Pencil Tube

Fast Warmup Time **Pre-Tinned Heater Pins**

Ceramic Metal, High-Mu Triode

Sturdy Coaxial-Electrode Structure

GENERAL

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	V
Current at 6.3 volts	0.225	A
Cathode Warmup Time (Average) to reach 80% of operating power output as RF oscillator or amplifier	5	s
Amplification Factor	70	
Transconductance, for dc plate current of 14 milliamperes, dc plate voltage of 125 volts, and cathode resistor of 50 ohms	16,000	μS
Direct Interelectrode Capacitances:		
Grid to plate	2.1	pF
Grid to cathode and heater	4.4	pF
Plate to cathode and heater	0.04 max.	pF
Operating Position		Any
Dimensions and Terminal Connections	See *Dimensional Outline*	
Weight (Approx.)	0.3	oz

Sockets:

Heater-Terminals Connector	Grayhill[a] No.22-5, or equivalent
Socket for operation up to about 550 MHz (Including heater-terminals connector)	Jettron[b] No.CD7010, or equivalent
Cavities (Including heater-terminals connector)	J-V-M[c] No.D-7980 Series, Resdel[d] No.10 Series, AML, Inc,[e] MCL, Inc,[f] or equivalent

RF POWER AMPLIFIER & OSC. – Class C Telegraphy[g] and RF POWER AMPLIFIER – Class C FM Telephony

Maximum CCS[h] Ratings, *Absolute-Maximum Values up to 5 GHz:*

For Altitudes up to 100,000 feet

DC Plate Voltage	250 max.	V
DC Grid Voltage	-50 max.	V
DC Cathode Current	25 max.	mA
DC Grid Current	6 max.	mA
Grid Resistor	0.25 max.	MΩ

Plate Dissipation	2.5 max.	W
Plate-Seal Temperature	225 max.	°C
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode	50 max.	V
Heater positive with respect to cathode	50 max.	V

Typical CCS Operation as Oscillator in Cathode-Drive Service:

	At 500 MHz	*At 1,000 MHz*	*At 2,000 MHz*	*At 3,000 MHz*	*At 4,150 MHz*	*At 5,000 MHz*	
DC Plate-to-Grid Voltage	205	203	151	125	200	200	V
DC Cathode-to-Grid Voltage	5	3	1	0.1	0.26	–	V
From a grid resistor of	1,000	600	250	500	130	100	Ω
DC Cathode Current	21	24	24	20	23	25	mA
DC Grid Current	5	5	4	0.2	2	–	mA
Useful Power Output (Approx.)	1.6	1.3	0.5	0.15	0.1	0.03	W

Typical CCS Operation as Amplifier in Cathode-Drive Service:

	At 500 MHz	*At 1,000 MHz*	
DC Plate-to-Grid Voltage	204	185	V
DC Cathode-to-Grid Voltage	4	10	V
From a grid resistor of	800	2,000	Ω
DC Cathode Current	21	24	mA
DC Grid Current	5	5	mA
Drive Power Input (Approx.)	0.2	0.2	W
Useful Power Output (Approx.)	2.2	1.4	W

FREQUENCY DOUBLER – Class C

Maximum CCS[h] Ratings, *Absolute-Maximum Values up to 2 GHz· For Altitudes up to 100,000 feet*

DC Plate Voltage	250 max.	V
DC Grid Voltage	-50 max.	V
DC Cathode Current	22 max.	mA
DC Grid Current	6 max.	mA
Grid Resistor	0.25 max.	MΩ

Plate Dissipation			2.5 max.		W
Plate-Seal Temperature			225 max.		°C
Peak Heater-Cathode Voltage:					
Heater negative with respect to cathode			50 max.		V
Heater positive with respect to cathode			50 max.		V

Typical CCS Operation as Doubler in Cathode-Drive Service:

	At 550 MHz		*At 1,000 MHz*		
DC Plate-to-Grid Voltage	193	207	218	181	V
DC Cathode-to-Grid Voltage	18	7	18	6	V
From a grid resistor of	3,600	2,300	3,600	2,000	Ω
DC Cathode Current	20	18	21	19	mA
DC Grid Current	5	3	5	3	mA
Drive Power Input (Approx.)	0.8	0.2	0.8	0.2	W
Drive Power Output (Approx.)	1.3	0.75	0.9	0.4	W

FREQUENCY TRIPLER – Class C

Maximum CCS[h] Ratings, *Absolute-Maximum Values*[i] *up to 2 GHz:*
For Altitudes up to 100,000 feet

DC Plate Voltage	250 max.	V
DC Grid Voltage	-50 max.	V
DC Cathode Current	20 max.	mA
DC Grid Current	6 max.	mA
Grid Resistor	0.25 max.	MΩ
Plate Dissipation	2.5 max.	W
Plate-Seal Temperature	225 max.	°C
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode	50 max.	V
Heater positive with respect to cathode	50 max.	V

Typical CCS Operation as Tripler in Cathode-Drive Service:

	At 645 MHz		*At 1,000 MHz*		
DC Plate-to-Grid Voltage	202	240	205	185	V
DC Cathode-to-Grid Voltage	27	15	30	10	V
From a Grid Resistor of	9,000	25,000	10,000	14,000	Ω
DC Cathode Current	19	13	19	12	mA
DC Grid Current	3	0.6	3	0.7	mA
Drive Power Input (Approx.)	0.6	0.2	0.6	0.2	W
Useful Power Output (Approx.)	0.7	0.4	0.4	0.15	W

CHARACTERISTICS RANGE VALUES

	Note	Min.	Max.	
Heater Current	1	0.205	0.245	A
Direct Interelectrode Capacitances:				
Grid to plate	–	1.5	2.7	pF
Grid to cathode	–	3.6	5.0	pF
Plate to cathode	–	–	0.04	pF
Heater-Cathode Leakage Current:				
Heater negative with respect to cathode	1,2	–	30	μA
Heater positive with respect to cathode.	1,3	–	30	μA
Leakage Resistance:				
From grid to plate and cathode connected together	1,4	100	–	MΩ
From plate to grid and cathode connected together	1,5	100	–	MΩ
Reverse Grid Current	1,6	–	0.3	μA
Emission Voltage	7	–	4	V
Amplification Factor	1,8	55	85	
Transconductance	1,8	12,500	19,500	μS
Plate Current (1)	1,8	9	19	mA
Plate Current (2)	1,9	–	50	μA
Power Output	1,10	1.7	–	W
Change in Power Output	1,10,11	–	0.2	W

Note 1: With 6.3 volts ac or dc on heater.

Note 2: With 60 volts dc between heater and cathode, heater negative with respect to cathode.

Note 3: With 60 volts dc between heater and cathode, heater positive with respect to cathode.

Note 4: With grid 100 volts negative with respect to plate and cathode which are connected together.

Note 5: With plate 300 volts negative with respect to grid and cathode which are connected together.

Note 6: With dc plate voltage of 200 volts, dc grid voltage of −2 volts, grid resistor of 0.5 megohm.

Note 7: With dc voltage on grid and plate which are connected together and adjusted to produce a cathode current of 30 milliamperes, and with 5.5 volts on heater.

Note 8: With dc plate-supply voltage of 125 volts, cathode resistor of 50 ohms, and cathode bypass capacitor of 1,000 microfarads.

Note 9: With dc plate voltage of 125 volts and dc grid voltage of −5 volts.

Note 10: In a single-tube, cathode-drive amplifier circuit operating at a frequency of approximately 550 ± 10 MHz, and with dc plate-to-cathode voltage of 250 volts, input-signal power of 0.2 watt, and dc grid voltage adjusted to produce a dc plate current of 20 milliamperes.

Note 11: Reduce heater voltage to 5.7 volts. Change in Power Output value from that obtained with 6.3 volts on heater will not exceed indicated value.

[a] Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.

[b] Jettron Products, Inc., 56 Route 10, Hanover, N.J.

[c] Fidelitone Microwave, Inc., JVM Division, 6415 N. Ravenswood Ave., Chicago, Ill. Indicated number applies to a series of cavities covering the range from 220 to 3500 MHz.

[d] Resdel Engineering Corp., 990 South Fair Oaks Ave., Pasadena, Calif. This series of cavities covers the range from 215 to 2325 MHz.

[e] Applied Microwave Laboratory, Inc., 106 Albion St., Wakefield, Mass.

[f] Microwave Cavity Laboratory, Inc., 10 Beach Ave., LaGrange, Ill.

[g] Key-down conditions per tube without amplitude modulation. 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.

[h] Continuous Commercial Service.

SPECIAL TESTS AND PERFORMANCE DATA

Low-Pressure Voltage Breakdown Test

This test (similar to MIL-E-1) is performed on a sample lot of tubes every 90 days. 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-Hz rms voltage of 300 volts is applied between the plate cylinder and grid flange.

Low-Frequency Vibration Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run under the

following conditions: Heater voltage of 6.3 volts, dc plate-supply voltage of 125 volts, cathode resistor of 50 ohms, and plate load resistor of 10,000 ohms. The tubes are vibrated in a plane perpendicular to the tube axis at 40 Hz at an acceleration of 10 g. The rms output voltage across the plate load resistor as a result of vibration of the tube will not exceed 100 millivolts.

At the end of this test the tubes will not show permanent shorts or open circuits and will meet the following test limit:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1*.

Variable-Frequency Vibration Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run. Tube operating conditions are the same as for *Low-Frequency Vibration*. The tubes are vibrated perpendicular to the major axis through a frequency range from 5 to 500 Hz and back. From 5 to 50 Hz, the tubes are vibrated at a constant displacement of 0.0400 ± 0.0025 inch. From 50 to 500 Hz, the tubes are vibrated at a constant acceleration of 10 ± 2 g. Total time to complete a sweep cycle is 10 ± 5 minutes. During the test, the tubes will not show an rms output voltage across the plate load resistor in excess of 150 millivolts.

Each tube is vibrated for 60 seconds at the frequency which gives maximum vibrational noise output. If, at the end of 60 seconds, the vibrational noise output is still increasing, the test is continued until there is no further increase.

The rms output voltage across the plate load resistor as a result of the vibration of the tube will not exceed the specified limit at any time during the test.

At the end of the test the tubes will not show permanent shorts or open circuits and will meet the following test limit:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Shock Test

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run. Tubes are held rigid and are subjected in three different positions to an impact acceleration of 500 g, 5 blows in each position.

At the end of this test, tubes will not show permanent shorts or open circuits and will meet the following limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Heater-Cathode Leakage Current . . . . . 60 max. μA

For conditions shown under *Characteristics Range Values, Notes 1, 3.*

Low-Frequency Vibration Output . . . . . 200 max. mV

For conditions shown above under *Low-Frequency Vibration Performance.*

Change in transconductance . . . . . -20 max. %

From initial value for conditions shown under *Characteristics Range Values, Notes 1, 8.*

Fatigue Vibration Test

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run. Tubes are rigidly mounted and subjected to 2.5 g vibrational acceleration in two positions (X1, Y1) for 32 hours each. At the end of this test, tubes are required to meet the limits specified for the *Shock Test.*

Shorts and Continuity Test

This test (similar to MIL-E-1) is performed on all tubes from each production run. Voltage applied between adjacent elements of the tube under test will be between 20 and 70 volts dc or peak ac. Plate and cathode terminals are tied together and connected to the grid terminal through the shorts test equipment. Tubes are tapped with a rubber tapper three times in each of three mutually perpendicular directions. If a short indication is obtained, the tapping cycle is repeated two times for verification. Acceptance criteria is based on the "Resistance vs. Time Duration" curve shown in MIL-E-1.

At the end of this test, the tubes will not show permanent shorts or open circuits and will meet the following limit:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Ceramic Seal Fracture Test

This test is performed on a sample lot of tubes every 90 days. With cathode- and plate-cylinder-supports spaced 15/16 ± 1/64 inch (23.812 ± 3.96 mm), and with the grid flange centered between these supports, the tubes will withstand the gradual application of a force of 30 pounds (13.6 kilograms), perpendicular to the axis of the tubes, upon the grid flange, without causing fracture of the ceramic insulation.

Seal Strain Test

This test (similar to MIL-E-1) is performed on a sample lot of tubes every 90 days. Tubes are tested by first immersing in water having a temperature of at least 97° C for at least 15 seconds and then immersing immediately in water at not more than 5° C for 5 seconds.

After drying for 48 hours at room temperature, the tubes will meet the following test limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Heater-Cycling Life Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run. With 6.3 volts on heater and no voltage on plate or grid, the heater is cycled three minutes on and three minutes off for at least 2,000 cycles.

At the end of this test, tubes will not show permanent shorts or open circuits, and are required to meet the following limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Heater-to-Cathode Leakage Current . . . . 30 max. μA

For conditions shown under *Characteristics Range Values, Notes 1, 3.*

Grid-to-Cathode Leakage Resistance . . . 50 min. MΩ

For conditions shown under *Characteristics Range Values, Notes 1, 4.*

1-Hour Stability Life Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run to insure that the tubes have been properly stabilized. Tubes are operated under the following conditions: Heater voltage of 6.3 volts, plate-supply voltage of 215 volts, and cathode resistor of 150 ohms.

At the end of 1 hour, the change in transconductance value for each tube, referred to its initial transconductance reading, will not exceed 15 percent of the initial value, for conditions shown under *Characteristics Range Values, Notes 1, 8.*

In addition the tubes will not show permanent shorts or open circuits and will meet the following limit:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

100-Hour Survival Life Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run to insure a low percentage of early inoperatives. Life-test conditions are the same as those specified for *1-Hour Stability Life Performance* except that all voltages are cycled at the rate of 110 minutes on and 10 minutes off.

At the end of 100 hours, the tubes will not show permanent shorts or open circuits and will meet the following limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Transconductance . . . . . 9,000 min. μS

For conditions shown under *Characteristics Range Values, Notes 1, 8.*

Plate Current (2) . . . . . 50 max. μA

For conditions shown under *Characteristics Range Values, Notes 1, 9.*

500- and 1000- Hour Dynamic Life Performance

This test (similar to MIL-E-1) is performed on a sample lot of tubes from each production run to insure high-quality rf performance. Each tube is life-tested as a Class C amplifier in special cavity at 550 ± 10 MHz under the following conditions: Heater voltage of 6.3 volts; plate-supply voltage of 250 volts; cathode resistor adjusted to give plate current of 25 milliamperes; and grid-circuit resistance adjusted to give grid current of 6 milliamperes, heater positive with respect to cathode by 67.5 volts, and plate-seal temperature of 225° C. Heater voltage is cycled at a rate of 110 minutes on and 10 minutes off.

At the end of 500 hours, the tubes will not show permanent shorts or open circuits, and will be criticized

for total number of tubes failing to pass the following limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Leakage Resistance:

From grid to plate and cathode connected together . . . . . 60 min. MΩ

From plate to grid and cathode connected together . . . . . 60 min. MΩ

For conditions shown under *Characteristics Range Values, Notes 1, 4, and 1, 5.*

Power Output . . . . . 1.5 min. W

For conditions shown under *Characteristics Range Values, Notes 1, 10.*

At the end of 1,000 hours, the tubes will not show permanent shorts or open circuits and will be criticized for total number of tubes failing to pass the following limits:

Negative Grid Current ($-I_C$) . . . . . 1 max. μA

For conditions shown under *Characteristics Range Values, Note 1.*

Power Output . . . . . 1.3 min. W

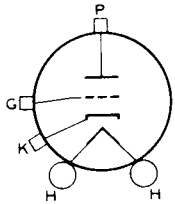
For conditions shown under *Characteristics Range Values, Notes 1, 10.*

OPERATING CONSIDERATIONS

Connections to the cathode cylinder, grid flange, and plate cylinder should be made by flexible spring contacts. The connectors should make firm large-surface contact, yet must be sufficiently flexible to insure that no part of the tube is subjected to excessive strain.

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

TERMINAL CONNECTIONS



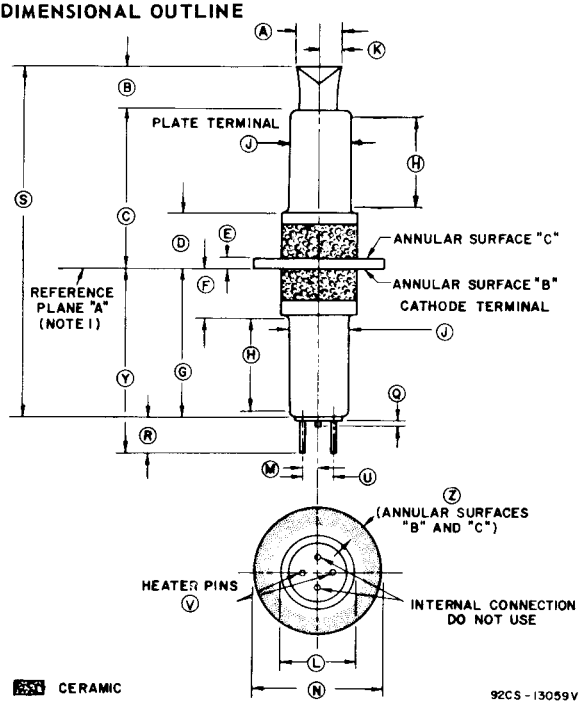
H: Heater Pin

K: Cathode Cylinder
(Adjacent to Heater Pins)

G: Grid Flange

P: Plate Cylinder
(Adjacent to pinch-off)

DIMENSIONAL OUTLINE



Reference plane "A" is defined as that plane against which annular surface "B" of the grid flange abuts.
Annular surface "B" is on the side of the grid flange toward the cathode cylinder.
Annular surface "C" is on the side of the grid flange toward the plate cylinder.

OUTLINE DIMENSIONS AND NOTES

Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	–	0.230	–	5.84	
B	–	0.180	–	4.57	
C	0.555	0.605	14.10	15.36	
D	0.165	0.205	4.19	5.20	
E	0.049	0.055	1.245	1.397	
F	0.120	0.150	3.05	3.81	
G	0.535	0.575	13.59	14.60	
H	0.320	–	8.13	–	4
J	0.245	0.252	6.223	6.401	1-4
K	–	0.115	–	2.92	
L	0.335	0.355	8.51	9.01	
M	0.048	0.068	1.22	1.72	
N	0.547	0.557	13.894	14.148	3,5
Q	–	0.010	–	0.254	
R	0.095	0.125	2.41	3.17	
S	–	1.360	–	34.54	
U	0.095	0.135	2.41	3.42	
V	0.020	0.030	0.508	0.762	
Y	0.650	0.700	16.51	17.78	
Z	0.060	–	1.52	–	

NOTE 1: With annular surface "B" resting on reference plane "A", the axis of the cathode cylinder will be within 2^{o} of a line perpendicular to reference plane "A".

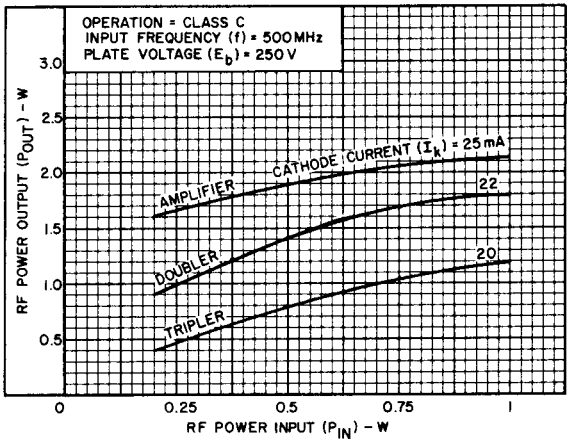
NOTE 2: The axes of the plate cylinder and cathode cylinder will coincide within 0.010".

NOTE 3: The axes of the cathode cylinder and grid flange will coincide within 0.005".

NOTE 4: The diameter along the 0.320" minimum length is measured with "go" and "no-go" ring gauges G1-1 and G1-2, respectively.

NOTE 5: This diameter is measured with "go" and "no-go" gauges G3-1 and G3-2, respectively.

TYPICAL POWER OUTPUT vs. POWER INPUT (500-MHz INPUT)



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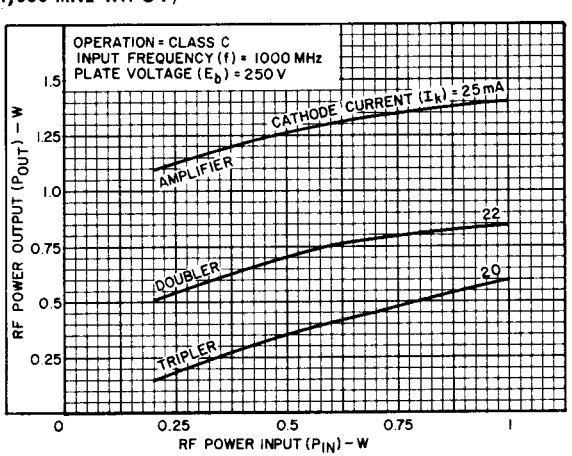
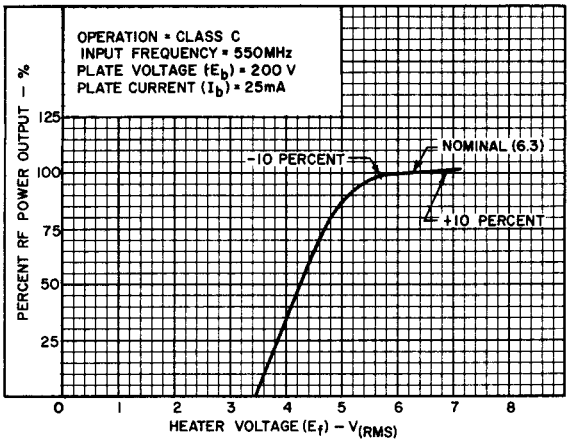
TYPICAL POWER OUTPUT vs. POWER INPUT (1,000-MHz INPUT)



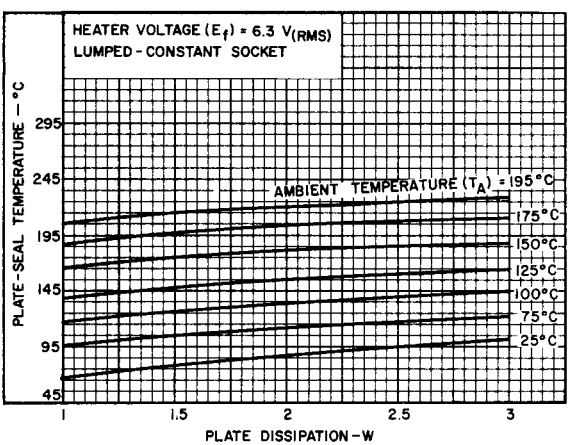
92CS-11626R2

TYPICAL POWER OUTPUT vs. HEATER VOLTAGE (550-MHz OPERATION)



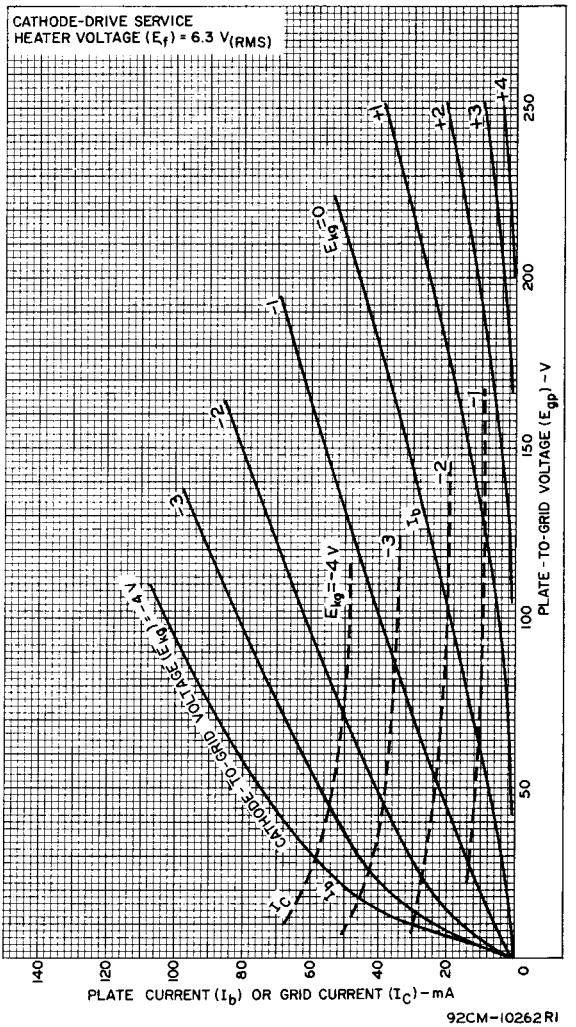
92CS-11624R2

TYPICAL PLATE-SEAL TEMPERATURE vs. PLATE DISSIPATION



92CS-11488RI

AVERAGE PLATE OR GRID CURRENT CHARACTERISTICS vs. PLATE-TO-GRID VOLTAGE FOR CATHODE DRIVE SERVICE



AVERAGE CONSTANT-CURRENT CHARACTERISTICS FOR CATHODE DRIVE SERVICE