

Refer to chart at end of section.

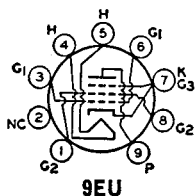
12A6Y

Refer to chart at end of section.

12A7

Refer to chart at end of section.

12A8GT



9EU

BEAM POWER TUBE

12AB5

Miniature type used in the output stage of automobile radio receivers operating from a 12-volt storage battery. Outlines section, 6E; requires miniature 9-contact socket.

Heater-Voltage Range (ac/dc)*	10 to 15.9	volts
Heater Current (Approx.) at 12.6 volts	0.2	ampere
Peak Heater-Cathode Voltage	±90 max	volts
Direct Interelectrode Capacitances:		
Grid No.1 to Plate	0.7 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, and Grid No.3	8	pF
Plate to Cathode, Heater, Grid No.2, and Grid No.3	8.5	pF

* For longest life, it is recommended that the heater be operated within the voltage range of 11 to 14 volts.

Class A₁ Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	315	volts
Grid-No.2 (Screen-Grid) Voltage	285	volts
Plate Dissipation	12	watts
Grid-No.2 Input	2	watts
Bulb Temperature (At hottest point)	250	°C

TYPICAL OPERATION WITH 12.6 VOLTS ON HEATER

Plate Supply Voltage	250	250	volts
Grid-No.2 Supply Voltage	200	250	volts
Grid-No.1 (Control-Grid) Voltage	—	—12.5	volts
Cathode-Bias Resistor	270	—	ohms
Peak AF Grid-No.1 Voltage	10.5	12.5	volts
Zero-Signal Plate Current	33.5	45	mA
Maximum-Signal Plate Current	36	47	mA
Zero-Signal Grid-No.2 Current	1.6	4.5	mA
Maximum-Signal Grid-No.2 Current	3.2	7	mA
Plate Resistance (Approx.)	75000	50000	ohms
Transconductance	4000	4100	μmhos
Load Resistance	6000	5000	ohms
Total Harmonic Distortion	8	8	per cent
Maximum-Signal Power Output	3.3	4.5	watts

MAXIMUM CIRCUIT VALUES

Grid-No.1-Circuit Resistance:		
For fixed-bias operation	0.1	megohm
For cathode-bias operation	0.5	megohm

Push-Pull Class AB₁ Amplifier

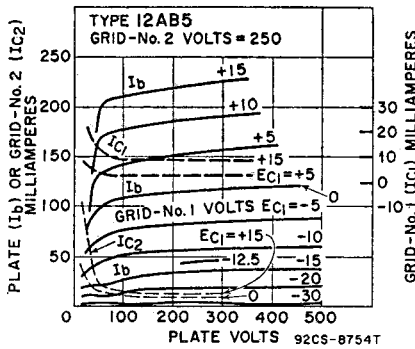
MAXIMUM RATINGS (Same as for Single-Tube Class A₁ Amplifier)

TYPICAL OPERATION WITH 12.6 VOLTS ON HEATER (Values are for two tubes)

Plate Voltage	250	volts
Grid-No.2 Voltage	250	volts
Grid-No.1 Voltage	—15	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	30	volts
Zero-Signal Plate Current	70	mA
Maximum-Signal Plate Current	79	mA
Zero-Signal Grid-No.2 Current	5	mA
Maximum-Signal Grid-No.2 Current	13	mA
Effective Load Resistance (Plate-to-Plate)	10000	ohms
Total Harmonic Distortion	5	per cent
Maximum-Signal Power Output	10	watts

MAXIMUM CIRCUIT VALUES

Grid-No.1-Circuit Resistance:		
For fixed-bias operation	0.1	megohm
For cathode-bias operation	0.5	megohm



12AC6

Refer to chart at end of section.

12AC10A

Refer to type 6AC10

12AD6

Refer to chart at end of section.

12AE6

Refer to chart at end of section.

12AE6A

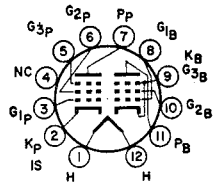
12AE7

Refer to chart at end of section.

12AE10

**BEAM POWER TUBE—
SHARP-CUTOFF PENTODE**

Duodecar type used as combined FM detector and audio-frequency output amplifier in television receivers. The beam power unit is used in af output stages and the pentode unit as an FM detector. Outlines section, 8C; requires duodecar 12-contact socket. Heater: volts (ac/dc), 12.6; amperes, 0.45; warm-up time (average), 11 seconds; maximum heater-cathode volts, ± 200 peak, 100 average.



12EZ

Beam Power Unit as Class A₁ Amplifier

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	165	volts
Grid-No.2 (Screen-Grid) Voltage	150	volts
Cathode Current	60	mA
Plate Dissipation	6	watts
Grid-No.2 Input	1.25	watts

TYPICAL OPERATION

Plate Voltage	145	volts
Grid-No.2 Voltage	110	volts
Grid-No.1 (Control-Grid) Voltage	-7	volts
Peak AF Grid-No.1 Voltage	7	volts
Zero-Signal Plate Current	34	mA
Maximum-Signal Plate Current	39	mA
Zero-Signal Grid-No.2 Current	6.5	mA
Maximum-Signal Grid-No.2 Current	9.3	mA
Plate Resistance (Approx.)	33000	ohms
Transconductance	5600	μ mhos
Load Resistance	2500	ohms
Total Harmonic Distortion (Approx.)	12	per cent
Maximum-Signal Power Output	1.45	watts

MAXIMUM CIRCUIT VALUE

Grid-No.1-Circuit Resistance: For cathode-bias operation	1	megohm
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Pentode Unit as Class A₁ Amplifier

CHARACTERISTICS

Plate Voltage	150	volts
Grid-No.3 (Suppressor-Grid) Voltage	0	volts
Grid-No.2 Voltage	100	volts
Cathode-Bias Resistor	560	ohms
Plate Resistance (Approx.)	0.15	megohm
Transconductance, Grid No.1	1000	μmhos
Transconductance, Grid No.3	400	μmhos
Plate Current	1.3	mA
Grid-No.2 Current	2	mA
Grid-No.1 Voltage (Approx.) for plate current of 10 μA	-4.5	volts
Grid-No.3 Voltage (Approx.) for plate current of 10 μA	-4.5	volts

Pentode Unit as FM Detector

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	330	volts
Grid-No.3 Voltage	28	volts
Grid-No.2 Supply Voltage	330	volts
Grid-No.2 Voltage	See curve page 300	
Grid-No.1 Voltage, Positive-bias value	0	volts
Plate Dissipation	1.7	watts
Grid-No.2 Input	1.1	watts

Refer to type 6AF3.

**12AF3
12AF3/12BR3/
12RK19**

Refer to chart at end of section.

12AF6

Refer to chart at end of section.

12AH7GT

Refer to chart at end of section.

12AJ6

Refer to type 6AL5.

12AL5

Refer to chart at end of section.

12AL8

Refer to type 6AL11.

12AL11

Refer to type 6AQ5A.

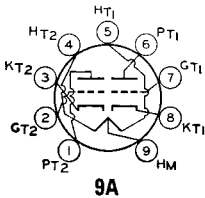
12AQ5

Refer to type 6AT6.

12AT6

For replacement use type 12AT7/ECC81.

12AT7



HIGH-MU TWIN TRIODE

**12AT7/
ECC81**

Miniature types used as push-pull cathode-drive amplifiers or frequency converters in the FM and television broadcast bands. **Outlines section, 6B**; require miniature 9-contact socket. Each triode unit is independent of the other except for the common heater. For typical operation as a resistance-coupled amplifier, refer to **Resistance-Coupled Amplifier section**.

Heater Arrangement:	Series	Parallel	
Heater Voltage (ac/dc)	12.6	6.3	volts
Heater Current	0.15	0.3	ampere
Peak Heater-Cathode Voltage		±90 max	volts

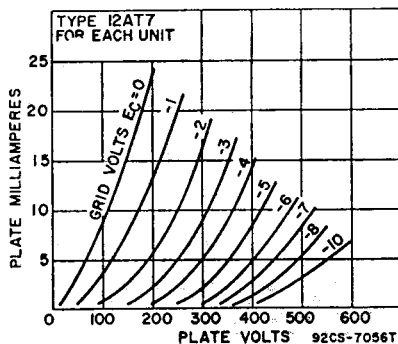
Direct Interelectrode Capacitances:

Grid-Drive Operation:		
Grid to Plate (Each unit)	1.5	pF
Grid to Cathode and Heater (Each unit)	2.2	pF
Plate to Cathode and Heater:		
Unit No.1	0.5	pF
Unit No.2	0.4	pF
Cathode-Drive Operation:		
Cathode to Plate (Each unit)	0.2	pF
Cathode to Grid and Heater (Each unit)	4.6	pF
Plate to Grid and Heater (Each unit)	1.8	pF
Heater to Cathode (Each Unit)	2.4	pF

Class A₁ Amplifier (Each Unit)

MAXIMUM AND MINIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Grid Voltage, Negative-bias value	50	volts
Plate Dissipation	2.5	watts



CHARACTERISTICS

Plate Supply Voltage	100	250	volts
Cathode-Bias Resistor	270	200	ohms
Amplification Factor	60	60	
Plate Resistance (Approx.)	15000	10900	ohms
Transconductance	4000	5500	μ mhos
Grid Voltage (Approx.) for plate current of 10 μ A	-5	-12	volts
Plate Current	3.7	10	mA

12AT7WA

Refer to chart at end of section.

12AT7WB

Refer to chart at end of section.

12AU6

Refer to type 6AU6A.

12AU7

Refer to chart at end of section.

For replacement use type 12AU7A/ECC82.

12AU7A

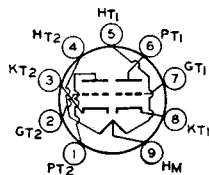
For replacement use type 12AU7A/ECC82.

12AU7A/ ECC82

7AU7, 9AU7

MEDIUM-MU TWIN TRIODE

Miniature types used as phase inverters or push-pull amplifiers in ac/dc radio equipment and as multivibrators or oscillators in industrial control devices. Also used as combined vertical oscillators and vertical-deflection amplifiers, and as horizontal-deflection oscillators, in color and black-and-white television receivers. Outlines section, 6B; require miniature 9-contact socket. Each triode unit is independent of the other except for the common heater. For typical opera-



9A

tion as a resistance-coupled amplifier, refer to **Resistance-Coupled Amplifier** section. Types 7AU7 and 9AU7 are identical with type 12AU7 and 12AU7A/ECC82 except for heater ratings.

	7AU7	9AU7	12AU7A 12AU7A/ ECC82	
Heater Voltage(ac/dc):				
Series	7	9.4	12.6	volts
Parallel	3.5	4.7	6.3	volts
Heater Current:				
Series	0.3	0.225	0.15	ampere
Parallel	0.6	0.45	0.3	ampere
Heater Warm-up Time (Parallel, Average) ..	11	11	—	seconds
Heater-Cathode Voltage:				
Peak value	±200 max	±200 max	±200 max	volts
Average value	100 max	100 max	100 max	volts
Direct Interelectrode Capacitances (Approx.):	Unit No.1		Unit No.2	
Grid to Plate	1.5		1.5	pF
Grid to Cathode and Heater	1.6		1.6	pF
Plate to Cathode and Heater	0.5		0.35	pF

Class A₁ Amplifier (Each Unit Unless Otherwise Specified)

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	330	volts
Cathode Current	22	mA
Plate Dissipation:		
Each Plate	2.75	watts
Both Plates (Both units operating)	5.5	watts

CHARACTERISTICS

Plate Voltage	100	250	volts
Grid Voltage	0	-8.5	volts
Amplification Factor	19.5	17	
Plate Resistance (Approx.)	6250	7700	ohms
Transconductance	3100	2200	μmhos
Plate Current	11.8	10.5	mA
Grid Voltage (Approx.) for plate current of 10 μA	—	-24	volts

MAXIMUM CIRCUIT VALUES

Grid-Circuit Resistance:		
For fixed-bias operation	0.25	megohm
For cathode-bias operation	1	megohm

Oscillator (Each Unit Unless Otherwise Specified)

For operation in a 525-line, 30-frame system

	Vertical-Deflection Oscillator	Horizontal-Deflection Oscillator	
MAXIMUM RATINGS (Design-Maximum Values)			
DC Plate Voltage	330	330	volts
Peak Negative-Pulse Grid Voltage	440	660	volts
Peak Cathode Current	66	330	mA
Average Cathode Current	22	22	mA
Plate Dissipation:			
Each Plate	2.75	2.75	watts
Both Plates (Both units operating)	5.5	5.5	watts

MAXIMUM CIRCUIT VALUES

Grid-Circuit Resistance	2.2	2.2	megohms
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Vertical-Deflection Amplifier (Each Unit Unless Otherwise Specified)

For operation in a 525-line, 30-frame system

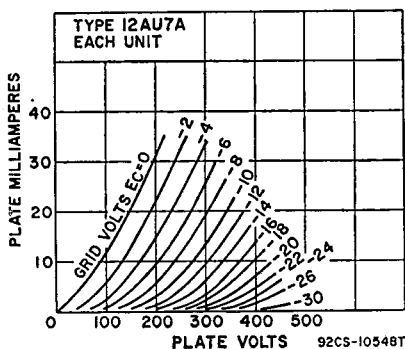
MAXIMUM RATINGS (Design-Maximum Values)

DC Plate Voltage	330	volts
Peak Positive-Pulse Plate Voltage#	1200	volts
Peak Negative-Pulse Grid Voltage	275	volts
Peak Cathode Current	66	mA
Average Cathode Current	22	mA
Plate Dissipation:		
Each Plate	275	volts
Both Plates (Both units operating)	5.5	watts

MAXIMUM CIRCUIT VALUE

Grid-Circuit Resistance, for cathode-bias operation	2.2	megohms
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Pulse duration must not exceed 15% of a vertical scanning cycle (2.5 milliseconds).

**12AV5GA**

Refer to type 6AV5GA.

12AV6

Refer to type 6AV6.

12AV7

Refer to chart at end of section.

12AW6

Refer to chart at end of section.

12AX3

Refer to type 6AX3.

**12AX4GT
12AX4GTA**

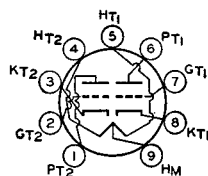
Refer to chart at end of section.

12AX4GTB

Refer to type 6AX4GTB.

12AX7Refer to chart at end of section.
For replacement use type 12AX7A/ECC83.**12AX7A**

For replacement use type 12AX7A/ECC83.

**12AX7A/
ECC83****HIGH-MU TWIN TRIODE****9A**

Miniature types used as phase inverters or twin resistance-coupled amplifiers in radio equipment. Outlines section, 6B; require miniature 9-contact socket. Each triode unit is independent of the other except for common heater. For characteristics and curves, refer to type 6AV6. For typical operation as a resistance-coupled amplifier, refer to Resistance-Coupled Amplifier section.

	Series	Parallel	
Heater Arrangement:			
Heater Voltage (ac/dc)	12.6	6.3	volts
Heater Current	0.15	0.3	ampere
Heater-Cathode-Voltage:			
Peak value		±200 max	volts
Average value		100 max	volts
Direct Interelectrode Capacitances (Approx.):	Unit No.1	Unit No.2	
Grid to Plate	1.7	1.7	pF
Grid to Cathode and Heater	1.6	1.6	pF
Plate to Cathode and Heater	0.46	0.34	pF

Class A₁ Amplifier (Each Unit)

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	330	volts
Grid Voltage:		
Negative-bias value	55	volts
Positive-bias value	0	volts
Plate Dissipation	1.2	watts

EQUIVALENT-NOISE AND HUM VOLTAGE (References To Grid, Each Unit)*

Average Value	1.8	μV rms
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* Measured in "true rms" units under the following conditions: Heater voltage (parallel connection), 6.3 volts ac; center tap of heater-transformer grounded; plate supply voltage, 250 volts dc; plate load resistor, 100000 ohms; cathode resistor, 2700 ohms bypassed by 100-μF capacitor; grid resistor, 0 ohms; and amplifier covering frequency range between 25 and 10000 Hz.

Refer to chart at end of section.

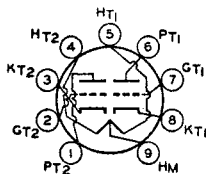
12AY3

Refer to type 6AY3B.

12AY3A

MEDIUM-MU TWIN TRIODE

12AY7



9A

Miniature type used in the first stages of high-gain audio-frequency amplifiers. Outlines section, 6B; requires miniature 9-contact socket. Each triode unit is independent of the other except for the common heater. Use of the 12.6-volt connection with an ac heater supply is not recommended for applications involving low hum. For typical operation as a resistance-coupled amplifier, refer to Resistance-Coupled Amplifier section.

Heater Arrangement:	Series	Parallel	
Heater Voltage (ac/dc)	12.6	6.3	volts
Heater Current	0.15	0.3	ampere
Peak Heater-Cathode Voltage		±90 max	volts
Direct Interelectrode Capacitances (Approx., Each Unit)			
Grid to Plate		1.3	pF
Grid to Cathode and Heater		1.3	pF
Plate to Cathode and Heater		0.6	pF

Class A₁ Amplifier (Each Unit)

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Grid Voltage:		
Negative-bias value	50	volts
Positive-bias value	0	volts
Cathode Current	10	mA
Plate Dissipation	1.5	watts

CHARACTERISTICS

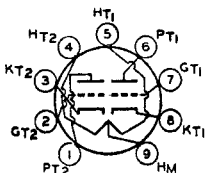
Plate Voltage	250	volts
Grid Voltage	-4	volts
Amplification Factor	40	
Plate Resistance	22800	ohms
Transconductance	1750	μmhos
Plate Current	3	mA
Grid Voltage (Approx.) for plate current of 10 mA	-11	volts

Refer to chart at end of section.

12AZ7

HIGH-MU TWIN TRIODE

12AZ7A



9A

Miniature type used in direct-coupled cathode-drive rf amplifier circuits of vhf color and black-and-white television tuners. Outlines section, 6B; requires miniature 9-contact socket. For characteristics as class A₁ amplifier, refer to miniature type 12AT7.

Heater Voltage (ac/dc):		
Series	12.6	volts
Parallel	6.3	volts
Heater Current:		
Series	0.225	ampere
Parallel	0.45	ampere
Heater Warm-up Time (Average)		
	11	seconds
Heater-Cathode Voltage:		
Peak value	±200 max	volts
Average value	100 max	volts
Direct Interelectrode Capacitance (Approx.):		
	Unshielded	Shielded ^A
Grid to Plate (Each unit)	2	1.9
Grid to Cathode and Heater (Each unit)	2.6	2.8
Plate to Cathode and Heater:		
Unit No.1	0.44	pF
Unit No.2	0.36	pF

^A With external shield connected to cathode of unit under test.

Class A₁ Amplifier (Each Unit)

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	330	volts
Grid Voltage, Negative-bias value	55	volts
Plate Dissipation	2.5	watts

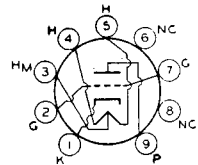
MAXIMUM CIRCUIT VALUES (Each Unit)

Grid-Circuit Resistance:		
For fixed-bias operation	0.25	megohm
For cathode-bias operation	1	megohm

12B4A

LOW-MU TRIODE

Miniature type used as vertical-deflection amplifier in television receivers. Outlines section, 6E; requires miniature 9-contact socket.



9AG

Heater Voltage		
	Series	Parallel
Heater Voltage	12.6	6.3
Heater Current	0.3	0.6
Heater Warm-up Time	—	11
Heater-Cathode Voltage:		
Peak value	±200 max	volts
Average value	100 max	volts
Direct Interelectrode Capacitances:		
Grid to Plate	4.8	pF
Grid to Cathode and Heater	5	pF
Plate to Cathode and Heater	1.5	pF

Class A₁ Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	550	volts
Grid Voltage, Negative-bias value	50	volts
Plate Dissipation	5.5	watts

CHARACTERISTICS

Plate Voltage	150	volts
Grid Voltage	-17.5	volts
Amplification Factor	6.5	
Plate Resistance (Approx.)	1030	ohms
Transconductance	6300	μmhos
Plate Current	34	mA
Plate Current for grid voltage of -23 volts	9.6	mA
Grid Voltage (Approx.) for plate current of 200 μA	-32	volts

MAXIMUM CIRCUIT VALUES

Grid-Circuit Resistance:		
For fixed-bias operation	0.47	megohm
For cathode-bias operation	2.2	megohms

Vertical-Deflection Amplifier

For operation in a 525-line, 30-frame system

MAXIMUM RATINGS (Design-Center Values)

DC Plate Voltage	550	volts
Peak Positive-Pulse Plate Voltage# (Absolute Maximum)	1000†	volts

Peak Negative-Pulse Grid Voltage	250	volts
Peak Cathode Current	105	mA
Average Cathode Current	30	mA
Plate Dissipation	5.5	watts

MAXIMUM CIRCUIT VALUE

Grid-Circuit Resistance, for cathode-bias operation	2.2	megohms
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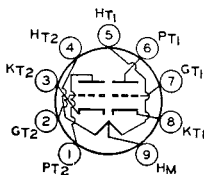
Pulse duration must not exceed 15% of a vertical scanning cycle (2.5 milliseconds).

† Under no circumstances should this absolute value be exceeded.

Refer to chart at end of section.	12B8GT
Refer to type 6BA6.	12BA6
Refer to chart at end of section.	12BA7
Refer to chart at end of section.	12BD6
Refer to type 6BE3.	12BE3
Refer to type 6BE6.	12BE6
Refer to chart at end of section.	12BF6
Refer to type 6BF11.	12BF11
Refer to chart at end of section.	12BH7

MEDIUM-MU TWIN TRIODE

12BH7A



9A

Miniature type used as combined vertical-deflection amplifier and vertical oscillator, and as horizontal-deflection oscillator, in television receivers, and in phase-inverter and multivibrator circuits. Outlines section, 6E; requires miniature 9-contact socket. Each triode unit is independent of the other except for the common heater.

Heater Arrangement:	Series	Parallel	
Heater Voltage (ac/dc)	12.6	6.3	volts
Heater Current	0.3	0.6	ampere
Heater Warm-up Time (Average)	—	11	seconds
Heater-Cathode Voltage:			
Peak value		±200 max	volts
Average value		100 max	volts
Direct Interelectrode Capacitances (Approx.):	Unit No.1	Unit No.2	
Grid to Plate	2.6	2.6	pF
Grid to Cathode and Heater	3.2	3.2	pF
Plate to Cathode and Heater	0.5	0.4	pF
Plate of Unit No.1 to Plate of Unit No.2	0.8		pF

Class A₁ Amplifier (Each Unit)

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Grid Voltage:		
Negative-bias value	50	volts
Positive-bias value	0	volts
Cathode Current	20	mA
Plate Dissipation:		
Each Plate	3.5	watts
Both plates (Both units operating)	7	watts

CHARACTERISTICS

Plate Voltage	250	volts
Grid Voltage	-10.5	volts
Amplification Factor	16.5	
Plate Resistance (Approx.)	5300	ohms
Transconductance	3100	μmhos
Plate Current	11.5	mA
Plate Current for grid voltage of -14 volts	4	mA
Grid Voltage (Approx.) for plate current of 50 μA	-23	volts

MAXIMUM CIRCUIT VALUES

Grid-Circuit Resistance:

For fixed-bias operation	0.25	megohm
For cathode-bias operation	1	megohm

Oscillator (Each Unit)

For operation in a 525-line, 30-frame system

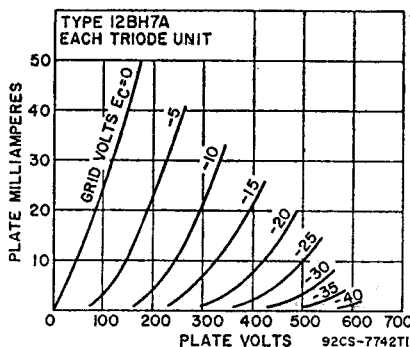
MAXIMUM RATINGS (Design-Center Values)	Vertical-Deflection Oscillator	Horizontal-Deflection Oscillator	
DC Plate Voltage	450	450	volts
Peak Negative-Pulse Grid Voltage	400	600	volts
Peak Cathode Current	70	300	mA
Average Cathode Current	20	20	mA
Plate Dissipation:			
Each Plate	3.5	3.5	watts
Both Plates (Both units operating)	7	7	watts
MAXIMUM CIRCUIT VALUES			
Grid-Circuit Resistance	2.2	2.2	megohms

Vertical-Deflection Amplifier (Each Unit)

For operation in a 525-line, 30-frame system

MAXIMUM RATINGS (Design-Center Values)

DC Plate Voltage	450	volts
Peak Positive-Pulse Plate Voltage# (Absolute maximum)	1500*	volts
Peak Negative-Pulse Grid Voltage	250	volts
Peak Cathode Current	70	mA
Average Cathode Current	20	mA
Plate Dissipation:		
Each Plate	3.5	watts
Both Plates (Both units operating)	7	watts

**MAXIMUM CIRCUIT VALUE**

Grid-Circuit Resistance for cathode-bias operation

2.2 megohms

Pulse duration must not exceed 15% of a vertical scanning cycle (2.5 milliseconds).

* Under no circumstances should this absolute value be exceeded.

12BK5

Refer to chart at end of section.

12BL6

Refer to chart at end of section.

12BN6

Refer to chart at end of section.

12BQ6GTB/12CU6

Refer to type 6BQ6GTB/6CU6.

12BR3

For replacement use type 12AF3/12BR3/12RK19.

12BR7

Refer to chart at end of section.

12BS3Refer to chart at end of section.
For replacement use type 12BS3A/12DW4A.