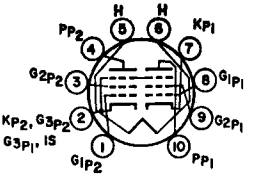
6AF9

11AF9

DUAL PENTODE



10L

Miniature type used in television receiver applications. Unit No.1 is used as a video output pentode, and unit No.2 as a sound if amplifier, agc amplifier, or sync separator. **Outlines section,** 6L, except has 10-pin base; requires miniature 10-contact socket. Type 11AF9 is identical with type 6AF9 except for heater ratings.

	6AF9	11AF9	
Heater Voltage (ac/dc)	6.3	11.5	volts
Heater Current	0.85	0.45	ampere
Peak Heater-Cathode Voltage	±200 max	±200 max	volts

Direct Interelectrode Capacitances:	Unit No.1	Unit No.2	
Plate to All Other Electrodes (except grid No.1)	7	11	pF
Grid No.1 to All Other Electrodes (except plate)	12	10	pF
Plate to Grid No.1	0.105	0.140	pF
Grid No.1 to Heater	—	0.140	pF
Plate of Unit No.1 to Plate of Unit No. 2	0.150 max		pF
Grid No.1 of Unit No.1 to Grid No.1 of Unit No. 2	0.010 max		pF
Plate of Unit No.1 to Grid No.1 of Unit No.2	0.100 max		pF
Plate of Unit No.2 to Grid No.1 of Unit No.1	0.005 max		pF

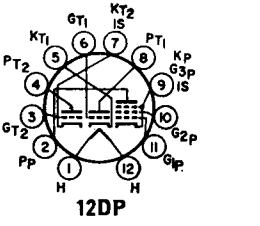
Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)	Unit No.1	Unit No.2	
Plate Supply Voltage	550	550	volts
Plate Voltage	250	250	volts
Grid-No.2 (Screen-Grid) Supply Voltage	550	550	volts
Grid-No.2 Voltage	250	250	volts
Cathode Current	60	15	mA
Plate Dissipation	5.1	1.5	watts
Grid-No.2 Input	2.5	0.5	watts
CHARACTERISTICS			
Plate Voltage	170	150	volts
Grid-No.2 Voltage	170	150	volts
Grid-No.1 (Control-Grid) Voltage	—2.6	—2.1	volts
Mu Factor, Grid No.1 to Grid No.2	38	38	
Internal Resistance	0.032	0.16	megohm
Transconductance	22000	8500	μmhos
Plate Current	30	10	mA
Grid-No.2 Current	7.2	3	mA
MAXIMUM CIRCUIT VALUES			
Grid-No.1-Circuit Resistance	1	1	megohm

6AF11

15AF11

DUAL TRIODE— SHARP-CUTOFF PENTODE



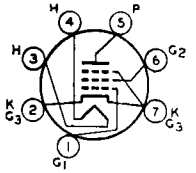
12DP

Duodecar type used in television receiver applications. The high-mu triode unit is used for agc keyer service, the medium-mu triode unit for sync separator service, and the pentode unit for video amplifier service. **Outlines section,** 8C; requires duodecar 12-contact socket. Type 15AF11 is identical with type 6AF11 except for heater ratings.

	6AF11	15AF11	
Heater Voltage (ac/dc)	6.3	14.7	volts
Heater Current	1.05	0.45	amperes
Heater Warm-up Time (Average)	—	11	seconds
Heater-Cathode Voltage:			
Peak value	±200 max	±200 max	volts
Average value	100 max	100 max	volts

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)	Triode Unit No.1	Triode Unit No.2	Pentode Unit	
Plate Voltage	330	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	0	volts
Plate Dissipation	1.1	2	5	watts
Grid-No.2 Input:				
For grid-No.2 voltages up to 165 volts	—	—	1.25	watts
For grid-No.2 voltages between 165 and 330 volts	—	—	See curve page 300	
CHARACTERISTICS				
Plate Supply Voltage	200	200	250	volts
Grid-No.2 Supply Voltage	—	—	150	volts
Grid-No.1 Voltage	−2	—	—	volts
Cathode-Bias Resistor	—	220	100	ohms
Amplification Factor	68	41	—	
Plate Resistance (Approx.)	12400	9400	68000	ohms
Transconductance	5500	4400	11000	μmhos
Plate Current	7	9.2	24	mA
Grid-No.2 Current	—	—	4.8	mA
Grid-No.1 Voltage (Approx.) for plate current of 100 μA	—	−6.5	−10	volts
MAXIMUM CIRCUIT VALUES				
Grid-No.1-Circuit Resistance:				
For fixed-bias operation	0.5	0.5	0.25	megohm
For cathode-bias operation	1	1	1	megohm



7BD

SHARP-CUTOFF PENTODE 6AG5

Miniature type used in compact radio equipment as an rf or if amplifier up to 400 MHz. **Outlines section, 5C;** requires miniature 7-contact socket. For typical operation as a resistance-coupled amplifier, refer to **Resistance-Coupled Amplifier** section.

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.3	ampere
Direct Interelectrode Capacitances:		
Pentode Unit:		
Grid No.1 to Plate	0.030 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	1.8	pF
Triode Unit:		
Grid No.1 to Plate and Grid No.2	2.5	pF
Grid No.1 to Cathode, Heater, Grid No.3, and Internal Shield	3.6	pF
Grid No.2 to Cathode, Heater, Grid No.3, and Internal Shield	3	pF
Plate to Cathode, Heater, Grid No.3, and Internal Shield	3	pF

Class A_1 Amplifier

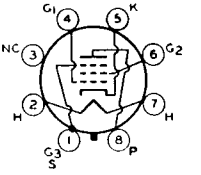
MAXIMUM RATINGS (Design-Center Values)	Triode Connection*	Pentode Connection	
Plate Voltage	300	300	volts
Grid-No.2 (Screen-Grid) Supply Voltage	—	300	volts
Grid-No.2 Voltage	—	See curve page 300	
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0	0	volts
Plate Dissipation	2.5	2	watts
Grid-No.2 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						
Plate Supply Voltage	180	250	100	125	250	volts
Grid-No.2 Supply Voltage	—	—	100	125	150	volts
Cathode-Bias Resistor	330	820	180	100	180	ohms
Amplification Factor	45	42	—	—	—	
Plate Resistance (Approx.)	0.008	0.01	0.6	0.5	0.8	megohm
Transconductance	5700	3800	4500	5100	5000	μmhos
Plate Current	7	5.5	4.5	7.2	6.5	mA

	Triode Connection*		Pentode Connection			
Grid-No.2 Current	—	—	1.4	2.1	2	mA
Grid-No.1 Voltage (Approx.) for plate current of 10 μA	—	—	−5	−6	−8	volts

* Grid No.2 connected to plate.

6AG7 POWER PENTODE



8Y

Metal type used in output stage of video amplifier of color and black-and-white television receivers. **Outlines section,** 2B; requires octal socket.

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.65	ampere
Peak Heater-Cathode Voltage	±90 max	volts
Direct Interelectrode Capacitances:*		
Grid No.1 to Plate	0.06 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, Shell, and Internal Shield	13	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, Shell, and Internal Shield	7.5	pF

* Pins 1 and 3 connected to Pin No.5.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Grid-No.2 Voltage	300	volts
Grid-No.1 Voltage, Positive-bias value	0	volts
Plate Dissipation	9	watts
Grid-No.2 Input	1.5	watts

CHARACTERISTICS

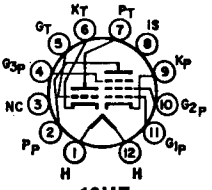
Plate Voltage	300	volts
Grid No.3 (Suppressor Grid)	Connected to cathode at socket	
Grid-No.2 (Screen-Grid) Voltage	150	volts
Grid-No.1 (Control-Grid) Voltage	−3	volts
Peak AF Grid-No.1 Voltage	3	volts
Zero-Signal Grid-No.2 Current	30	mA
Maximum-Signal Grid-No.2 Current	30.5	mA
Zero-Signal Grid-No.2 Current	7	mA
Maximum-Signal Grid-No.2 Current	9	mA
Plate Resistance	0.13	megohm
Transconductance	11000	μmhos
Load Resistance	10000	ohms
Total Harmonic Distortion	7	per cent
Maximum-Signal Power Output	3	watts

MAXIMUM CIRCUIT VALUES

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

6AG7Y Refer to chart at end of section.

6AG9 MEDIUM-MU TRIODE—SHARP-CUTOFF PENTODE



12HE

Duodecar type with frame grid pentode unit used in color and black-and-white television receiver applications. The pentode unit is used as a video amplifier; the triode unit is used as an agc amplifier. **Outlines section,** 8C; requires duodecar 12-contact socket. **Heater:** volts (ac/dc), 6.3; amperes, 0.82; maximum heater-cathode volts, ±200 peak, 100 average.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)	Triode Unit	Pentode Unit	
Plate Voltage	330	330	volts
Grid-No.2 (Screen-Grid) Voltage	—	200	volts
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0	0	volts
Plate Dissipation	1.1	10	watts
Grid-No.2 Input	—	1.5	watts
CHARACTERISTICS			
Plate Voltage	150	55 250	volts
Grid-No.2 Voltage	—	125 150	volts
Grid-No.1 Voltage	—	0 —	volts
Cathode-Bias Resistor	350	— 56	ohms
Amplification Factor	39	— —	
Plate Resistance (Approx.)	8500	— 40000	ohms
Transconductance	4600	— 30000	μmhos
Plate Current	6.2	56 28	mA
Grid-No.2 Current	—	21 5.6	mA
Grid-No.1 Voltage (Approx.) for plate current of 20 μA	—7	— —	volts
Grid-No.1 Voltage (Approx.) for plate current of 100 μA	—	— —5.4	volts
MAXIMUM CIRCUIT VALUES			
Grid-No.1-Circuit Resistance:			
For fixed-bias operation	0.5	0.1	megohm
For cathode-bias operation	1	0.25	megohm

Refer to chart at end of section. **6AG11**

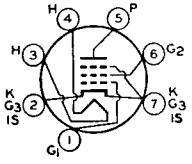
Refer to chart at end of section. **6AH4GT**

Refer to chart at end of section. **6AH6**

Refer to chart at end of section. **6AH9**

Refer to chart at end of section. **6AJ8/ECH81**

For replacement use type 6AK5/EF95. **6AK5**



7BD

SHARP-CUTOFF PENTODE

6AK5/ EF95

Miniature types used as rf or if amplifiers especially in high-frequency wide-band applications at frequencies up to 400 MHz. **Outlines section**, 5B; require miniature 7-contact socket.

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.175	ampere
Peak Heater-Cathode Voltage	±90 max	volts
Direct Interelectrode Capacitances (Approx.):▪		
Grid No.1 to Plate	0.02 max	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	4	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	2.8	pF

▪ With external shield connected to pin 2 or 7.

Class A_1 Amplifier

MAXIMUM RATINGS (Design-Center Values)		
Plate Voltage	180	volts
Grid-No.2 (Screen-Grid) Voltage	See curve page 300	
Grid-No.2 Supply Voltage	180	volts
Grid-No.1 Voltage, Positive-bias value	0	volts
Plate Dissipation	1.7	watts
Grid-No.2 Input:		
For grid-No.2 voltages up to 90 volts	0.5	watt
For grid-No.2 voltages between 90 and 180 volts	See curve page 300	
Cathode Current	18	mA

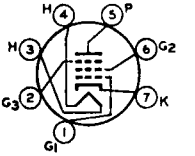
CHARACTERISTICS

Plate Supply Voltage	120	180	volts
Grid-No.2 Supply Voltage	120	120	volts
Cathode-Bias Resistor	180	180	ohms
Plate Resistance (Approx.)	0.3	0.5	megohm
Transconductance	5000	5100	μmhos
Plate Current	7.5	7.7	mA
Grid-No.2 Current	2.5	2.4	mA
Grid-No.1 Voltage for plate current of 10 μA	—8.5	—8.5	volts

6AK6

INDUSTRIAL TYPE

POWER AMPLIFIER PENTODE



7BK

Miniature type for use as a power output pentode in compact equipment. **Outlines section, 5C;** requires miniature 7-contact socket.

Heater Voltage (ac/dc)	6.3	volts
Heater Current	0.15	ampere
Heater-Cathode Voltage	100 max	volts
Direct Interelectrode Capacitances (Approx.):		
Grid to Plate	0.12	pF
Input	3.6	pF
Output	4.2	pF

A-F Power Amplifier

MAXIMUM RATINGS (Design-Center Values)

Plate Voltage	300	volts
Screen Voltage (Grid No. 2)	250	volts
Plate Dissipation	2.75	watts
Screen Dissipation	0.75	watt

CHARACTERISTICS AND TYPICAL OPERATION

Plate Voltage	180	volts
Suppressor (Grid No. 3)	Connected to cathode at socket	
Screen Voltage	180	volts
Grid Voltage (Grid No. 1)	—9	volts
Peak A-F Grid Voltage	9	volts
Zero-Signal Plate Current	15	mA
Zero-Signal Screen Current	2.5	mA
Plate Resistance	0.2	megohm
Transconductance	2300	μmhos
Load Resistance	10000	ohms
Total Harmonic Distortion	10	%
Max.-Sig. Power Output	1.1	watts

MAXIMUM CIRCUIT VALUES

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

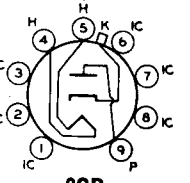
6AK8/EABC80 Refer to chart at end of section.

6AK10 Refer to chart at end of section.

6AL3 Refer to chart at end of section.

6AL3/EY88

HALF-WAVE VACUUM RECTIFIER



9CB

Miniature type used as damper tube in horizontal-deflection circuits of black-and-white television receivers. **Outlines section,** 7D; requires miniature 9-contact socket. Socket terminals 1, 2, 3, 6, 7, and 8 should not be used as tie points. It is especially important that this tube, like other power-handling tubes, be adequately ventilated. **Heater:** volts (ac/dc), 6.3; amperes, 1.55.

Damper Service

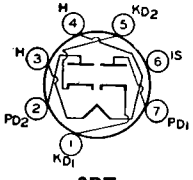
For operation in a 525-line, 30-frame system

MAXIMUM RATINGS (Design-Center Values)

Peak Inverse Plate Voltage# (Absolute maximum)	7500°	volts
Peak Plate Current	550	mA
Average Plate Current	220	mA
Plate Dissipation	5	watts
Peak Heater-Cathode Voltage	6600	volts

° Under no circumstances should this absolute value be exceeded.

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



6BT

6AL5

TWIN DIODE

3AL5, 12AL5

Miniature, high-perveance type used as detector in FM and television circuits, especially as a ratio detector in ac-operated FM receivers. Each diode section can be used independently of the other, or the two sections can be combined in parallel or full-wave arrangement. Resonant frequency of each unit is approximately 700 MHz. Outlines section, 5B; requires miniature 7-contact socket. Types 3AL5 and 12AL5 are identical with type 6AL5 except for heater ratings.

	3AL5	6AL5	12AL5	
Heater Voltage (ac/dc)	3.15	6.3	12.6	volts
Heater Current	0.6	0.3	0.15	ampere
Heater Warm-up Time (Average)	11	—	—	seconds
Peak Heater-Cathode Voltage	±330 max	±330 max	±330 max	volts
Direct Interelectrode Capacitances:				
Plate No.1 to Cathode No.1, Heater, and Internal Shield			2.5	pF
Plate No.2 to Cathode No.2, Heater, and Internal Shield			2.5	pF
Cathode No.1 to Plate No.1, Heater, and Internal Shield			3.4	pF
Cathode No.2 to Plate No.2, Heater, and Internal Shield			3.4	pF
Plate No.1 to Plate No.2			0.068 max	pF

Half-Wave Rectifier

MAXIMUM RATINGS (Design-Center Values)

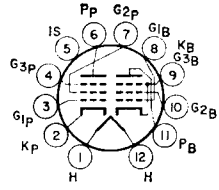
Peak Inverse Plate Voltage	330	volts
Peak Plate Current (Per Plate)	54	mA
Average Output Current (Per Plate)	9	mA

TYPICAL OPERATION

AC Plate Voltage per Plate (rms)	117	volts
Min. Total Effective Plate-Supply Impedance per Plate	300	ohms
Average Output Current per Plate	9	mA

Refer to chart at end of section.

6AL7GT



12BU

6AL11

BEAM POWER TUBE—SHARP-CUTOFF PENTODE

10AL11, 12AL11

Duodecar type used as FM detector and audio-frequency output amplifier in television receivers. Outlines section, 8C; requires duodecar 12-contact socket. Types 10AL11 and 12AL11 are identical with type 6AL11 except for heater ratings.

	6AL11	10AL11	12AL11	
Heater Voltage (ac/dc)	6.3	9.8	12.6	volts
Heater Current	0.9	0.6	0.45	ampere
Heater Warm-up Time (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 Capacitance:		
Beam Power Unit:		
Grid No.1 to Plate	0.26	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	11	pF
Plate to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	12	pF
Pentode Unit:		
Grid No.1 to Plate	0.034	pF
Grid No.3 to Plate	3.2	pF
Grid No.1 to Cathode, Heater, Grid No.2, Grid No.3, and Internal Shield	6.5	pF
Grid No.3 to Cathode, Heater, Grid No.1, Grid No.2, Plate, and Internal Shield	7.5	pF
Grid No.1 to Grid No.3	0.24	pF
Pentode Plate to Beam Power Plate	0.12	pF

Beam Power Unit as Class A_1 Amplifier

MAXIMUM RATINGS (Design-Maximum Values)

Plate Voltage	275	volts
Grid-No.2 (Screen-Grid) Voltage	275	volts
Plate Dissipation	10	watts
Grid-No.2 Input	2	watts

TYPICAL OPERATION

Plate Voltage	250	volts
Grid-No.2 Voltage	250	volts
Grid-No.1 (Control-Grid) Voltage	—8	volts
Peak AF Grid-No.1 Voltage	8	volts
Zero-Signal Plate Current	35	mA
Maximum-Signal Plate Current	39	mA
Zero-Signal Grid-No.2 Current	2.5	mA
Maximum-Signal Grid-No.2 Current	7	mA
Plate Resistance (Approx.)	0.1	megohm
Transconductance	6500	μmhos
Load Resistance	5000	ohms
Total Harmonic Distortion	10	per cent
Maximum-Signal Power Output	4.2	watts

MAXIMUM CIRCUIT VALUE

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

Pentode Unit as Class A_1 Amplifier

CHARACTERISTICS

Plate Supply Voltage	150	volts
Grid-No.3 (Suppressor-Grid) Voltage	0	volts
Grid-No.2 (Screen-Grid) Supply Voltage	100	volts
Cathode-Bias Resistor	560	ohms
Plate Resistance (Approx.)	0.15	megohm
Transconductance, Grid No.1 to Plate	1000	μmhos
Transconductance Grid No.3 to Plate	400	μmhos
Plate Current	1.3	mA
Grid-No.2 Current	2.1	mA
Grid-No.1 Voltage (Approx.) for plate current of 30 μA	—4.5	volts
Grid-No.3 Voltage (Approx.) for plate current of 50 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 (Control-Grid) Voltage, Positive-bias value	0	volts
Plate Dissipation	1.7	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	

6AM4 Refer to chart at end of section.

6AM6/EF91 Refer to chart at end of section.