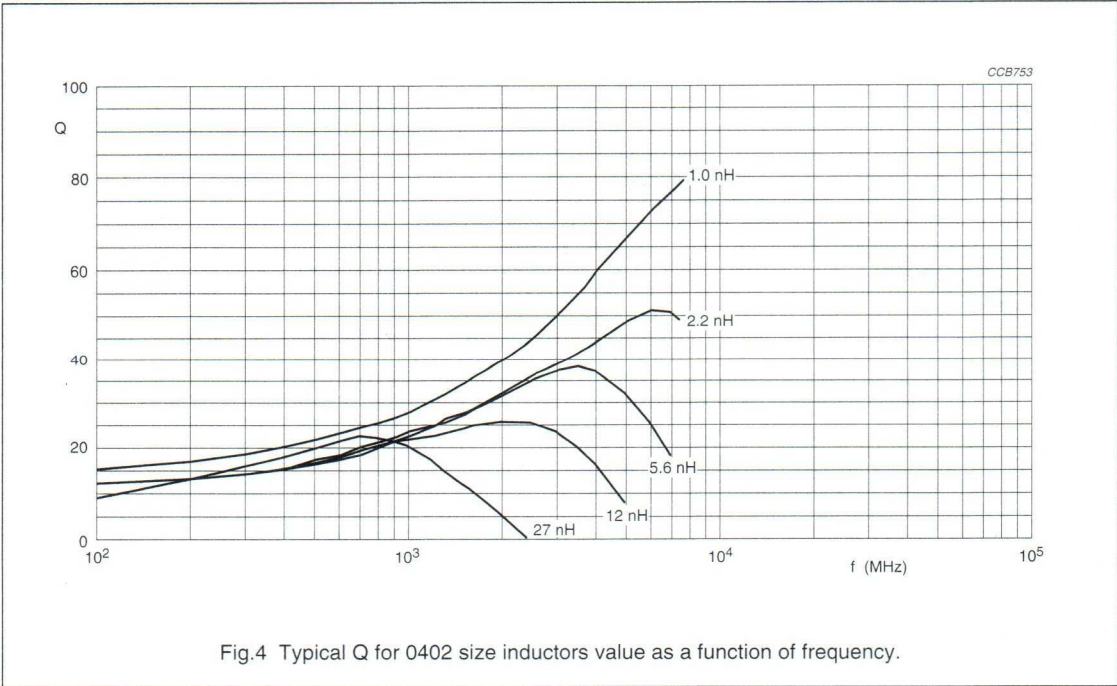
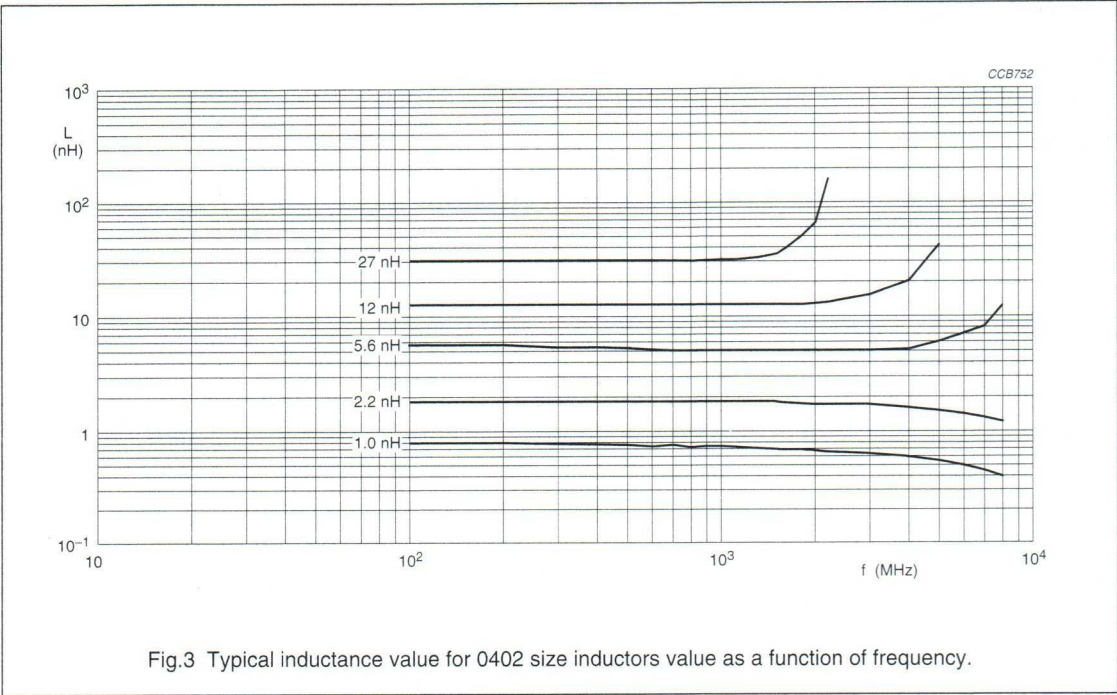


Fig.1 Typical inductance value for 0603 size inductors value as a function of frequency.

Fig.2 Typical Q for 0603 size inductors as a function of frequency.

Thin film, high frequency inductors

THL (0402; 0603)



Thin film, high frequency inductors

THL (0402; 0603)

MECHANICAL DATA

Marking

PACKAGE MARKING

The reel and package are marked with inductance value, tolerance, class, catalogue number, quantity, production period, batch number and source code.

Outlines

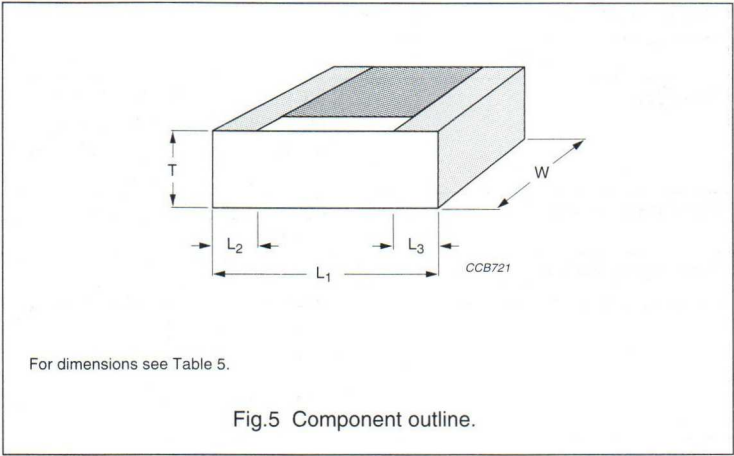


Table 5 Inductor dimensions; see Fig.5

CASE SIZE	L ₁ (mm)	W (mm)	T (mm)	L ₂ (mm)	L ₃ (mm)
0402	1.0 ±0.1	0.5 ±0.1	0.4 ±0.1	0.25 ±0.05	0.25 ±0.05
0603	1.6 ±0.1	0.8 ±0.1	0.45 ±0.1	0.3 ±0.2	0.3 ±0.2

Thin film, high frequency inductors

THL (0402; 0603)

TESTS AND REQUIREMENTS

Table 6 Test procedures and requirements

TEST	PROCEDURE	REQUIREMENTS
Mounting	the inductors may be mounted on printed-circuit boards (PCBs) or ceramic substrates by applying reflow soldering or conductive adhesive	no visible damage
Visual inspection and dimension check	any applicable method using $\times 10$ magnification	in accordance with specification
Mechanical performance		
Resistance to soldering heat	260 ± 5 °C for 10 +0.5 s in a static soldering bath	no visible damage $\Delta L/L_{\max}:: \pm 5\%$ $\Delta Q/Q_{\max}:: \pm 10\%$ ($L \geq 10$ nH) $\Delta Q/Q_{\max}:: \pm 20\%$ ($L < 10$ nH)
Solderability	unmounted chips completely immersed for 2 +0.5 s in a soldering bath at 235 ± 5 °C	good tinning (>95% covered), no visible damage
Environmental performance		
Endurance at 70 °C	1000 hours at 70 °C, loaded with I_{rated} , 1.5 hours on, 0.5 hours off	no visible damage $\Delta L/L_{\max}:: \pm 5\%$ $\Delta Q/Q_{\max}:: \pm 10\%$ ($L \geq 10$ nH) $\Delta Q/Q_{\max}:: \pm 20\%$ ($L < 10$ nH)
Rapid change of temperature	-55 to +125 °C, 50 cycles	no visible damage $\Delta L/L_{\max}:: \pm 5\%$ $\Delta Q/Q_{\max}:: \pm 10\%$ ($L \geq 10$ nH) $\Delta Q/Q_{\max}:: \pm 20\%$ ($L < 10$ nH)
Loaded, damp heat, steady state (JIS)	1000 hours at 40 °C; 90 to 95% RH; loaded with I_{rated} , 1.5 hours on, 0.5 hours off	no visible damage $\Delta L/L_{\max}:: \pm 5\%$ $\Delta Q/Q_{\max}:: \pm 10\%$ ($L \geq 10$ nH) $\Delta Q/Q_{\max}:: \pm 20\%$ ($L < 10$ nH)

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Philips Components data handbooks are available for selected product ranges and contain all relevant data available at the time of publication and each is revised and updated regularly.

Loose data sheets are sent to subscribers to keep them up-to-date on additions or alterations made during the lifetime of each edition.

Our data handbook titles are listed here.

Display Components

<i>Book</i>	<i>Title</i>
DC01	Colour Television and Multimedia Tubes
DC02	Monochrome Monitor Tubes and Deflection Units
DC03	Television Tuners, Coaxial Aerial Input Assemblies
DC04	Colour Monitor and Multimedia Tubes
DC05	Wire Wound Components

Advanced Ceramics & Modules

<i>Book</i>	<i>Title</i>
ACM1 (MA01)	Soft Ferrites
ACM2	Discrete Ceramics
ACM3 (MA03)	Piezoelectric Ceramics and Specialty Ferrites

BC Components

<i>Book</i>	<i>Title</i>
PA01	Electrolytic Capacitors
PA02	Varistors, Thermistors and Sensors
PA03	Potentiometers
PA04	Variable Capacitors
PA05	Film Capacitors
PA06	Ceramic Capacitors
PA06a	Surface Mounted Ceramic Multilayer Capacitors
PA06b	Leaded Ceramic Capacitors
PA08	Fixed Resistors
PA10	Quartz Crystals
PA11	Quartz Oscillators

MORE INFORMATION FROM PHILIPS COMPONENTS?

For more information about Philips Components data handbooks, catalogues and subscriptions, please contact your nearest Philips Components sales organization **(see address list on the back cover of this handbook).**

OVERVIEW OF PHILIPS SEMICONDUCTORS DATA HANDBOOKS

Our sister product division, Philips Semiconductors, also has a comprehensive data handbook system to support their products. Their data handbook titles are listed here.

Integrated circuits

Book	Title
IC01	Semiconductors for Radio, Audio and CD/DVD Systems
IC02	Semiconductors for Television and Video Systems
IC03	Semiconductors for Wired Telecom Systems
IC04	HE4000B Logic Family CMOS
IC05	Advanced Low-power Schottky (ALS) Logic
IC06	High-speed CMOS Logic Family
IC11	General-purpose/Linear ICs
IC12	I ² C Peripherals
IC13	Programmable Logic Devices (PLD)
IC14	8048-based 8-bit Microcontrollers
IC15	FAST TTL Logic Series
IC16	CMOS ICs for Clocks, Watches and Real Time Clocks
IC17	Semiconductors for Wireless Communications
IC18	Semiconductors for In-Car Electronics
IC19	ICs for Data Communications
IC20	80C51-based 8-bit Microcontrollers
IC22	Multimedia ICs
IC23	BiCMOS Bus Interface Logic
IC24	Low Voltage CMOS & BiCMOS Logic
IC25	16-bit 80C51XA Microcontrollers (eXtended Architecture)
IC26	Integrated Circuit Packages
IC27	Complex Programmable Logic Devices

Discrete semiconductors

Book	Title
SC01	Small-signal and Medium-power Diodes
SC02	Power Diodes
SC03	Power Thyristors and Triacs
SC04	Small-signal Transistors
SC05	Video Transistors and Modules for Monitors
SC06	High-voltage and Switching NPN Power Transistors
SC07	Small-signal Field-effect Transistors
SC13	PowerMOS Transistors
SC14	RF Wideband Transistors
SC16	Wideband Hybrid Amplifier Modules for CATV
SC17	Semiconductor Sensors
SC18	Discrete Semiconductor Packages
SC19	RF & Microwave Power Transistors, RF Power Modules and Circulators/Isolators

MORE INFORMATION FROM PHILIPS SEMICONDUCTORS?

For more information contact your nearest Philips Semiconductors national organization shown in the following list.

Argentina: see South America
Australia: NORTH RYDE, Tel. +61 2 9805 4455 Fax. +61 2 9805 4466
Austria: WIEN, Tel. +43 1 60 101, Fax. +43 1 60 101 1210
Belarus: MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773
Belgium: see The Netherlands
Brazil: see South America
Bulgaria: SOFIA, Tel. +359 2 689 211, Fax. +359 2 689 102
Canada: SCARBOROUGH, Tel. +1 800 234 7381
Chile: see South America
China/Hong Kong: HONG KONG, Tel. +852 2319 7888, Fax. +852 2319 7700
Colombia: see South America
Czech Republic: see Austria
Denmark: COPENHAGEN, Tel. +45 3329 3333, Fax. +45 3329 3905
Finland: ESPOO, Tel. +358 9 615800, Fax. +358 9 61580920
France: SURESNES, Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427
Germany: HAMBURG, Tel. +49 40 23 53 60, Fax. +49 40 23 536 300
Greece: TAVROS/ATHENS, Tel. +30 1 4894 339/239, Fax. +30 1 4814 240
Hungary: see Austria
India: BOMBAY, Tel. +91 22 4938 541, Fax. +91 22 4938 722
Indonesia: JAKARTA, Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080
Ireland: DUBLIN, Tel. +353 1 7640 000, Fax. +353 1 7640 200
Israel: TEL AVIV, Tel. +972 3 645 0444, Fax. +972 3 649 1007
Italy: MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557
Japan: TOKIO, Tel. +81 3 3740 5130, Fax. +81 3 3740 5077
Korea: SEOUL, Tel. +82 2 709 1412, Fax. +82 2 709 1415
Malaysia: SELANGOR, Tel. +60 3 750 5214, Fax. +60 3 757 4880
Mexico: EL PASO, TEXAS, Tel. +9-5 800 234 7381
Middle East: see Italy
Netherlands: EINDHOVEN, Tel. +31 40 27 82785, Fax. +31 40 27 88399
New Zealand: AUCKLAND, Tel. +64 9 849 4160, Fax. +64 9 849 7811
Norway: OSLO, Tel. +47 22 74 8000, Fax. +47 22 74 8341
Pakistan: see Singapore
Philippines: MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474
Poland: WARSZAWA, Tel. +48 22 612 2831, Fax. +48 22 612 2327
Portugal: see Spain
Romania: see Italy
Russia: MOSCOW, Tel. +7 095 755 6918, Fax. +7 095 755 6919
Singapore: SINGAPORE, Tel. +65 350 2538, Fax. +65 251 6500
Slovakia: see Austria
Slovenia: see Italy
South Africa: JOHANNESBURG, Tel. +27 11 470 5911, Fax. +27 11 470 5494
South America: SÃO PAULO, Tel. +55 11 821 2333, Fax. +55 11 821 2382
Spain: BARCELONA, Tel. +34 93 301 6312, Fax. +34 93 301 4107
Sweden: STOCKHOLM, Tel. +46 8 5985 2000, Fax. +46 8 5985 2745
Switzerland: ZÜRICH, Tel. +41 1 488 2741, Fax. +41 1 488 3263
Taiwan: TAIPEI, Tel. +886 2 2134 2886, Fax. +886 2 2134 2874
Thailand: BANGKOK, Tel. +66 2 745 4090, Fax. +66 2 398 0793
Turkey: ISTANBUL, Tel. +90 212 279 2770, Fax. +90 212 282 6707
Ukraine: KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461
United Kingdom: HAYES, Tel. +44 181 730 5000, Fax. +44 181 754 8421
United States: SUNNYVALE, Tel. +1 800 234 7381
Uruguay: see South America
Vietnam: see Singapore
Yugoslavia: BEOGRAD, Tel. +381 11 625 344, Fax. +381 11 635 777

Internet: <http://www.semiconductors.philips.com>

For all other countries apply to:

Philips Semiconductors,
 International Marketing & Sales Communications, Building BE-p,
 P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands,
 Fax. +31-40-2724825

NOTES

NOTES

NOTES

NOTES

NOTES

STANDARD SERIES OF VALUES IN A DECADE FOR RESISTANCES AND CAPACITANCES

According to "IEC publication 63".

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E24	E12	E6	E3
100	100	100	178	178	178	316	316	316	562	562	562	10	10	10	10
101			180			320			569			11			
102	102		182	182		324	324		576	576		12	12		
104			184			328			583			13			
105	105	105	187	187	187	332	332	332	590	590	590	15	15	15	
106			189			336			597			16			
107	107		191	191		340	340		604	604		18	18		
109			193			344			612			20			
110	110	110	196	196	196	348	348	348	619	619	619	22	22	22	22
111			198			352			626			24			
113	113		200	200		357	357		634	634		27	27		
114			203			361			642			30			
115	115	115	205	205	205	365	365	365	649	649	649	33	33	33	
117			208			370			657			36			
118	118		210	210		374	374		665	665		39	39		
120			213			379			673			43			
121	121	121	215	215	215	383	383	383	681	681	681	47	47	47	47
123			218			388			690			51			
124	124		221	221		392	392		698	698		56	56		
126			223			397			706			62			
127	127	127	226	226	226	402	402	402	715	715	715	68	68	68	
129			229			407			723			75			
130	130		232	232		412	412		732	732		82	82		
132			234			417			741			91			
133	133	133	237	237	237	422	422	422	750	750	750				
135			240			427			759						
137	137		243	243		432	432		768	768					
138			246			437			777						
140	140	140	249	249	249	442	442	442	787	787	787				
142			252			448			796						
143	143		255	255		453	453		806	806					
145			258			459			816						
147	147	147	261	261	261	464	464	464	825	825	825				
149			264			470			835						
150	150		267	267		475	475		845	845					
152			271			481			856						
154	154	154	274	274	274	487	487	487	866	866	866				
156			277			493			876						
158	158		280	280		499	499		887	887					
160			284			505			898						
162	162	162	287	287	287	511	511	511	909	909	909				
164			291			517			920						
165	165		294	294		523	523		931	931					
167			298			530			942						
169	169	169	301	301	301	536	536	536	953	953	953				
172			305			542			965						
174	174		309	309		549	549		976	976					
176			312			556			988						

Philips Components – a worldwide company

Australia: Philips Components Pty Ltd., NORTH RYDE,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Österreichische Philips Industrie GmbH, WIEN,
Tel. +43 1 60 101 12 41, Fax. +43 1 60 101 12 11

Belarus: Philips Office Belarus, MINSK,
Tel. +375 172 200 924/733, Fax. +375 172 200 773

Benelux: Philips Nederland B.V., EINDHOVEN, NL,
Tel. +31 40 2783 749, Fax. +31 40 2788 399

Brazil: Philips Components, SÃO PAULO,
Tel. +55 11 821 2333, Fax. +55 11 829 1849

Canada: Philips Electronics Ltd., SCARBOROUGH,
Tel. +1 416 292 5161, Fax. +1 416 754 6248

China: Philips Company, SHANGHAI,
Tel. +86 21 6354 1088, Fax. +86 21 6354 1060

Denmark: Philips Components A/S, COPENHAGEN V,
Tel. +45 3329 3333, Fax. +45 3329 3905

Finland: Philips Components, ESPOO,
Tel. +358 9 615 800, Fax. +358 9 615 80510

France: Philips Composants, SURESNES,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6493

Germany: Philips Components GmbH, HAMBURG,
Tel. +49 40 2489-0, Fax. +49 40 2489 1400

Greece: Philips Hellas S.A., TAVROS,
Tel. +30 1 4894 339/+30 1 4894 239, Fax. +30 1 4814 240

Hong Kong: Philips Hong Kong, KOWLOON,
Tel. +852 2784 3000, Fax. +852 2784 3003

India: Philips India Ltd., MUMBAI,
Tel. +91 22 4930 311, Fax. +91 22 4930 966/4950 304

Indonesia: P.T. Philips Development Corp., JAKARTA,
Tel. +62 21 794 0040, Fax. +62 21 794 0080

Ireland: Philips Electronics (Ireland) Ltd., DUBLIN,
Tel. +353 1 7640 203, Fax. +353 1 7640 210

Israel: Rapac Electronics Ltd., TEL AVIV,
Tel. +972 3 6450 444, Fax. +972 3 6491 007

Italy: Philips Components S.r.l., MILANO,
Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Japan Ltd., TOKYO,
Tel. +81 3 3740 5135, Fax. +81 3 3740 5035

Korea (Republic of): Philips Electronics (Korea) Ltd., SEOUL,
Tel. +82 2 709 1472, Fax. +82 2 709 1480

Philippines: Philips Semiconductors Philippines Inc.,
METRO MANILA, Tel. +63 2 816 6345, Fax. +63 2 817 3474

Poland: Philips Poland Sp. z o.o., WARSZAWA,
Tel. +48 22 612 2594, Fax. +48 22 612 2327

Portugal: Philips Portuguesa S.A.,
Philips Components: LINDA-A-VELHA,
Tel. +351 1 416 3160/416 3333, Fax. +351 1 416 3174/416 3366

Russia: Philips Russia, MOSCOW,
Tel. +7 95 755 6918, Fax. +7 95 755 6919

Singapore: Philips Singapore Pte Ltd., SINGAPORE,
Tel. +65 350 2000, Fax. +65 355 1758

South Africa: S.A. Philips Pty Ltd., JOHANNESBURG,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

Spain: Philips Components, BARCELONA,
Tel. +34 93 301 63 12, Fax. +34 93 301 42 43

Sweden: Philips Components AB, STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Philips Components AG, ZÜRICH,
Tel. +41 1 488 22 11, Fax. +41 1 481 7730

Taiwan: Philips Taiwan Ltd., TAIPEI,
Tel. +886 2 2134 2900, Fax. +886 2 2134 2929

Thailand: Philips Electronics (Thailand) Ltd., BANGKOK,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Türk Philips Ticaret A.S., GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

United Kingdom: Philips Components Ltd., DORKING,
Tel. +44 1306 512 000, Fax. +44 1306 512 345

United States:

- Philips Components, SAN JOSE, CA,
Tel. +1 408 570 5600, Fax. +1 408 570 5700
- Philips Display Components, ANN ARBOR, MI,
Tel. +1 734 996 9400, Fax. +1 734 761 2776

Yugoslavia (Federal Republic of): Philips Components, BELGRADE,
Tel. +381 11 625 344 / +381 11 3341 299, Fax. +381 11 635 777

Internet:

- Philips ceramic components: www.passives.comp.philips.com
- Philips display components: www.dc.comp.philips.com

For all other countries apply to:

Philips Components, Building BF-1, P.O. Box 218, 5600 MD EINDHOVEN,
The Netherlands, Fax. +31-40-27 23 903.

COD23

© Philips Electronics N.V. 1999

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

0410(12) 10/13500/01/pp416
Document order number:

Date of release: March 1999
9398 184 22011



TEXIM electronics

P.O. BOX 172, NL-7480 AD HAAKSBERGEN
TEL.: +31-535733333, FAX: +31-535733888



PHILIPS

Let's make things better.