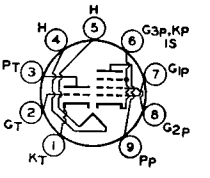
6AW8A
8AW8A

HIGH-MU TRIODE—SHARP-CUTOFF PENTODE



9DX

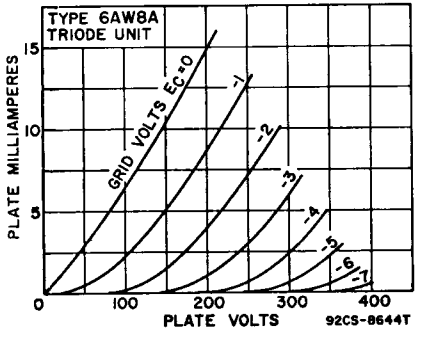
Miniature type used in television receiver applications. The pentode unit is used as an if amplifier, video amplifier, agc amplifier, or reactance tube. The triode unit is used in low-frequency oscillator, sync-separator, sync-clipper, and phase-splitter circuits. **Outlines section,** 6E; requires miniature 9-contact socket. Type 8AW8A is identical with type 6AW8A except for heater ratings.

	6AW8A	8AW8A	
Heater Voltage (ac/dc)	6.3	8.4	volts
Heater Current	0.6	0.45	ampere
Heater Warm-up Time (Average)	11	11	seconds
Heater-Cathode Voltage:			
Peak value	±200 max	±200 max	volts
Average value	100 max	100 max	volts
Direct Interelectrode Capacitances:	**Unshielded**	**Shielded**	
Triode Unit:			
Grid to Plate	2.2	2.2	pF
Grid to Cathode, Pentode Cathode, Pentode Grid No.3, Internal Shield, and Heater	3.2	3.4	pF
Plate to Cathode, Pentode Cathode, Pentode Grid No.3, Internal Shield, and Heater	1.8	3	pF
Pentode Unit:			
Grid No.1 to Plate	0.06 max	0.05 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	10	10	pF
Plate to Cathode, Heater, Griid No.2, Grid No.3, and Internal Shield	3.6	4.5	pF
Pentode Grid No.1 to Triode Plate	0.008 max	0.005 max	pF
Pentode Plate to Triode Plate	0.15 max	0.025 max	pF

■ With external shield connected to pins 4 and 5.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)	Triode Unit	Pentode Unit	
Plate Voltage	330	330	volts
Grid-No.2 (Screen-Grid) Supply Voltage	—	330	volts
Grid-No.2 Voltage	—	See curve page 300	
Grid-No.1 (Control-Grid) Voltage, positive-bias value	0	0	volts
Plate Dissipation	1.1	3.75	watts
Grid-No.2 Input:			
For grid-No.2 voltages up to 165 volts	—	1.1	watts
For grid-No.2 voltages between 165 and 330 volts	—	See curve page 300	
CHARACTERISTICS			
Plate Supply Voltage	200	150	volts
Grid-No.2 Supply Voltage	—	150	volts
Grid-No.1 Voltage	−2	—	volts
Cathode-Bias Resistor	—	150	ohms
Amplification Factor	70	—	



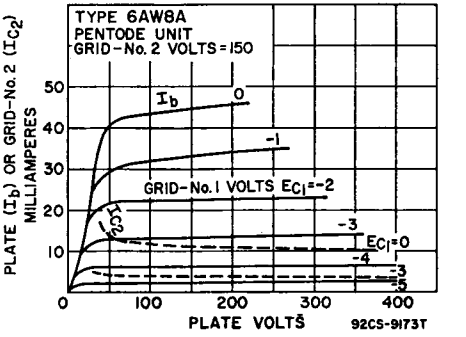
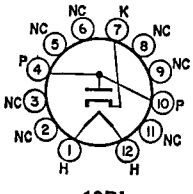


Plate Resistance (Approx.)	—	0.2	megohm
Transconductance	4000	9500	μmhos
Plate Current	4	15	mA
Grid-No.2 Current	—	3.5	mA
Grid-No.1 Voltage (Approx.) for plate current of 20 μA	—5	—8	volts

MAXIMUM CIRCUIT VALUES

Grid-No.1-Circuit Resistance:			
For fixed-bias operation	0.5	0.25	megohm
For cathode-bias operation	1	1	megohm



12BL

HALF-WAVE VACUUM RECTIFIER

6AX3

12AX3, 17AX3

Duodecar type used as damper tube in horizontal-deflection circuits of television receivers. **Outlines section,** 8C; requires 12-contact socket. Socket terminals 5, 6, 8, and 9 should not be used as tie points. This tube, like other power-handling tubes, should be adequately ventilated. Types 12AX3 and 17AX3 are identical with type 6AX3 except for heater ratings.

	6AX3	12AX3	17AX3	
Heater Voltage (ac/dc)	6.3	12.6	16.8	volts
Heater Current	1.2	0.6	0.45	amperes
Heater Warm-up Time (Average)	—	11	11	seconds
Direct Interelectrode Capacitances:				
Plate to Cathode and Heater			5.5	pF
Cathode to Plate and Heater			7.5	pF
Heater to Cathode			2.8	pF

Damper Service

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

MAXIMUM RATINGS (Design-Maximum Values)

Peak Inverse Plate Voltage#		5000	volts
Peak Plate Current		1000	mA
Average Plate Current		165	mA
Plate Dissipation		5.3	watts
Heater-Cathode Voltage:			
Peak value	+300	—5000	volts
Average value	+100	—900	volts

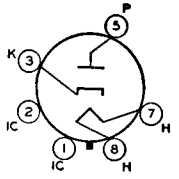
CHARACTERISTIC

Tube Voltage Drop for plate current of 250 mA	32	volts

Pulse duration must not exceed 15% of a horizontal scanning cycle (10 microseconds).

Refer to chart at end of section.

6AX4GT



4CG

HALF-WAVE VACUUM RECTIFIER

6AX4GTB

12AX4GTB, 17AX4GTA

Glass octal type used as damper tube in horizontal-deflection circuits of color and black-and-white television receivers. **Outlines section,** 13D; requires octal socket. May be supplied with pin No. 1 omitted. Socket terminals 1, 2, 4, and 6 should not be used as tie points. This tube, like other power-handling tubes, should be adequately ventilated. Types 12AX4GTB and 17AX4GTA are identical with type 6AX4GTB except for heater ratings.

	6AX4-GTB	12AX4-GTB	17AX4-GTA	
Heater Voltage (ac/dc)	6.3	12.6	16.8	volts
Heater Current	1.2	0.6	0.45	amperes
Heater Warm-up Time (Average)	—	11	11	seconds
Direct Interelectrode Capacitances (Approx.):				
Cathode to Plate and Heater			8.5	pF
Plate to Cathode and Heater			5	pF
Heater to Cathode			4	pF

Damper Service

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

MAXIMUM RATINGS (Design-Maximum Values)

Peak Inverse Plate Voltage#		5000	volts
Peak Plate Current		1000	mA
Average Plate Current		165	mA
Plate Dissipation		5.3	watts
Heater-Cathode Voltage:			
Peak value	+300	−5000	volts
Average value	+100	−900	volts

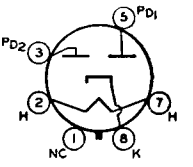
CHARACTERISTIC, Instantaneous Value

Tube Voltage Drop for plate current of 250 mA		32	volts

Pulse duration must not exceed 15% of a horizontal scanning cycle (10 microseconds).

6AX5GT

FULL-WAVE VACUUM RECTIFIER



6S

Glass octal type used in power supplies of radio equipment having moderate dc requirements. **Outlines section,** 13D; requires octal socket. This type may be supplied with pin No. 1 omitted. This tube, like other power-handling tubes, should be adequately ventilated. **Heater:** volts (ac), 6.3; amperes, 1.2.

Full-Wave Rectifier

MAXIMUM RATINGS (Design-Center Values)

Peak Inverse Plate Voltage	1250	volts
Peak Plate Current (Per Plate)	375	mA
Hot-Switching Transient Plate Current:		
For duration of 0.2 second maximum	2.6	amperes
AC Plate Supply Voltage (Per Plate, rms)	See Rating Chart	
Average Output Current (Per Plate, rms)	See Rating Chart	
Peak Heater-Cathode Voltage	±450	volts

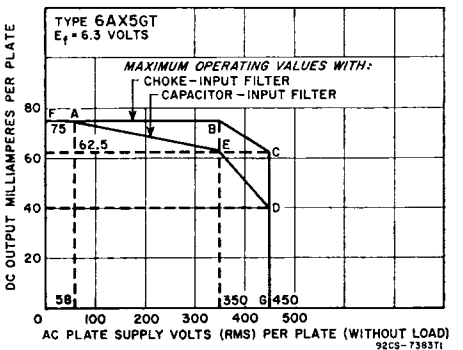
TYPICAL OPERATION WITH CAPACITOR INPUT TO FILTER

AC Plate-to-Plate Supply Voltage (rms)	700	900	volts
Filter Input Capacitor*	10	10	μF
Effective Plate-Supply Impedance Per Plate	50	105	ohms
DC Output Voltage at Input to Filter (Approx.):			
At half-load current of { 62.5 mA	395	—	volts
At half-load current of { 40 mA	—	540	volts
At full-load current of { 125 mA	350	—	volts
At full-load current of { 80 mA	—	490	volts
Voltage Regulation (Approx.):			
Half-load to full-load current	45	50	volts

TYPICAL OPERATION WITH CHOKE INPUT TO FILTER

AC Plate-to-Plate Supply Voltage (rms)	700	900	volts
Filter Input Choke	10#	10##	henries
DC Output Voltage at Input to Filter (Approx.):			
At half-load current of { 75 mA	270		volts
At half-load current of { 62.5 mA	—	365	volts
At full-load current of { 150 mA	250		volts
At full-load current of { 125 mA	—	350	volts

RATING CHART



Voltage Regulation (Approx.):			
Half-load to full-load current	20	15	volts

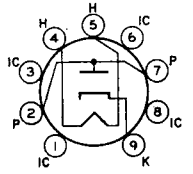
* Higher values of capacitance than indicated may be used but the effective plate-supply impedance may have to be increased to prevent exceeding the maximum rating for hot-switching transient plate current.

This value is adequate to maintain optimum regulation provided the load current is not less than 30 mA. For load currents less than 30 mA, a larger value of inductance is required for optimum regulation.

This value is adequate to maintain optimum regulation provided the load current is not less than 35 mA. For load currents less than 35 mA, a larger value of inductance is required for optimum regulation.

Refer to chart at end of section. **6AX8**

Refer to chart at end of section. **6AY3**



9HP

HALF-WAVE VACUUM RECTIFIER

6AY3B

12AY3A, 17AY3A

Novar type used as damper tube in horizontal-deflection circuits of black-and-white television receivers. **Outlines section,** 30B; requires novar 9-contact socket. Socket terminals 1, 3, 6, and 8 should not be used as tie points. It is especially important that these tubes, like other power-handling tubes, be adequately ventilated. Types 12AY3A and 17AY3A are identical with type 6AY3B except for heater ratings.

	6AY3B	12AY3A	17AY3A	
Heater Voltage (ac/dc)	6.3	12.6	16.8	volts
Heater Current	1.2	0.6	0.45	amperes
Heater Warm-up Time (Average)	—	11	11	seconds
Direct Interelectrode Capacitances (Approx.):				
Plate to Cathode and Heater			6.5	pF
Cathode to Plate and Heater			9	pF
Heater to Cathode			2.8	pF

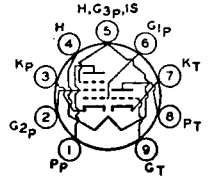
Damper Service

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

MAXIMUM RATINGS (Design-Maximum Values)			
Peak Inverse Plate Voltage#		5000	volts
Peak Plate Current		1100	mA
Average Plate Current		175	mA
Plate Dissipation		6.5	watts
Heater-Cathode Voltage:			
Peak value	+300	—5000	volts
Average value	+100	—900	volts
CHARACTERISTIC, Instantaneous Value			
Tube Voltage Drop for plate current of 350 mA		32	volts

Pulse duration must not exceed 15% of a horizontal scanning cycle (10 microseconds).

Refer to chart at end of section. **6AY11**



9ED

MEDIUM-MU TRIODE— SHARP-CUTOFF PENTODE

6AZ8

Miniature type used in color and black-and-white television receiver applications. The pentode unit is used as an if amplifier, video amplifier, agc amplifier, or reactance tube. The triode unit is used in low-frequency oscillator, sync-separator, sync-clipper, and phase-splitter circuits. **Outlines section,** 6B; requires miniature 9-contact socket.

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.45	ampere
Heater-Cathode Voltage:▲		
Peak value	±200 max	volts
Average value	100 max	volts

Direct Interelectrode Capacitances:		
Triode Unit:		
Grid to Plate	1.7	pF
Grid to Cathode, Heater, Pentode Grid No.3, and Internal Shield	2	pF
Plate to Cathode, Heater, Pentode Grid No.3, and Internal Shield	1.7	pF
Pentode Unit:		
Grid No.1 to Plate	0.02 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	6.5	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	2.2	pF
Triode Grid to Pentode Plate	0.027 max	pF
Pentode Grid No.1 to Triode Plate	0.020 max	pF
Pentode Plate to Triode Plate	0.045 max	pF

▲ The heater-cathode voltage of the pentode unit should not exceed the value of the operating cathode bias. Grid No.3 will be made negative with respect to cathode if this value is exceeded, and thus possibly cause a change in tube characteristics.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Center Values)	Triode Unit	Pentode Unit	
Plate Voltage	300	300	volts
Grid-No.2 (Screen-Grid) Supply Voltage	—	300	volts
Grid-No.2 Voltage	—	See curve page 300	
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0	0	volts
Plate Dissipation	2.6	2	watts
Grid-No.2 Input:			
For grid-No.2 voltages up to 150 volts	—	0.5	watt
For grid-No.2 voltages between 150 and 300 volts	—	See curve page 300	
CHARACTERISTICS	**Triode Unit**	**Pentode Unit**	
Plate Supply Voltage	200	200	volts
Grid-No.2 Voltage	—	150	volts
Grid-No.1 Voltage	—6	—	volts
Cathode-Bias Resistor	—	180	ohms
Amplification Factor	19	—	
Plate Resistance (Approx.)	5750	300000	ohms
Transconductance	3300	6000	μmhos
Plate Current	13	9.5	mA
Grid-No.2 Current	—	3	mA
Grid-No.1 Voltage (Approx.) for plate current of 10 μA	—19	—	volts
Grid-No.1 Voltage (Approx.) for transconductance of 100 μmhos	—	—12.5	volts
MAXIMUM CIRCUIT VALUES			
Grid-No.1-Circuit Resistance:*			
For fixed-bias operation	0.5	0.25	megohm
For cathode-bias operation	1	1	megohm

* If either unit is operating at maximum rated conditions, grid-No.1-circuit resistance for both units should not exceed the stated values.

6B4G Refer to chart at end of section.

6B5 Refer to chart at end of section.

6B6G Refer to chart at end of section.

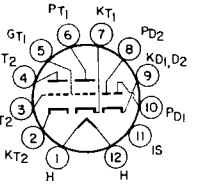
6B7
6B7S Refer to chart at end of section.

6B8
6B8G Refer to chart at end of section.

6B10
8B10

TWIN DIODE— MEDIUM-MU TWIN TRIODE

Duodecar type used in television receiver applications; diode units are used in horizontal-phase-detector circuits, and triode units are used in horizontal-oscillator circuits. **Outlines section,** 8A; requires duodecar 12-contact socket. Type 8B10 is identical with type 6B10 except for heater ratings.



12BF

	6B10	8B10	
Heater Voltage (ac/dc)	6.3	8.5	volts
Heater Current	0.6	0.45	ampere
Heater Warm-up Time (Average)	11	11	seconds
Heater-Cathode Voltage:			
Peak value	±200 max	±200 max	volts
Average value	100 max	100 max	volts

Class A_1 Amplifier (Each Triode Unit)

MAXIMUM RATING (Design-Maximum Value)

Plate Voltage	330	volts
Average Cathode Current	20	mA
Plate Dissipation	3	watts

CHARACTERISTICS

Plate Voltage	250	volts
Grid Voltage	−8	volts
Amplification Factor	18	
Plate Resistance (Approx.)	7200	ohms
Transconductance	2500	μmhos
Plate Current	10	mA
Grid Voltage (Approx.) for plate current of 50 μA	−20	volts

MAXIMUM CIRCUIT VALUES

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

Diode Units (Each Unit)

MAXIMUM RATING (Design-Maximum Value)

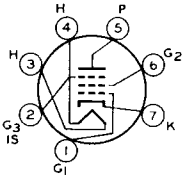
Plate Current	5	mA

CHARACTERISTIC, Instantaneous Value

Tube Voltage Drop for plate current of 20 mA	5	volts

Refer to chart at end of section. **6BA3**

For replacement use type 6BA6/EF93. **6BA6**



7BK

REMOTE-CUTOFF PENTODE

6BA6/EF93

12BA6

Miniature types used as **rf** amplifiers in standard broadcast and FM receivers, as well as in wide-band, high-frequency applications. The low value of grid-No.1-to-plate capacitance minimizes regenerative effects, while the high transconductance makes possible high signal-to-noise ratio. **Outlines section,** 5C; require miniature 7-contact socket. Type 12BA6 is identical with type 6BA6/EF93 except for heater ratings.

	6BA6/EF93	12BA6	
Heater Voltage (ac/dc)	6.3	12.6	volts
Heater Current	0.3	0.15	ampere
Heater-Cathode Voltage:			
Peak value	±200 max	±200 max	volts
Average value	100 max	100 max	volts
Direct Interelectrode Capacitances:			
Grid No.1 to Plate		0.0035 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield		5.5	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield		5▪	pF

▪ This value is 5.5 pF with external shield connected to cathode.

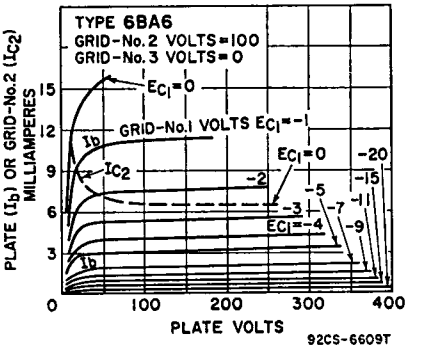
Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	330	volts
Grid-No.3 (Suppressor-Grid) Voltage, Positive value	0	volts
Grid-No.2 (Screen-Grid) Voltage	See curve page 300	
Grid-No.2 Supply Voltage	330	volts
Plate Dissipation	3.4	watts
Grid-No.2 Input:		
For grid-No.2 voltages up to 165 volts	0.7	watt
For grid-No.2 voltages between 165 and 330 volts	See curve page 300	
Grid-No.1 (Control-Grid) Voltage:		
Negative-bias value	55	volts
Positive-bias value	0	volts

CHARACTERISTICS

Plate Supply Voltage	100	250	volts
Grid No.3 and Internal Shield	Connected to cathode at socket		
Grid-No.2 Supply Voltage	100	100	volts
Cathode-Bias Resistor	68	68	ohms
Plate Resistance (Approx.)	0.25	1	megohm
Transconductance	4300	4400	μmhos
Plate Current	10.8	11	mA
Grid-No.2 Current	4.4	4.2	mA
Grid-No.1 Voltage (Approx.) for transconductance of 40 μmhos	−20	−20	volts

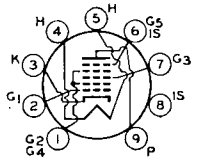


Installation and Application

Control-grid bias variation is effective in changing the volume of the receiver. To obtain adequate volume control, an available grid-No.1-bias voltage of approximately 50 volts is required. The exact value depends upon the circuit design and operating conditions. This voltage may be obtained, depending on the receiver requirements, from a potentiometer across a fixed supply voltage, from a variable cathode-bias resistor, from the avc system, or from a combination of these methods.

The **grid-No.2 (screen-grid)** voltage may be obtained from a potentiometer or bleeder circuit across the B-supply source, or through a dropping resistor from the plate supply. The use of series resistors for obtaining satisfactory control of grid-No.2 voltage in the case of four-electrode tubes is usually impossible because of secondary-emission phenomena. In the 6BA6, however, because grid No.3 practically removes these effects, it is practical to obtain grid-No.2 voltage through a series-dropping resistor from the plate supply or from some high intermediate voltage, provided the source does not exceed the plate-supply voltage. With this method, the grid-No.2-to-cathode voltage will fall off very little from minimum to maximum value of the resistor controlling cathode bias. In some cases, it may actually rise. This rise of grid-No.2-to-cathode voltage above the normal maximum value is allowable because both the grid-No.2 current and the plate current are reduced simultaneously by a sufficient amount to prevent damage to the tube. It should be recognized that, in general, the series-

resistor method of obtaining grid-No.2 voltage from a higher voltage supply necessitates the use of the variable cathode-resistor method of controlling volume in order to prevent too high a voltage on grid No.2. When grid-No.2 and control-grid voltage are obtained in this manner, the remote "cutoff" advantage of the 6BA6 can be fully realized. However, it should be noted that the use of a resistor in the grid-No.2 circuit has an effect on the change in plate resistance with variation in grid-No.3 (suppressor-grid) voltage in case grid No.3 is utilized for control purposes.



8CT

PENTAGRID CONVERTER — 6BA7

Miniature type used as converter in AM and FM receivers. **Outlines section, 6E;** requires miniature 9-contact socket.

Heater Voltage	6.3	volts
Heater Current	0.3	ampere
Peak Heater-Cathode Voltage	±90	volts
Direct Interelectrode Capacitances:		
Grid No. 3 to All Other Electrodes	9.5	pF
Plate to All Other Electrodes	8.3	pF
Grid No. 1 to All Other Electrodes	6.7	pF
Grid No. 3 to Plate	0.19 max	pF
Grid No. 3 to Grid No. 1	0.1 max	pF
Grid No. 1 to Plate	0.05 max	pF
Grid No. 1 to All Other Electrodes, except Cathode	3.4	pF
Grid No. 1 to Cathode	3.3	pF
Cathode to All Other Electrodes except Grid No. 1	4	pF

Converter Service

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Grid-No.5-and-Internal-Shield Voltage▵	0	volts
Grids-No.-2-and-No.4 (Screen-Grid) Voltage	100	volts
Grids-No.2-and-No.4 Supply Voltage	300	volts
Plate Dissipation	2	watts
Grids-No.2-and-No.4 Input	1.5	watts
Total Cathode Current	22	mA
Grid-No.3 Voltage:		
Negative-bias value	100	volts
Positive-bias value	0	volts

CHARACTERISTICS (Separate Excitation)*

Plate Voltage	100	250	volts
Grid No.5 and Internal Shield▵	Connected directly to ground		
Grids-No.2-and-No.4 (Screen-Grid) Voltage	100	100	volts
Grid-No.3 (Control-Grid) Voltage	−1	−1	volt
Grid-No.1 (Oscillator-Grid) Resistor	20000	20000	ohms
Plate Resistance (Approx.)	0.5	1	megohm
Conversion Transconductance	900	950	μmhos
Conversion Transconductance (Approx.)**	3.5	3.5	μmhos
Plate Current	3.6	3.8	mA
Grids-No.2-and-No.4 Current	10.2	10	mA
Grid-No.1 Current	0.35	0.35	mA
Total Cathode Current	14.2	14.2	mA

NOTE: The transconductance between grid No.1 and grids No.2 and No.4 connected to plate (not oscillating) is approximately 8000 μmhos under the following conditions: signal applied to grid No.1 at zero bias; grids No.2 and No.4 and plate at 100 volts; grid No.3 grounded. Under the same conditions, the plate current is 32 milliamperes, and the amplification factor is 16.5.

* The characteristics shown with separate excitation correspond very closely with those obtained in a self-excited oscillator circuit operating with zero bias.

** With grid-No.3 bias of −20 volts.

▵ Internal Shield (pins No.6 and No.8) connected directly to ground.