Medium-Mu Triode

GLASS-METAL PENCIL TYPE

FAST WARM-UP TIME — STURDY COAXIAL-ELECTRODE STRUCTURE

For Use in Cathode-Drive Service at Frequencies up to 4000 Mc

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC):		
Under transmitting conditions	6.0 +5% −10%	volts
Under standby conditions	6.3 max.	volts
Current at 6.0 volts	0.280	amp
Amplification Factor	27	
Transconductance, for dc plate ma. = 25, dc plate volts = 200	6000	μmhos
Direct Interelectrode Capacitances:[a]		
Grid to plate	1.7	μμf
Grid to cathode	2.4	μμf
Plate to cathode	0.07 max.	μμf

Mechanical:

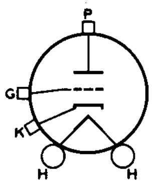
Operating Position . . . . Any

Dimensions and Terminal Connections . . . . See *Dimensional Outline*

Socket for Heater Pins . . Grayhill No.22-3[b], Cinch 54A16325[c], or equivalent

Terminal Connections (See *Dimensional Outline*):

H - Heater
K - Cathode



G - Grid
P - Plate

Thermal:

Plate-Seal Temperature (Measured on plate seal)	175 max.	°C

RF AMPLIFIER — Class A_1

Maximum CCS[d] Ratings, *Absolute-Maximum Values:*

For altitudes up to 100,000 feet and frequencies up to 2000 Mc

DC PLATE VOLTAGE	330 max.	volts
DC GRID VOLTAGE	−100 max.	volts

← Indicates a change.

DC PLATE CURRENT	35 max.	ma
PLATE DISSIPATION[e]	7 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	90 max.	volts
Heater positive with respect to cathode	90 max.	volts

Maximum Circuit Values:

Grid-Circuit Resistance	0.5 max.	megohm

PLATE-PULSED OSCILLATOR[f] — Class C

Maximum CCS[d] Ratings, *Absolute-Maximum Values:*

For altitudes up to 100,000 feet, frequencies up to 4000 Mc, and for a maximum "ON" time[g] of 5 microseconds in any 5000-microsecond interval

PEAK POSITIVE-PULSE PLATE-SUPPLY VOLTAGE[h]	1750 max.	volts
PEAK NEGATIVE-PULSE GRID-BIAS VOLTAGE	150 max.	volts
PEAK PLATE CURRENT FROM PULSE SUPPLY	3 max.	amp
PEAK RECTIFIED GRID CURRENT	1.3 max.	amp
DC PLATE CURRENT	0.003 max.	amp
DC GRID CURRENT	0.0013 max.	amp
PLATE DISSIPATION[e]	6 max.	watts
PULSE DURATION	1.5 max.	μsec

Typical Operation:

In cathode-drive circuit with rectangular wave shape at 3300 Mc, with duty factor[j] of 0.001, and pulse duration of 1 microsecond

Peak Positive-Pulse Plate-Supply Voltage[h]	1750	volts
Peak Negative-Pulse Grid-Bias Voltage	110	volts
From grid resistor of	100	ohms
Peak Plate Current from Pulse Supply	3	amp
Peak Rectified Grid Current	1.1	amp
DC Plate Current	0.003	amp
DC Grid Current	0.0011	amp
Useful Power Output at Peak of Pulse[k] (Approx.)	1200	watts

RF POWER AMPLIFIER AND OSCILLATOR — Class C Telegraphy

Key down conditions per tube without amplitude modulation[m]

Maximum Ratings, *Absolute-Maximum Values:*

For altitudes up to 100,000 feet and frequencies up to 2000 Mc

	CCS[d]	*ICAS*[n]	
DC PLATE VOLTAGE	320 max.	400 max.	volts
DC GRID VOLTAGE	−100 max.	−100 max.	volts

DC PLATE CURRENT	35 max.	40 max.	ma
DC GRID CURRENT	15 max.	15 max.	ma
PLATE INPUT	11 max.	16 max.	watts
PLATE DISSIPATION[e]	7 max.	8 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	90 max.	90 max.	volts
Heater positive with respect to cathode	90 max.	90 max.	volts

Typical Operation: ←

As rf power amplifier in cathode-drive circuit

	At 500 Mc		*At 1000 Mc*		
DC Plate-to-Grid Voltage	347	401	330	383	volts
DC Cathode-to-Grid Voltage[p]	47	51	30	33	volts
DC Plate Current	33	35	33	35	ma
DC Grid Current (Approx.)	13	13	12	13	ma
Driver Power Output (Approx.)	2	2.5	1.9	2.4	watts
Useful Power Output (Approx.)	7.5	8.5	5.5	6.5	watts

As oscillator in cathode-drive circuit ←

	At 500 Mc		
DC Plate-to-Grid Voltage	347	401	volts
DC Cathode-to-Grid Voltage[p]	47	51	volts
DC Plate Current	33	35	ma
DC Grid Current (Approx.)	13	13	ma
Useful Power Output (Approx.)	5	6	watts

Maximum Circuit Values:

Grid-Circuit Resistance	0.1 max.	0.1 max.	megohm

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1

Maximum Ratings, *Absolute-Maximum Values:*

For altitudes up to 100,000 feet and frequencies up to 2000 Mc

	CCS[d]	*ICAS*[n]	
DC PLATE VOLTAGE	260 max.	320 max.	volts
DC GRID VOLTAGE	-100 max.	-100 max.	volts
DC PLATE CURRENT	33 max.	33 max.	ma
DC GRID CURRENT	15 max.	15 max.	ma
PLATE INPUT	8.5 max.	10.5 max.	watts
PLATE DISSIPATION[e]	5 max.	5.5 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	90 max.	90 max.	volts
Heater positive with respect to cathode	90 max.	90 max.	volts

← Indicates a change.

→ Typical Operation:

In cathode-drive circuit at 500 Mc

DC Plate-to-Grid Voltage	286	345	volts
DC Cathode-to-Grid Voltage[p]	36	45	volts
DC Plate Current	30	30	ma
DC Grid Current (Approx.)	11	12	ma
Driver Power Output (Approx.)	1.8	2	watts
Useful Power Output (Approx.)	5.5	6.5	watts

Maximum Circuit Values:

Grid-Circuit Resistance	0.1 max.	0.1 max.	megohm

FREQUENCY DOUBLER

Maximum Ratings, *Absolute-Maximum Values:*

For altitudes up to 100,000 feet and frequencies up to 2000 Mc

	CCS[d]	*ICAS*[n]	
DC PLATE VOLTAGE	260 max.	320 max.	volts
DC GRID VOLTAGE	-100 max.	-100 max.	volts
DC PLATE CURRENT	33 max.	33 max.	ma
DC GRID CURRENT	12 max.	12 max.	ma
PLATE INPUT	8.5 max.	10.5 max.	watts
PLATE DISSIPATION[e]	6 max.	7.5 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	90 max.	90 max.	volts
Heater positive with respect to cathode	90 max.	90 max.	volts

→ Typical Operation:

In cathode-drive circuit up to 1000 Mc

DC Plate-to-Grid Voltage	290	350	volts
DC Cathode-to-Grid Voltage[p]	40	50	volts
DC Plate Current	33	33	ma
DC Grid Current (Approx.)	7	8	ma
Driver Power Output (Approx.)	3.2	3.5	watts
Useful Power Output (Approx.)	2.75	3	watts

Maximum Circuit Values:

Grid-Circuit Resistance	0.1 max.	0.1 max.	megohm

[a] Without external shield.
[b] Grayhill, Inc., 561 Hillgrove Avenue, LaGrange, Illinois.
[c] Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago, Illinois.
[d] Continuous Commercial Service.
[e] In applications where the plate dissipation exceeds 2.5 watts, it is important that a large area of contact be provided between the plate cylinder and the connector in order to provide adequate heat conduction.
[f] In this class of service, the heater should be allowed to warm up for a minimum of 60 seconds before plate voltage s applied.

→ Indicates a change.

g *"ON"* time is defined as the sum of the duration of all individual pulses which occur during the indicated interval. *Pulse duration* is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak power value. The *peak value* is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

h The magnitude of any spike on the plate voltage pulse should not exceed a value of 2000 volts with respect to cathode and its duration should not exceed 0.01 microsecond measured at the peak-pulse-value level.

j Duty factor is the product of pulse duration and repetition rate. For variable pulse durations and pulse repetition rates, the duty factor is defined as the ratio of time "ON" to total elapsed time in any 5000-microsecond interval.

k The power output at peak of pulse is obtained from the average power output using the duty factor of the peak pulse. This procedure is necessary since the power output pulse duty factor may be less than the applied voltage pulse duty factor because of a delay in the start of rf power output.

m Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

n Intermittent Commercial and Amateur Service. No operating or "ON" period exceeds 5 minutes and every "ON" period is followed by an "OFF" or stand by period of at least the same or greater duration.

p Obtained from grid resistor.

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN ←

	Note	*Min.*	*Max.*	
Heater Current	1	0.260	0.300	amp
Direct Interelectrode Capacitances:				
Grid to plate	–	1.30	1.80	μμf
Grid to cathode	–	2.05	2.95	μμf
Plate to cathode	–	–	0.07	μμf
Heater-Cathode Leakage Current:				
Heater negative with respect to cathode	1,2	–	200	μa
Heater positive with respect to cathode	1,2	–	500	μa
Leakage Resistance:				
From grid to plate and cathode tied together	1,3	25	–	megohms
From plate to grid and cathode tied together	1,4	25	–	megohms
Reverse Grid Current	1,5	–	1	μa
Emission Voltage	6	–	14	volts
Peak Emission Current	1,7	2.75	–	amp
Amplification Factor	1,8	18	36	
Transconductance	1,8	4800	7200	μmhos
Plate Current (1)	1,8	16	34	ma
Plate Current (2)	1,9	–	55	μa
Power Output	1,10	4.5	–	watts
Power Output at Peak of Pulse	1,11	750	–	watts
Change in Output Frequency	12	–	3	Mc

Note 1: With 6.0 volts ac or dc on heater.

Note 2: With 100 volts dc between heater and cathode.

Note 3: With grid 100 volts negative with respect to plate and cathode which are tied together.

Note 4: With plate 300 volts negative with respect to grid and cathode which are tied together.

← Indicates a change.

Note 5: With dc plate voltage of 200 volts, dc grid voltage of −2.5 volts, grid resistor of 0.1 megohm.

Note 6: With dc voltage on grid and plate which are tied together adjusted to produce a cathode current of 30 ma, and with 5.4 volts on heater.

Note 7: With 150 volts on grid and plate which are connected together, duty factor of 0.001, and pulse duration of 1 microsecond.

Note 8: With dc plate voltage of 200 volts, cathode resistor of 100 ± 10% ohms, and cathode bypass capacitor of 1000 μf.

Note 9: With dc plate voltage of 200 volts, dc grid voltage of −20 volts.

Note 10: With dc plate voltage of 350 volts, cathode resistor adjusted to give a dc plate current of 33 milliamperes in a cavity-type oscillator operating at 500 ± 15 Mc.

Note 11: With peak positive-pulse plate supply voltage of 1750 volts, grid resistor varied to give dc plate current of 3 ma, dc grid current of approximately 1.3 ma, duty factor of 0.001, pulse duration of 1 microsecond, and frequency of 3300 ± 100 Mc.

Note 12: At end of Peak Power Output test, reduce heater voltage to 5.4 volts and note change in output frequency, then increase heater voltage to 6.3 volts and note change in output frequency.

SPECIAL TESTS & PERFORMANCE DATA

Low-Pressure Voltage Breakdown Test:

This test (similar to MIL-E-1D, paragraph 4.9.12.1) is performed on a sample lot of tubes from each production run. Tubes are tested in a chamber at an air pressure equivalent to an altitude of 100,000 feet. Breakdown will not occur when a 60-cycle rms voltage of 400 volts is applied between the plate cylinder and grid flange.

Low-Frequency Vibration Performance:

This test (similar to MIL-E-1D, paragraph 4.9.19.1) is performed on a sample lot of tubes from each production run under the following conditions:

Heater voltage of 6.0 volts, dc plate supply voltage of 200 volts, grid voltage of −2.5 volts, and plate load resistor of 10,000 ohms. The tubes are vibrated in a plane perpendicular to the tube axis at 25 cycles per second at an acceleration of 2.5 g. The rms output voltage across the plate load resistor as a result of vibration of the tube will not exceed 100 millivolts.

High-Frequency Vibration Performance:

This test (similar to MIL-E-1D, paragraph 4.9.19.2) is performed on a sample lot of tubes from each production run. The tube is vibrated perpendicular to its axis, with no voltages applied to the tube. Vibration frequency is 40 to 60 cps and acceleration is 10 g. At the end of this test, tubes will not show permanent shorts or open circuits.

Shorts and Continuity Test:

This test (similar to MIL-E-1D, paragraph 4.7.3) is performed on all tubes from each production run. In this test, a tube is considered inoperative if it shows a permanent or temporary short or open circuit, an air leak, or reverse grid current in excess of 1 microampere for the conditions shown under *Characteristics Range Values, Notes 1,5.*

Glass Seal Fracture Tests:

Fracture tests are performed on sample lots of tubes from each production run.

1. Tubes are placed on supports spaced 15/16" ± 1/64" apart with the grid flange centered between these supports. Tubes will withstand gradual application, perpendicular to the tube axis, of a force of 50 pounds upon the grid flange without causing fracture of the glass insulation.

2. Tubes are held by clamping to the cathode terminal. Tubes will withstand gradual application of a torque of 15 inch-pounds upon the plate terminal without causing fracture of the glass insulation.

100-Hour Dynamic Life Performance:

This test (similar to MIL-E-1D, paragraph 4.11.3.2) is performed on a sample lot of tubes from each production run to insure high quality of rf performance. Each tube is life-tested in a cavity-type oscillator at 3300 ± 100 Mc under the following conditions.

> Heater voltage of 6.0 volts, peak positive-pulse plate supply voltage of 1750 volts, grid resistor is adjusted to give a dc plate current of 3 ma., dc grid current of approximately 1.3 ma., duty factor of 0.001, and pulse duration of 1 microsecond.

At the end of 100 hours, the tubes will have a minimum peak pulse power output of 600 watts.

500-Hour Dynamic Life Performance:

This test (similar to MIL-E-1D, paragraph 4.11.3.2) is performed on a sample lot of tubes from each production run to insure high quality of rf performance. Each tube is life-tested in a cavity-type oscillator at 500 ± 15 Mc under the following conditions:

> Heater voltage of 6.0 volts, plate supply voltage of 350 volts, cathode resistor is adjusted to give a dc plate current of 33 ma.

At the end of 500 hours, the tubes will have a minimum power output of 3.5 watts.

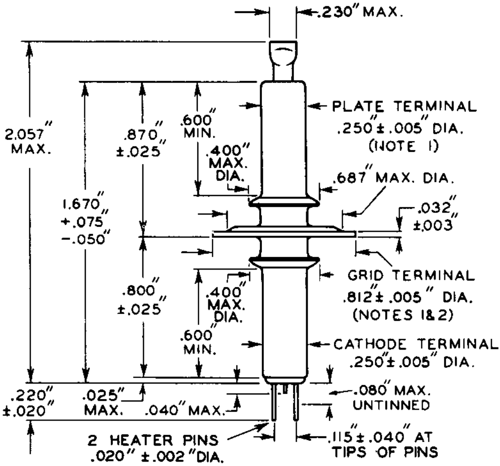
OPERATING CONSIDERATIONS

The *mounting* for this type in coaxial-line, parallel-line, or lumped circuits may support the tube securely by any one of the three terminals. Connections to the other two terminals must be made by contacts with flexible leads.

The *mounting* for this type in cavity-type circuits should preferably support the tube by the grid flange which should make firm contact to the cavity surface.

The *heater pins* of this type should not be soldered to circuit elements. The heat of the soldering operation may crack the glass seals of the heater pins and damage the tube.

The *cathode* should preferably be connected to one side of the heater. When, in some circuit designs, the heater is not connected directly to the cathode, precautions must be taken to hold the peak heater-cathode voltage to the maximum values shown in the tabulated data.



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NOTE 1: MAXIMUM ECCENTRICITY OF CENTER LINE (AXIS) OF PLATE TERMINAL OR GRID-TERMINAL FLANGE WITH RESPECT TO THE CENTER LINE (AXIS) OF THE CATHODE TERMINAL IS 0.010".

NOTE 2: TILT OF GRID-TERMINAL FLANGE WITH RESPECT TO ROTATIONAL AXIS OF CATHODE TERMINAL IS DETERMINED BY CHUCKING THE CATHODE TERMINAL, ROTATING THE TUBE, AND GAUGING THE TOTAL TRAVEL DISTANCE OF THE GRID-TERMINAL FLANGE PARALLEL TO THE AXIS AT A POINT APPROXIMATELY 0.020" INWARD FROM ITS EDGE FOR ONE COMPLETE ROTATION. THE TOTAL TRAVEL DISTANCE WILL NOT EXCEED 0.020".

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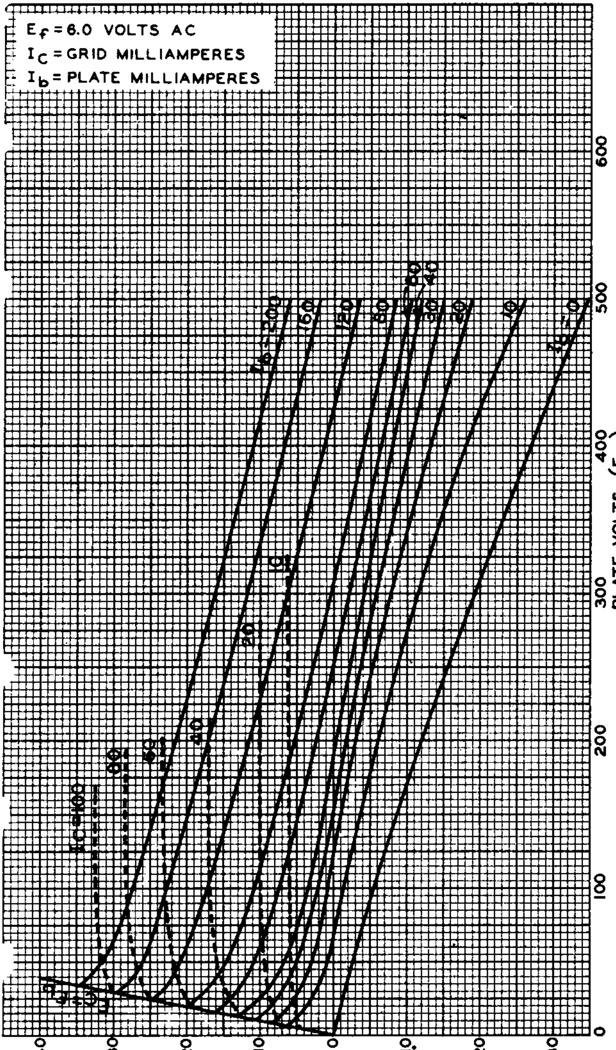
'ERAGE CONSTANT-CURRENT CHARACTERISTICS



JAN. 23, 1952

TUBE DEPARTMENT

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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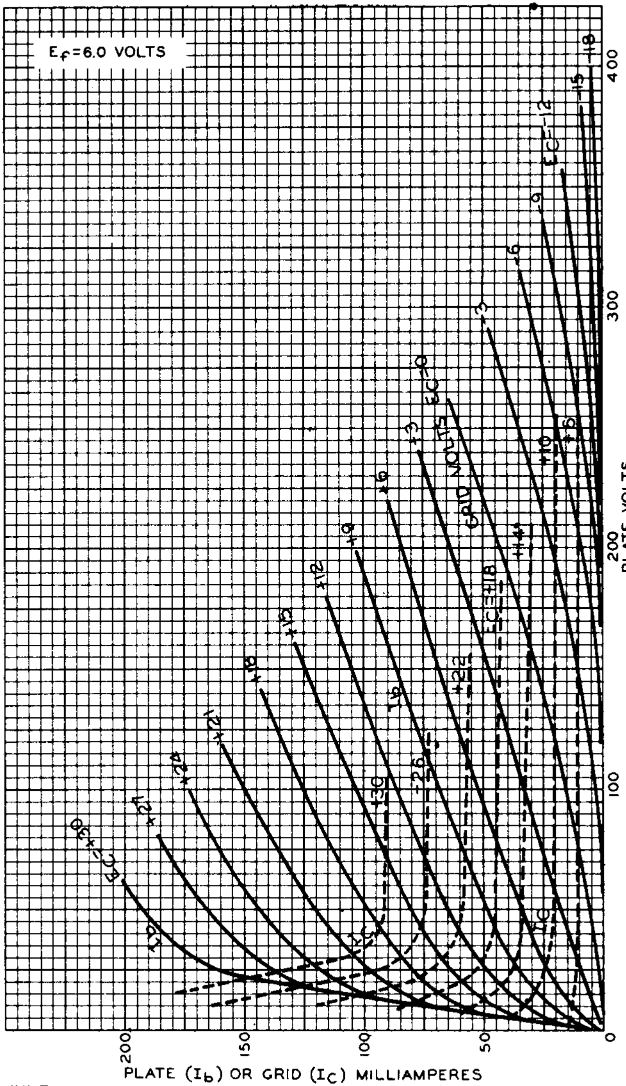
AVERAGE PLATE CHARACTERISTICS



JUNE 13, 1951

TUBE DEPARTMENT

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