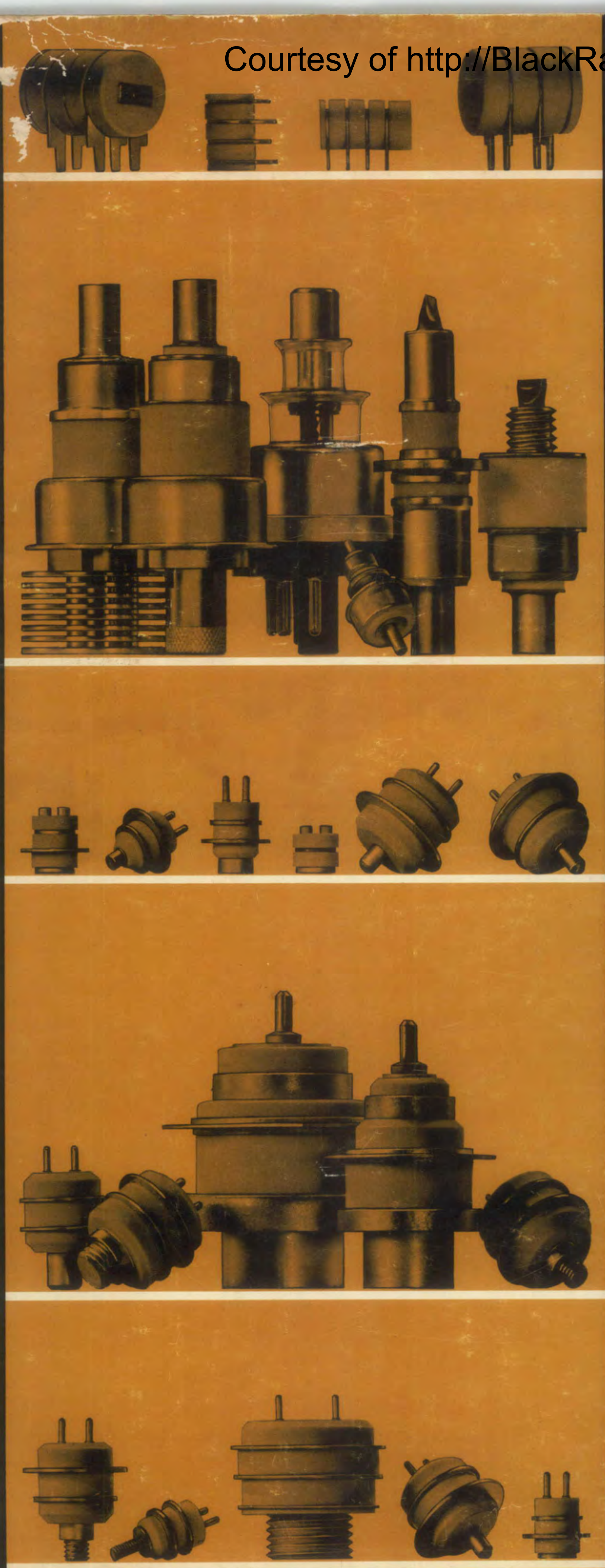
General Electric Ceramic Tubes



Reference Data

$5

Reference Data For General Electric Ceramic Tubes

TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

Published January, 1968

FOREWORD

This publication contains published data sheets and application notes on General Electric Ceramic tube types. Twenty-nine of these types are registered EIA types, and are available from stock. Forty are developmental types and are available from stock or with several weeks lead time.

This line of tubes represent the state of the art in many areas. Major advantages offered by various types are as follows:

Small Size
Low Noise
High Gain
Large Gain-Band Width Products
Operation to C and X Band
High Temperature Tolerance, 400-500° C
Tolerance to Shock and Vibration
Radiation Resistance
Long Pulse Ratings
High Pulsed Duty Factors

These devices compete favorably in many applications with low power klystrons, TWT's, parametric amplifiers, varactors, and transistors.

This publication is revised periodically, but supplements are not distributed between publications. For the latest information on new developments or applications of General Electric Ceramic tubes, contact our Regional OEM Sales Manager in your area, or a franchised General Electric Industrial Tube Distributor.

RESEARCH AND DEVELOPMENT AREAS

1. High Current Density Cathodes
2. Lower Heater Power Designs
3. Fast Warm-Up Heater-Cathode Structures
4. High Dissipation Anodes
5. X Band (10 Gc.) CW and Pulse Triodes
6. Integral Tube-Cavity Microwave Oscillators
7. Broadband Pulse Amplifiers
8. Radiation Environment Performance Evaluation
9. Dual Mode Transmit and Receive Operation

OTHER USES FOR CERAMIC TUBES

. Frequency Multipliers
. RF Power Source for Varactor Multipliers
. Microwave Mixers and Detectors
. Doppler Radars for Traffic Control and Motion Detection
. Broadband Amplifiers
. Video Amplifiers
. Audio, Servo, and Sub-Audio Amplifiers
. High-Voltage Rectifiers
. High-Voltage Regulators
. Microwave Modulators

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GENERAL TECHNICAL INFORMATION

General Electric

CERAMIC TUBE SELECTION CHART

Classification	Type	Approx. Envelope Diameter	Type of Terminals	Maximum Ratings Plate Dissipation (Watts)	Current (milliamperes)	G_m	u	Typical Application	Useful Frequencies Extend to **
Triode - Class A Operation	2C40* •	1.3"	Octal	6.5Δ	I_b = 25	4850	36	UHF Amp.	3000 mc
	2C40A* •	1.3"	Octal	6.5Δ	I_b = 25	5100	35	UHF Amp.	3000 mc
	6299	0.5"	Coax.	2.0Δ	I_b = 12	15000	110	Low-Noise UHF Amp.	3000 mc
	6771	0.5"	Coax.	6.25Δ	I_b = 25	23000	90	UHF Amp.	4000 mc
	7077	0.3"	Coax.	1.0	I_k = 10	10000	90	Low-Noise UHF Amp.	3000 mc
	7296	0.5"	Lug (T)	5.5	I_k = 30	16500	90	VHF Amp.	500 mc
	7462	0.3"	Lug	1.0	I_k = 10	10500	94	Low-Noise VHF Amp.	500 mc
	7588	0.5"	Lug (T)	5.5	I_k = 30	45000	175	Low-Noise VHF Amp.	500 mc
	7644 •	0.5"	Coax.	2.0	I_b = 12	15000	110	Same as 6299 but Controlled for Black-out	3000 mc
	7768	0.5"	Coax.	5.5	I_k = 30	50000	225	Low-Noise VHF Amp.	3000 mc
	7784 •	0.5"	Coax.	2.0Δ	I_b = 12	15000	110	Isolated Heater Version of 6299	3000 mc
	8083 •	0.3"	Lug (T)	1.0	I_k = 10	10500	94	Characteristics same as 7462	500 mc
	Y-1032	0.3"	Coax.	0.6	I_k = 10	10000	36	Low-mu, Low Plate Voltage Osc., Amp., or Mult.	3000 mc
	Z-2354 •	1.0"	Lug	12	I_k = 100	4300	8	Servo Power Amp.	-------
	Z-2835 •	0.5"	Coax.	5.5	I_k = 30	16500	90	UHF Amp.	3000 mc
Triode - Class B or C Operation	2C39B	1.3"	Coax.	100Δ	I_k = 125	24800	95	UHF Power Amp. Osc., or Freq. Mult.	2500 mc
	2C40A* •	1.3"	Octal	6.5Δ	I_b = 25	5100	35	UHF Power Amp. or Osc.	3000 mc
	2C43* •	1.3"	Octal	12Δ	I_b = 40	8100	50	UHF Power Amp. or Osc.	3000 mc
	3CX100A5 •	1.3"	Coax.	100Δ	I_k = 125	25000	100	See 7289	3000 mc
	6442	0.5"	Coax.	8.0Δ	I_b = 35	16500	50	UHF Power Amp., Osc., or Freq. Mult.	5000 mc
	6771	0.5"	Coax.	6.25Δ	I_b = 25	23000	90	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	6897	1.3"	Coax.	100Δ	I_k = 125	24800	95	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	7289	1.0"	Coax.	100Δ	I_k = 125	25000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	7296	0.5"	Lug (T)	5.5	I_k = 30	16500	90	VHF Power Amp., Osc., or Freq. Mult.	500 mc
	7391	0.5"	Coax.	2.25Δ	I_b = 15	11000	62	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	7486	0.3"	Coax.	1.0	I_k = 10	10500	90	UHF Power Amp., Osc. or Freq. Mult.	3000 mc
	7720	0.3"	Lug	1.0	I_k = 10	10500	90	VHF Power Amp., Osc., or Freq. Mult.	500 mc
	7913	0.5"	Coax.	5.5	I_k = 30	40000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	8082•	0.3"	Lug (T)	1.0	I_k = 11	10500	90	Characteristics same as 7720	500 mc
	A-0897	1.0"	Coax.	7.0Δ	I_k = 100	24800	95	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Y-1223	0.5"	Coax.	30.0	I_k = 100	40000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Y-1251	0.3"	Coax.	2.5	I_p = 20	13500	65	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	Y-1266	0.3"	Coax.	4.0	I_k = 40	8000	35	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Z-2835•	0.5"	Coax.	5.5	I_k = 30	16500	90	UHF Power Amp., Osc., or Freq. Mult.	3000 mc

• Detailed Rating Sheet not included

* Glass - Metal lighthouse tube.

** The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.

(T) Provision is made for mounting with T-bolt.

Δ At this dissipation level, anode cooling is usually necessary to prevent exceeding maximum permissible seal temperature.

General Electric

CERAMIC TUBE SELECTION CHART

Classification	Type	Approx. Envelope Diameter	Type of Terminals	Maximum Ratings Plate Dissipation (Watts)	Current (milliamperes)	G_m	u	Typical Application	Useful Frequencies Extend to **
Triode Pulse Operation	2C40A* •	1.3"	Octal	4.0Δ	$\hat{i}_p$ = 2000	5100	35	Pulsed Osc. or Amp.	3000 mc
	2C43 •	1.3"	Octal	6.0Δ	$\hat{i}_p$ = 2750	8100	50	Pulsed Osc. or Amp.	3370 mc
	6442	0.5"	Coax.	7.5Δ	$\hat{i}_p$ = 2500 $\hat{i}_g$ = 1250	16500	50	Pulsed Osc. or Amp.	6000 mc
	6771	0.5"	Coax.	5.0Δ	$\hat{i}_p$ = 1250 $\hat{i}_g$ = 700	23000	90	Pulsed Osc. or Amp.	6000 mc
	7815	1.2"	Coax.	10.0Δ	$\hat{i}_p$ 3000 $\hat{i}_g$ 1500			Pulsed Osc. or Amp.	3000 mc
	7910	0.3"	Coax.	1.5	$\hat{i}_p$ 600	16000	75	Pulsed Oscillator	7500 mc
	7911	0.5"	Coax.	6.5	$\hat{i}_p$ 2500	25000	58	Pulsed Osc. or Amp.	6000 mc
	Y-1124	0.3"	Coax.	2.6	$\hat{i}_p$ 400 $\hat{i}_g$ 100	12000	75	Pulsed Osc. or Amp.	6000 mc
	Y-1236	0.5"	Coax.	30.0Δ	$\hat{i}_p$ 2000	27000	55	Pulsed Oscillator	6000 mc
Diode Signal	7266	0.3"	Coax.	Tube Voltage Drop: 1 Volt @ I_b = 1.0 milliamperes I_b = 2 milliamperes maximum				Signal Detector	3000 mc
	7841 •	0.3"	Coax.	Tube Voltage Drop: 2.6 Volts @ I_b = 5.0 milliamperes I_b = 5 milliamperes maximum				Signal Detector, Low Voltage Drop 7266	3000 mc
Diode Power	Z-2689	0.5"	Lug (T)	Tube Voltage Drop: 18 Volts @ I_b = 40 milliamperes I_b = 25 milliamperes maximum				Low Current Power Rectifier	-------

• Detailed Rating Sheet not included

* Glass - Metal lighthouse tube.

** The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.

(T) Provision is made for mounting with T-bolt.

Δ At this dissipation level, anode cooling is usually necessary to prevent exceeding maximum permissible seal temperature.

COAXIAL TUBE SELECTION CHART

CAPABILITIES OF GENERAL ELECTRIC

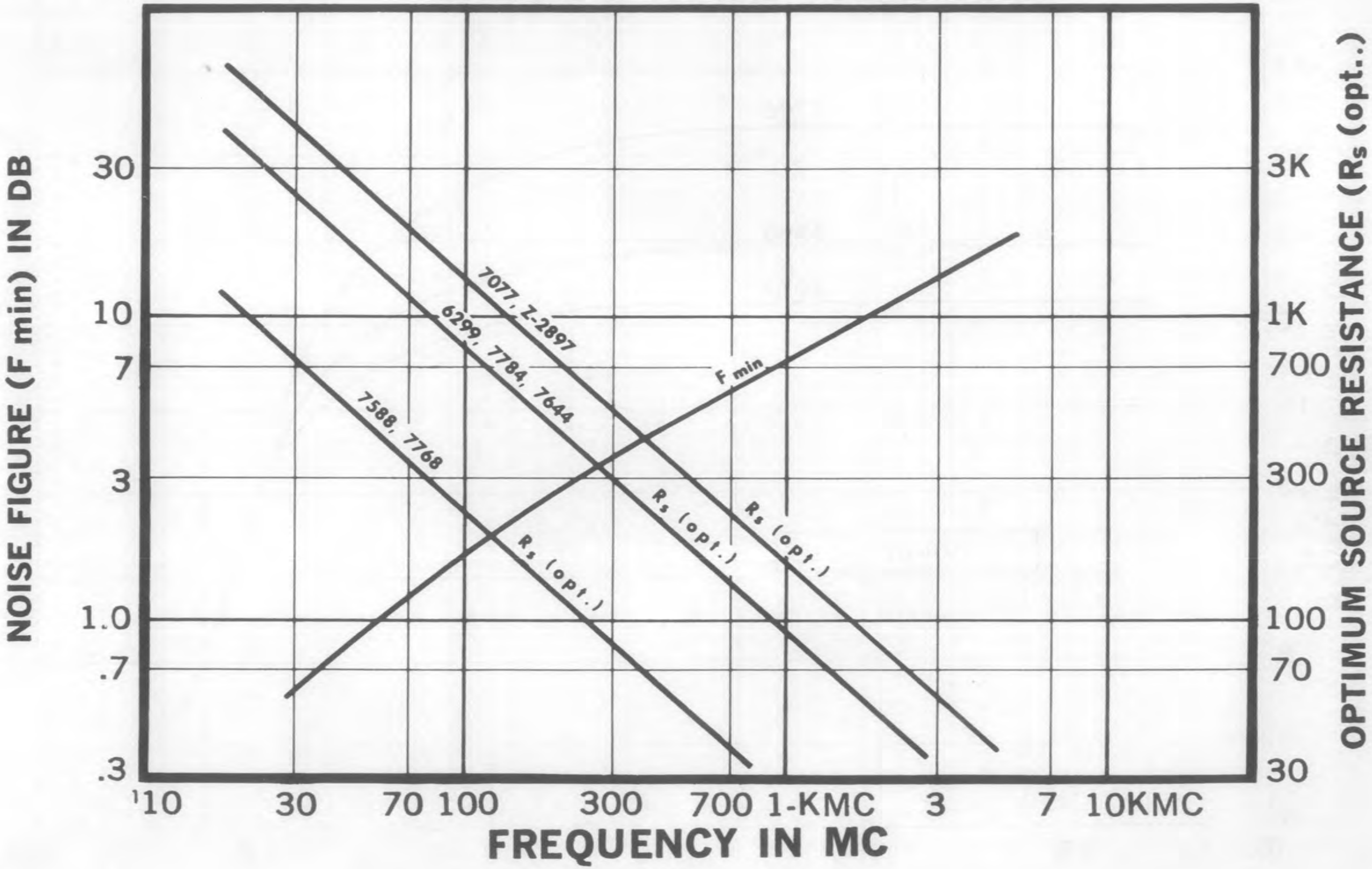
METAL-CERAMIC TRIODES AND TETRODES

Application	Tube Type	Service	Typical Capabilities	Cooling
Phased Array and Conventional Radar (200-1300 mcs, approx)	GL-7399 ZP-1038 *	RF-Pulsed Amplifier	500 mcs; 10% Bandwidth 250 μsec; 0.005 Duty 30 KW, Peak; 10 db Gain	Forced-air
	GL-7399 ZP-1038 *	RF-Pulsed Amplifier	425 mcs; 11% Bandwidth 50 μsec; 0.010 Duty 10 KW, Peak; 9 db Gain	Forced-air
	GL-7399 ZP-1038 *	RF-Pulsed Amplifier	425 mcs; 5% Bandwidth 20 μsec; 0.001 Duty 60 KW, Peak; 10 db Gain	Forced-air
	ZP-1034	RF-Pulsed Amplifier	1300 mcs; 10% Bandwidth 500 μsec; 0.060 Duty 5 KW, Peak; 10 db Gain	Liquid
	ZP-1065	RF-Pulsed Amplifier	425 mcs; 20% Bandwidth 3.5 μsec; 0.005 Duty 10 KW, Peak; 7 db Gain	Forced-air
	ZP-1025	RF-Pulsed Oscillator	1300 mcs; 25 KW, Peak 10 μsec; 0.001 Duty	Conduction
	ZP-1074	RF-Pulsed Oscillator	425 mcs; 40 KW, Peak 10 μsec; 0.002 Duty	Conduction
AM and FM Transmitters (50-1250 mcs, approx)	GL-6283 GL-8500 ZP-1070	RF Amplifier	225-400 mcs 440 Watts PEP; 13 db Gain 300 Watts CW; 13 db Gain	Forced-air
	GL-6942	RF Amplifier	1000 mcs 1 KW CW; 11 db Gain	Forced-air
	ZP-1064	RF Amplifier	225-400 mcs 3 KW PEP; 16 db Gain 4 KW CW; 14 db Gain	Forced-air
	GL-6848	RF Amplifier	225-400 mcs 3.2 KW CW; 15 db Gain	Forced-air
	GL-7985	RF Amplifier	225-400 mcs 4.4 KW PEP; 17 db Gain	Liquid
	GL-8513 ZP-1039	RF Amplifier	225-400 mcs 6 KW PEP; 15 db Gain < 5% Distortion	Forced-air

*Liquid-Cooled Version Available (ZP-1079)

Application	Tube Type	Service	Typical Capabilities	Cooling
IFF Radar (1030 & 1090 mcs)	GL-7399 ZP-1015 ZP-1065	RF-Pulsed Amplifier (Grid-Pulsed)	1030 mcs 10 µsec; 0.010 Duty 10 KW, Peak; 8.5 db Gain	Forced-air or Conduction
	GL-8866	RF-Pulsed Amplifier (Grid-Pulsed)	1030 mcs 10 µsec; 0.020 Duty 2 KW, Peak; 10 db Gain	Conduction
	ZP-1043	RF-Pulsed Amplifier (Grid-Pulsed)	1030 mcs 10 µsec; 0.004 Duty 2 KW, Peak; 7 db Gain	Conduction
	ZP-1061	RF-Pulsed Oscillator (Grid-Pulsed)	1090 mcs; 1 KW, Peak 20 µsec; 0.010 Duty	Conduction
	ZP-1029	RF Switching	1030 mcs; 10 KW, Peak 0.007 Duty	Conduction
CW or Pulsed Signal Generators (200-2000 mcs, approx)	ZP-1025 ZP-1074	RF-Pulsed Oscillator	200-1300 mcs 5 µsec; 0.005 Duty 5 KW, Peak 200-1300 mcs 5 µsec; 0.001 Duty 20 KW, Peak	Conduction
	ZP-1044	RF CW Oscillator	200-1000 mcs 1 KW	Forced-air
	ZP-1057	RF CW Oscillator	200-1300 mcs 200 Watts	Forced-air
	ZP-1058	RF CW Oscillator	200-2000 mcs 100 Watts	Forced-air
Electronic Voltage Regulators	ZP-1016B	High-Voltage Series Regulator	10 KV DC Hold-Off 300 Watts Dissipation	Forced-air
	ZP-1038R	High-Voltage Series Regulator	10 KV DC Hold-Off 1000 Watts Dissipation	Circulating Oil
VHF-UHF Television	GL-6283 GL-8500 ZP-1070	RF Amplifier	900 mcs 260 Watts, Synch Peak	Forced-air
	GL-6942	RF Amplifier	900 mcs 1000 Watts, Synch Peak	Forced-air
	GL-6251	RF Amplifier	216 mcs 25 KW, Synch Peak	Liquid

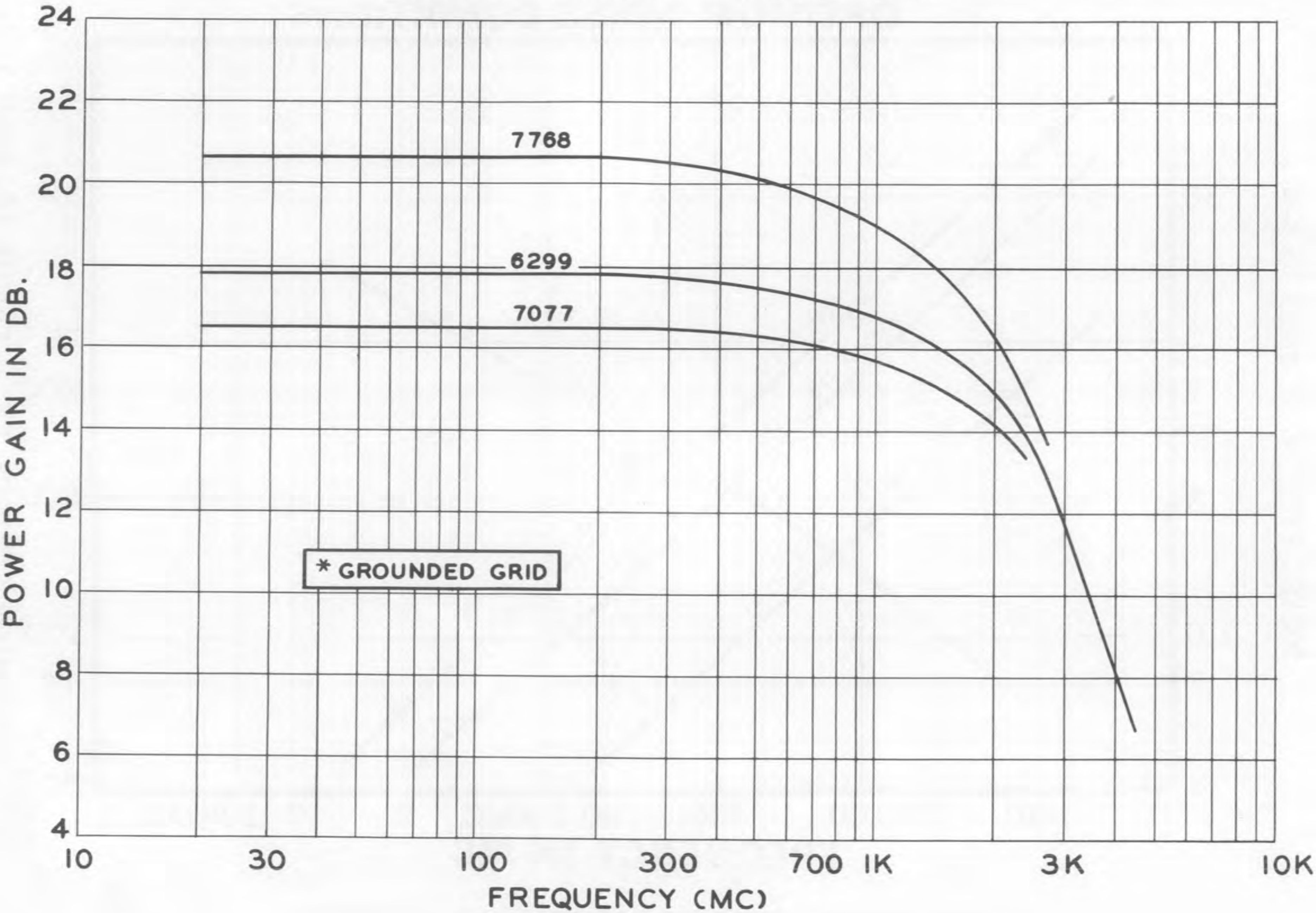
OPTIMUM NOISE CONDITIONS



It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

(FOR FURTHER DETAILS SEE ARTICLE ON NOISE IN THE GENERAL TECHNICAL INFORMATION SECTION)

SMALL SIGNAL TRIODE GAIN *

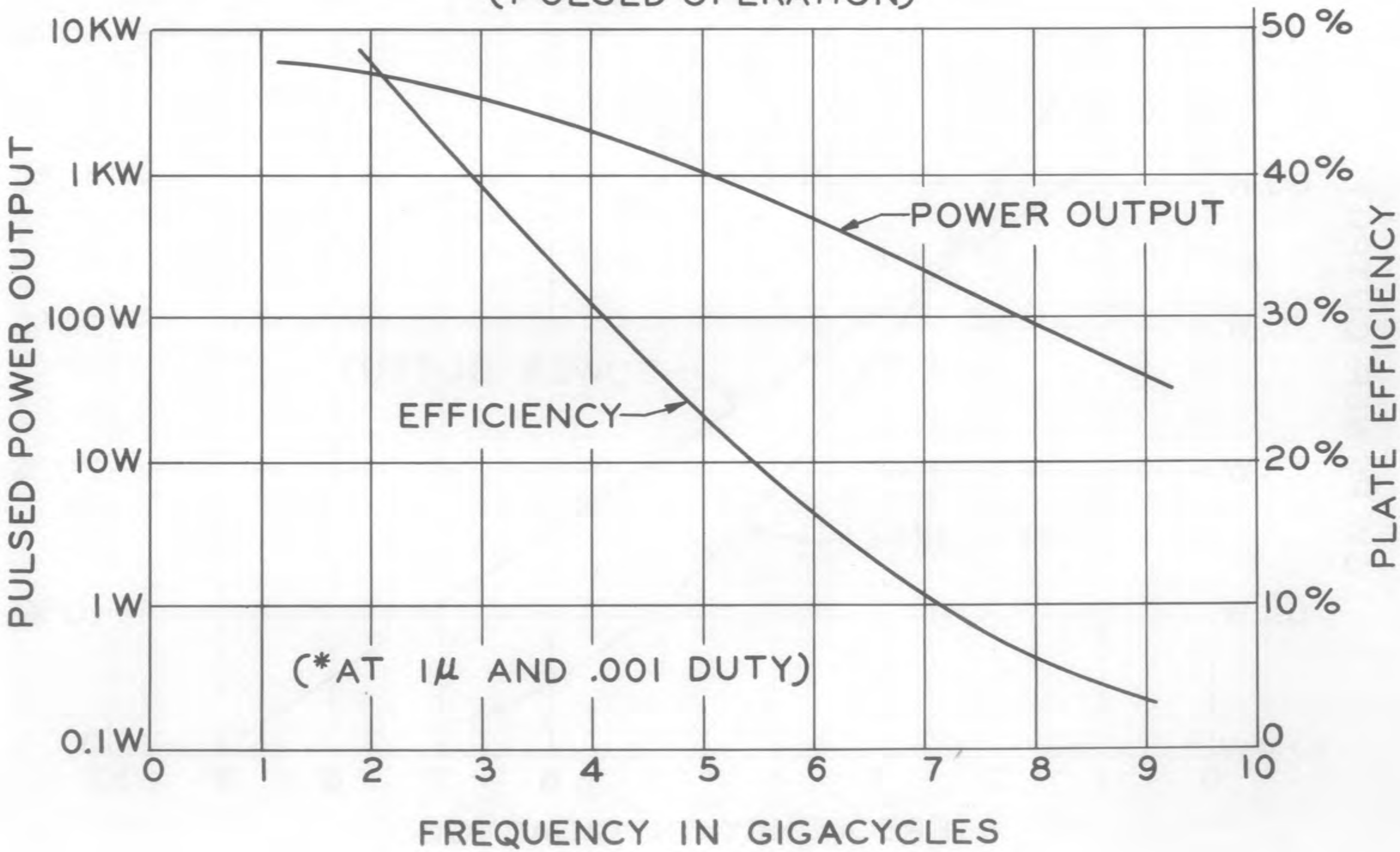


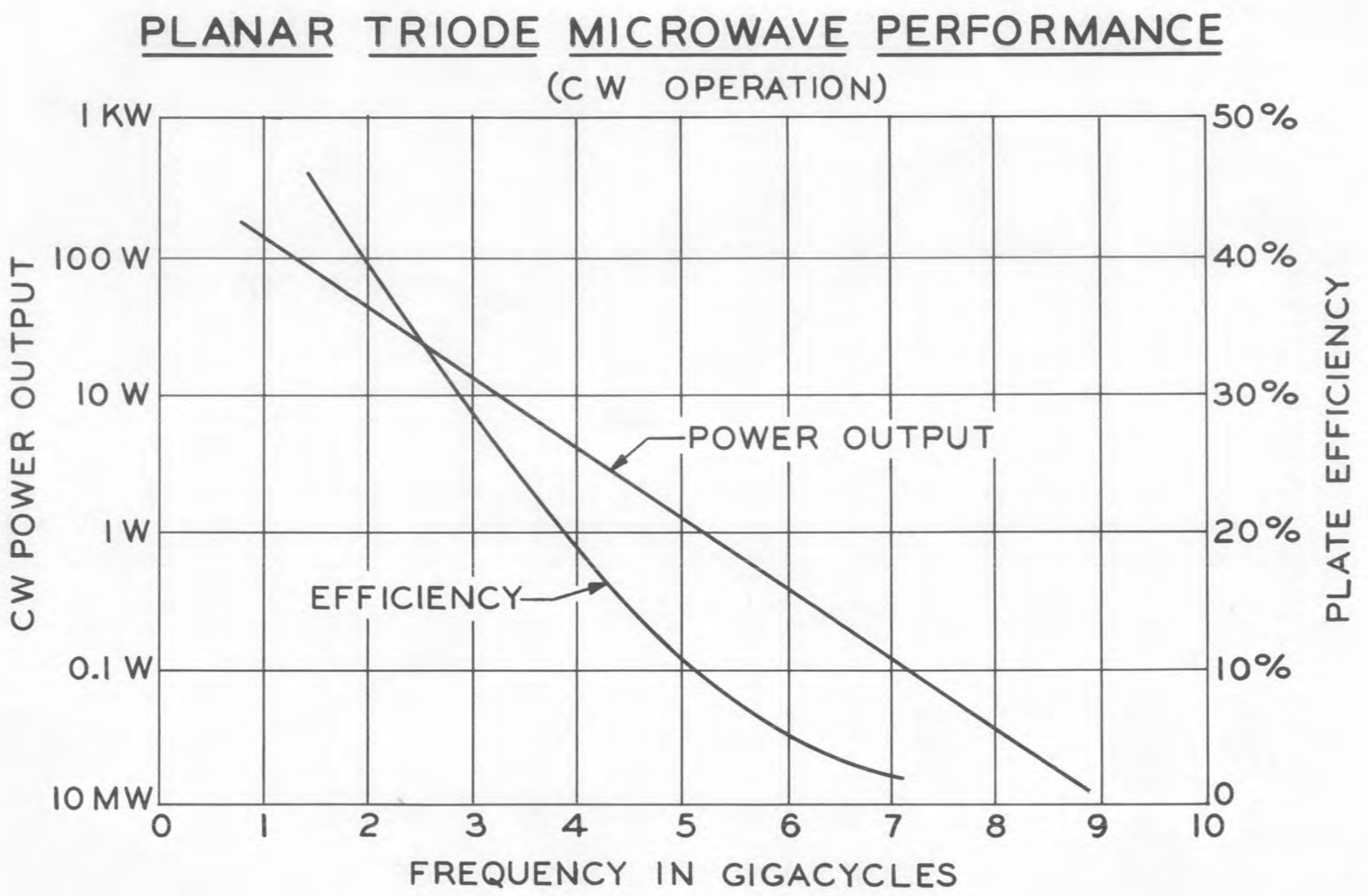
OPERATING FREQUENCY

It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

PLANAR TRIODE MICROWAVE PERFORMANCE

(PULSED OPERATION)




PLANAR TRIODE MICROWAVE PERFORMANCE
(C W OPERATION)
1 KW
100 W
10 W
1 W
0.1 W
10 MW
50%
40%
30%
20%
10%
0
CW POWER OUTPUT
PLATE EFFICIENCY
POWER OUTPUT
EFFICIENCY
0
1
2
3
4
5
6
7
8
9
10
FREQUENCY IN GIGACYCLES

DATA FOR REGISTERED TYPES

DATA FOR REGISTERED TYPES

ELECTRONICS

2C39-B
PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Low Interelectrode Capacitances
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 2C39-B is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

Features of the 2C39-B include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to Be Used as a Socket Stop and Clamp

Net Weight, approximate	2	Ounces

Cooling
Plate and Plate Seal—Conduction and Forced Air
Grid and Cathode Seals—Conduction and Forced Air
Recommended Air Flow Cowling—157-JAN
Recommended Air Flow on Plate Radiator at Sea Level
Incoming Air Temperature 25C, Plate Dissipation

100 Watts	12.5	Cubic Feet Per Minute

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

Supersedes ET-T1054A dated 9-57

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage△		Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

RADIO FREQUENCY OSCILLATOR—CLASS C

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	−40	−22	Volts
Useful Power Output	40	17	Watts

‡ Measured in a special shielded socket.

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

Where long life and reliable operation are important, lower envelope temperatures should be used.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

△ Adjusted for Ib = 75 milliamperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	−1.3	−2.5	−3.5	Volts
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	−7.0	−9.5	−15	Volts
Transconductance Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	.....	.....	3.0	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results Grid to Cathode at 500 volts d-c	50	.....	.....	Megohms
Interelectrode Capacitances Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

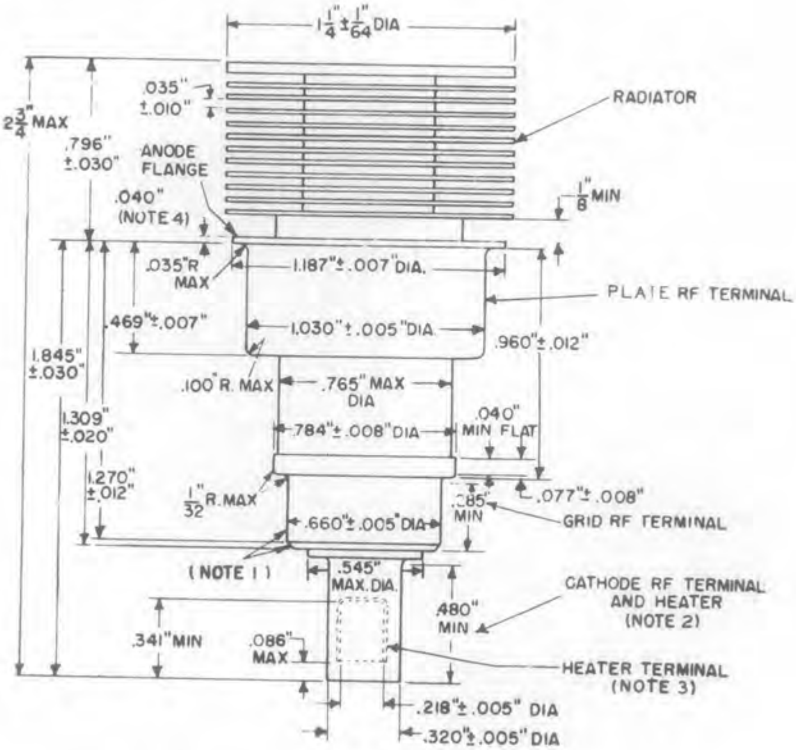
Shock

Statistical sample subjected to 5 input accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS

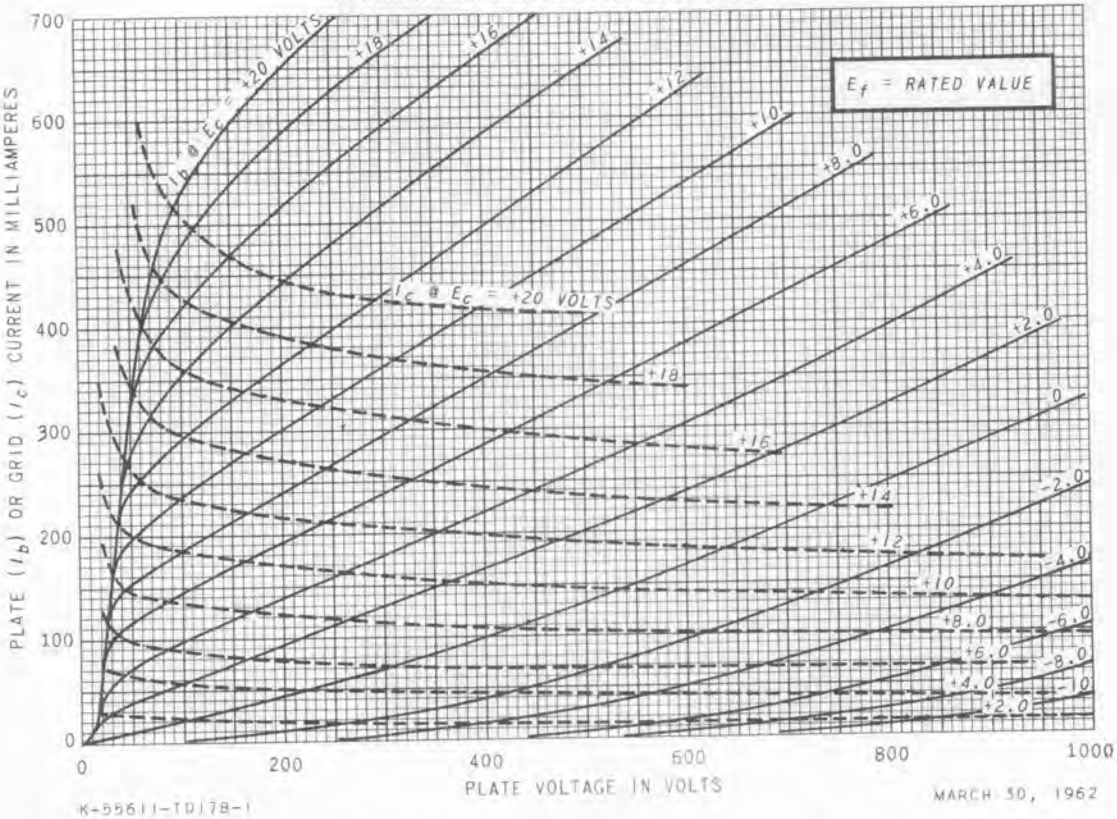


NOTES:

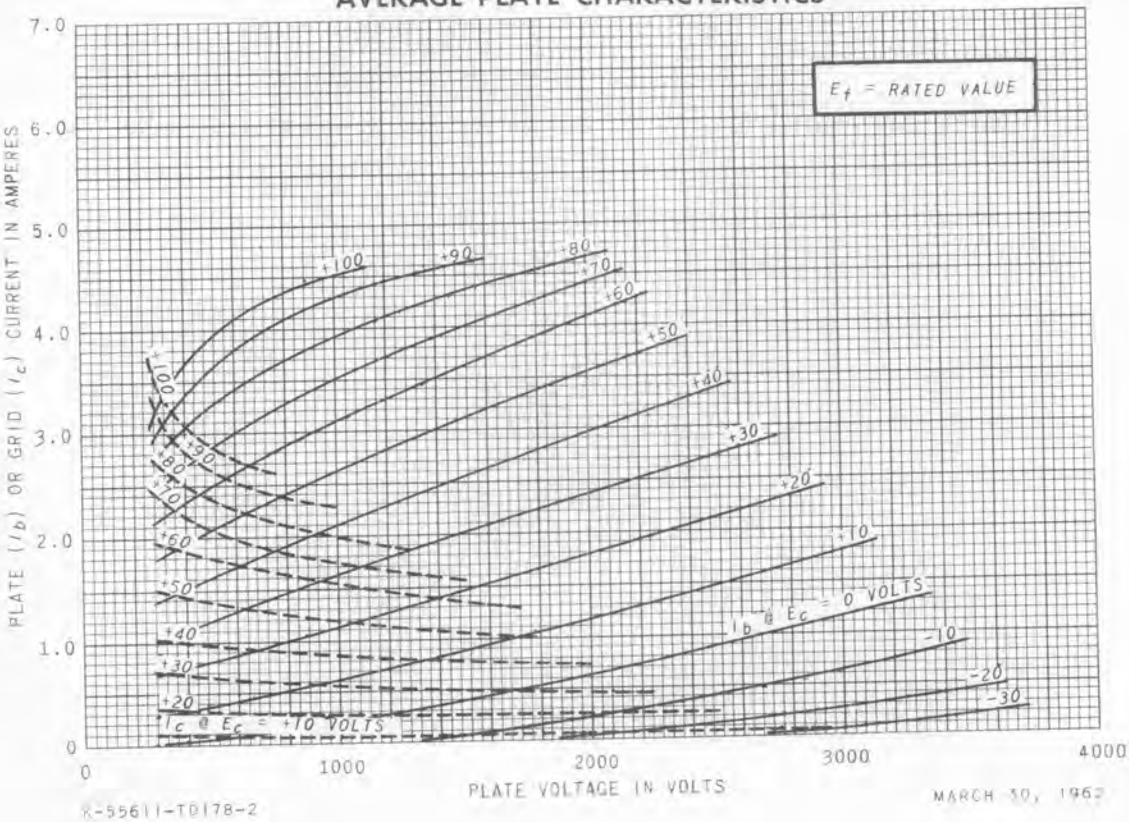
1. Solder not to extend radially beyond grid RF terminal.
2. Total indicated runout of the grid-contact surface and the cathode-contact surface with respect to the anode shall not exceed 0.020".
3. Total indicated runout of the cathode-contact surface with respect to the heater-contact surface shall not exceed 0.012".
4. Only this flange to be used as a socket stop and clamp.

¶ New pages 3 to 6 supersede old pages 3 and 4 dated 12-61.

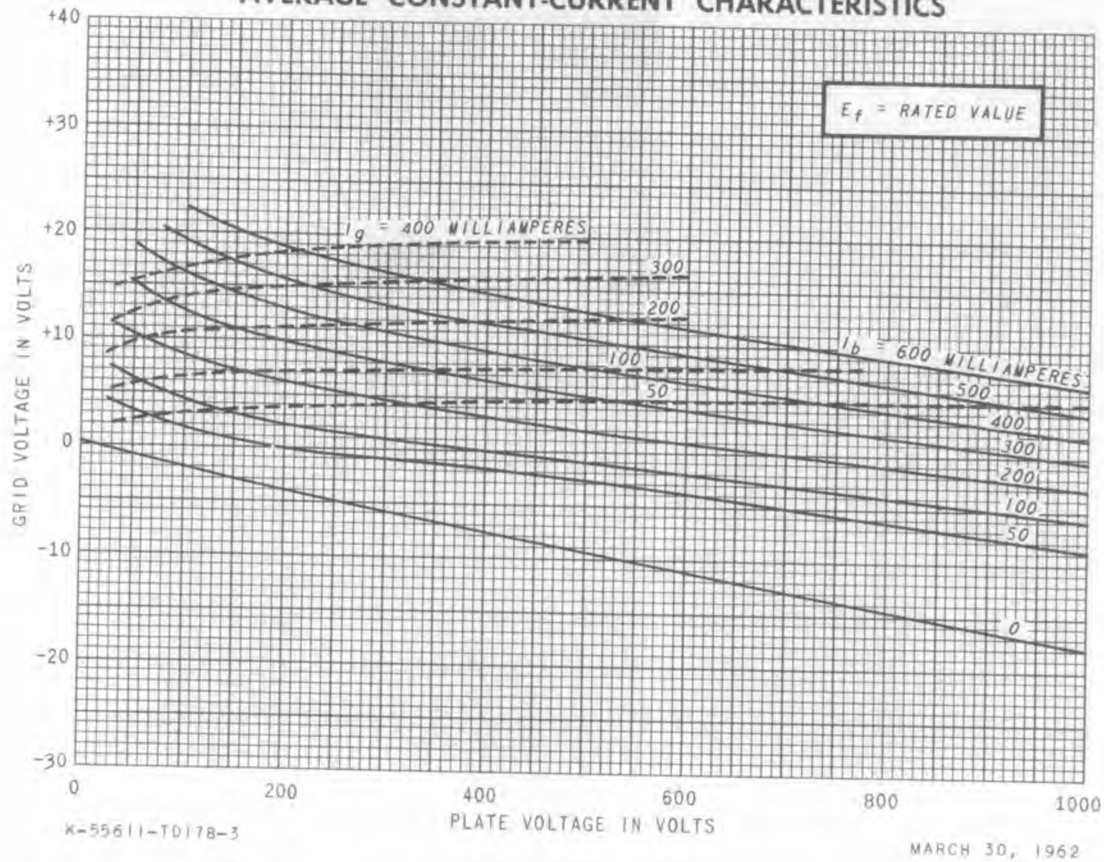
AVERAGE PLATE CHARACTERISTICS



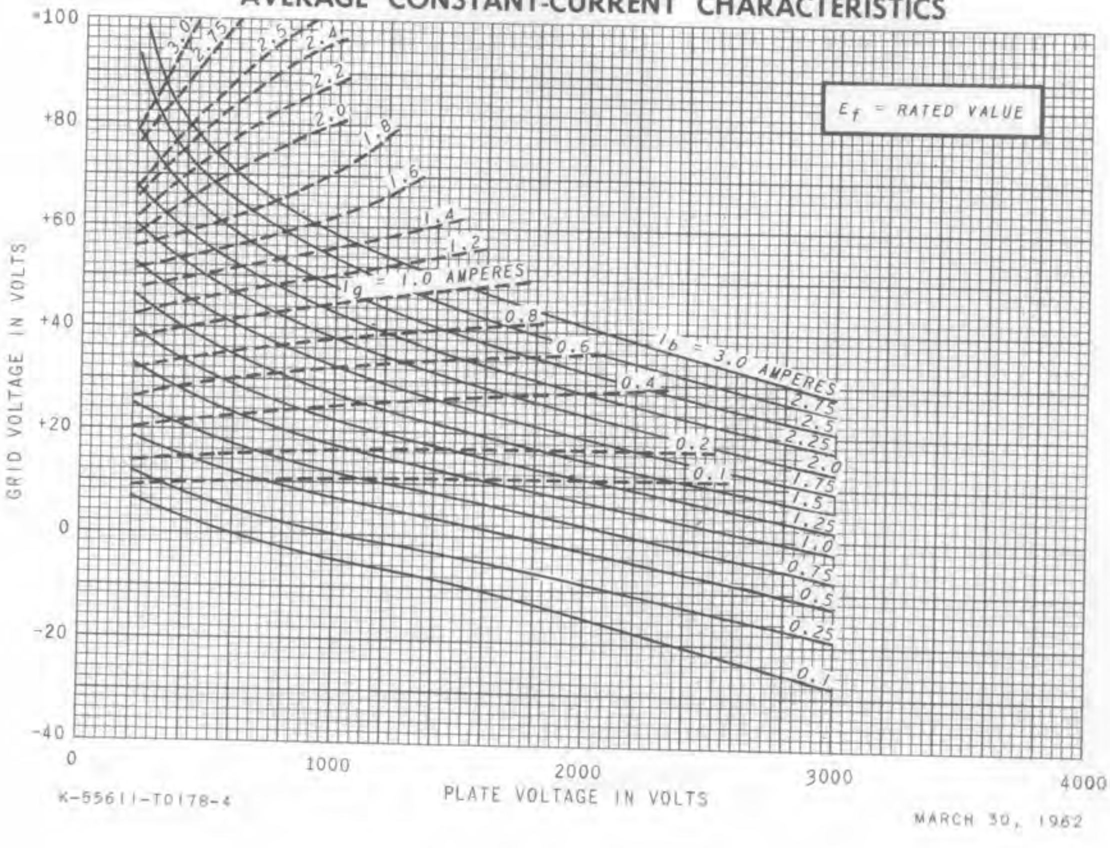
AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



Tetrode

GL-6251

25-KILOWATTS VHF TELEVISION OUTPUT
VHF TETRODE
GROUNDED-GRID CIRCUITS

WATER COOLED
METAL AND CERAMIC
GAIN IN EXCESS OF 10

The GL-6251 is a four-electrode, water-and-forced-air-cooled transmitting tube for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating twenty-five kilowatts. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 220 megacycles.

In Class B grounded-grid broadband television amplifier service this tube has a useful synchronizing peak-power output of twenty-five kilowatts at 220 megacycles. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulator. The ring-seal design permits quick plug-in installation. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit.

Electrical

	Minimum	Bogey	Maximum	
⊕Filament Voltage	5.1	5.5	5.75	Volts
Filament Current at 5.5 Volts	..	190	...	Amperes
Filament Starting Current	..	...	360	Amperes
Filament Cold Resistance	..	0.004	...	Ohms
Filament Heating Time	30	...	...	Seconds
Amplification Factor, G_2 to G_1				
E_b=1000 Volts, I_b=0.1 Amps	..	20	...	
Peak Cathode Current*	..	...	30	Amperes
Direct Interelectrode Capacitances§				
Grounded-Grid Circuit				
Cathode-Plate†	..	0.06	...	μμf
Input	..	75	...	μμf
Output	..	27	...	μμf

Mechanical

Mounting Position	Vertical, anode down	
Net Weight, approximate	15	Pounds

Thermal

Type of Cooling—Water and Forced Air

Water Cooling		
Water Flow		
Anode	12 Min	Gallons per Minute
Water Pressure	80 Max	Pounds per Square Inch
Pressure Drop at Rated Flow, approximate	13	Pounds per Square Inch
Outlet Water Temperature	70 Max	C
Air Cooling		
Air Flow		
Anode Seal	30 Min	Cubic Feet per Minute
Filament Seal	15 Min	Cubic Feet per Minute
Grid-to-Grid Seal	10 Min	Cubic Feet per Minute
Ceramic Temperature	200 Max	C
□Seal and Terminal Temperature	180 Max	C

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions Per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

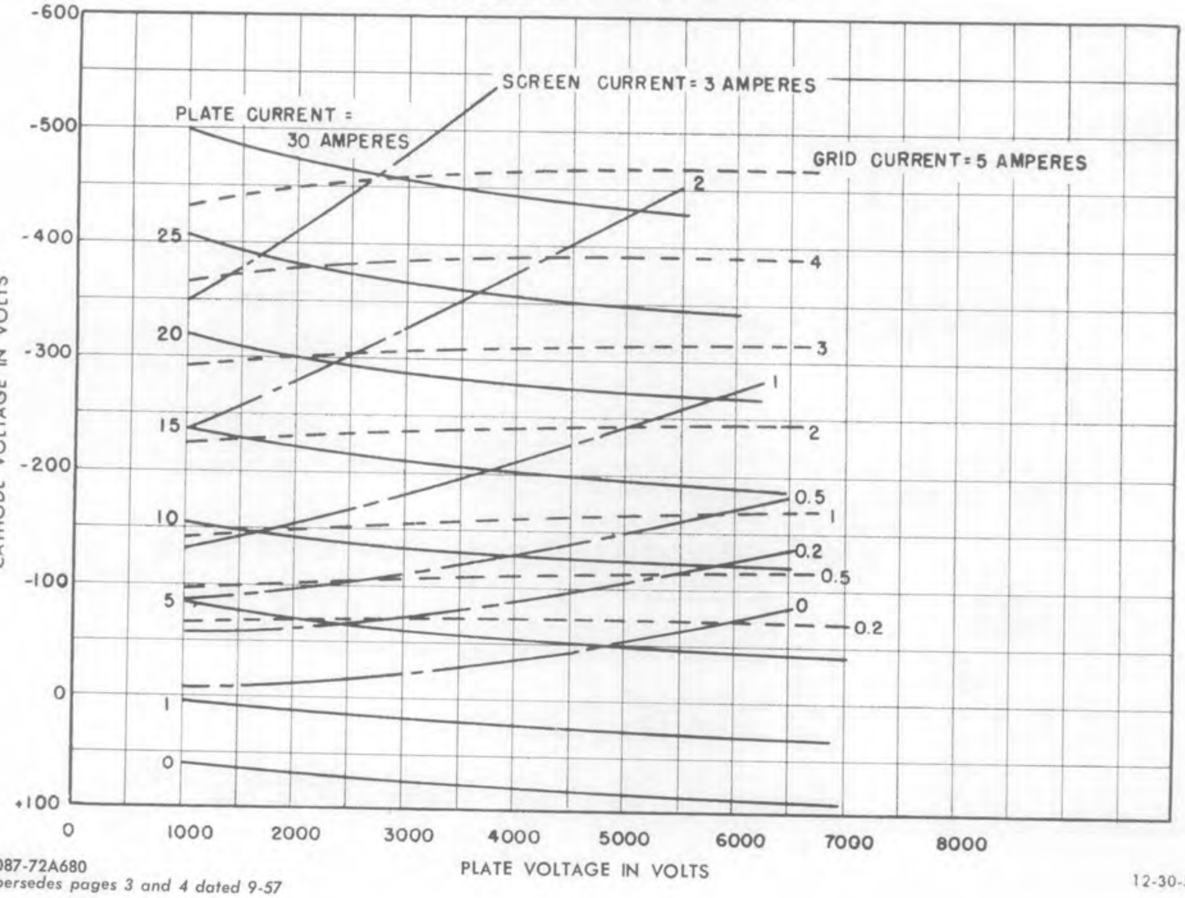
DC Plate Voltage	7000	Max	Volts
⊕DC Grid-No. 2 Voltage	700	Max	Volts
DC Plate Current	8	Max	Amperes
Plate Input	50	Max	Kilowatts
Grid-No. 2 Input‡	350	Max	Watts
⊕DC Grid-No. 2 Current			
Pedestal Level	0.200	Max	Amperes
Plate Dissipation	25	Max	Kilowatts
Grid-No. 1 Dissipation	150	Max	Watts
⊕DC Grid-No. 1 Current	1.0	Max	Amperes

Typical Operation—Grounded-Grid Circuit up to 216 Megacycles

Bandwidth 7 Megacycles, 1 Decibel Voltage		
DC Plate Voltage	6800	Volts
⊕DC Grid-No. 2 Voltage//	600	Volts
DC Grid-No. 1 Voltage	—20	Volts
Peak RF Plate Voltage		
Synchronizing Level	4800	Volts
Pedestal Level	3600	Volts
Peak RF Driving Voltage		
Synchronizing Level	350	Volts
Pedestal Level	250	Volts
DC Plate Current		
Synchronizing Level	7.5	Amperes
Pedestal Level	5.8	Amperes
DC Grid-No. 2 Current//		
Pedestal Level	0.05	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.90	Amperes
Pedestal Level	0.55	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	2.3	Kilowatts
Pedestal Level	1.3	Kilowatts
Power Output, approximate¶		
Synchronlzing Level	25	Kilowatts
Pedestal Level	15	Kilowatts

* Maximum usable cathode current (plate current plus current to each grid) for any condition of operation.
§ Control grid and screened grid are connected together.
† Measured with 12-inch diameter flat metal disk attached to the screen-grid terminal and grounded.
‡ Calculated from characteristic curve only. This value includes dissipation transferred from driving power. Maximum allowable screen input as indicated by measured d-c current and voltage is much lower because of secondary screen emission.
//DC Grid-No. 2 voltage and current should be held at the minimum values consistent with proper circuit operation. Negative values of screen current are frequently encountered but are not detrimental.
¶ Useful power output including power transferred from driver stage.
⊕Denotes a change.
□ Denotes an addition.

CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE=700 VOLTS, CONTROL-GRID GROUNDED
ELECTRODE VOLTAGES MEASURED TO GROUND



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▲*Supersedes pages 3 and 4 dated 9-57*

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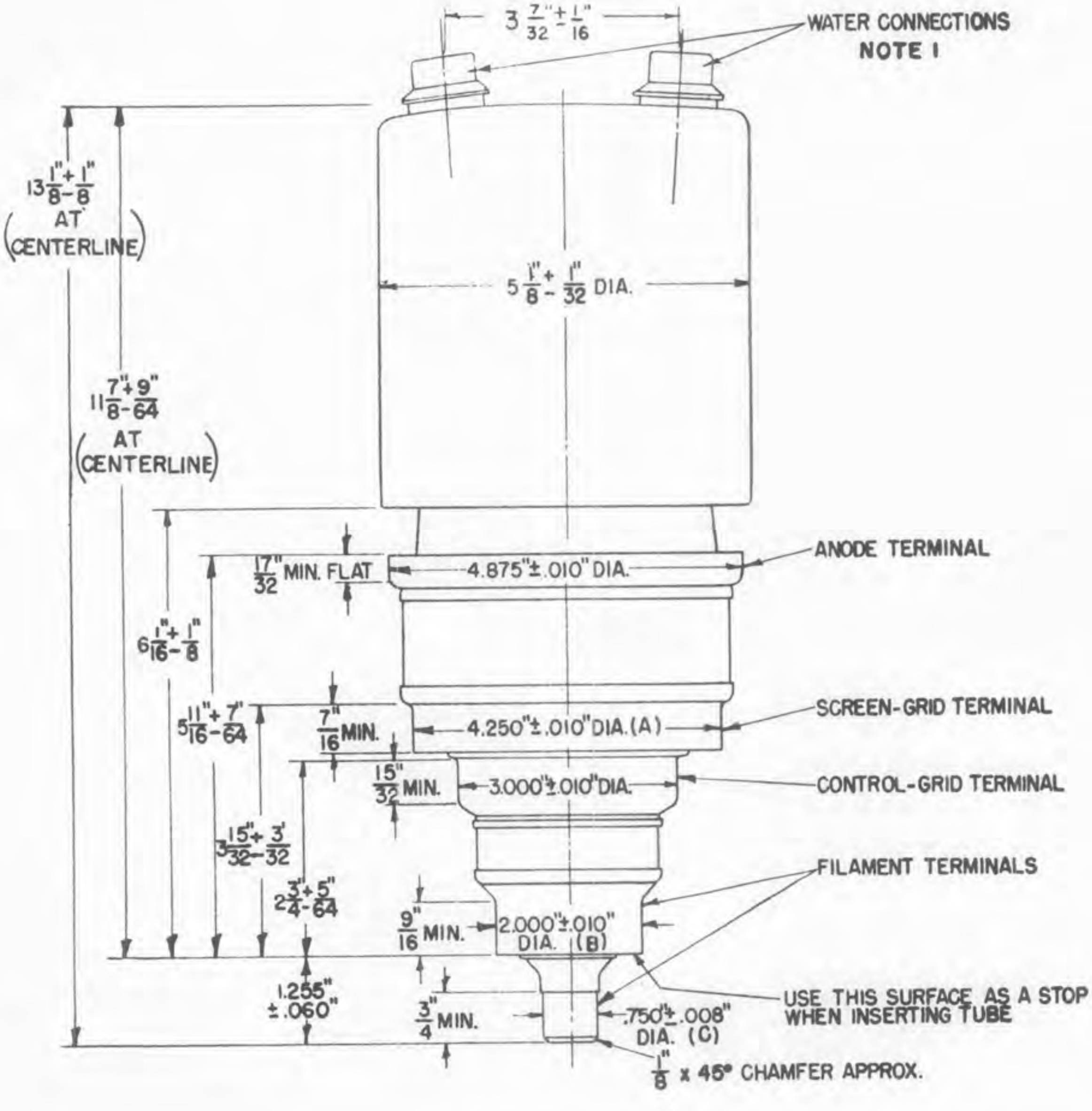


(A) MAX. ECCENTRICITY .040"
(B) MAX. ECCENTRICITY .040"
(C) MAX. ECCENTRICITY .050"
WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE TERMINAL & CONTROL-GRID TERMINAL.

NOTE 1: MATES WITH WIGGINS SOCKET NO. BC-323B OR EQUIVALENT.
E. B. WIGGINS OIL TOOL COMPANY, INC., LOS ANGELES, CALIFORNIA

N-20726AZ 1-6-59

GL-6283
TETRODE

RADIO-FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-6283 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225–400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low—approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-6283 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	6.3	6.8	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 1000V$ DC; $E_g2 = 275V$ DC; $I_b = 0.2$ A DC	—	14	—	
Peak Cathode Current†	—	—	1.75	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	0.006	—	μμf
Input, G_2 tied to G_1	—	18.25	—	μμf
Output, G_2 tied to G_1♦	—	6.4	—	μμf

Mechanical

Mounting Position—Any		
Net Weight, approximate	1.0	Pounds

Thermal

Cooling—Forced Air§ Through Radiator, at Sea Level**				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	17.0	12.0	6.5	Cubic Feet per Minute
Static Pressure, approximate	0.9	0.5	0.2	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal	—	—	250	C
Seals				
Screen-Grid to Control-Grid, approximate	—	—	1	Cubic Feet per Minute
Heater to Cathode, approximate	—	—	1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum	—	—	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Amperes
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	500	Watts

Typical Operation

Grounded-Grid Circuit at 225–400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	−20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Amperes
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Amperes
DC Grid-No. 2 Current	0.005	Amperes
DC Grid-No. 1 Current	0.010	Amperes
Driving Power, approximate	5	Watts
Power Output♥	110	Watts

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions Per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	1600 Max	Volts
DC Grid-No. 2 Voltage	320 Max	Volts
DC Plate Current	0.400 Max	Amperes
Plate Input	600 Max	Watts
Grid-No. 2 Input	15 Max	Watts
Plate Dissipation	500 Max	Watts
Grid-No. 1 Dissipation	2 Max	Watts

Typical Operation—Grounded-Grid Circuit up to 900 Megacycles

Bandwidth 6 Megacycles		
DC Plate Voltage	1500	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage	−25	Volts
Peak RF Plate Voltage		
Synchronizing Level	1100	Volts
Pedestal Level	825	Volts
Peak RF Driving Voltage		
Synchronizing Level	35	Volts
Pedestal Level	27	Volts
DC Plate Current		
Synchronizing Level	0.400	Amperes
Pedestal Level	0.295	Amperes
DC Grid-No.2 Current (Pedestal Level)	0.007	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.036	Amperes
Pedestal Level	0.016	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	25	Watts
Pedestal Level	15	Watts
Power Output, approximate		
Synchronizing Level¶	260	Watts
Pedestal Level¶	145	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

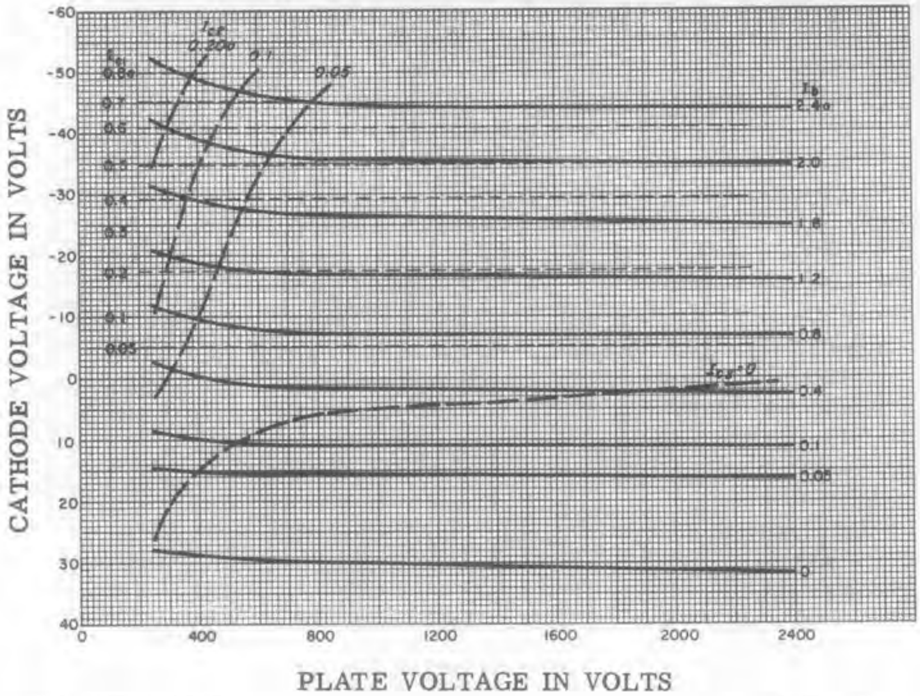
Maximum Ratings	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	−100	−100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	500	500	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles			
DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	−40	−40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.
† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.
‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.
♦ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.
§ Forced-air cooling to be applied before and during the application of any voltages.
**Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.
♥Useful power output as measured in output-circuit load.
¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.
△Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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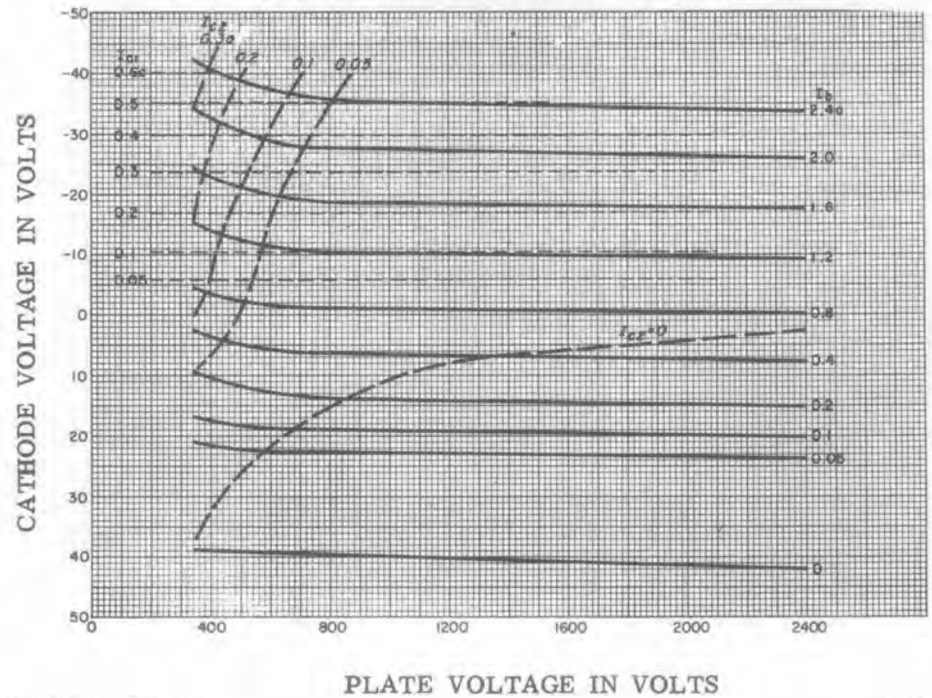
CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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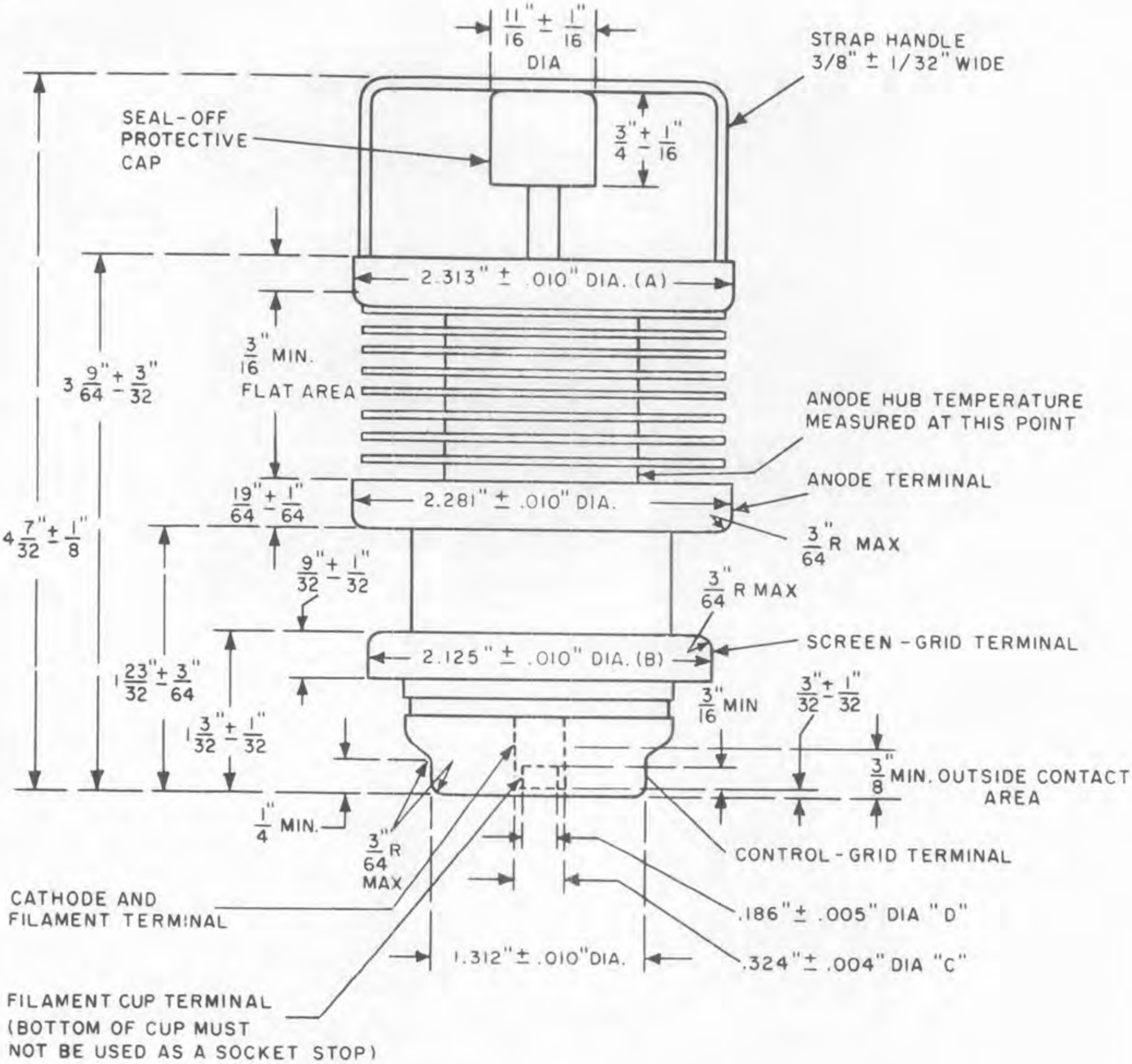


CONCENTRICITIES

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL GRID TERMINAL

DIAMETER A – 0.030 INCHES
DIAMETER B – 0.016 INCHES
DIAMETER C – 0.036 INCHES
DIAMETER D – 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT CUP TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT TERMINAL DIAMETER (C) – 0.016 INCHES

K-69087-72A578 8-1-62

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

6299

Planar Triode

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

The 6299 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid, Class A radio-frequency amplifier at frequencies as high as 3000 megacycles.

Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

At 1200 megacycles a noise figure of less than 8.5 decibels may be obtained when the 6299 is used in a grounded-grid coaxial circuit.

In radar receivers, or similar applications, where the grid of the tube may be driven positive by leakage pulses, consideration should be given to use of the 7644 in place of the 6299.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.3	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.75	pf
Grid to Cathode and Heater: g to (h + k)	3.65	pf
Plate to Cathode and Heater: p to (h + k)	0.015	pf

MECHANICAL

Operating Position - Any

Net Weight, approximate . . . . . 1/6 Ounce

Cooling - Conduction¶

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.0	Watts
DC Plate Current	12	Milliamperes
DC Grid Current#	0Δ	Milliamperes
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1166D dated 12-61

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage¢	---	Volts
Amplification Factor	110	
Plate Resistance, approximate	7300	Ohms
Transconductance	15000	Micromhos
Plate Current	10	Milliamperes
Plate Voltage, approximate, Ib = 10 Milliamperes, Ec = 0 volts	125	Volts

CLASS A, RF AMPLIFIER—GROUNDED-GRID, COAXIAL-TYPE CIRCUIT

Frequency	450	1200	1200	1200	3000	Megacycles
Plate Voltage	**	---	**	175	**	Volts
Plate-Supply Voltage‡‡	---	300	---	---	---	Volts
Resistor in Plate Circuit (bypassed)	---	17500	---	---	---	Ohms
Grid Voltage§§	0	0	0	¶¶	0	Volts
Plate Current	10	10	10	10	10	Milliamperes
Bandwidth, min	9	10	10	10	10	Megacycles
Gain	17.5	17	17	17	11	Decibels
Noise Figure, Power-Matched	4.5	8.2	8.0	8.5	13.2	Decibels

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ Good thermal contact to the anode and cathode must be provided to conduct heat from the elements. The anode contact must be sufficiently flexible to keep lateral force on the anode terminal at a minimum.

The 6299 is rated only for Class A amplifier service.

Δ Does not apply to initial-emission-velocity current.

¢ Adjusted for Ib = 10 milliamperes.

** Adjust for Ib = 10 milliamperes; range must be variable from 75 to 200 volts.

‡‡ Supply should be regulated.

§§ For operation above 1000 megacycles, the minimum noise figure will generally be obtained by operation at zero bias. For operation below 1000 megacycles, the use of a cathode resistor or grid bias should be evaluated for the particular application.

¶¶ Adjusted for Ib = 10 milliamperes; 200 ohm variable cathode resistor recommended.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	280	300	320	Milliamperes
Plate Voltage Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma	75	125	175	Volts
Transconductance Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma.	11500	15000	---	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	85	110	140	
Interelectrode Leakage Resistance Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to Cathode and Heater at 45 volts d-c	0.25	---	---	Megohms
Grid to Plate at 500 volts d-c	5.0	---	---	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.5	1.75	2.0	Picofarads
Grid to Cathode and Heater: g to (h + k)	3.0	3.65	5.0	Picofarads
Plate to Cathode and Heater: p to (h + k)	---	0.015	0.025	Picofarads

SPECIAL PERFORMANCE TESTS

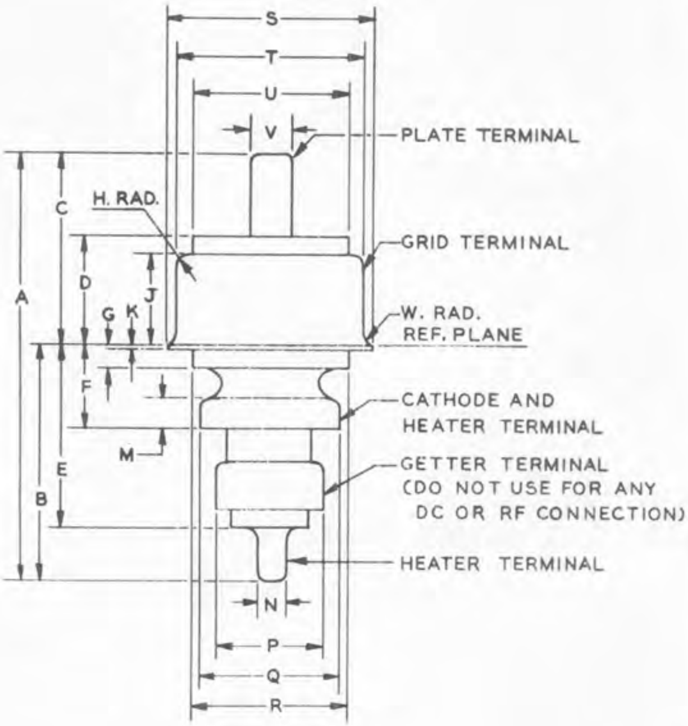
	Min.	Max.	
Noise Figure - 450 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450±5 MC	---	5.0	Decibels
Noise Figure - 1200 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200±5 MC	---	8.5	Decibels
Noise Figure - 3000 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000±5 MC	---	13.5	Decibels
Power Gain - 450 Mc Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450±5 MC, Bandwidth = 9 MC, min	15	---	Decibels
Power Gain - 1200 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200±5 MC, Bandwidth = 10 MC, min.	15	---	Decibels
Power Gain - 3000 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000±5 MC, Bandwidth = 10 MC, min.	10	---	Decibels

DEGRADATION RATE TESTS

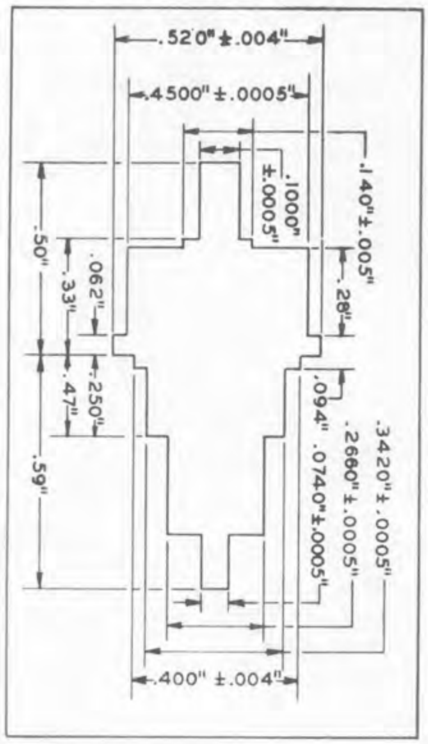
1000-Hour Life

Statistical sample operated for 1000 hours to evaluate changes in transconductance and noise figure with life.

PHYSICAL DIMENSIONS

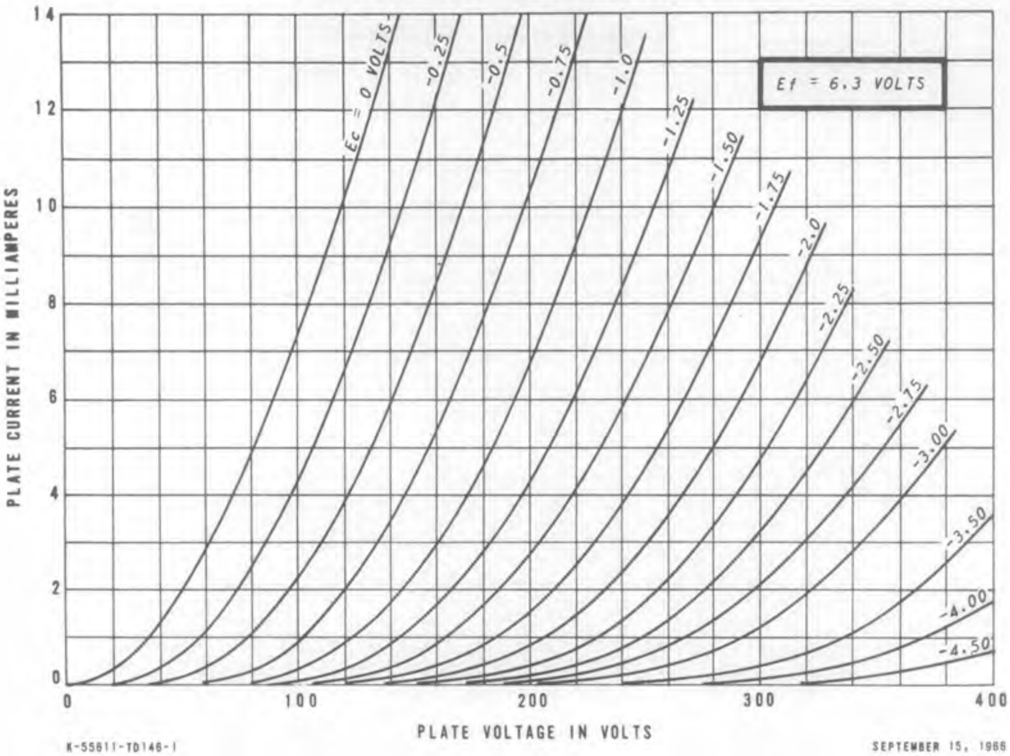


ALIGNMENT GAUGE

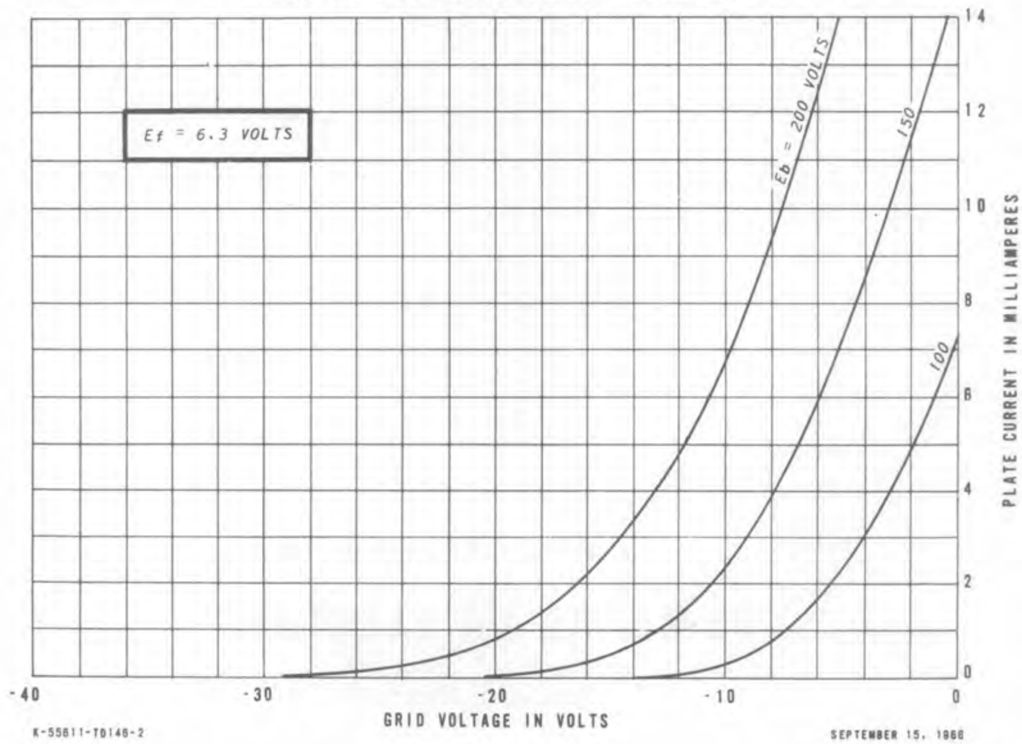


Ref.	INCHES		MILLIMETERS	
	Minimum	Maximum	Minimum	Maximum
A	0.960	1.040	24.38	26.42
B	0.530	0.590	13.46	14.99
C	0.410	0.470	10.41	11.94
D	---	0.272	---	6.91
E	---	0.475	---	12.07
F	0.163	0.193	4.14	4.90
G	---	0.060	---	1.52
H	---	0.030	---	0.76
J	0.190	0.210	4.83	5.33
K	0.009	0.015	0.23	0.38
M	0.040	0.070	1.02	1.78
N	0.059	0.065	1.50	1.65
P	---	0.257	---	6.53
Q	0.326	0.334	8.28	8.48
R	---	0.385	---	9.78
S	0.483	0.497	12.27	12.62
T	0.435	0.445	11.05	11.30
U	---	0.385	---	9.78
V	0.088	0.094	2.24	2.39
W	---	0.008	---	0.20

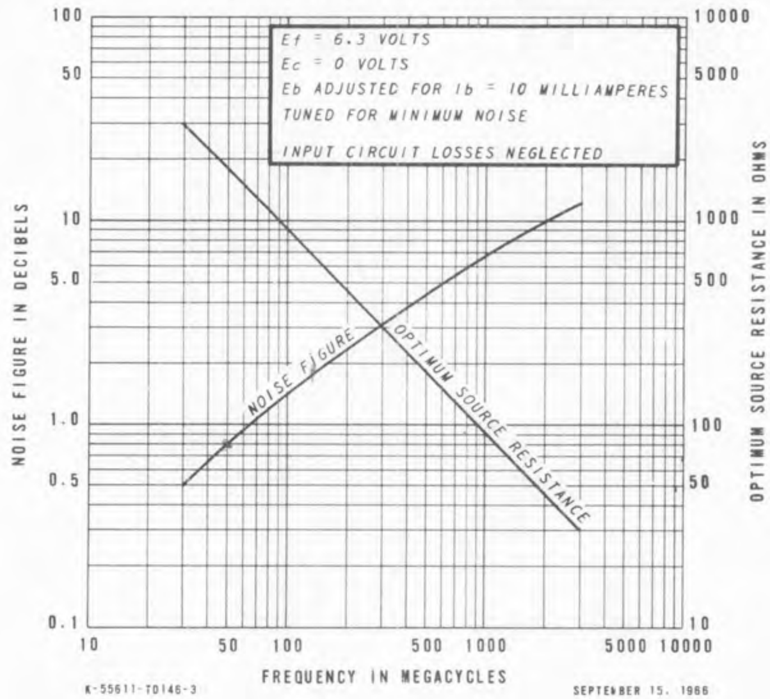
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



PREDICATED NOISE PERFORMANCE



TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

GE ELECTRONICS

6442
PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Small Size

Two Kilowatts Useful Pulse Power Output

The 6442 is a high-mu, metal-and-ceramic triode intended for operation as a plate-pulsed, grounded-grid oscillator at frequencies as high as 5000 megacycles. The 6442 is also useful as a CW, radio-frequency power amplifier or frequency multiplier at frequencies as high as 2500 megacycles.

Features of the 6442 include small size, planar electrode construction with close spacing, inherent rigidity, an envelope structure convenient for coaxial circuit applications, and excellent resistance to vibration and shock.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	0.9†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.3	pf
Grid to Cathode: (g to k)	5.0	pf
Plate to Cathode: (p to k), max.	0.045	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1	Ounce

Cooling—Conduction and Convection

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES
PLATE-PULSED OSCILLATOR SERVICE

Heater Voltage*	5.7 to 6.3	Volts
Cathode Heating Time, minimum	60	Seconds
Frequency	5000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶ #	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average #	2.5	Milliamperes
Average During Plate Pulse △	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average #	1.25	Milliamperes
Average During Plate Pulse	1.25	Amperes
Plate Dissipation #	7.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS (Continued)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down Conditions per Tube Without Amplitude Modulation**

Heater Voltage*	4.5 to 5.7	Volts
Cathode Heating Time, minimum	30	Seconds
Frequency	2500	Megacycles
DC Plate Voltage	350	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	35	Milliamperes
DC Grid Current	15	Milliamperes
Plate Dissipation	8.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
Cathode Heating Time, minimum	30	Seconds
Frequency	2500	Megacycles
DC Plate Voltage	275	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	35	Milliamperes
DC Grid Current	15	Milliamperes
Plate Dissipation	6.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	350	Volts
Grid Voltage	−4.25	Volts
Amplification Factor	50	
Transconductance	16500	Micromhos
Plate Current	35	Milliamperes

PLATE-PULSED OSCILLATOR

Frequency	3500	5000	Megacycles
Heater Voltage	6.0	6.0	Volts
Duty Factor	0.001	0.001	
Pulse Duration	1.0	1.0	Microseconds
Pulse Repetition Rate	1000	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	3000	3000	Volts
Negative Grid Voltage			
Average During Plate Pulse	75	75	Volts
Grid-Bias Resistor	50	50	Ohms
Plate Current			
Average	2.5	2.5	Milliamperes
Average During Plate Pulse	2.5	2.5	Amperes
Grid Current			
Average	1.25	1.25	Milliamperes
Average During Plate Pulse	1.25	1.25	Amperes
Useful Power Output			
Average	2.0	0.5	Watts
Average During Plate Pulse	2.0	0.5	Kilowatts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEGRAPHY

Frequency	1000	Megacycles
Heater Voltage	5.7	Volts
DC Plate Voltage	250	Volts
DC Plate Current	23	Milliamperes
DC Grid Current	6.0	Milliamperes
Driving Power	0.35	Watts
Useful Power Output	2.8	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.3 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

In any 5000 microsecond interval.

△ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

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

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	.840	900	960	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 350 volts				
Ib = 35 ma	−2.5	−4.25	−5.75	Volts
Transconductance				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma	13500	16500	19000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma	35	50	65	
Negative Grid Current				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma		.....	0.5	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 100 volts d-c	25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	250	.....	.....	Megohms
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode		.....	100	Microamperes
Heater Negative with Respect to Cathode		.....	100	Microamperes
Interelectrode Capacitances				
Grid to Plate: (g to p)	2.10	2.3	2.45	Picofarads
Grid to Cathode: (g to k)	4.60	5.0	5.45	Picofarads
Plate to Cathode: (p to k)		.....	0.045	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Pulsed-Oscillator Power Output — Tubes are tested for power output as an oscillator under the following conditions: Ef = 6.0 volts; F = 3450 MC, min.; epy = 3000 volts; tp = 1.0 μsec. ± 10%; prr adjusted for Du = 0.001 ± 5%; Rg adjusted for Ib = 2.5 ma	1.75	.....	Watts
Pulse Emission — Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts; tp = 1 to 3 μsec.; Du = 0.0005, min.; prr = 500 pps, max.; eb = ec and adjusted for is = 8 amp	.....	175	Volts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 250 mm Hg. Tubes shall not give visual evidence of flashover when 3000 volts RMS, 60 cps, is applied between the plate and grid terminals

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 20 mm Hg. Tubes shall not give visual evidence of flashover when 500 volts RMS, 60 cps, is applied between the plate and grid terminals

DEGRADATION RATE TESTS

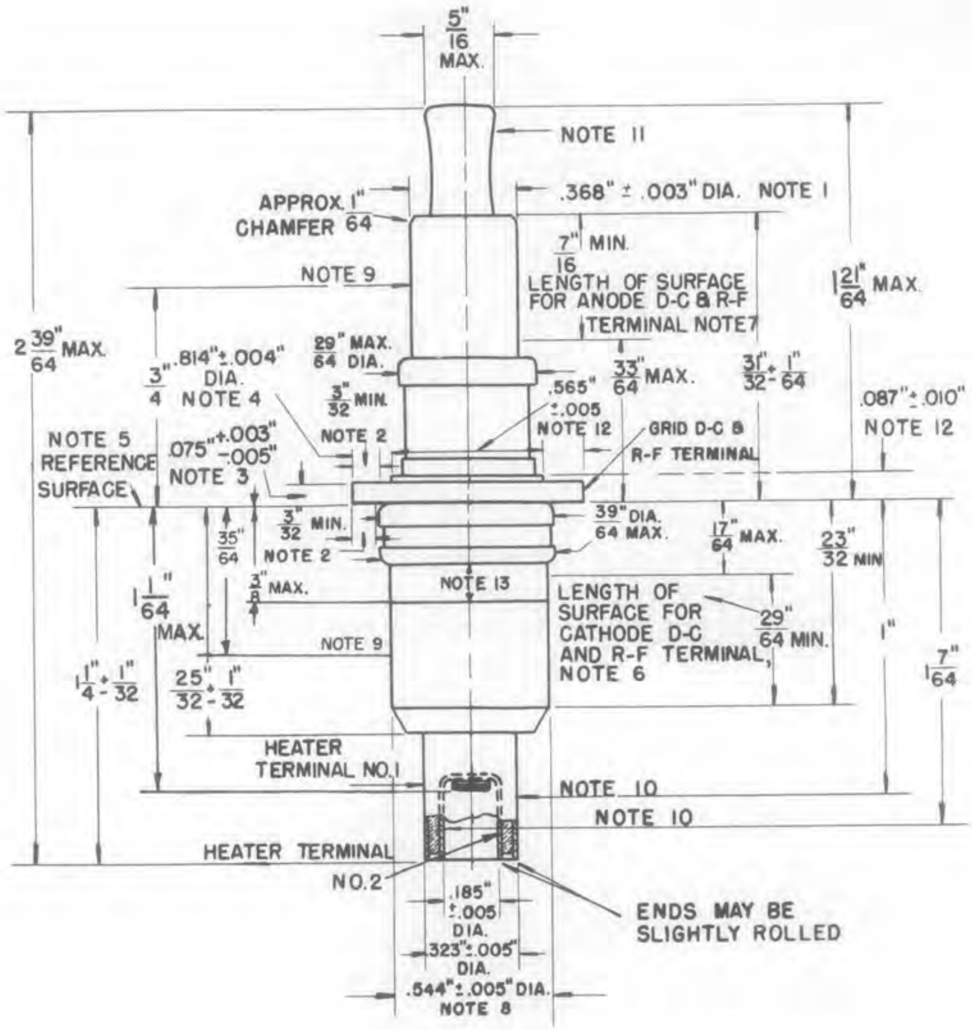
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as a pulsed oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS



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Note 1. Applies to minimum surface for anode d-c and r-f terminal only. Other surfaces must not be used for these terminal purposes.

Note 2. Applies to minimum surface for grid d-c and r-f terminal only. Other surfaces, except for Notes 3 and 4, must not be used for terminal purposes.

Note 3. Applies to minimum surfaces for grid d-c and r-f terminal only.

Note 4. The cylindrical surface of this diameter may be used for grid d-c and r-f terminal purposes.

Note 5. The surfaces defined by Notes 2, 3, and 4 shall be the only surfaces used for tube stops and clamping purposes.

Note 6. Other surfaces shall not be used for cathode d-c and r-f terminal purposes.

Note 7. Other surfaces shall not be used for anode d-c and r-f terminal purposes.

Note 8. Applies to surface designated for cathode d-c and r-f terminal. Solder at brazed joint will not exceed the maximum diameter.

Note 9. The maximum eccentricity of the anode and cathode with respect to the grid terminal in a prescribed jig is 0.010 (or maximum total runout of 0.020) and is measured by indicators at the points designated.

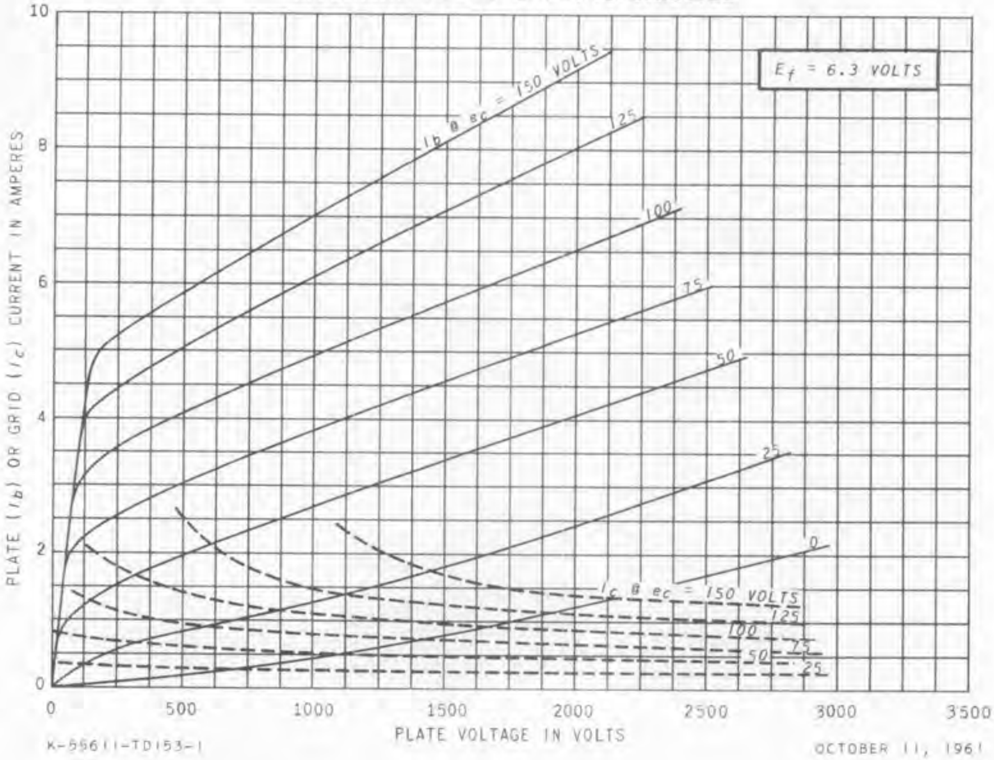
Note 10. The maximum eccentricity of heater-terminal No. 1 and heater-terminal No. 2 with respect to the grid terminal in a prescribed jig is 0.015 (or maximum total runout of 0.030) and is measured by indicators at the points designated.

Note 11. Exhaust tubulation must not be subjected to any mechanical stress.

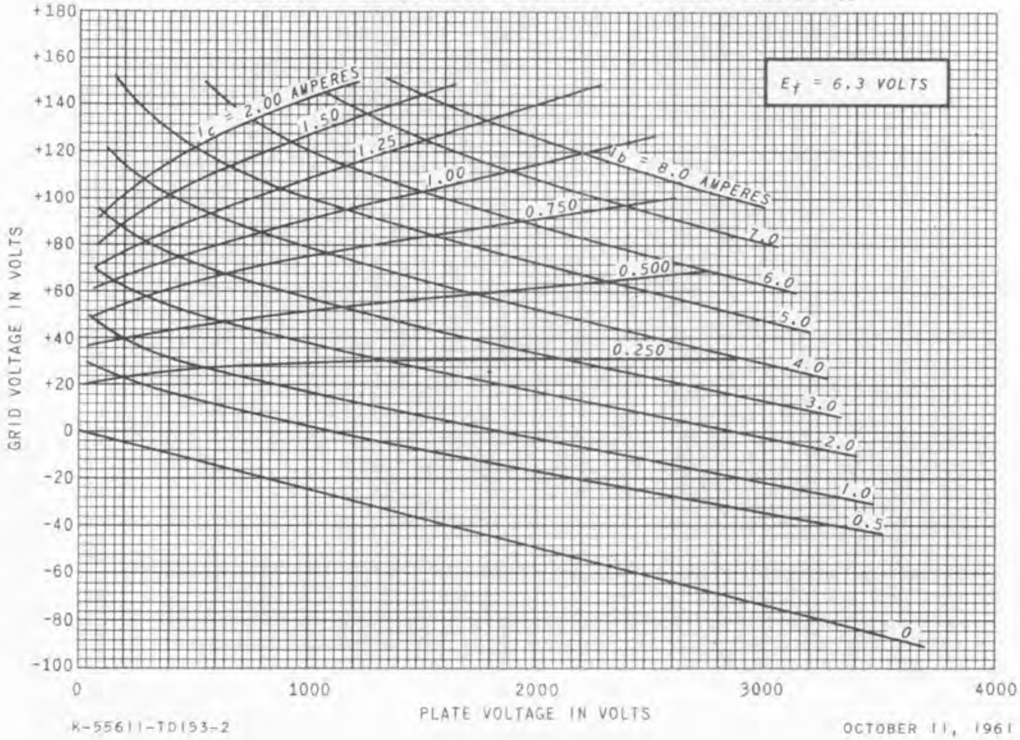
Note 12. For reference only. Dimension does not include any possible solder fillet.

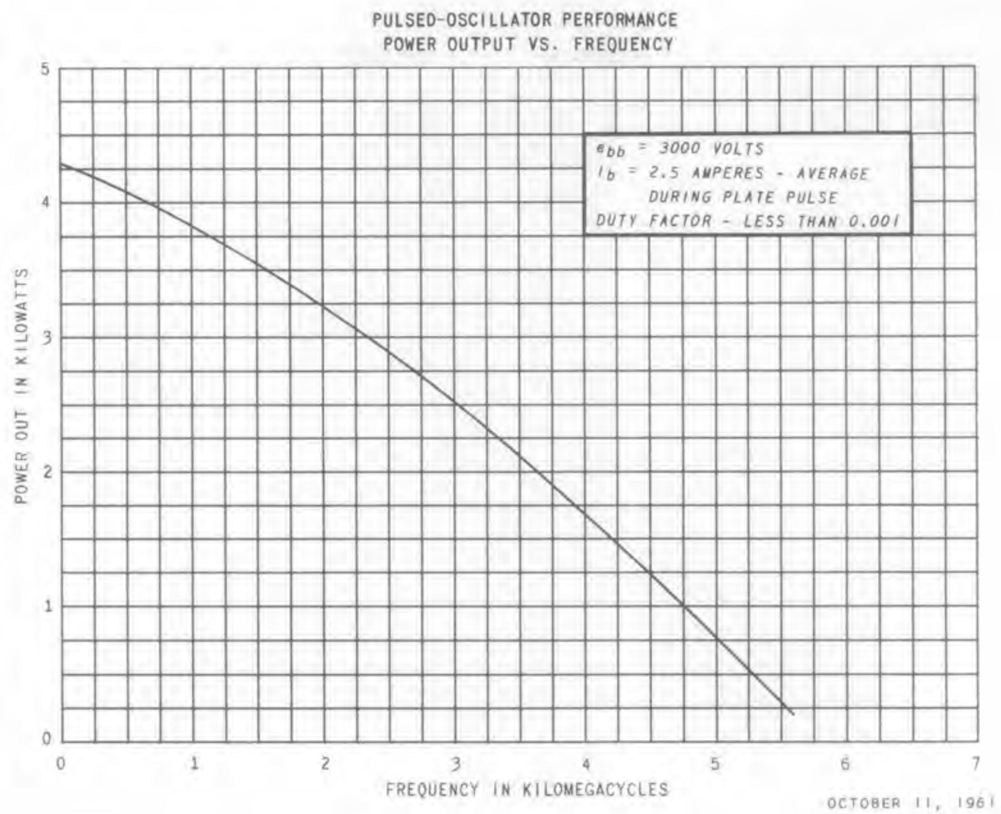
Note 13. This area is reserved for tube stamping and coding.

AVERAGE PLATE CHARACTERISTICS

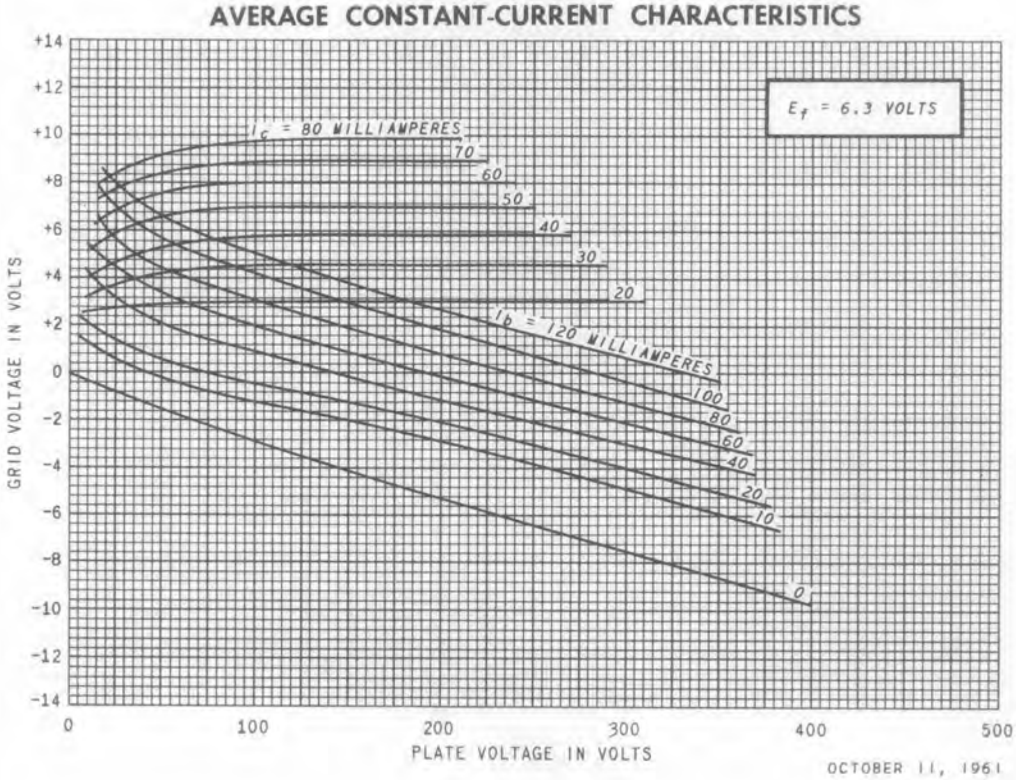


AVERAGE CONSTANT-CURRENT CHARACTERISTICS

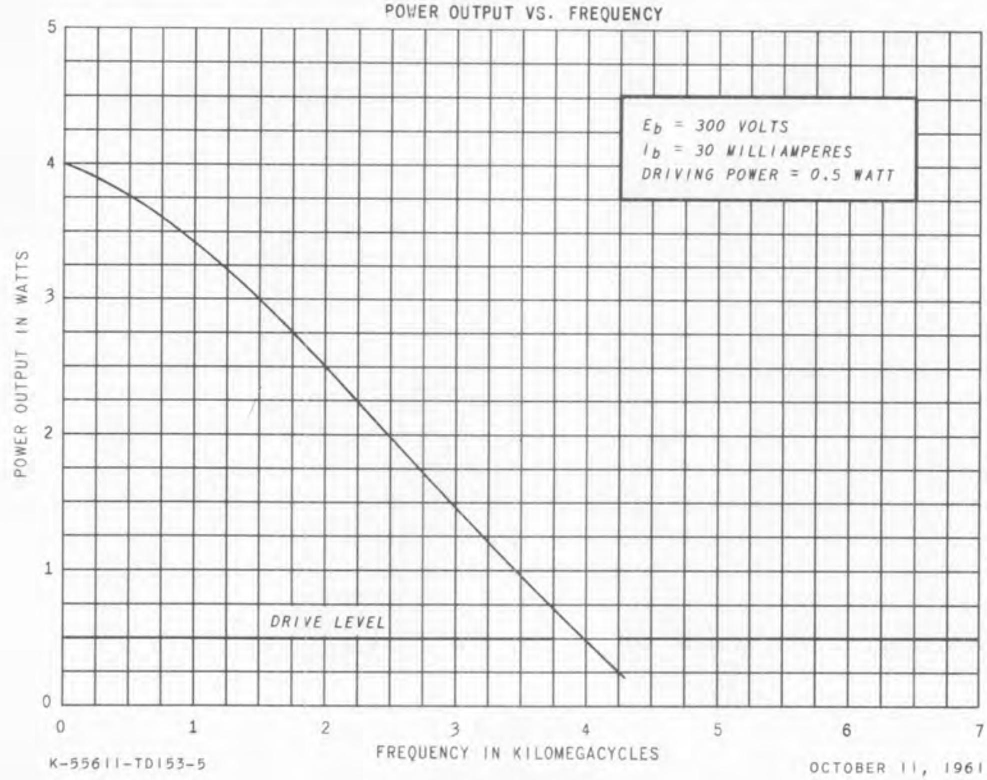




AVERAGE CONSTANT-CURRENT CHARACTERISTICS



CW - AMPLIFIER PERFORMANCE
POWER OUTPUT VS. FREQUENCY



GE ELECTRONICS

6771
PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR, AMPLIFIER, AND FREQUENCY MULTIPLIER SERVICE

Metal and Ceramic — Small Size

The 6771 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid oscillator, radio-frequency power amplifier, or frequency multiplier at frequencies as high as 4000 megacycles. The 6771 is also useful as a plate-pulsed, grounded-grid oscillator at frequencies as high as 5000 megacycles.

Features of the 6771 include small size, planar electrode construction with close spacing, inherent rigidity, an envelope structure convenient for coaxial circuit applications, and excellent resistance to vibration and shock.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	0.575†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.03	pf
Grid to Cathode: (g to k)	4.05	pf
Plate to Cathode: (p to k)	0.018	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	0.9	Ounces

Cooling—Conduction and Convection

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY AMPLIFIER—CLASS A

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	300	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	25	Milliamperes
Plate Dissipation	6.25	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.5	Megohms
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS (Continued)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	275	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	25	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	6.25	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	250	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	22	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	5.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

FREQUENCY MULTIPLIER

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	250	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	20	Milliamperes
DC Grid Current	5.0	Milliamperes
Plate Dissipation	5.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

PLATE-PULSED OSCILLATOR SERVICE

Heater Voltage*	5.7 to 6.3	Volts
Cathode Heating Time, minimum	60	Seconds
Frequency	5000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	1750	Volts
Duty Factor of Plate Pulse¶ #	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average #	1.25	Milliamperes
Average During Plate Pulse△	1.25	Amperes
Negative Grid Voltage		
Average During Plate Pulse	75	Volts
Grid Current		
Average #	0.7	Milliamperes
Average During Plate Pulse	700	Milliamperes
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Grid Voltage, approximate	−1.6	Volts
Amplification Factor	90	
Transconductance	23000	Micromhos
Plate Current	25	Milliamperes

RADIO-FREQUENCY OSCILLATOR

Frequency	4000	Megacycles
Heater Voltage	4.5	Volts
DC Plate Voltage	275	Volts
DC Plate Current	25	Milliamperes
Power Output	300	Milliwatts

FREQUENCY MULTIPLIER—DOUBLER TO 1000 MEGACYCLES

Heater Voltage	5.25	Volts
DC Plate Voltage	250	Volts
DC Plate Current	20	Milliamperes
DC Grid Voltage	−10	Volts
DC Grid Current	5.0	Milliamperes
Driving Power	300	Milliwatts
Power Output	2.0	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.3 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

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

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

In any 5000 microsecond interval.

△ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 12.5 amperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	530	575	620	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 250 volts, Ib = 25 ma	−0.90	−1.60	−2.65	Volts
Grid Voltage				
Ef = 6.3 volts, Eb = 250 volts, Ib = 2 ma	−2.00	−3.50	−5.40	Volts
Transconductance				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	18500	23000	27500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	60	90	120	
Negative Grid Current				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	.....	.....	0.35	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 100 volts d-c	25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	250	.....	.....	Megohms
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	100	Microamperes
Heater Negative with Respect to Cathode	.....	.....	100	Microamperes
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.75	2.03	2.30	Picofarads
Grid to Cathode: (g to k)	3.60	4.05	4.55	Picofarads
Plate to Cathode: (p to k)	0.012	0.018	0.024	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 4.5 volts; F = 4000 MC, min.; Eb = 275 volts, Ec adjusted for Ib = 25 ma	200	...	Milliwatts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 20 mm Hg. Tubes shall not give visual evidence of flashover when 500 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

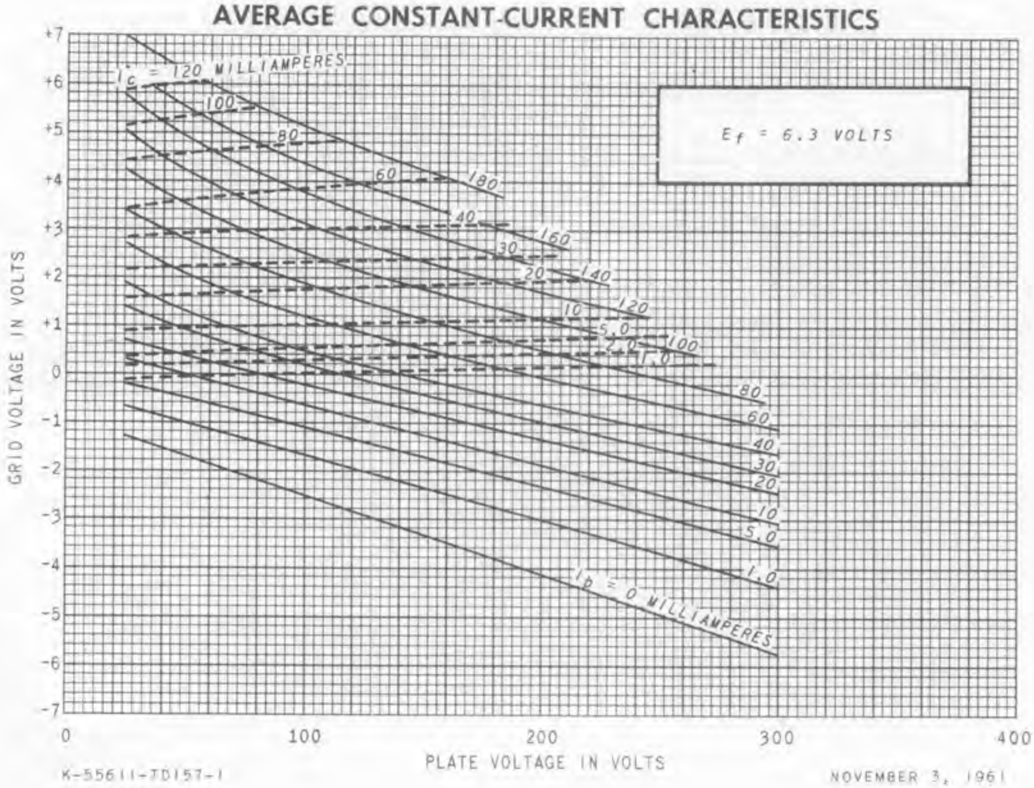
Shock

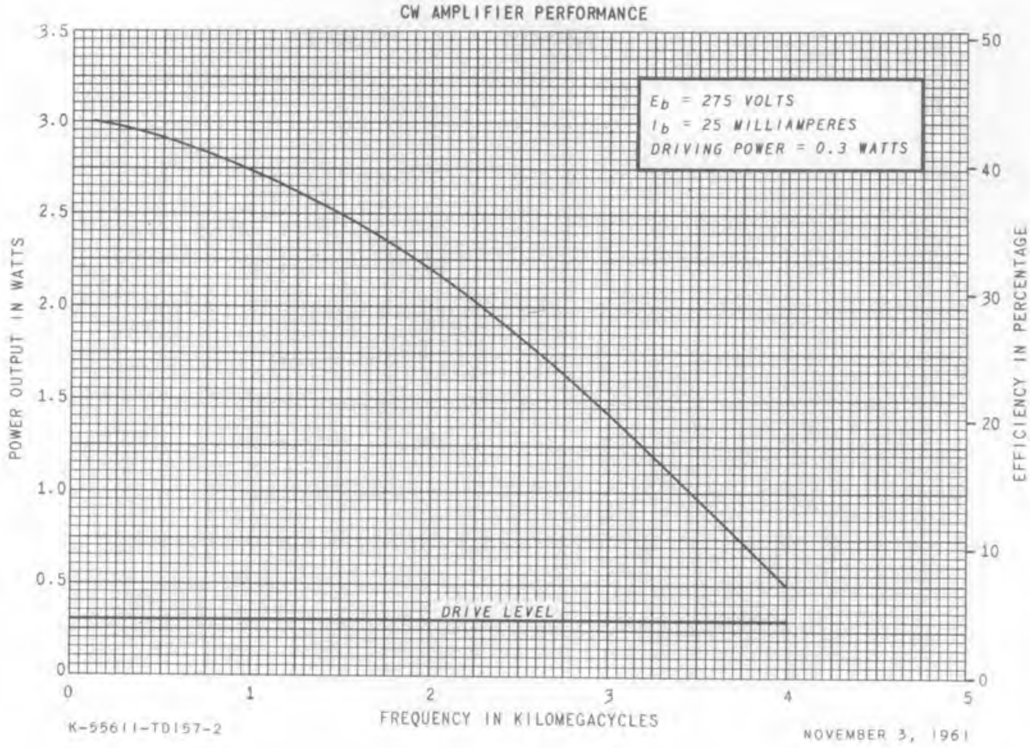
Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

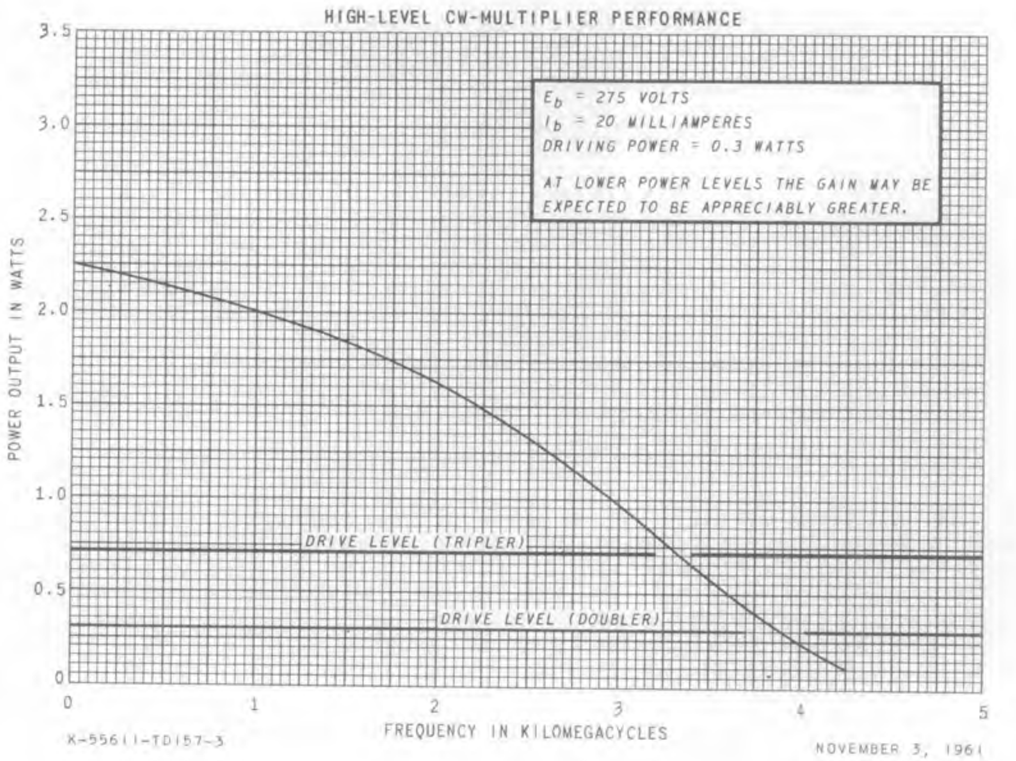
1000-Hour Life Test

Statistical sample operated for 1000 hours as an oscillator to evaluate changes in power output with life.

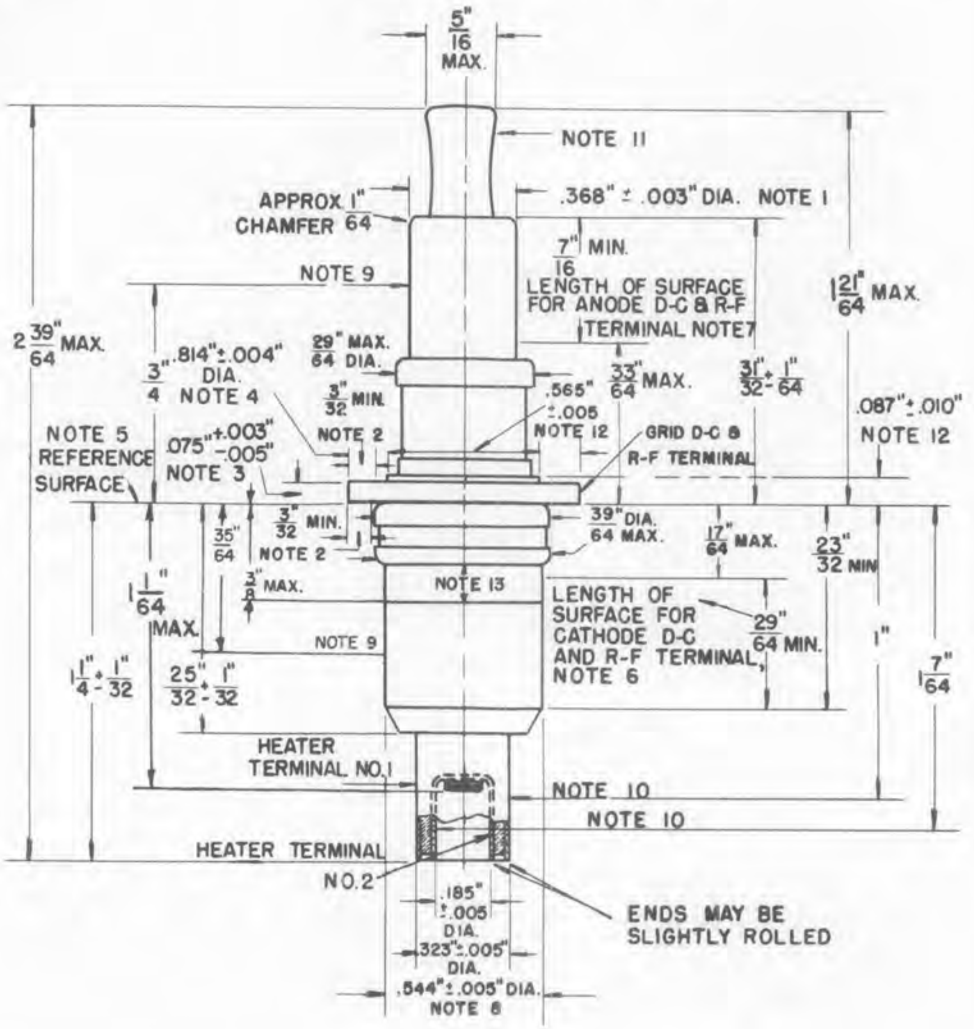
AVERAGE CONSTANT-CURRENT CHARACTERISTICS




CW AMPLIFIER PERFORMANCE
E_b = 275 VOLTS
I_b = 25 MILLIAMPERES
DRIVING POWER = 0.3 WATTS
DRIVE LEVEL
POWER OUTPUT IN WATTS
EFFICIENCY IN PERCENTAGE
FREQUENCY IN KILOMEGACYCLES
K-55611-TD157-2
NOVEMBER 3, 1961


HIGH-LEVEL CW-MULTIPLIER PERFORMANCE
E_b = 275 VOLTS
I_b = 20 MILLIAMPERES
DRIVING POWER = 0.3 WATTS
AT LOWER POWER LEVELS THE GAIN MAY BE EXPECTED TO BE APPRECIABLY GREATER.
DRIVE LEVEL (TRIPLER)
DRIVE LEVEL (DOUBLER)
POWER OUTPUT IN WATTS
FREQUENCY IN KILOMEGACYCLES
K-55611-TD157-3
NOVEMBER 3, 1961

PHYSICAL DIMENSIONS



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Note 1. Applies to minimum surface for anode d-c and r-f terminal only. Other surfaces must not be used for these terminal purposes.

Note 2. Applies to minimum surface for grid d-c and r-f terminal only. Other surfaces, except for Notes 3 and 4, must not be used for terminal purposes.

Note 3. Applies to minimum surfaces for grid d-c and r-f terminal only.

Note 4. The cylindrical surface of this diameter may be used for grid d-c and r-f terminal purposes.

Note 5. The surfaces defined by Notes 2, 3, and 4 shall be the only surfaces used for tube stops and clamping purposes.

Note 6. Other surfaces shall not be used for cathode d-c and r-f terminal purposes.

Note 7. Other surfaces shall not be used for anode d-c and r-f terminal purposes.

Note 8. Applies to surface designated for cathode d-c and r-f terminal. Solder at brazed joint will not exceed the maximum diameter.

Note 9. The maximum eccentricity of the anode and cathode with respect to the grid terminal in a prescribed jig is 0.010 (or maximum total runout of 0.020) and is measured by indicators at the points designated.

Note 10. The maximum eccentricity of heater-terminal No. 1 and heater-terminal No. 2 with respect to the grid terminal in a prescribed jig is 0.015 (or maximum total runout of 0.030) and is measured by indicators at the points designated.

Note 11. Exhaust tubulation must not be subjected to any mechanical stress.

Note 12. For reference only. Dimension does not include any possible solder fillet.

Note 13. This area is reserved for tube stamping and coding.

GL-6848
TETRODE

VHF-UHF | **FORCED-AIR COOLED**
RING-SEAL CONSTRUCTION | **METAL AND CERAMIC**
GROUNDED-GRID CIRCUIT

The GL-6848 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 2 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-6848 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	μμf
Input, G_2 tied to G_1	—	27.8	—	μμf
Output, G_2 tied to G_1¶	—	6.4	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate .... 6.0 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow				
Through Radiator				
Percentage Rated Plate Dissipation	100	80	60	Percent
Air Flow	120	70	48	Cubic Feet per Minute
Static Pressure	3.2	1.5	0.8	Inches
Screen-grid to Control-grid Seals			15	Min Cubic Feet per Minute
Heater-to-Cathode Seals			7.5	Min Cubic Feet per Minute
Anode Ceramic			10	Min Cubic Feet per Minute

Incoming Air Temperature	45	Max C
Anode Hub Temperature	180	Max C
Ceramic Temperature at Any Point	200	Max C
Temperature at Any Other Point	200	Max C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The air duct can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	2.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	2.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

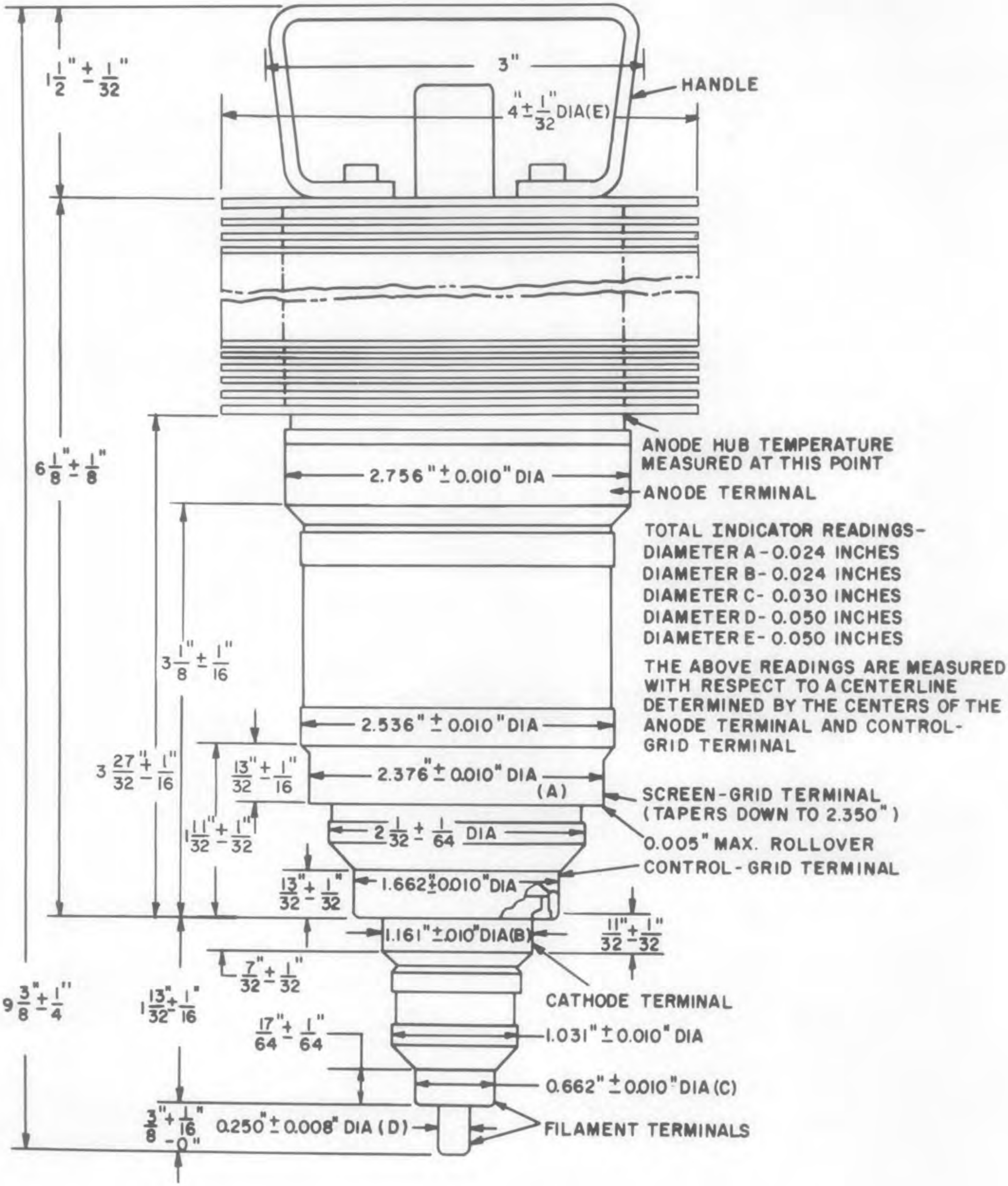
* The cathode of the GL-6848, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

‡ Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

\# Useful power output including power transferred from driver stage.


3"
HANDLE
4" ± 1/32" DIA(E)
1 1/2" ± 1/32"
6 1/8" ± 1/8"
ANODE HUB TEMPERATURE MEASURED AT THIS POINT
2.756" ± 0.010" DIA
ANODE TERMINAL
TOTAL INDICATOR READINGS-
DIAMETER A - 0.024 INCHES
DIAMETER B - 0.024 INCHES
DIAMETER C - 0.030 INCHES
DIAMETER D - 0.050 INCHES
DIAMETER E - 0.050 INCHES
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL
3 1/8" ± 1/16"
2.536" ± 0.010" DIA
3 27/32" ± 1/16"
13/32" ± 1/16"
2.376" ± 0.010" DIA (A)
SCREEN-GRID TERMINAL (TAPERS DOWN TO 2.350")
1 11/32" ± 1/32"
2 1/32 ± 1/64 DIA
0.005" MAX. ROLLOVER
CONTROL-GRID TERMINAL
13/32" ± 1/32"
1.662" ± 0.010" DIA
1.161" ± .010" DIA (B)
11/32" ± 1/32"
7/32" ± 1/32"
CATHODE TERMINAL
9 3/8" ± 1/4"
1 13/32" ± 1/16"
17/64" ± 1/64"
1.031" ± 0.010" DIA
0.662" ± 0.010" DIA (C)
3/8" + 1/16" - 0"
0.250" ± 0.008" DIA (D)
FILAMENT TERMINALS

GE ELECTRONICS

6897

PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Low Interelectrode Capacitances
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 6897 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

Features of the 6897 include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to be Used as a Socket Stop and Clamp

Net Weight, approximate . . . 2 Ounces

Cooling
- Plate and Plate Seal—Conduction and Forced Air
- Grid and Cathode Seals—Conduction and Forced Air
- Recommended Air Flow Cowling—157-JAN
- Recommended Air Flow on Plate Radiator at Sea Level
  - Incoming Air Temperature 25C,
    - Plate Dissipation
      - 100 Watts . . . 12.5 Cu. Ft./Min.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR —CLASS C TELEGRAPHY

Key-down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR —CLASS C TELEPHONY

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage△	.....	Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

RADIO-FREQUENCY OSCILLATOR—CLASS C

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	−40	−22	Volts
Useful Power Output	40	17	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

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

※ Where long life and reliable operation are important, lower envelope temperatures should be used.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

△ Adjusted for Ib = 75 milliamperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	−1.3	−2.5	−3.5	Volts
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	−7.0	−9.5	−15	Volts
Transconductance				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	.....	.....	3.0	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 500 volts d-c	50	.....	.....	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma.	15	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals

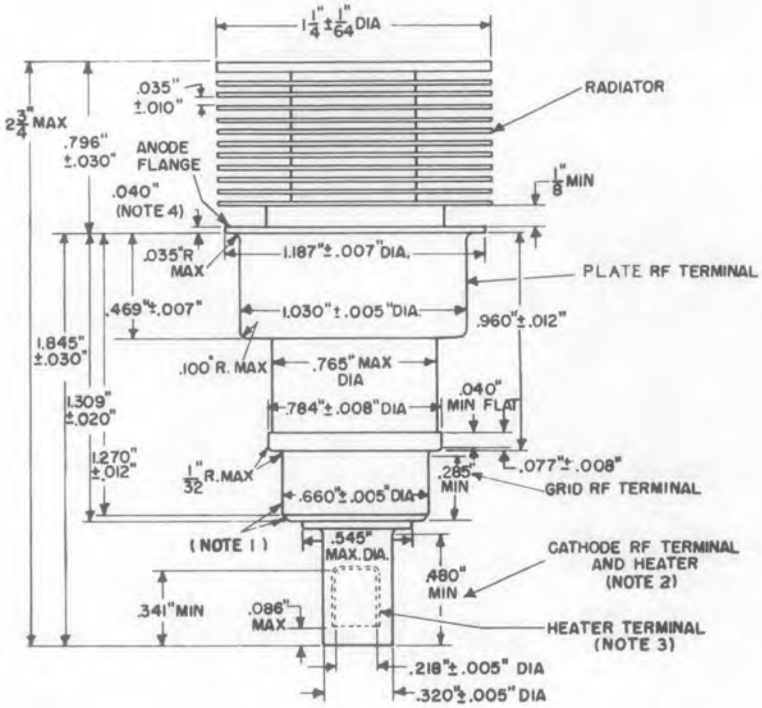
DEGRADATION RATE TESTS

Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

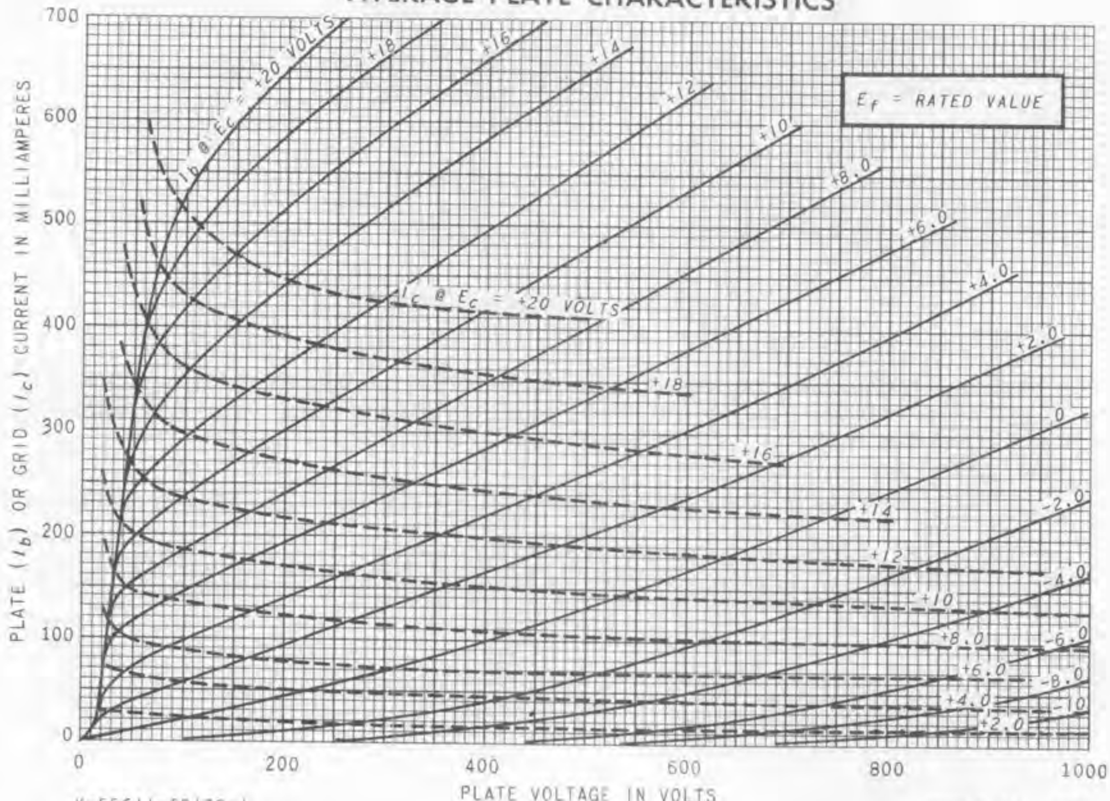


NOTES:

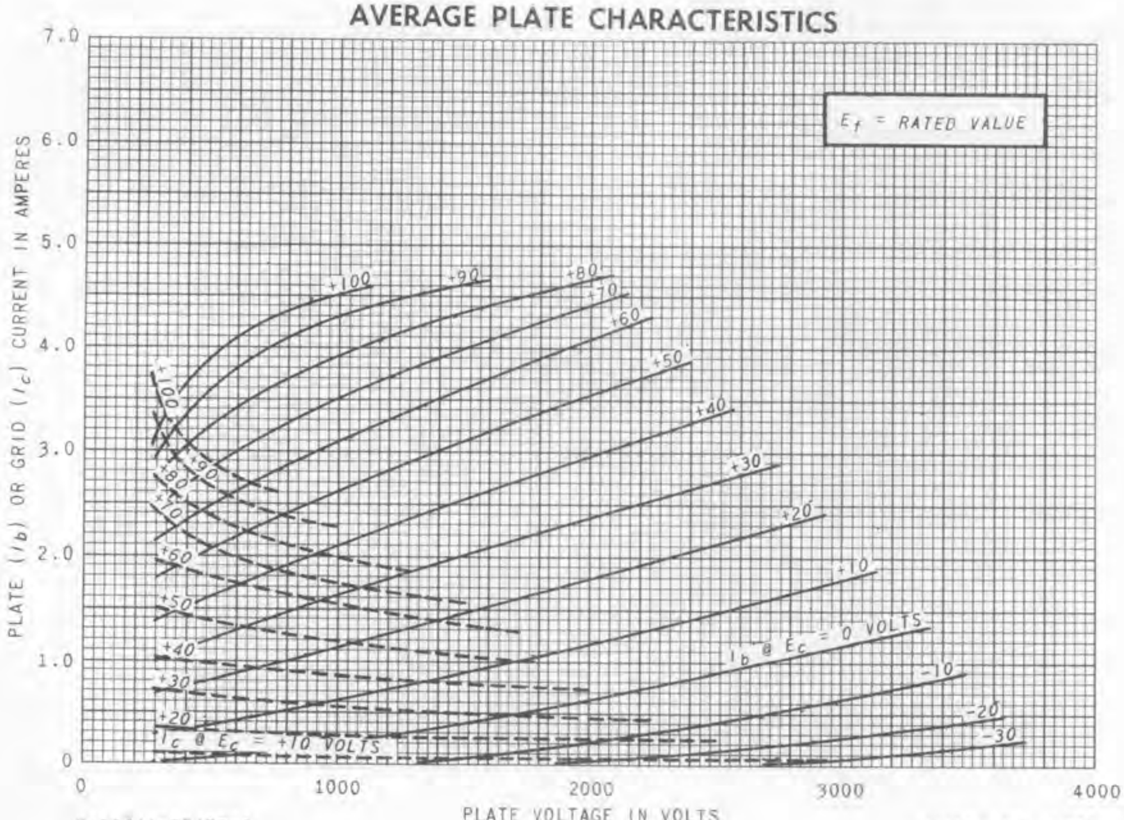
1. Solder not to extend radially beyond grid RF terminal.
2. Total indicated runout of the grid-contact surface and the cathode-contact surface with respect to the anode shall not exceed 0.020".
3. Total indicated runout of the cathode-contact surface with respect to the heater-contact surface shall not exceed 0.012".
4. Only this flange to be used as a socket stop and clamp.

¶ New pages 3 to 6 supersede pages 3 and 4 dated 12-61.

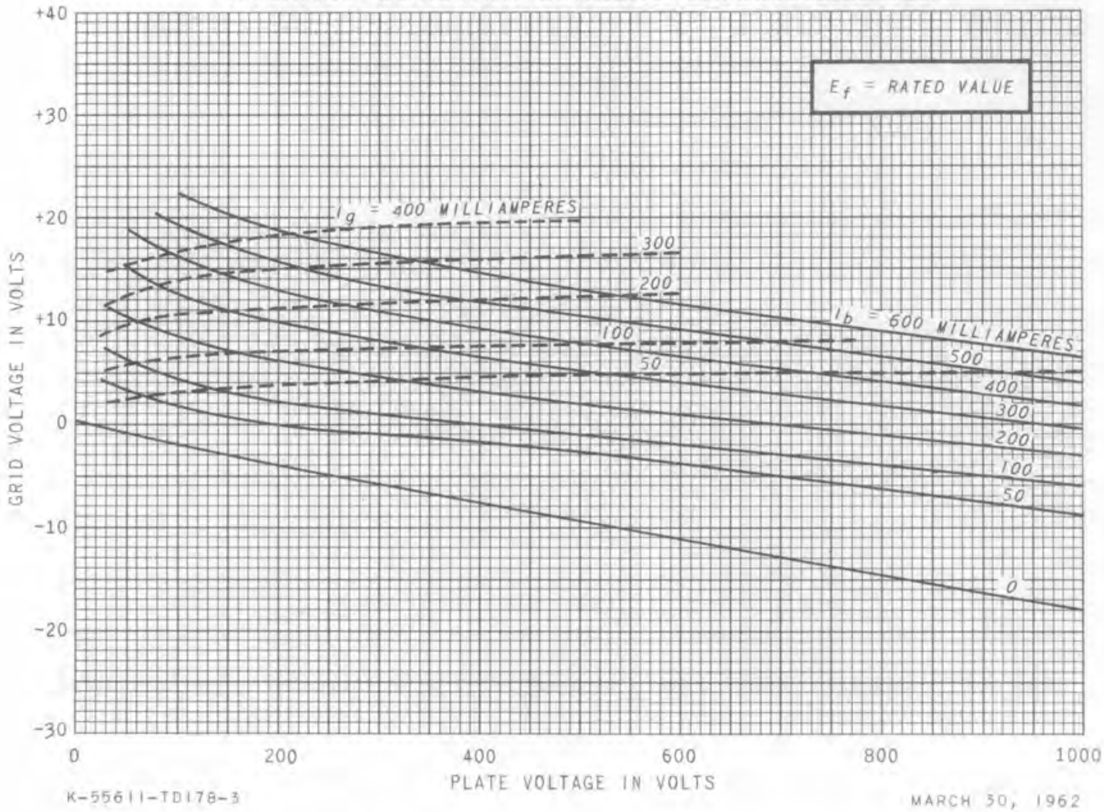
AVERAGE PLATE CHARACTERISTICS



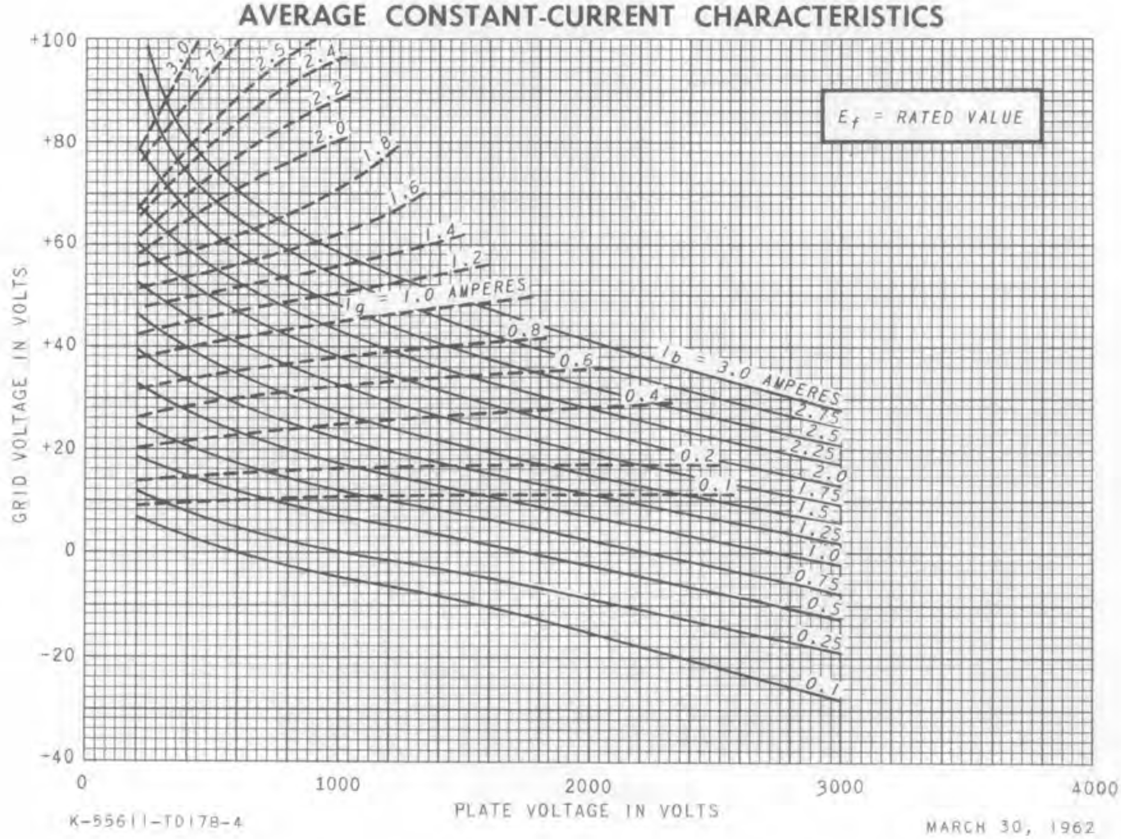
AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



ELECTRONIC INNOVATIONS IN ACTION

TUBES

GL-6942

Tetrode

ONE KILOWATT UHF TELEVISION OUTPUT
UHF TETRODE
GROUNDED-GRID CIRCUITS
FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR
THORIATED-TUNGSTEN CATHODE

The GL-6942 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope designed for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating one and one half kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is indirectly heated thoriated tungsten. Maximum ratings apply up to 1000 megacycles.

When used as a Class B grounded-grid broadband television amplifier this tube has a useful synchronizing peak-power output of one kilowatt at 900 megacycles; in narrow band Class C service the output is one kilowatt of continuous power as an amplifier or oscillator. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the small size and close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulators. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit. The small size of the GL-6942 permits compact mounting, and the ring-seal construction allows quick plug-in installation.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	5.7	6.0	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	—	—	36	Amperes
Heater Cold Resistance	—	0.02	—	Ohms
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, Eb = 2000 Volts, I_b = 0.200 Ampere, E_c2 = 475 Volts	12	17	22	
Peak Cathode Current†	—	—	3.0	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	—	0.006	μμf
Input, G_2 tied to G_1	15.5	17.0	18.5	μμf
Output, G_2 tied to G_1§	5.0	5.5	6.0	μμf

Mechanical

Mounting Position .... Any
Net Weight, approximate .... 3.6 Pounds

Thermal

Air Flow¶		
Through Radiator—See drawing for air duct form on page 3.		
Plate Dissipation	1.5	Kilowatts
Air Flow	60 Min	Cubic Feet per Minute
Static Pressure	1.5	Inches Water
Heater-to-Cathode Seals	8 Min	Cubic Feet per Minute
Screen-Grid to Control-Grid Seals	4 Min	Cubic Feet per Minute
Anode to Screen-Grid Ceramic Insulator	6 Min	Cubic Feet per Minute
Incoming Air Temperature	45 Max	C
Radiator Hub Temperature at Fin Adjacent to Anode Seal	180 Max	C
Ceramic Temperature at Any Point	200 Max	C

Forced-air cooling to be applied before and during the application of any voltages. Forced-air cooling must be maintained for one minute after the removal of all voltages.

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Plate Current	0.7 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

Typical Operation—Grounded-Grid Circuit up to 900 Megacycles

Bandwidth 6 Megacycles, measured to 1 decibel point		
DC Plate Voltage	3500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−40	Volts
Peak RF Plate Voltage		
Synchronizing Level	2500	Volts
Pedestal Level	1875	Volts
Peak RF Driving Voltage		
Synchronizing Level	110	Volts
Pedestal Level	70	Volts
DC Plate Current		
Synchronizing Level	0.520	Amperes
Pedestal Level	0.360	Amperes
DC Grid-No. 2		
Pedestal Level	0.035	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.110	Amperes
Pedestal Level	0.035	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	100	Watts
Pedestal Level	25	Watts
Power Output, approximateϕ		
Synchronizing Level	1000	Watts
Pedestal Level	560	Watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	3200 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−120 Max	Volts
DC Plate Current	0.35 Max	Amperes
Dc Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	1.12 Max	Kilowatts
Grid-No. 2 Input	10 Max	Watts
Plate Dissipation	1200 Max	Watts

Typical Operation, Grounded-Grid Circuit up to 900 Megacycles

DC Plate Voltage	3000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2300	Volts
Peak RF Driving Voltage	137	Volts
DC Plate Current	0.25	Amperes
DC Grid-No. 2 Current	0.01	Amperes
DC Grid-No. 1 Current, approximate	0.047	Amperes
Driving Power, approximate⧫	38	Watts
Power Outputϕ	565	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube without Amplitude Modulation▲

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−150 Max	Volts
DC Plate Current	0.7 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

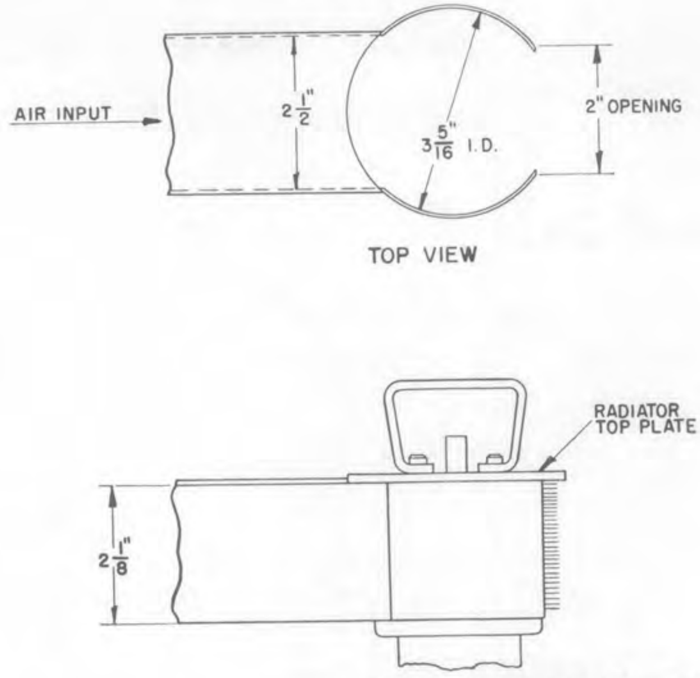
Typical Operation—Grounded-Grid Circuit at 1000 Megacycles, ¼λ Output

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−110	Volts
DC Plate Current	0.42	Amperes
DC Grid-No. 2 Current	0.011	Amperes
DC Grid-No. 1 Current, approximate	0.055	Amperes
Driving Power, approximate	65	Watts
Power Output, usefulϕ	1000	Watts

* The cathode of the GL-6942 because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the heater input to prevent overheating of the cathode with resulting short life. For long life, the GL-6942 should be put in operation with rated heater voltage. After the circuit has been adjusted for proper tube operation the heater voltage should be reduced to a value slightly above that at which circuit performance is affected. At a frequency of 900 megacycles and with typical operating conditions the heater voltage can be reduced to approximately 5.3 volts. At lower frequencies, the reduction will be less. Minor curcuit readjustment may be necessary after this adjustment.

† Represents maximum useable cathode current (plate current plus current to each grid) for any condition of operation.
‡ Measured with complete external shielding between cathode and anode.
§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.
¶ The volume of cooling air indicated for the various seals is for sea-level conditions and approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most staisfactory operation the maximum temperature of any point on the tube should be below 200 C.
ϕ Useful power output including power transferred from driver stage.
⧫ The carrier of the driver modulated 100 percent.
▲ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

BLOWER DUCT



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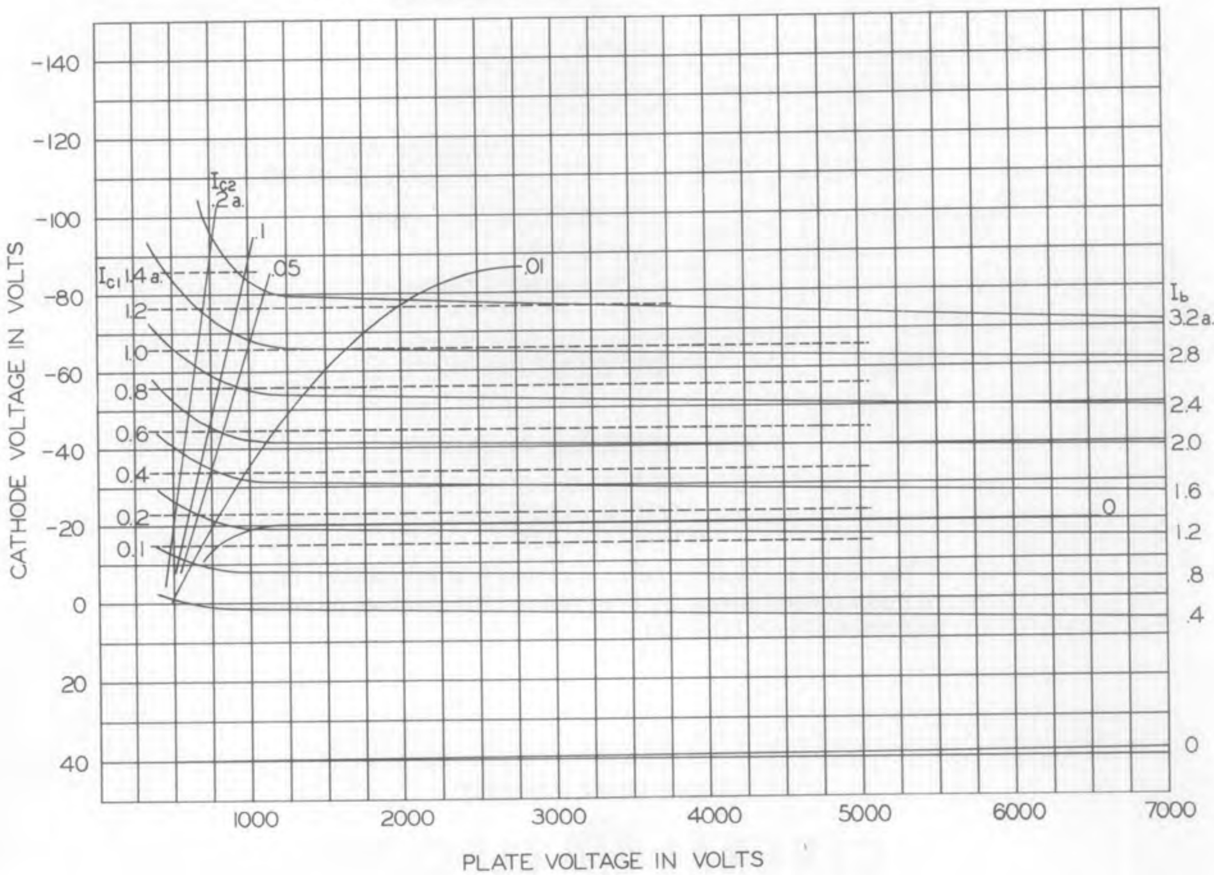
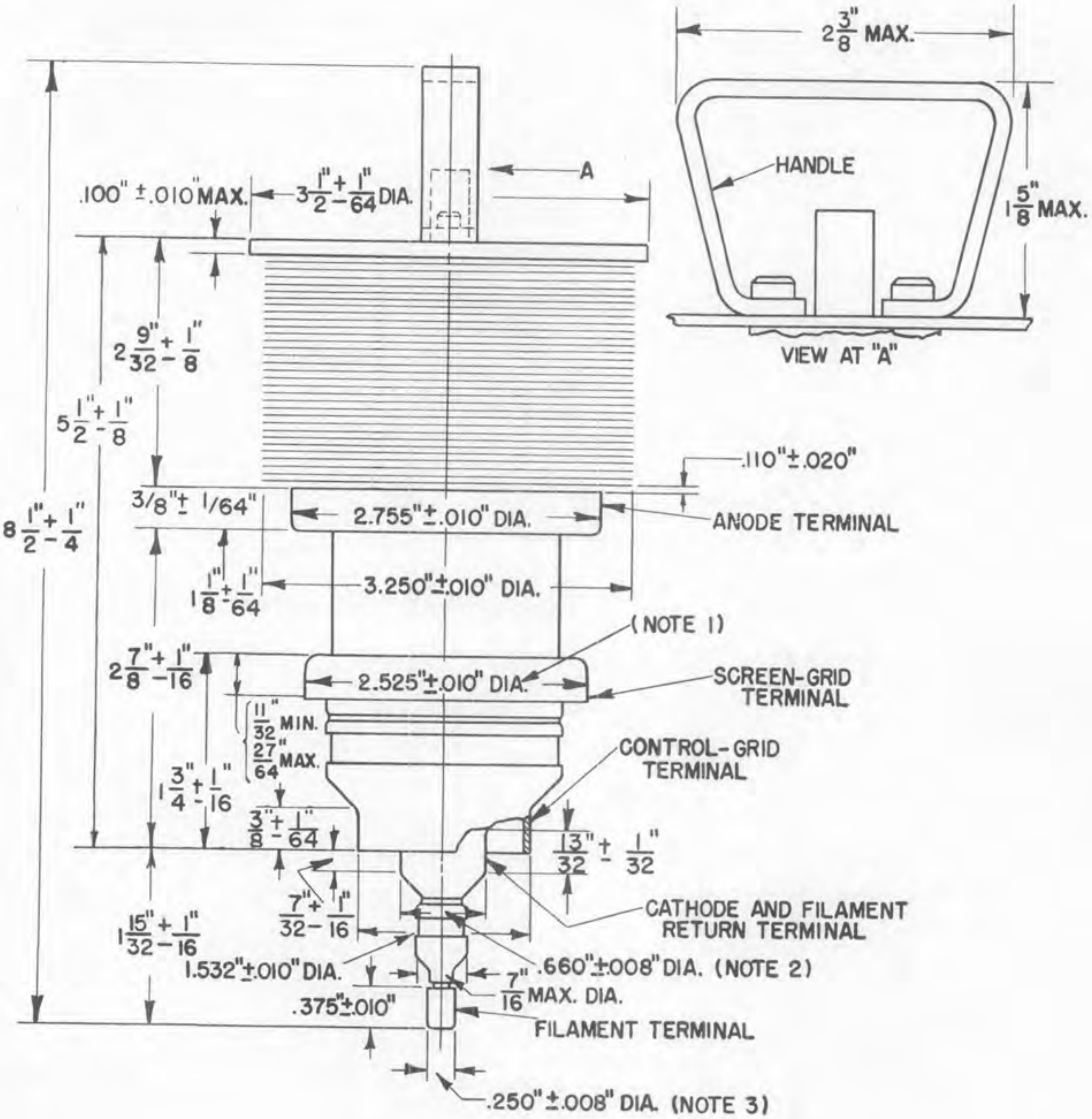
8-29-56

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 500 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





TOTAL INDICATOR READINGS

NOTE 1: 0.020″
NOTE 2: 0.030″
NOTE 3: 0.060″

The above readings are measured with respect to a centerline determined by the centers of the anode terminal and control-grid terminal.

TUBE DEPARTMENT

GENERAL ELECTRIC

Schenectady, New York 12305

GE ELECTRONICS

7077

METAL-CERAMIC TRIODE

FOR UHF AMPLIFIER APPLICATIONS

DESCRIPTION AND RATING

The 7077 is a high-mu triode of ceramic and metal planar construction primarily intended for use as an r-f amplifier in the UHF range. It features an extremely low noise figure throughout its frequency range. The 7077 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h+k)	1.7	pf
Output: p to (h+k)	0.01	pf
Heater to Cathode: (h to k)	1.1	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	1.1	Watts
DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature§	250	C
Grid-Circuit Resistance	0.01	Megohms

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

Supersedes ET-T1488 dated 3-58 and 10-59

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Supply Voltage	250	Volts
Resistor in Plate Circuit (bypassed)	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Amplification Factor	90	
Plate Resistance, approximate	9000	Ohms
Transconductance	10000	Micromhos
Plate Current	6.5	Milliamperes
Grid Voltage, approximate Gm = 50 Micromhos	−5	Volts

GROUNDED-GRID AMPLIFIER—450 MEGACYCLES

Plate Supply Voltage¶	250	Volts
Resistor in Plate Circuit (bypassed)¶	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Plate Current	6.5	Milliamperes
Bandwidth, approximate	7.5	Megacycles
Power Gain, approximate	14.5	Decibels
Noise Figure (Measured with power-matched input, using argon lamp noise source), approximate	5.5	Decibels

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

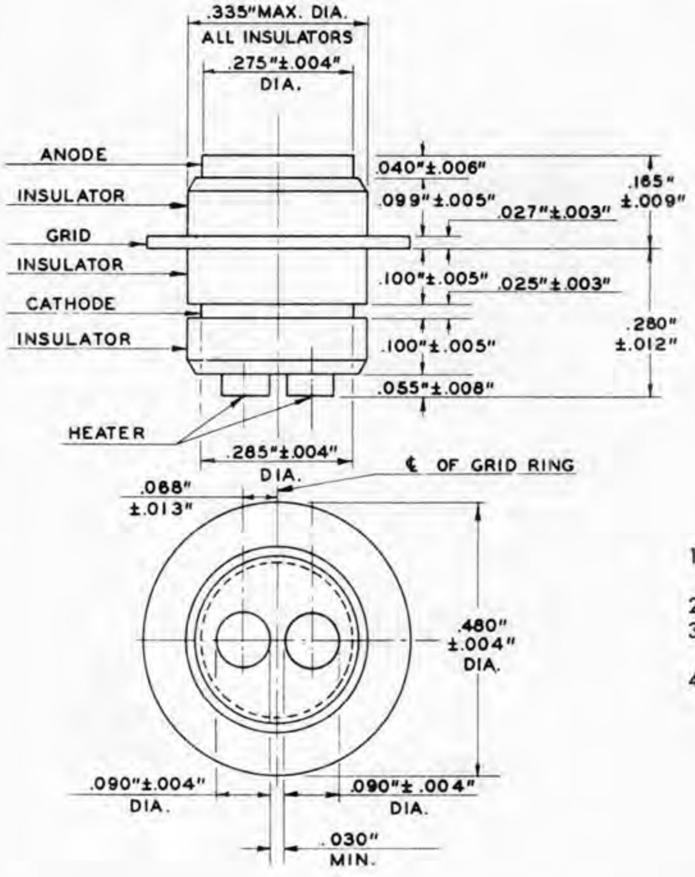
† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured using a grounded adapter that provides shielding between external terminals of tube.

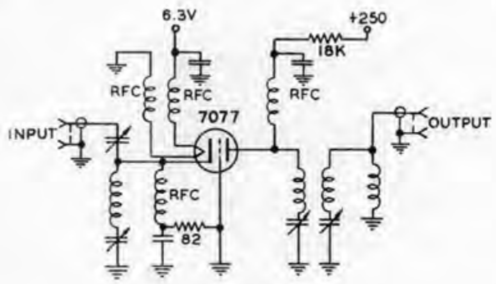
§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7077 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

¶ Lower supply voltage and a lower value of resistor may be used in the plate circuit with some sacrifice in uniformity of performance.

OUTLINE DRAWING



TYPICAL GROUNDED-GRID AMPLIFIER CIRCUIT USING THE 7077



1—Maximum eccentricity of anode, grid, and cathode 0.005″ from center line.
2—Maximum eccentricity of insulators 0.010″ from center line.
3—Center line of grid ring used as reference line for horizontal tolerances.
4—Bottom surface of grid ring used as reference line for vertical tolerances.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	222	240	258	Milliamperes
Plate Current				
Ef = 6.3 volts, Ebb = 250 volts, R_L = 18000 ohms, Rk = 82 ohms (bypassed)	4.5	6.5	8.5	Milliamperes
Transconductance				
Ef = 6.3 volts, Ebb = 250 volts, R_L = 18000 ohms (bypassed), Rk = 82 ohms (bypassed)	7000	10000	13000	Micromhos
Transconductance Change with Heater Voltage				
Difference between Transconductance measured at Ef = 6.3 and Ef = 6.0 volts (other conditions the same) expressed as a percentage	....	.....	20	Percent
Amplification Factor				
Ef = 6.3 volts, Ebb = 250 volts, R_L = 18000 ohms (bypassed), Rk = 82 ohms (bypassed)	65	90	115	
Interelectrode Capacitances				
Grid to Plate: (g to p)	0.84	1.00	1.16	Picofarads
Input: g to (h + k)	1.25	1.70	2.15	Picofarads
Output: p to (h + k)	0.004	0.010	0.016	Picofarads
Heater to Cathode: (h to k)	0.80	1.10	1.40	Picofarads
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	....	.....	20	Microamperes
Heater Negative with Respect to Cathode	....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Ebb = 250 volts, Ecc = −20 volts, Rk = 82 ohms (bypassed), Rg = 0.1 meg, R_L = 18000 ohms (bypassed)	....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Noise Figure				
Ef = 6.3 volts, Ebb = 250 volts, Rk = 82 ohms, R_L = 18000 ohms, F = 450 mc	....	5.5	6.6	Decibels
Noise Figure at Reduced Heater Voltage				
Ef = 6.0 volts, Ebb = 250 volts, Rk = 82 ohms, R_L = 18000 ohms, F = 450 mc	....	.....	8.1	Decibels
Power Gain				
Ef = 6.3 volts, Ebb = 250 volts, Rk = 82 ohms, R_L = 18000 ohms, F = 450 mc	12.5	14.5	.....	Decibels

SPECIAL PERFORMANCE TESTS (Continued)

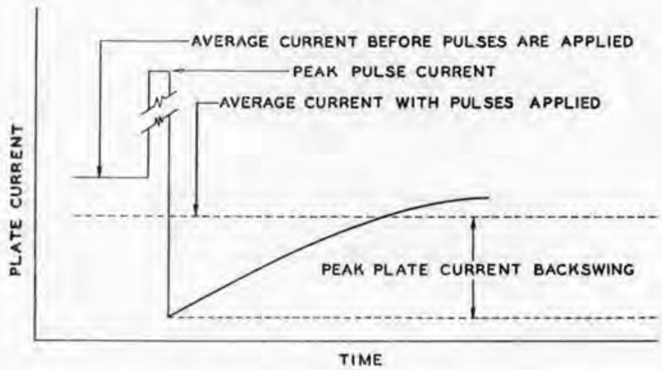
Grid Recovery

Change in Average Plate Current	0.6	Milliamperes
Peak Plate Current Backswing	1.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7077 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5 volts positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

PLATE CURRENT VS. TIME
—GRID RECOVERY TEST



	Min.	Bogey	Max.
Low Frequency Vibrational Output			10 Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 15 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of 96 hours, 48 hours in each of two planes, at a peak acceleration of 10G. Frequency is 60 cps. Tubes are operated during the test with Ef = 6.3 volts (no other voltages applied). Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, noise figure, and gain.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency

DEGRADATION RATE TESTS (Continued)

vibrational output, heater-cathode leakage, heater current, noise figure, and gain.

Stability Life Test

Statistical sample operated under Intermittent Life Test conditions is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

Statistical sample operated under Intermittent Life Test conditions is evaluated for shorted and open elements, transconductance, and noise figure following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 300 volts, Ehk = +70 volts d-c, Rk = 82 ohms, R_L = 18000 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, noise figure, gain, heater-cathode leakage, and interelectrode leakage resistance.

High-Temperature Intermittent Life Test

Statistical sample operated for 1000 hours under Intermittent Life Test conditions except that minimum envelope temperature shall be 250C. Tubes are evaluated, following 500 and 1000 of life test, for shorted or open elements, heater current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

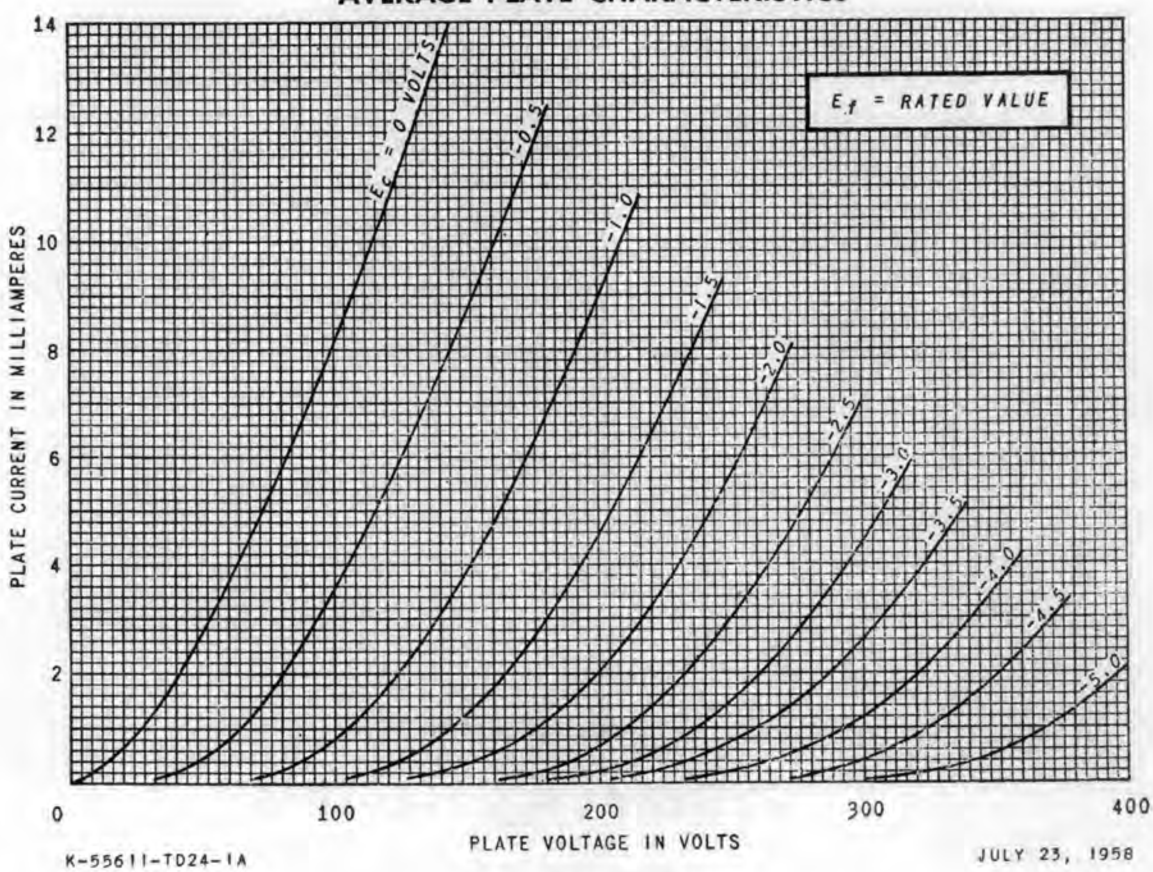
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

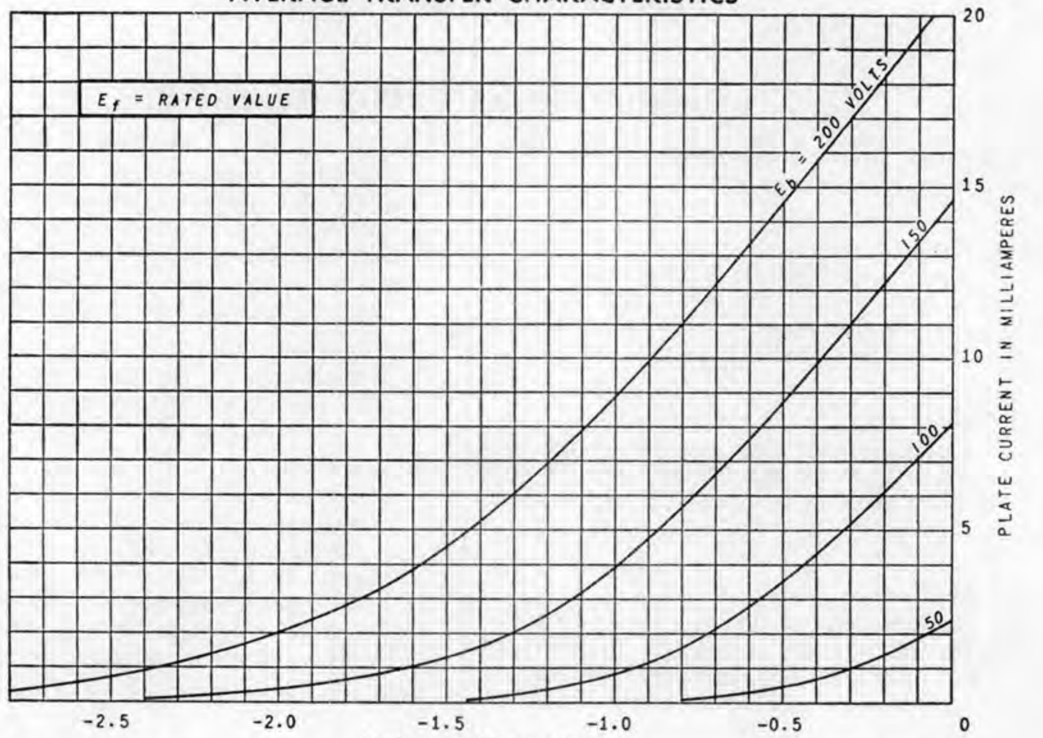
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable operating conditions.

AVERAGE PLATE CHARACTERISTICS

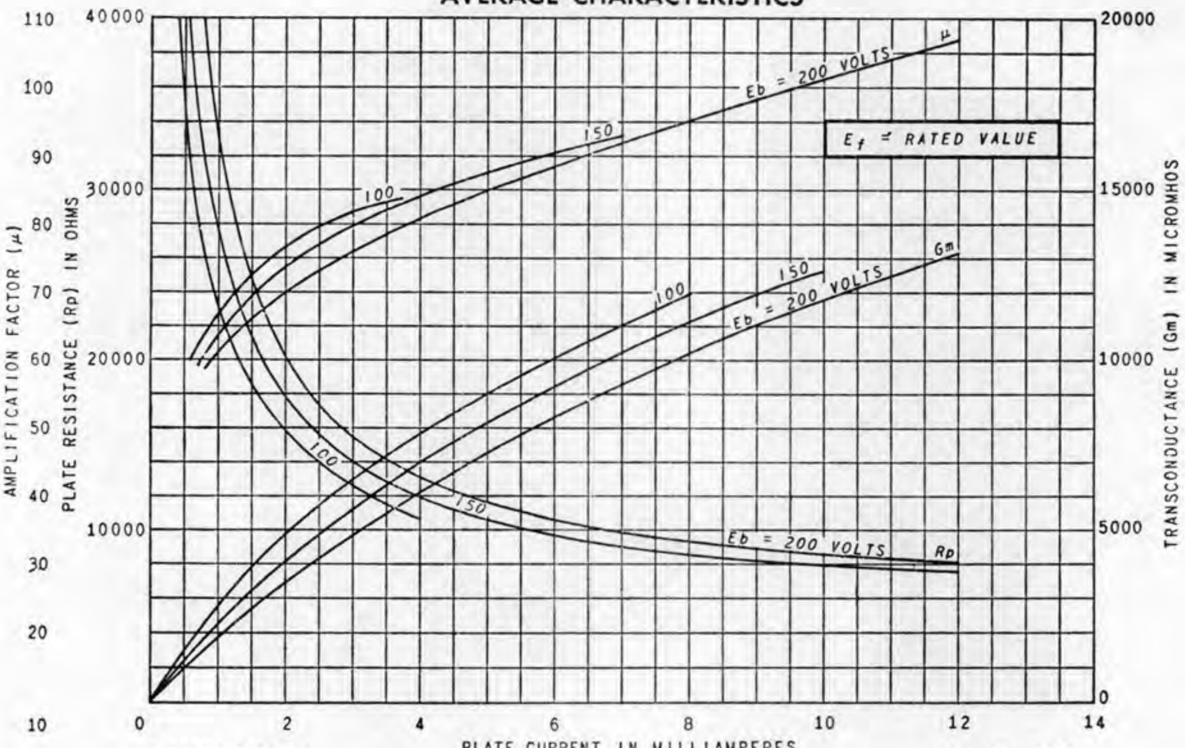


AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD24-2A JULY 23, 1958

AVERAGE CHARACTERISTICS



K-55611-TD24-3A JULY 23, 1958

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

METAL-CERAMIC DIODE

DESCRIPTION AND RATING

The 7266 is a cathode-type diode of ceramic-and-metal planar construction. It is intended for detector, high-frequency instrument probe, and low-current rectifier applications. The 7266 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings
Heater Voltage, AC or DC* . . . . . . 6.3 ± 0.3 Volts
Heater Current† . . . . 0.215 Amperes
Direct Interelectrode Capacitances‡
Plate to Cathode: (p to k) . . . . 1.0 pf
Heater to Cathode: (h to k) . . . . 1.3 pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Peak Inverse Plate Voltage . . . . 600 Volts
Steady-State Peak Plate Current . . . . 11 Milliamperes
DC Output Current . . . . 2.2 Milliamperes
Heater-Cathode Voltage
Heater Positive with Respect to Cathode . . . . 50 Volts
Heater Negative with Respect to Cathode . . . . 50 Volts
Envelope Temperature at Hottest Point§ . . . . 250 C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop
Ib = 1.0 Milliamperes DC . . . . 1.0 Volts

AVERAGE CHARACTERISTICS (Continued)

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured using a grounded adapter that provides shielding between external terminals of tube.

§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7266 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	198	215	232	Milliamperes
Tube Voltage Drop Ef = 6.3 volts, Eb adjusted for Ib = 1.0 ma	0.4	1.0	2.0	Volts
Tube Voltage Drop at Reduced Heater Voltage Ef = 5.7 volts, Eb adjusted for Ib = 1.0 ma	...	...	2.3	Volts
Emission Ef = 6.3 volts, Eb = 9 volts d-c	10	...	...	Milliamperes
Plate Current Ef = 6.3 volts, Ebb = 0 volts, R_L = 40000 ohms	2	8	16	Microamperes
Interelectrode Capacitances Plate to Cathode: (p to k)	0.7	1.0	1.3	Picofarads
Heater to Cathode: (h to k)	0.9	1.3	1.7	Picofarads
Heater-Cathode Leakage Current Ef = 6.3 volts, Ehk = 100 volts Heater Positive with Respect to Cathode	...	...	20	Microamperes
Heater Negative with Respect to Cathode	...	...	20	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode omission results. Plate to A11 at 500 volts d-c	10000	...	...	Megohms

SPECIAL PERFORMANCE TESTS

Low Pressure Voltage Breakdown Test
Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and cathode terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts and Ehk = +100 volts. Following the test, tubes are evaluated for heater-cathode leakage and heater current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts and Ehk = +100 volts. Following the test, tubes are evaluated for heater-cathode leakage and heater current.

Survival Rate Life Test

The combined statistical samples subjected to the Intermittent and Standby Life Tests are evaluated for shorted and open elements and tube voltage drop following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 220 volts RMS, Ehk = −70 volts d-c, R_L = 0.13 meg, C_L = 1.0 µf, and Rs = 1300 ohms. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, tube voltage drop, heater-cathode leakage, interelectrode leakage resistance, and emission.

Standby Life Test

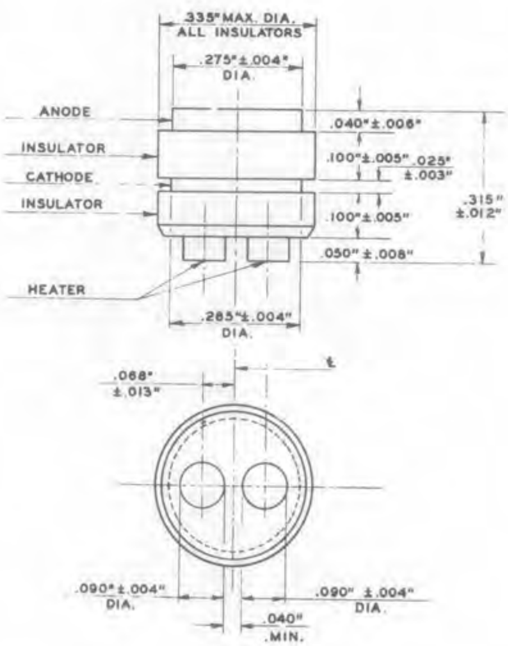
Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour) no other voltages applied. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, tube voltage drop, heater-cathode leakage, interelectrode leakage resistance, and emission.

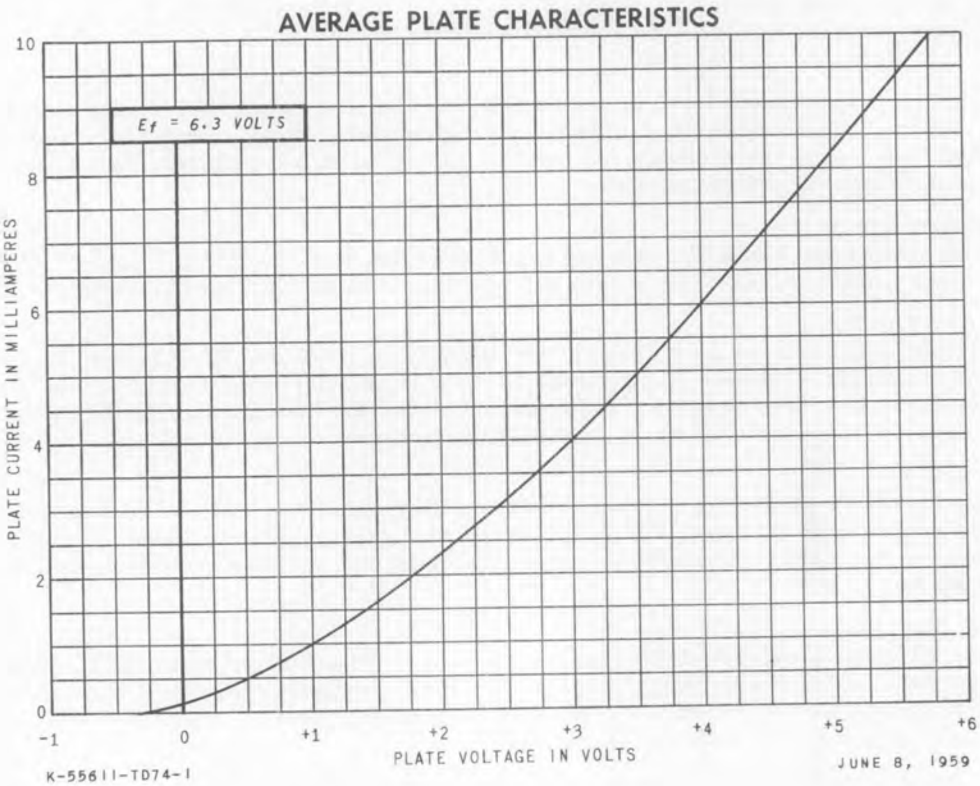
Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable operating conditions.

OUTLINE DRAWING





RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR, AMPLIFIER, AND FREQUENCY MULTIPLIER SERVICE

Metal and Ceramic — Pulse Rated
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 7289 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid CW oscillator, amplifier, or frequency multiplier at frequencies as high as 2500 megacycles. In addition, it may be used as a plate-pulsed oscillator or amplifier at frequencies as high as 3000 megacycles.

Features of the 7289 include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.0 volts	1.0†	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.0	pf
Grid to Cathode: (g to k)	6.3	pf
Plate to Cathode: (p to k), maximum	0.035	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to be Used as a Socket Stop and Clamp

Net Weight, approximate	2.5	Ounces

Cooling
Plate and Plate Seal—Conduction and Forced Air
Grid and Cathode Seals—Conduction and Forced Air
Recommended Air Flow Cowling—157-JAN
Recommended Air Flow on Plate Radiator at Sea Level Incoming Air Temperature 25C, Plate Dissipation 100 Watts . . . 12.5 Cu.Ft.PerMin.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions Per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions Per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

PLATE-PULSED OSCILLATOR OR AMPLIFIER

Heater Voltage*	5.7 to 6.0	Volts
Frequency	3000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3500	Volts
Duty Factor of Plate Pulse ⋕ △	0.0025	
Pulse Duration	3.0	Microseconds
Plate Current, Average During Plate Pulse △**	3.0	Amperes
Negative Grid Voltage, Average During Plate Pulse††	150	Volts
Grid Current, Average During Plate Pulse	1.8	Amperes
Plate Dissipation △	27	Watts
Grid Dissipation △	2.0	Watts
Envelope Temperature at Hottest Point	300	C

GENERAL ELECTRIC

⊕ *Supersedes pages 1 and 2 of D & R sheet for 7289 dated 12-61*

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.0	Volts
Plate Voltage	600	Volts
Grid Voltage§§		Volts
Amplification Factor	100	
Transconductance	25000	Micromhos
Plate Current	70	Milliamperes

RADIO-FREQUENCY POWER AMPLIFIER

Frequency	500	Megacycles
DC Plate Voltage	900	Volts
DC Grid Voltage	−40	Volts
DC Plate Current	90	Milliamperes
DC Grid Current, approximate	30	Milliamperes
Driving Power, approximate	6	Watts
Useful Power Output	40	Watts

RADIO-FREQUENCY OSCILLATOR

Frequency	2500	Megacycles
DC Plate Voltage	1000	Volts
DC Grid Voltage, approximate	−22	Volts
DC Plate Current	90	Milliamperes
DC Grid Current	10	Milliamperes
Useful Power Output	17	Watts

PLATE-PULSED OSCILLATOR

Frequency	3000	Megacycles
Heater Voltage	5.8	Volts
Duty Factor	0.0025	
Pulse Duration	3.0	Microseconds
Peak Positive-Pulse Plate-Supply Voltage	3500	Volts
Plate Current Average During Plate Pulse	3.0	Amperes
Grid Current Average During Plate Pulse	1.8	Amperes
Useful Power Output Average During Plate Pulse	1.6	Kilowatts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.0 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.0 volts.

‡ Measured in a special shielded socket.

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

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

Applications with a duty factor greater than 0.0025 should be referred to your General Electric tube sales representative for recommendations.

△ In any 5000-microsecond interval.

** The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 30 amperes.

†† The maximum instantaneous value should be within the range of +250 to −750 volts.

§§ Adjusted for Ib = 70 milliamperes.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

INITIAL CHARACTERISTICS LIMITS

	Min.	Max.	
Heater Current			
Ef = 6.0 volts	0.90	1.05	Amperes
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 100 ma	−2.0	−7.0	Volts
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 1.0 ma	....	−25	Volts
Negative Grid Current			
Ef = 6.0 volts, Eb = 1000 volts, Ec adjusted for Ib = 100 ma	....	8.0	Microamperes
Interelectrode Leakage Resistance			
Ef = 6.0 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results			
Grid to Cathode at 500 volts d-c	50	....	Megohms
Interelectrode Capacitances			
Grid to Plate: (g to p)	1.95	2.15	Picofarads
Grid to Cathode: (g to k)	5.6	7.0	Picofarads
Plate to Cathode: (p to k)	....	0.035	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts
Pulsed-Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.8 volts; F = 3000 MC, min.; epy = 3500 volts; tp = 3.0 μsec. ±10%; Du = 0.0025 ±5%; Rg adjusted for Ib = 7.5 ma; Ec = −1.5 volts, max.; Ic = 4.5 ma, max.	4.0	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 54 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

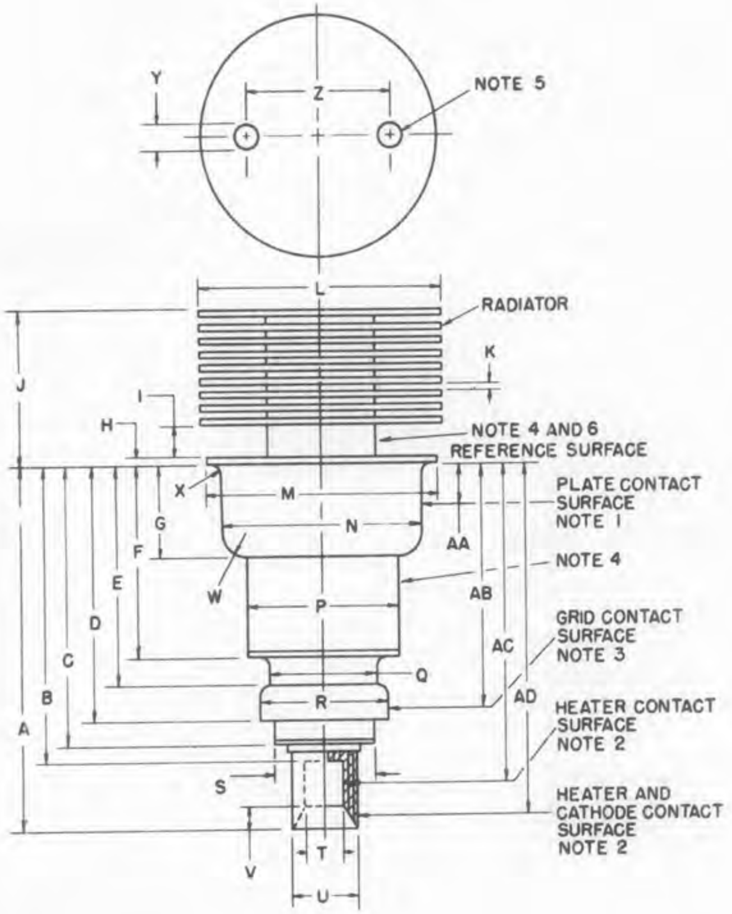
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 0.5 milliseconds duration in each of three positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS



DIMENSIONS FOR OUTLINE (INCHES)

Ref.	Minimum	Maximum
A	1.815	1.875
B	....	1.534
C	....	1.475
D	1.289	1.329
E	1.085	1.135
F	.880	.920
G	.462	.477
H	....	.040
I	.125	.185
J	.766	.826
K	.025	.046
L	1.234	1.264
M	1.180	1.195
N	1.025	1.035
P	.772	.792
Q	.541	.561
R	.655	.665
S	....	.545
T	.213	.223
U	.315	.325
V	....	.086
W	....	.100
X	....	.035
Y	.105	.145
Z	.650	.850

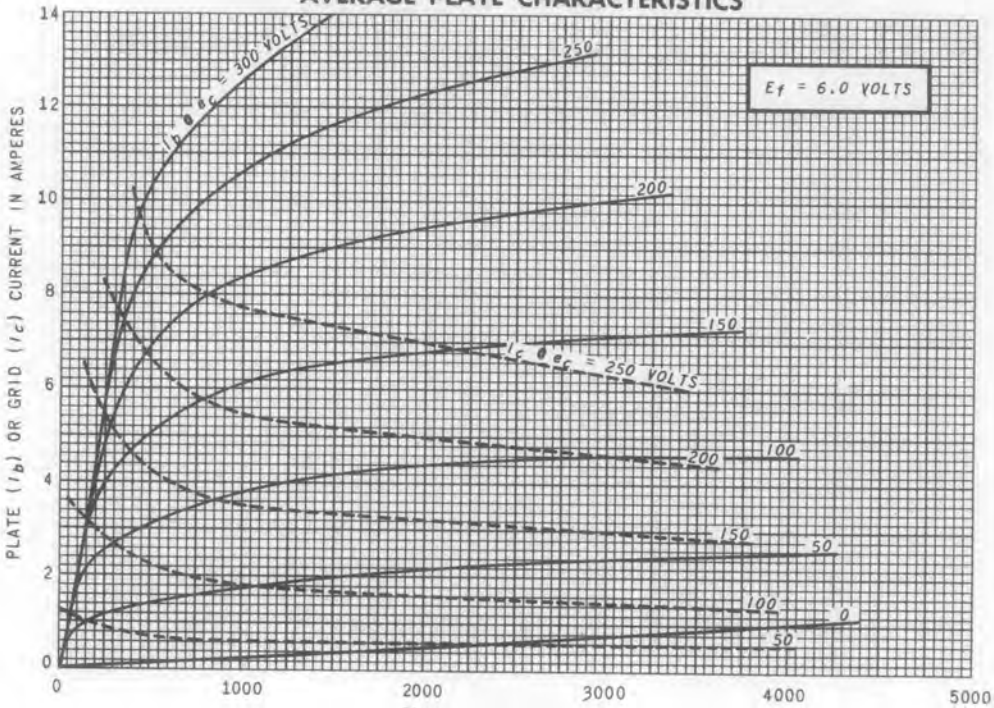
DIMENSIONS FOR ELECTRODE CONTACT AREA (INCHES)

Ref.	Dimension	Contact
AA	.198 ± .163	Plate
AB	1.225 ± .040	Grid
AC	1.631 ± .097	Heater
AD	1.645 ± .170	Cathode

NOTES

1. The total indicated runout of the plate contact surface with respect to the cathode contact surfaces will not exceed .020 inch.
2. The total indicated runout of the cathode contact surface with respect to the heater contact surfaces will not exceed .012 inch.
3. The total indicated runout of the grid contact surface with respect to the cathode contact surface will not exceed .020 inch.
4. Do not clamp or locate on this surface.
5. Hole provided for tube extractor through the top fin only.
6. Measure plate shank temperature on this surface.

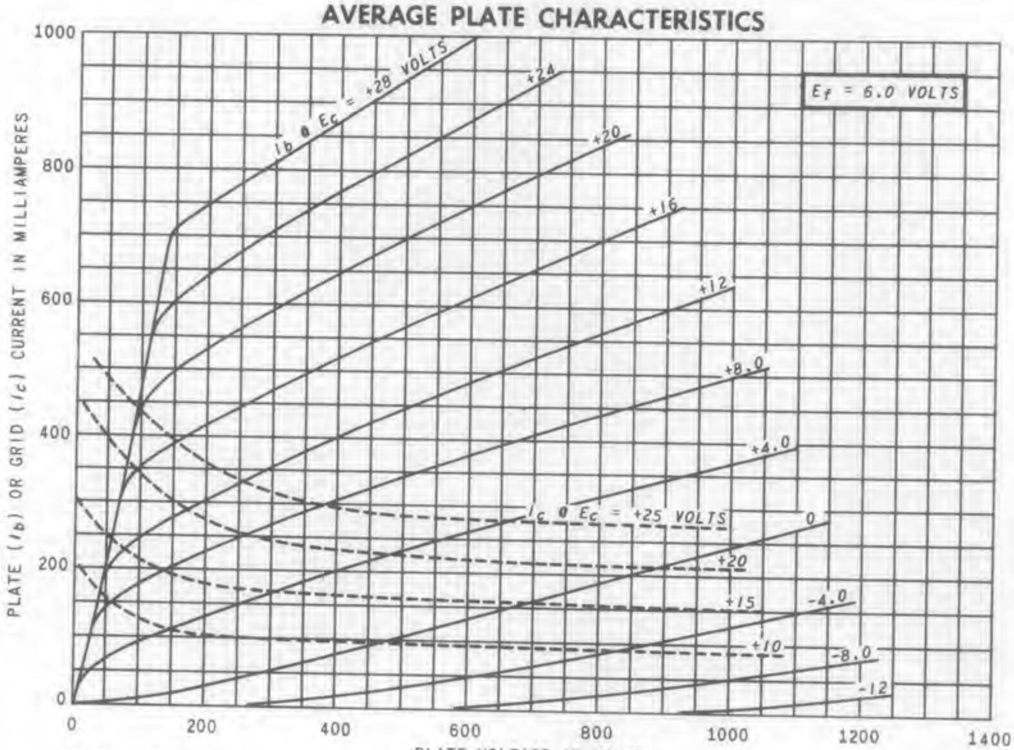
AVERAGE PLATE CHARACTERISTICS



K-55611-TD154-1

OCTOBER 18, 1961

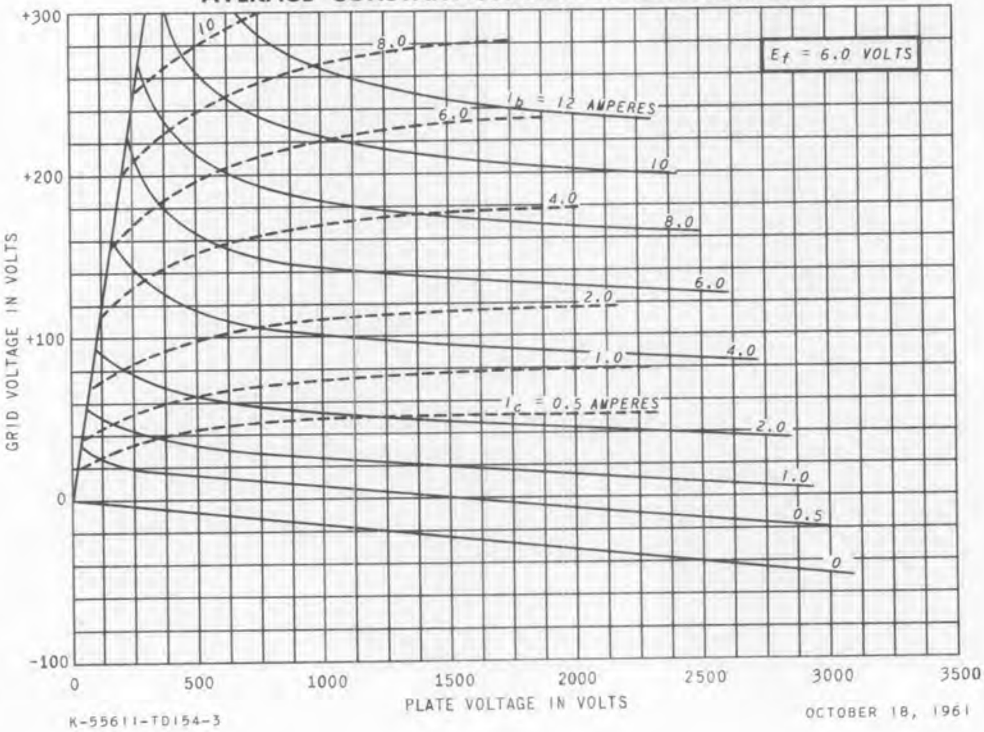
AVERAGE PLATE CHARACTERISTICS



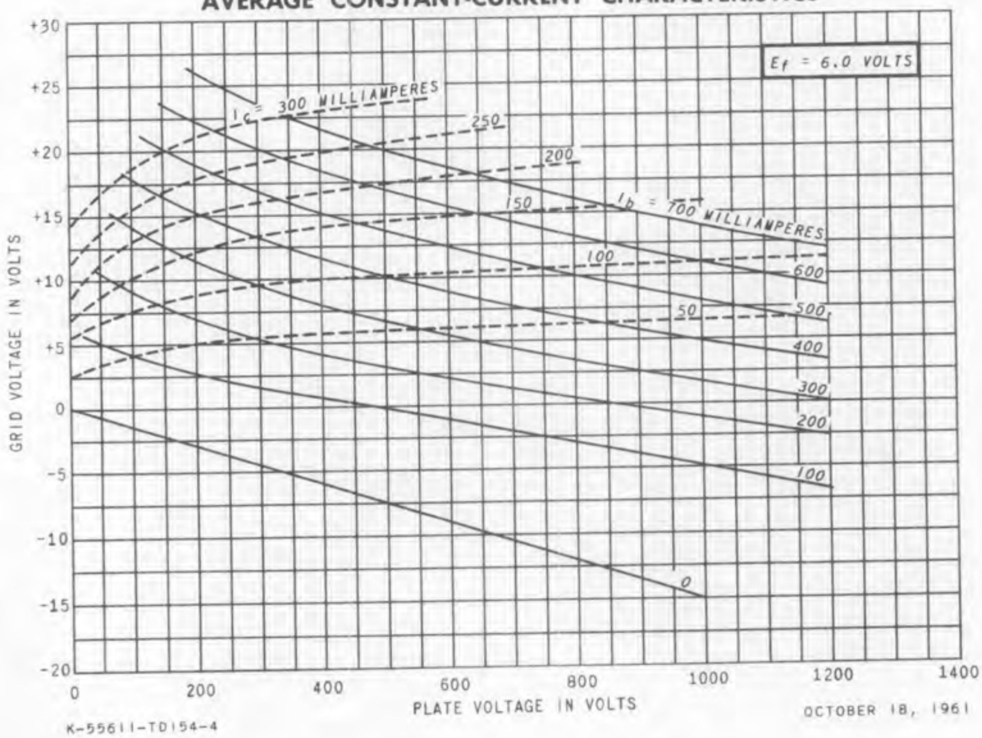
K-55611-TD154-2

OCTOBER 18, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS

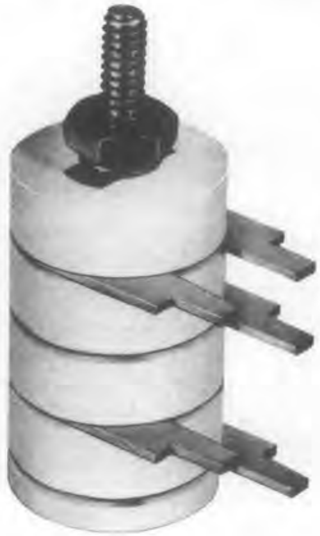


RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7296
METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

FOR VHF OSCILLATOR AND AMPLIFIER APPLICATIONS

The 7296 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator, broadband radio-frequency amplifier, or VHF power amplifier. The 7296 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential		
Heater Voltage, AC or DC *	6.3±0.3	Volts
Heater Current +	0.4	Amperes
Direct Interelectrode Capacitances ‡		
Grid to Plate: (g to p)	2.2	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.075	pf
Heater to Cathode: (h to k)	2.8	pf

MECHANICAL

Mounting Position—Any §

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	5.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance		
With Fixed Bias	0.1	Megohms
With Cathode Bias	0.18	Megohms
Envelope Temperature at Hottest Point #		
Plate Dissipation not over 3.3 Watts	300	C
Plate Dissipation up to 5.5 Watts	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	68	Ohms
Amplification Factor	90	
Plate Resistance, approximate	5450	Ohms
Transconductance	16500	Micromhos
Plate Current	17	Milliamperes
Grid Voltage, approximate Ib = 10 Microamperes	−5.5	Volts

* The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ One method of mounting the 7296 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 4-40 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

Operation below the rated maximum envelope temperatures is recommended for applications requiring the longest possible tube life. The 7296 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)	10	17	24	Milliamperes
Transconductance Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)	13000	16500	20000	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 100 volts, Rk = 68 ohms (bypassed)	65	90	115	
Zero-Bias Transconductance Ef = 6.3 volts, Eb = 100 volts, Ec = 0 volts	13000	20000	.....	Micromhos
Grid Voltage Cutoff Ef = 6.3 volts, Eb = 200 volts, Ib = 10 μa	.....	−5.5	−9.5	Volts
Interelectrode Capacitances				
Grid to Plate (g to p)	1.9	2.2	2.5	pf
Input: g to (h + k)	3.7	5.0	6.3	pf
Output: p to (h + k)	0.05	0.075	0.1	pf
Heater to Cathode: (h to k)	2.1	2.8	3.5	pf
Negative Grid Current Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 68 ohms (bypassed), Rg = 0.18 meg	.....	.....	0.5	Microamperes
Heater-Cathode Leakage Current Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.18 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
400 Megacycle Oscillator Power Output	1.6	2.0	.....	Watts

Tubes are tested for power output as an oscillator under the following conditions: F = 400 mc, Ef = 6.3 volts, Eb = 300 volts, Rg = 1400 ohms, Ib = 20 ma maximum, Ic = 6.0–9.0 ma.

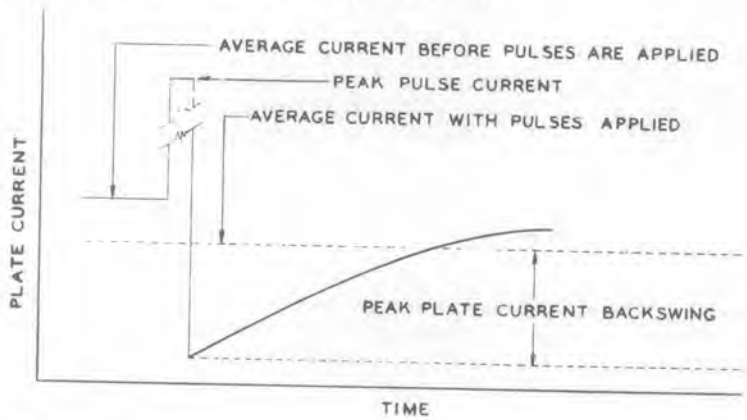
	Min.	Bogey	Max.	
Pulse Emission	320	.....	.....	Milliamperes

Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts, Eb = 200 volts, Ec = −20 volts, egk = +12 volts, prr = 1000 pps, duty cycle 1%. Pulse cathode current is measured.

	Min.	Bogey	Max.	
Grid Recovery ..... Change in Average Plate Current	.....	.....	1.0	Milliamperes
Peak Plate Current Backswing	.....	.....	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7296 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 10 ma.

Upon application to the grid of a pulse driving it 3 volts positive with respect to cathode (prr = 60 pps, duty cycle = 0.12%) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current—time relationship for a tube (with poor grid recovery) subjected to this test:



	Min.	Bogey	Max.	
Low Frequency Vibrational Output	.....	.....	15	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15 G. Tube is operated with Ef = 6.3 volts, Ebb = 200 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 100 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10 G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue
Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 200 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock
Statistical sample subjected to 5 impact accelerations of approximately 600 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 42° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 200 volts, Ehk = +100 volts, Rg = 0.1 Meg, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test
The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test
The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

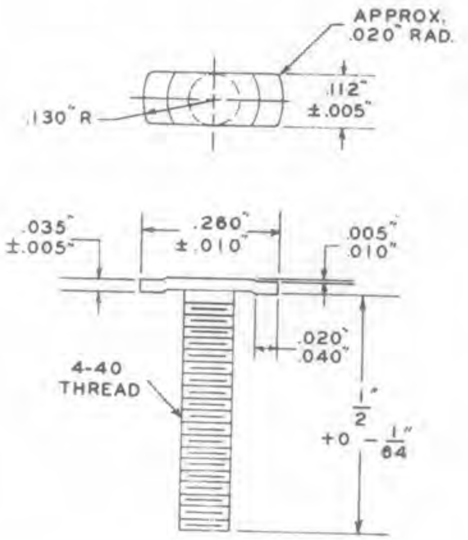
Dynamic Life Test
Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, zero-bias transconductance, oscillator power output, and heater-cathode leakage.

Pulse Life Test
Statistical sample operated with 400 ma peak cathode current, 1% duty cycle, for 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse emission, and heater-cathode leakage.

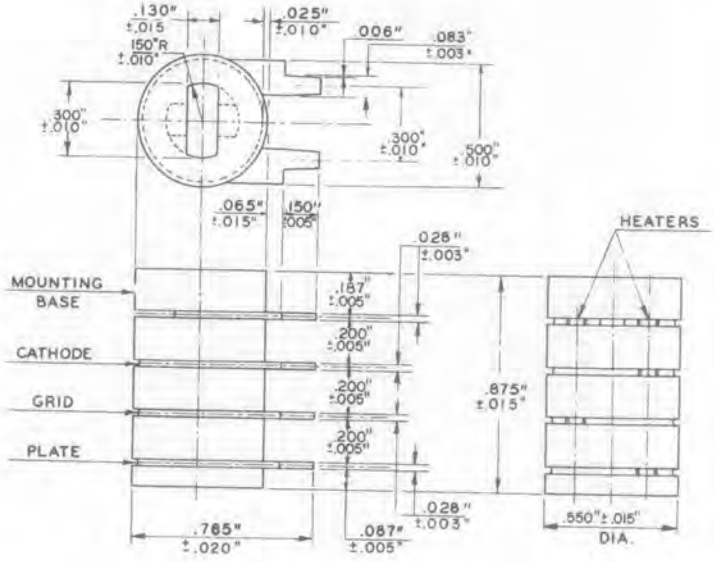
Interface Life Test
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

MOUNTING BOLT

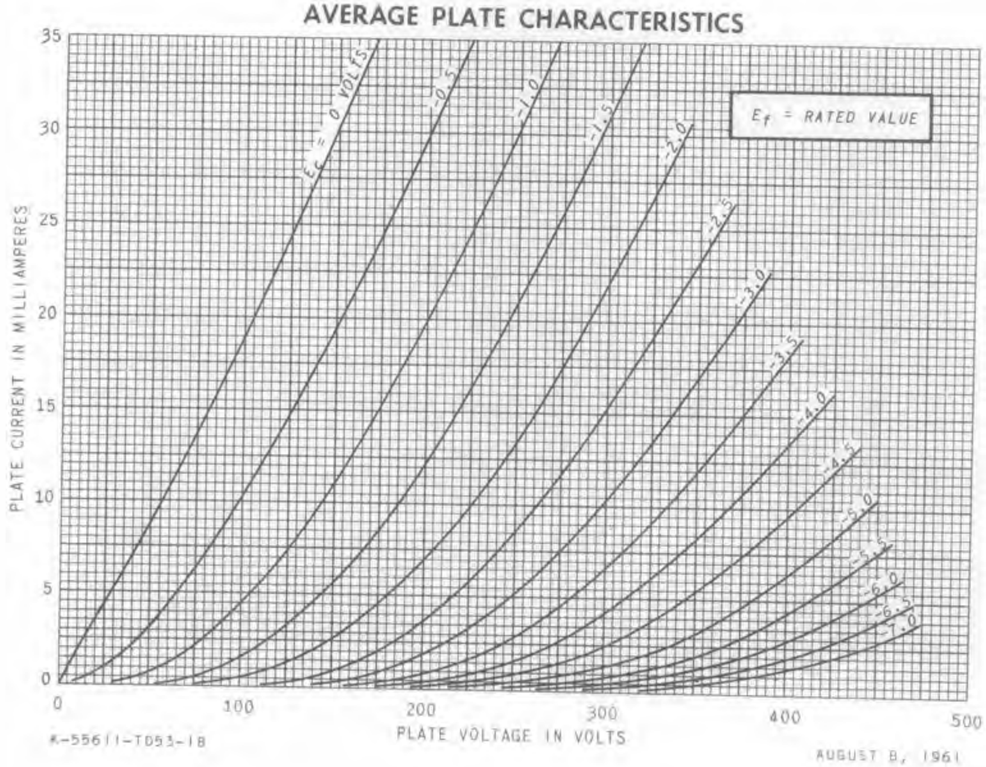


PHYSICAL DIMENSIONS

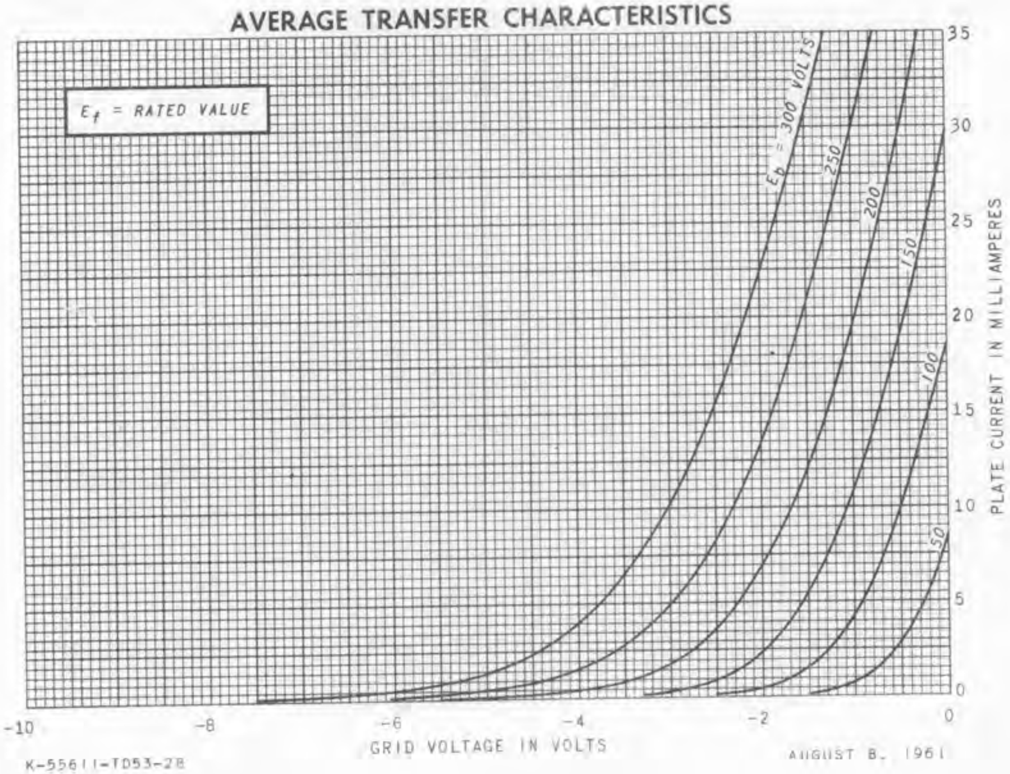


Maximum eccentricity of insulators 0.015 in. from center line.

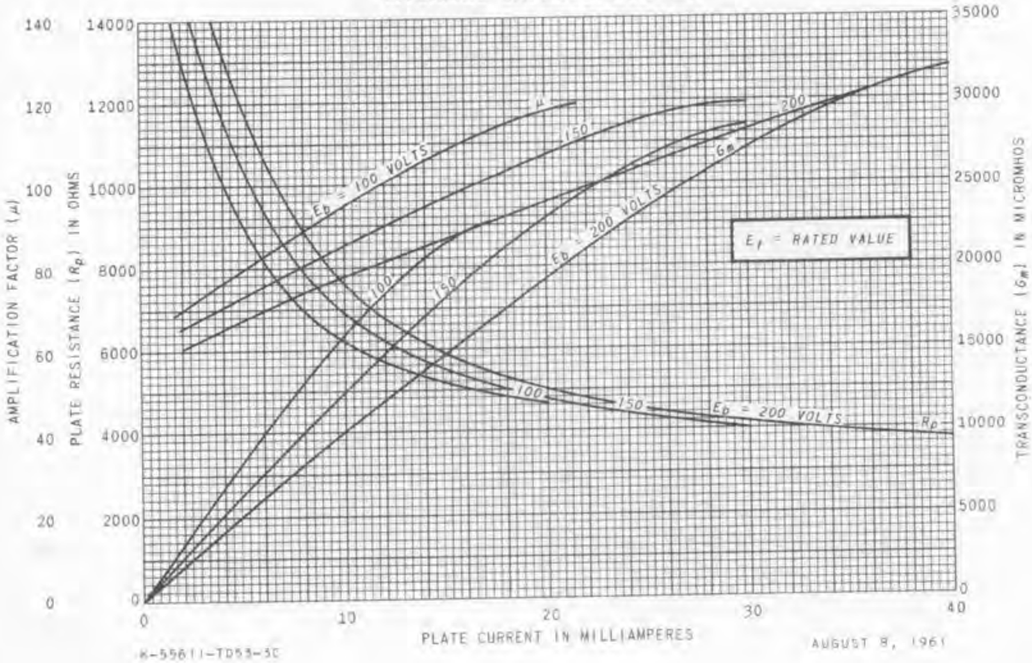
AVERAGE PLATE CHARACTERISTICS



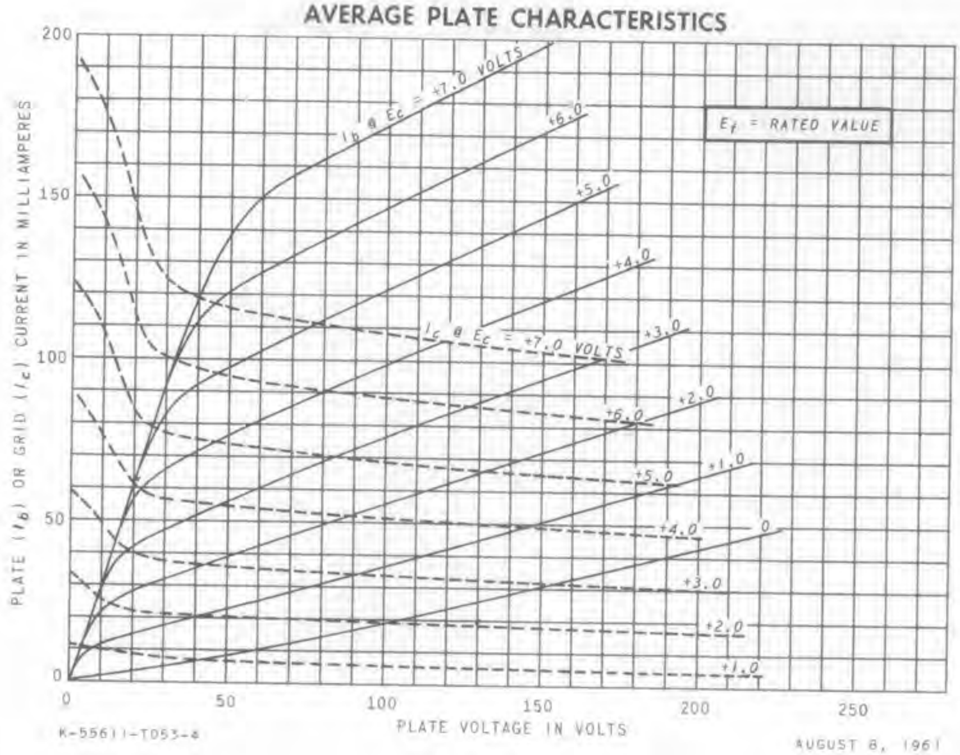
AVERAGE TRANSFER CHARACTERISTICS



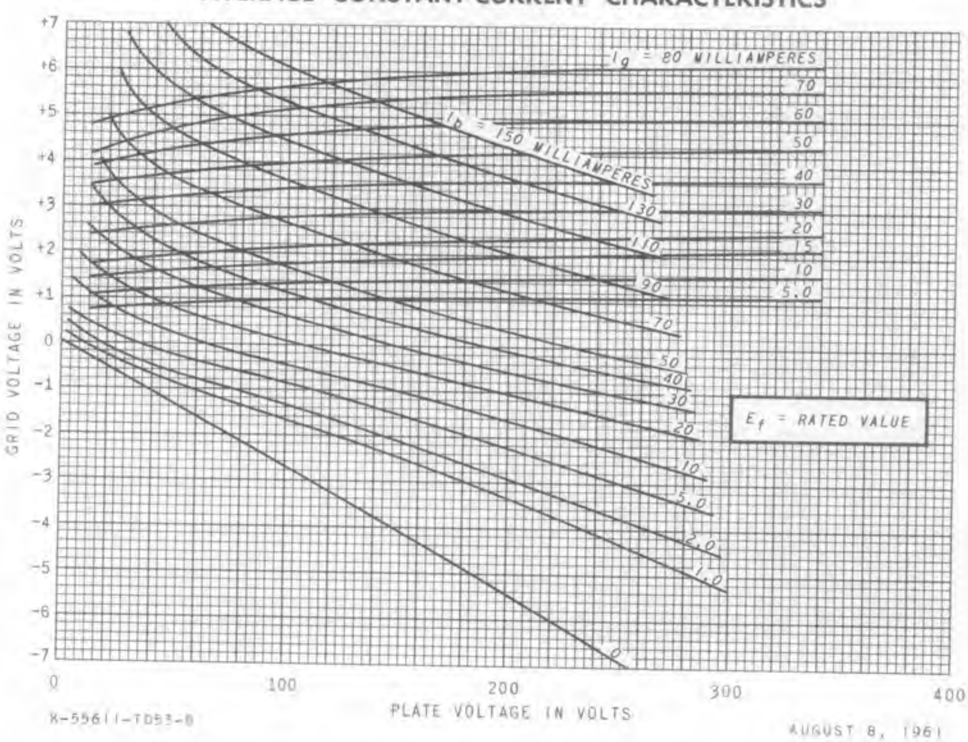
AVERAGE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

7391

Planar Triode

FOR GROUNDED-GRID CLASS C OSCILLATOR APPLICATIONS

The 7391 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid, Class C oscillator at frequencies as high as 6000 megacycles.

Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

The physical appearance and dimensions of the 7391 are identical to those of the 6299.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.38	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.58	pf
Grid to Cathode and Heater: g to (h + k)	3.25	pf
Plate to Cathode and Heater: p to (h + k)	0.0158	pf

MECHANICAL

Operating Position - Any

Net Weight, approximate . . . . . . 1/6 Ounce

Cooling - Conduction¶

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.25	Watts
DC Plate Current	15	Milliamperes
DC Grid Current	3.0	Milliamperes
DC Cathode Current	15	Milliamperes
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1614A dated 12-61

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage	-1.5	Volts
Amplification Factor	62	
Transconductance	11000	Micromhos
Plate Current	10	Milliamperes

CLASS C CW OSCILLATOR—GROUNDED-GRID COAXIAL-TYPE CIRCUIT

Frequency	500	1000	5400	Megacycles
Plate Voltage	150	150	150	Volts
Plate Current	12	12	12	Milliamperes
Grid Current	3.0	3.0	3.0	Milliamperes
Power Output	500	250	65	Milliwatts

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ The electrical connections to the plate and cathode must provide good thermal conductivity from these electrodes. The plate contact must be sufficiently flexible to keep the lateral force on the plate terminal at a minimum.

INITIAL CHARACTERISTICS LIMITS

	Minimum	Bogey	Maximum	
Heater Current Ef = 6.3 volts	360	380	400	Milliamperes
Grid Voltage Ef = 6.3 volts, Eb = 175 volts, Ib = 10 ma	-0.7	-1.5	-2.55	Volts
Transconductance Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma.	8000	11000	13500	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma.	46	62	80	
Grid Voltage Cutoff Ef = 6.3 volts, Eb = 175 volts, Ib = 100 μa.	-2.4	-4.2	-7.0	Volts
Interelectrode Leakage Resistance Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to Cathode and Heater at 45 volts d-c	0.25	---	---	Megohms
Grid to Plate at 500 volts d-c	5.0	---	---	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.40	1.58	1.80	pf
Grid to Cathode and Heater: g to (h + k)	2.60	3.25	3.95	pf
Plate to Cathode and Heater: p to (h + k)	0.010	0.0158	0.023	pf

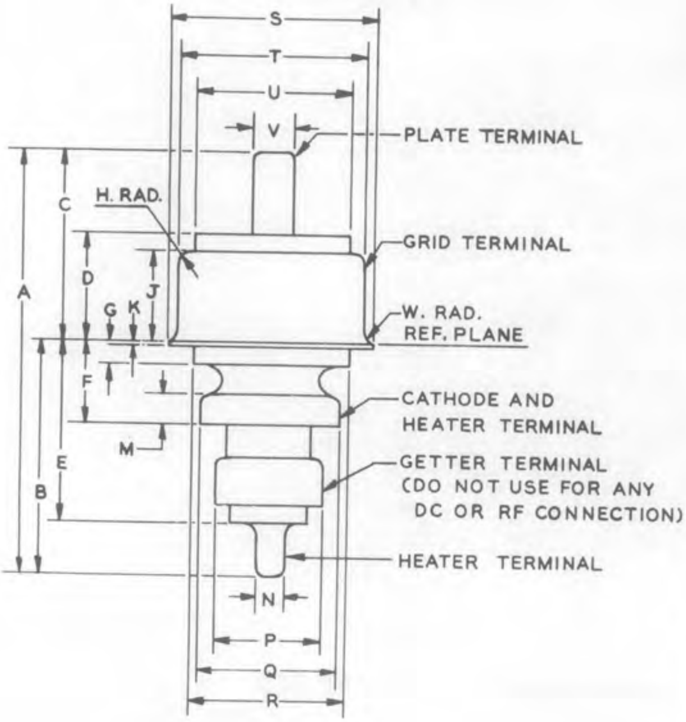
SPECIAL PERFORMANCE TESTS

5400 Megacycle Oscillator Power Output Ef = 6.3 volts, Eb = 150 volts, Rg = 2000 ohms, Ib = 15±0.5 ma, F = 5400 MC, min.	30	65	---	Milliwatts

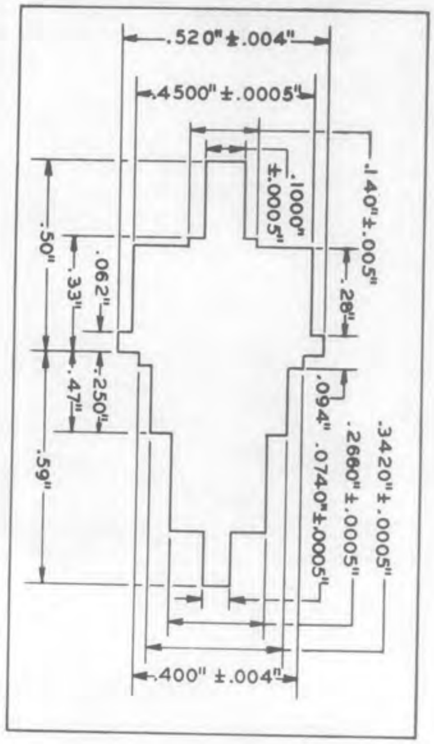
DEGRADATION RATE TESTS

500-Hour Life
Statistical sample operated for 500 hours to evaluate changes in power output and transconductance with life.

PHYSICAL DIMENSIONS

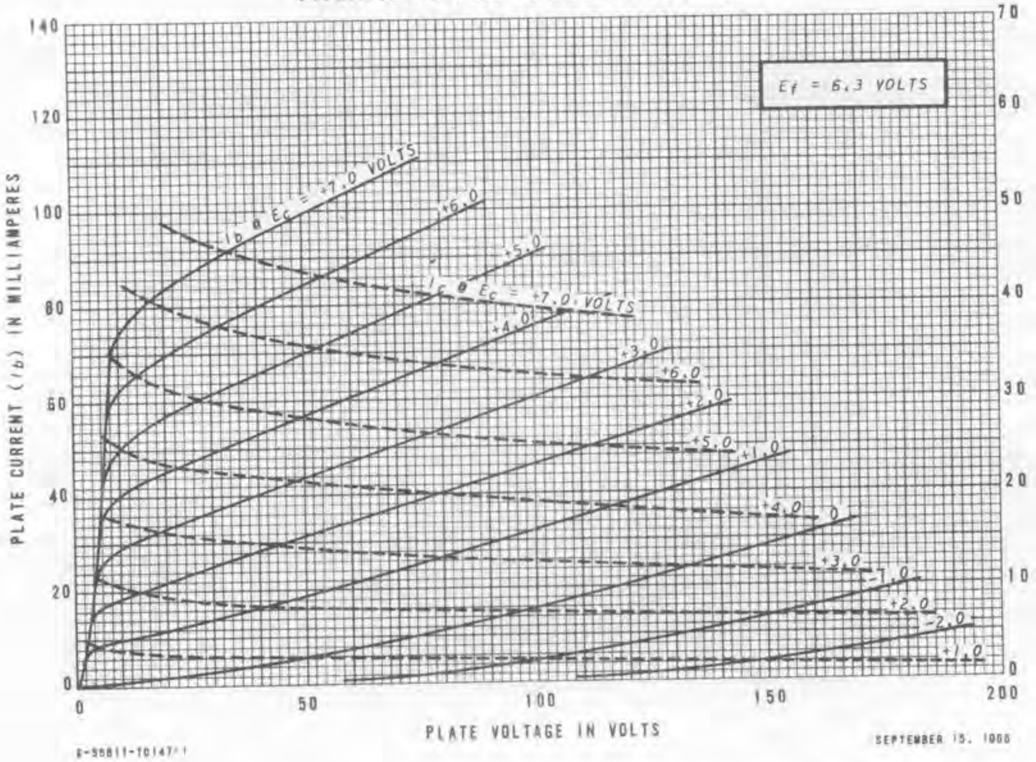


ALIGNMENT GAUGE

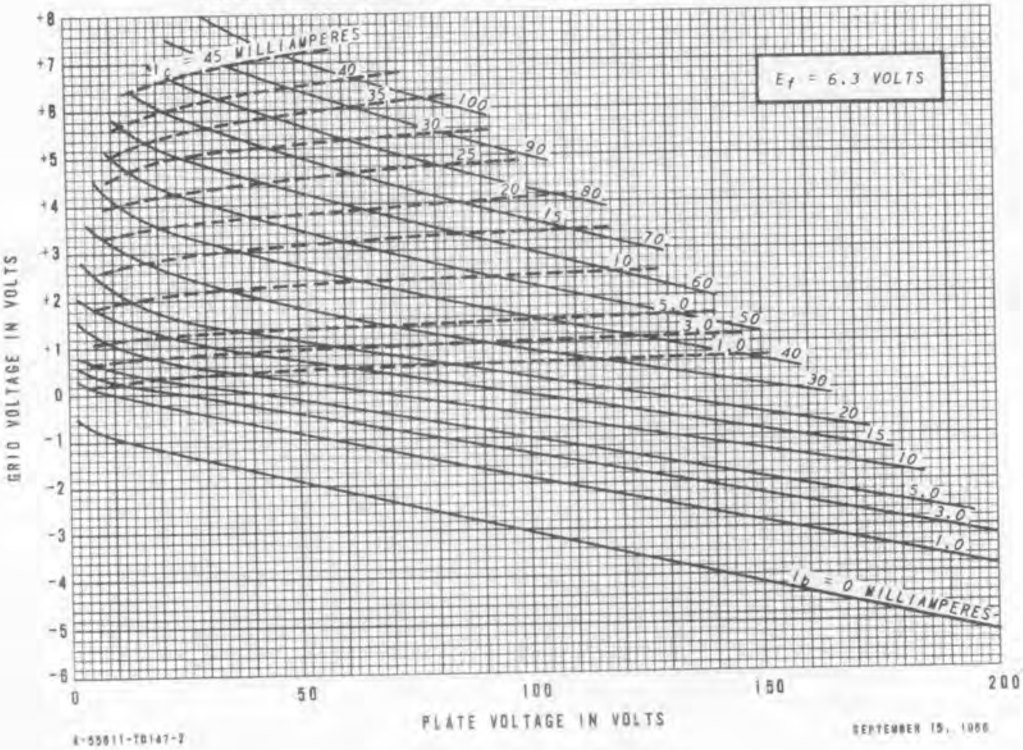


Ref.	INCHES		MILLIMETERS	
	Minimum	Maximum	Minimum	Maximum
A	0.960	1.040	24.38	26.42
B	0.530	0.590	13.46	14.99
C	0.410	0.470	10.41	11.94
D	---	0.272	---	6.91
E	---	0.475	---	12.07
F	0.163	0.193	4.14	4.90
G	---	0.060	---	1.52
H	---	0.030	---	0.76
J	0.190	0.210	4.83	5.33
K	0.009	0.015	0.23	0.38
M	0.040	0.070	1.02	1.78
N	0.059	0.065	1.50	1.65
P	---	0.257	---	6.53
Q	0.326	0.334	8.28	8.48
R	---	0.385	---	9.78
S	0.483	0.497	12.27	12.62
T	0.435	0.445	11.05	11.30
U	---	0.385	---	9.78
V	0.088	0.094	2.24	2.39
W	---	0.008	---	0.20

AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONIC INNOVATIONS IN ACTION

TUBES

Tetrode

GL-7399

PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

INTEGRAL RADIATOR

The GL-7399 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier or -oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-7399 include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	—	6.3	6.8	Volts
Heater Current		5.6		Amperes
Amplification Factor, G_2 to G_1		10.5		
E_{g2} = 275 Volts DC, E_b = 1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1			Minute
Direct Interelectrode Capacitances*				
Cathode to Plate†		0.012		μμf
Input		24.0		μμf
Output		9.3		μμf

Mechanical

Mounting Position—Any		
Net Weight	1.0	Pounds

Thermal

Cooling—Forced Air‡				
Radiator§				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C incoming air temperature	17.0	12.0	6.5	Min Cubic Feet per Minute
Static Pressure, approximate anode at room temperature	0.9	0.5	0.2	Inches-Water
Anode Hub Temperature▲			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Maximum Ratings

Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	−175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥♦	15	Microseconds
Duty Factor♥ϕ	0.0012	

Typical Operation

Grounded-grid Circuit, 500 Megacycles

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	−125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width♦	15	Microseconds
Duty Factor	0.001	

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

GENERAL ELECTRIC

Supersedes ET-T1598C dated 4-64

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	−225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width ♥♦	15	Microseconds
Duty Factor ♥ϕϕ	0.01	

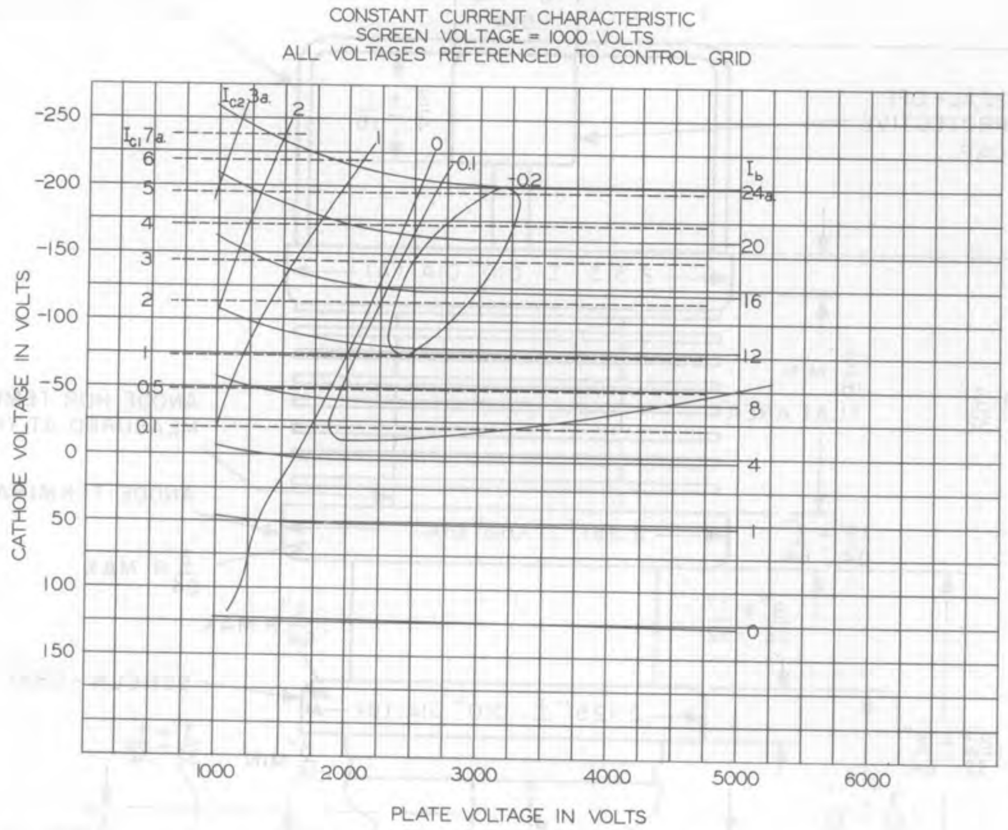
Typical Operation

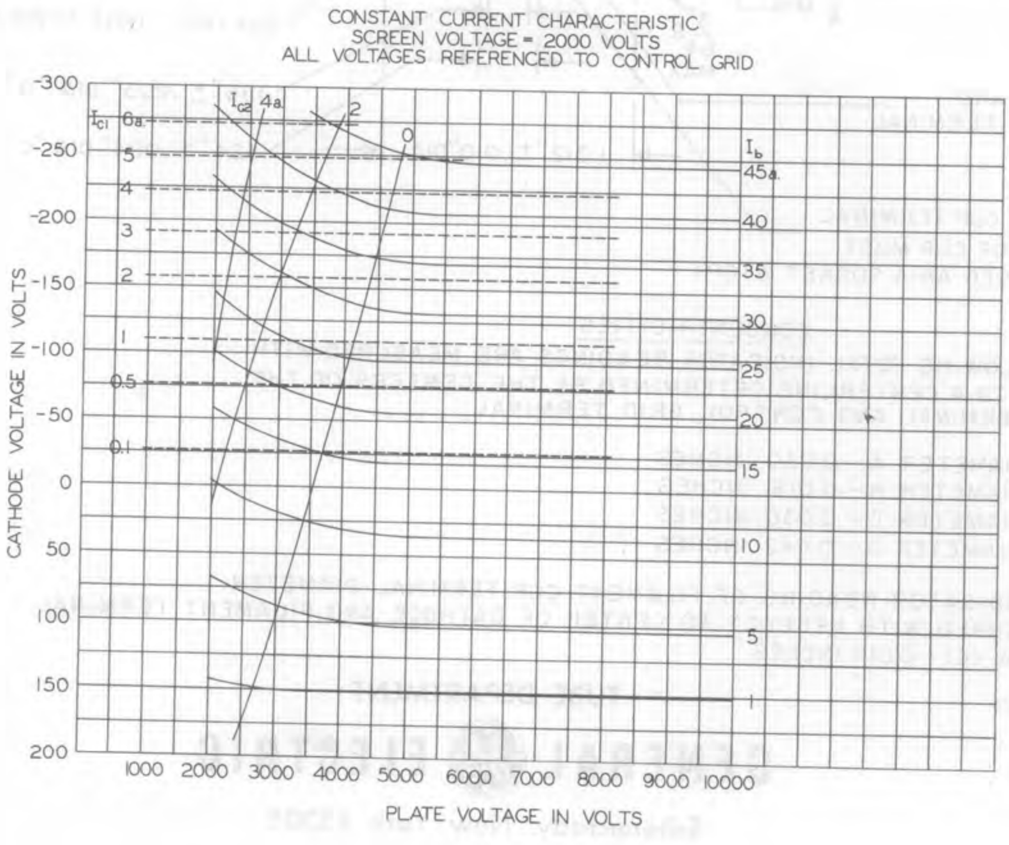
Grounded-grid Circuit at 1100 Megacycles, $\frac{3}{4}\lambda$ Output Circuit

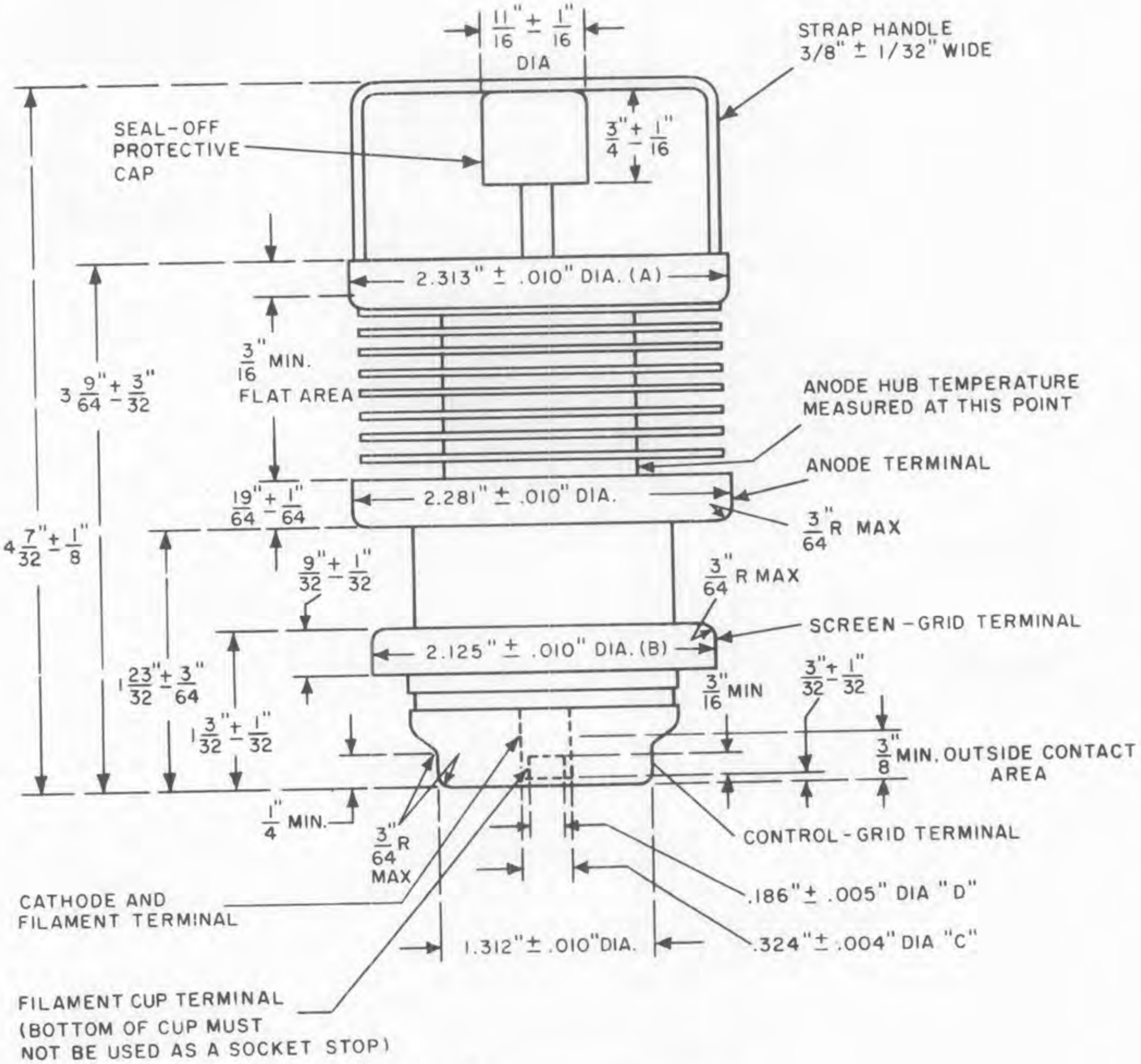
DC Plate Voltage**	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	−200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ♦	15	Microseconds
Duty Factor	0.01	

---

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air between radiator fins, and between the anode terminal and adjacent fins.
▲ Measured at the base of the fin adjacent to the plate terminal. See outline drawing on page 4.
♣ Maximum average value.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
♦ Pulse duration measured between points at 70 percent of peak 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.
ϕ Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
ϕϕ Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.


CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_{c2} 3a.
I_{c1} 7a.
I_b 24a.
-250
-200
-150
-100
-50
0
50
100
150
1000
2000
3000
4000
5000
6000


CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_{c2} 4a.
I_{c1} 6a.
I_b 45a.
-300
-250
-200
-150
-100
-50
0
50
100
150
200
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000



CONCENTRICITIES

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL GRID TERMINAL

DIAMETER A – 0.030 INCHES
DIAMETER B – 0.016 INCHES
DIAMETER C – 0.036 INCHES
DIAMETER D – 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT CUP TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT TERMINAL DIAMETER (C) – 0.016 INCHES

TUBE DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305

PRINTED IN U.S.A.

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7462 is a high-mu triode of ceramic-and-metal planar construction primarily intended for radio-frequency amplifier service from low frequencies into the ultra-high-frequency range. It is similar to the 7077 in characteristics but differs in having terminal lugs for use in print-board circuits.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current†	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.25	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	1.1	Watts
DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance, with Fixed Bias§	0.01	Megohms
Bulb Temperature at Hottest Point¶	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

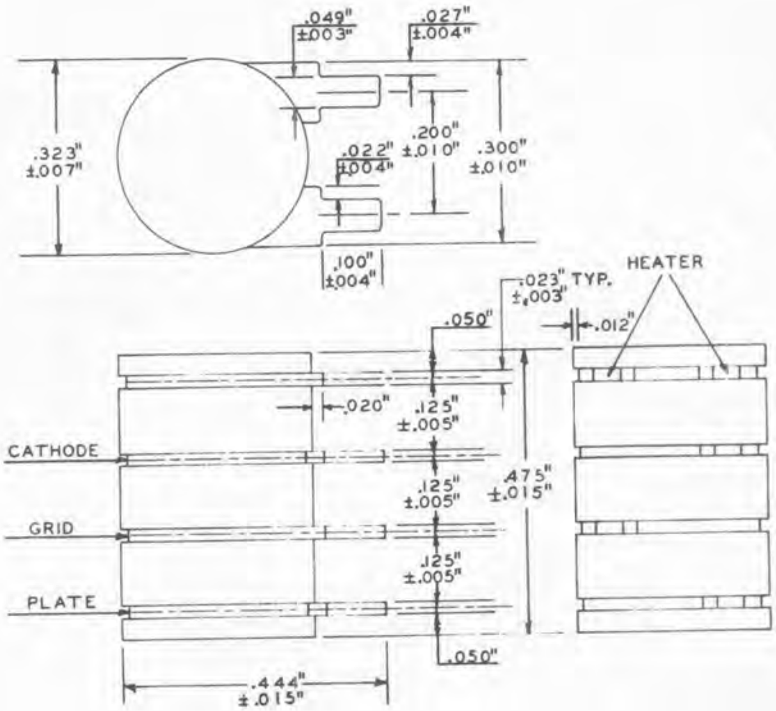
AVERAGE CHARACTERISTICS

Plate Voltage	150	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	910	Ohms
Amplification Factor	94	
Plate Resistance, approximate	9000	Ohms
Transconductance	10500	Micromhos
Plate Current	7.2	Milliamperes
Grid Voltage, approximate		
Ib = 100 Microamperes	−2.4	Volts

Supersedes 7462 D & R sheet ET-T1540A, dated 2-60

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.
§ If a cathode bias resistor is used, the grid-circuit resistance may be as high as $(10{,}000 + 100\ Rk + R_L)$ ohms, where Rk is the value of the cathode-bias resistor in ohms and R_L is the value of the plate-load resistor in ohms.
¶ For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.



NOTE: Maximum eccentricity of insulators 0.010 in. from center line.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	222	240	258	Milliamperes
Plate Current Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	4.5	7.5	11	Milliamperes
Transconductance Ef = 6.3 volts, Eb = 150 volts, Ec = +6 volts, Rk = 910 ohms (bypassed)	8000	10500	13000	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 150 volts, Ec = +6 volts, Rk = 910 ohms (bypassed)	65	94	115	

INITIAL CHARACTERISTICS LIMITS (Continued)

	Min.	Bogey	Max.	
Transconductance Change with Heater Voltage				
Difference between transconductance at Ef = 6.3 volts and transconductance at Ef = 6.0 volts (other conditions the same) expressed as a percentage of transconductance at Ef = 6.3 volts	.....	.....	15	Percent
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 150 volts, Ib = 100 μa	.....	−2.4	−4.5	Volts
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.05	1.25	1.45	pf
Input: g to (h+k)	1.25	1.8	2.25	pf
Output: p to (h+k)	0.013	0.032	0.045	pf
Heater to Cathode: (h to k)	1.1	1.5	1.9	pf
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All of 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 100 volts, Ecc = −10 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

Low Frequency Vibrational Output				
Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15 G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms	.....	.....	10	Millivolts RMS
Variable Frequency Vibrational Output				
Statistical sample is subjected to vibration according to the procedure given below. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed) R_L = 10000 ohms	.....	.....	15	Millivolts RMS

The variable-frequency vibration test shall be performed as follows:

1. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.
2. The tube shall be vibrated with simple harmonic motion in each of two planes: first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug. At all frequencies from 100 to 2000 cps, the total harmonic distortion of the acceleration waveform shall be less than 5%.
3. The peak acceleration shall be maintained at 10 ± 1.0 G throughout the test.
4. The value of the alternating voltage produced across the load resistor (R_L), as a result of the vibration, shall be measured with a suitable device having a response to the RMS value of the voltage to within ±0.5 db of the response at 400 cps for the frequency range of 100 to 3000 cps, and having a band-pass filter with an attenuation rate of 24 db per octave below the low frequency cutoff point of 50 cps and above the high frequency cutoff point of 5000 cps. The meter shall have a dynamic response characteristic equivalent to or faster than a VU meter (operated in accordance with ASA Standard No. C16.5-1954).

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, Rg = 0.1 meg, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements, and transconductance, following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated 1000 hours under the following conditions: Ef = 6.3 volts, Eb = 150 volts, Ecc = +6 volts, Ehk = −70 volts, Rk = 910 ohms, Rg = 0.1 meg. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

Statistical sample operated for 500 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

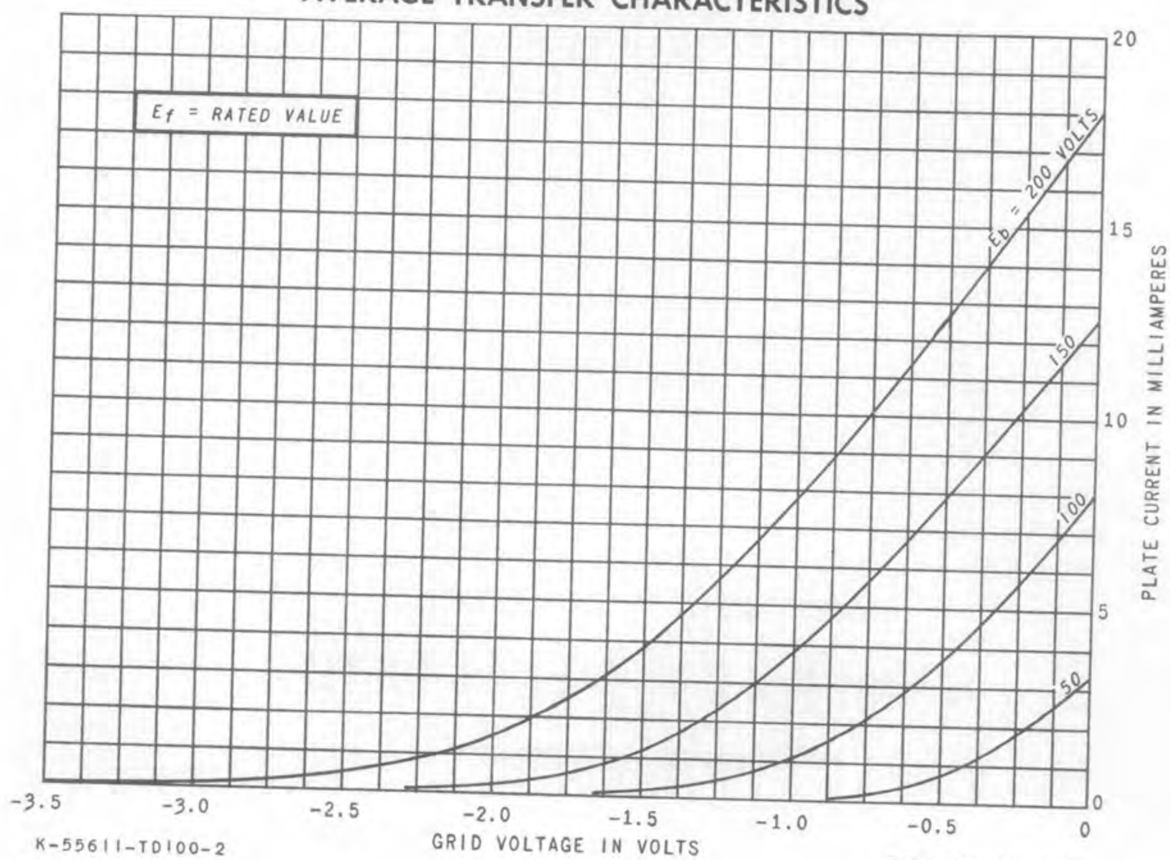
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following the test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage.

AVERAGE PLATE CHARACTERISTICS

K-55611-TD100-1

FEBRUARY 12, 1960

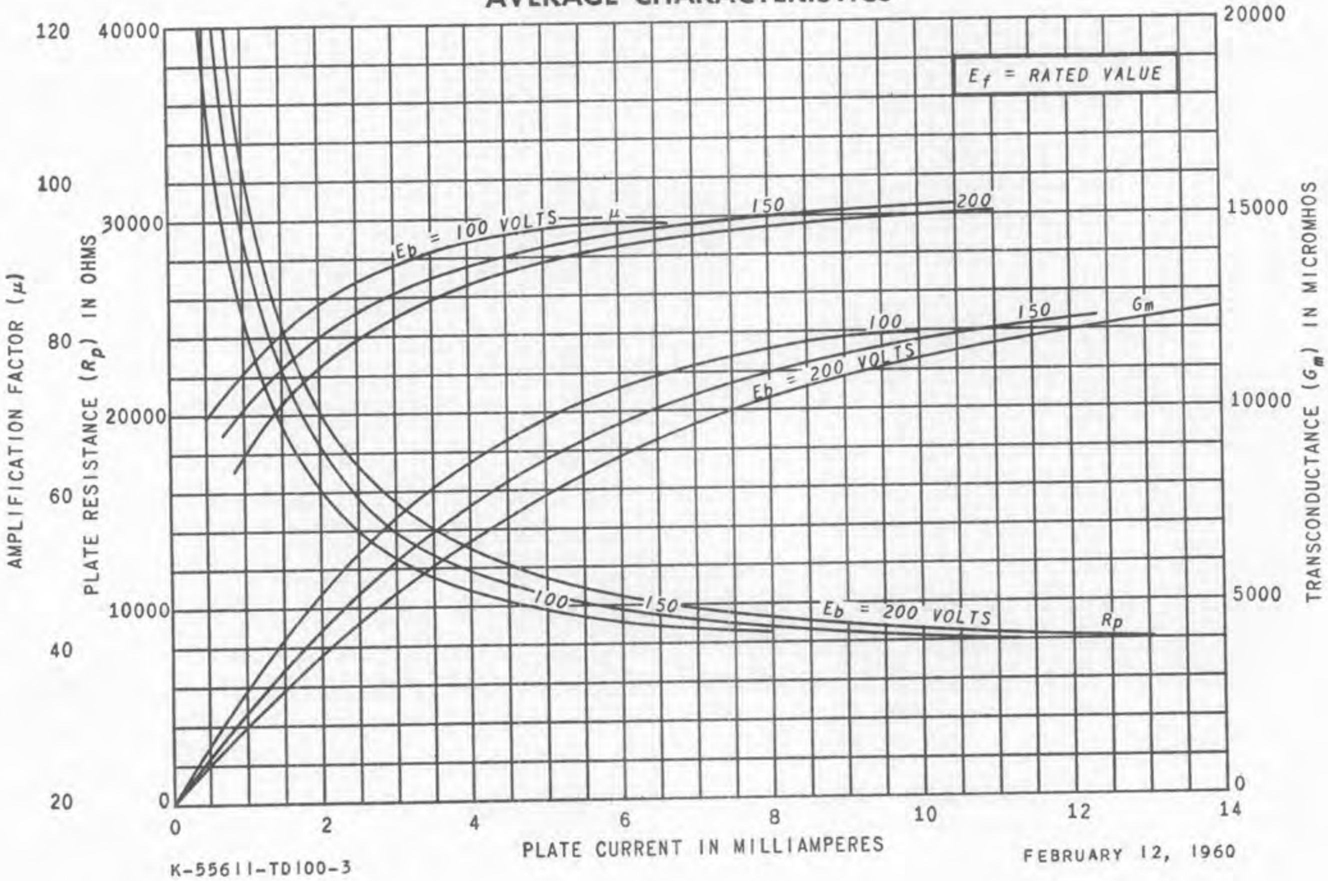
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD100-2

FEBRUARY 12, 1960

AVERAGE CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS

7486

METAL-CERAMIC TRIODE

FOR UHF OSCILLATOR AND POWER AMPLIFIER APPLICATIONS

DESCRIPTION AND RATING

The 7486 is a high-mu triode of ceramic-and-metal planar construction intended for use as an oscillator or radio-frequency power amplifier in the ultra-high-frequency range. The 7486 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h+k)	1.7	pf
Output: p to (h+k)	0.01	pf
Heater to Cathode: (h to k)	1.1	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	1.0	Watts
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point§	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1531 dated 6-59

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	100	150	Volts
Grid Voltage	0	.....	Volts
Cathode-Bias Resistor	.....	82	Ohms
Amplification Factor	.....	90	
Transconductance	11500	10500	Micromhos
Plate Current	8.0	7.5	Milliamperes

UHF Oscillator Service

Plate Voltage	150	150	Volts
Grid Resistor	1000	1000	Ohms
Plate Current	8.0	8.0	Milliamperes
Grid Current	2.0	2.0	Milliamperes
Frequency	450	1200	Megacycles
Power Output, approximate	450	300	Milliwatts

Class C RF Amplifier

Plate Voltage	150	Volts
Grid Resistor	3000	Ohms
Plate Current	5.0	Milliamperes
Grid Current	1.0	Milliamperes
Frequency	450	Megacycles
Power Output, approximate	300	Milliwatts

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured using a grounded adapter that provides shielding between external terminals of tube.

§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7486 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	222	240	258	Milliamperes
Plate Current Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	4.5	.....	11	Milliamperes
Zero-Bias Transconductance Ef = 6.3 volts, Eb = 100 volts, Ec = 0 volts	8000	11500	.....	Micromhos
Transconductance Change with Heater Voltage Difference between Zero-Bias Transconductance measured at Ef = 6.3 volts and Ef = 6.0 volts (other conditions the same) expressed as a percentage	.....	.....	20	Percent
Amplification Factor Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	65	90	115	
Grid Voltage Cutoff Ef = 6.3 volts, Eb = 150 volts, Ib = 100 μa	.....	−2.4	−4.5	Volts
Interelectrode Capacitances				
Grid to Plate: (g to p)	0.84	1.00	1.16	Picofarads
Input: g to (h+k)	1.25	1.70	2.15	Picofarads
Output: p to (h+k)	0.004	0.010	0.016	Picofarads
Heater to Cathode: (h to k)	0.80	1.10	1.40	Picofarads

INITIAL CHARACTERISTICS LIMITS (Continued)

	Min.	Bogey	Max.	
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 150 volts, Ecc = −20 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
1200 Megacycle Oscillator Power Output	200	.....	.....	Milliwatts

Tubes are tested for power output as an oscillator under the following conditions: F = 1200 mc ± 50 mc, Ef = 6.3 volts, Eb = 150 volts, Rg = 1000 ohms, Ib = 8.0 ma maximum, Ic = 1.6 − 2.0 ma

	Min.	Bogey	Max.	
Pulse Emission	90	.....	.....	Milliamperes

Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts, Eb = 150 volts, Ec = −10 volts, egk = +7 V, prr = 1000 pps, duty factor = 0.01. Pulse cathode current is measured

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current	.....	.....	0.6	Milliamperes
Peak Plate Current Backswing	.....	.....	1.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7486 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5-volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

OUTLINE DRAWING

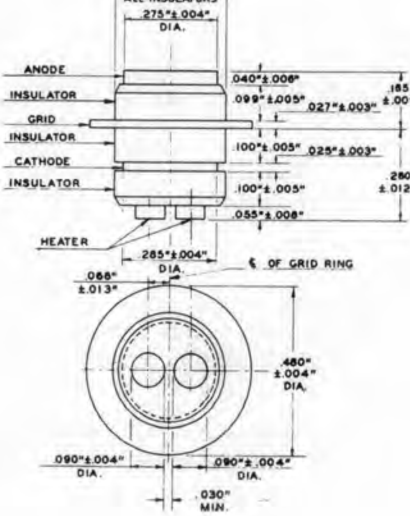
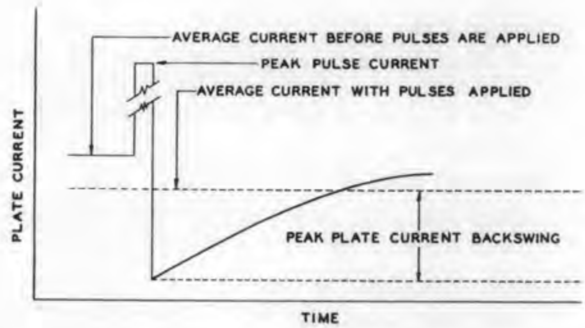


PLATE CURRENT VS TIME— GRID RECOVERY TEST



1—Maximum eccentricity of anode, grid, and cathode 0.005" from center line.

2—Maximum eccentricity of insulators 0.010" from center line.

3—Center line of grid ring used as reference line for horizontal tolerances.

4—Bottom surface of grid ring used as reference line for vertical tolerances.

SPECIAL PERFORMANCE TESTS (Continued)

	Min.	Bogey	Max.	
Low Frequency Vibrational Output	.....	.....	10	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 15 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Stability Life Test

The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

Dynamic Life Test

Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, oscillator power output, zero-bias transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Pulse Life Test

Statistical sample operated with 120 ma peak cathode current, 0.01 duty factor, for 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse cathode current, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

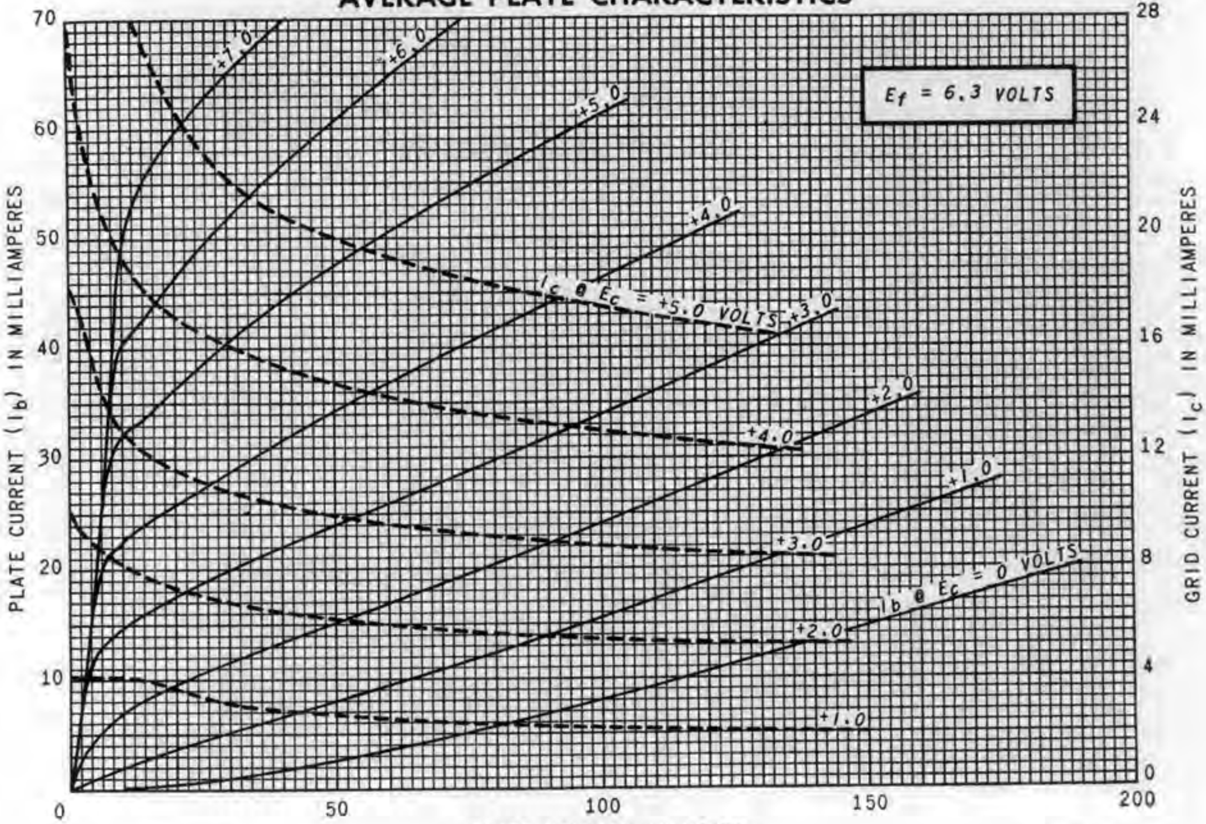
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

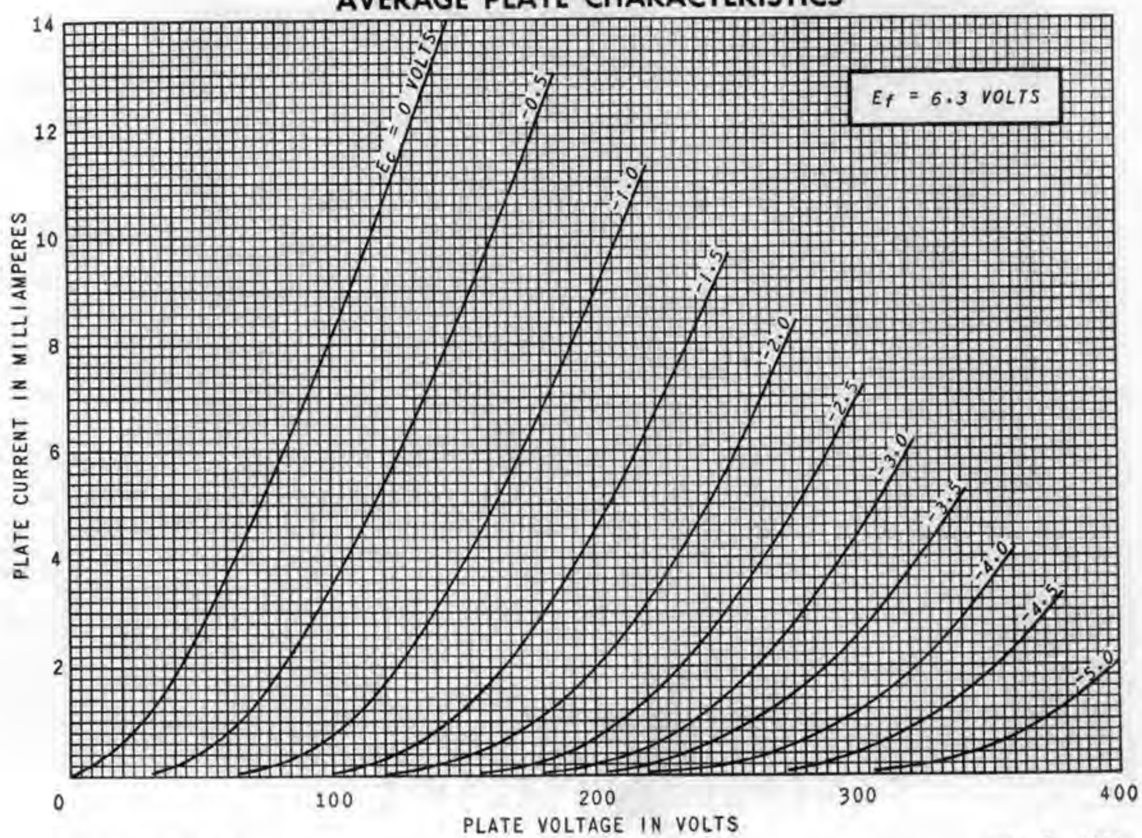
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

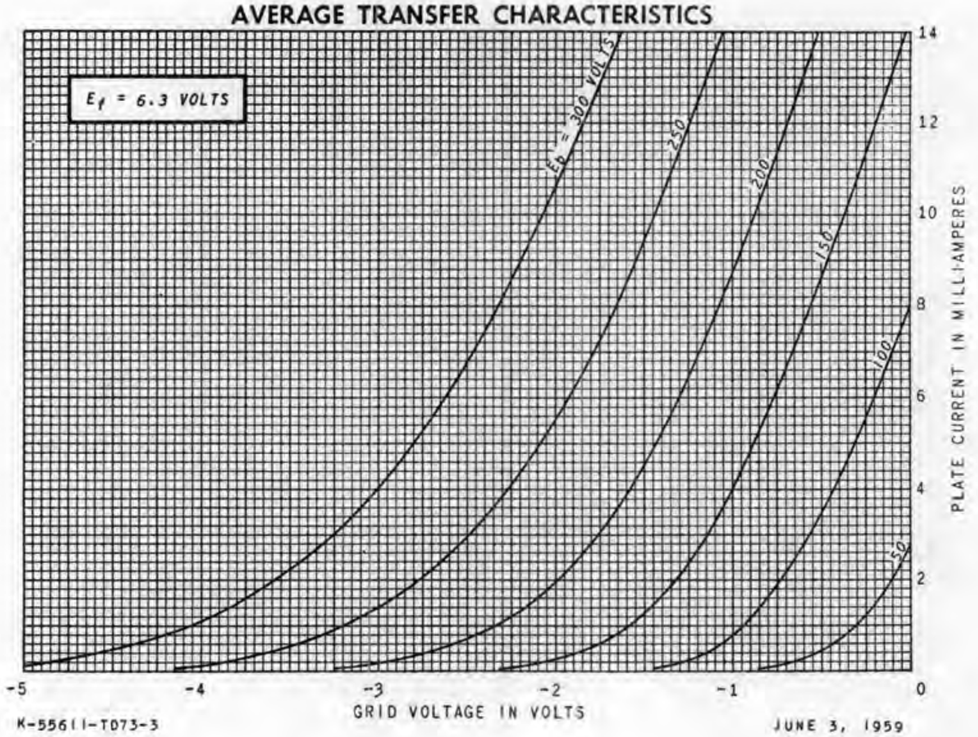
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-2

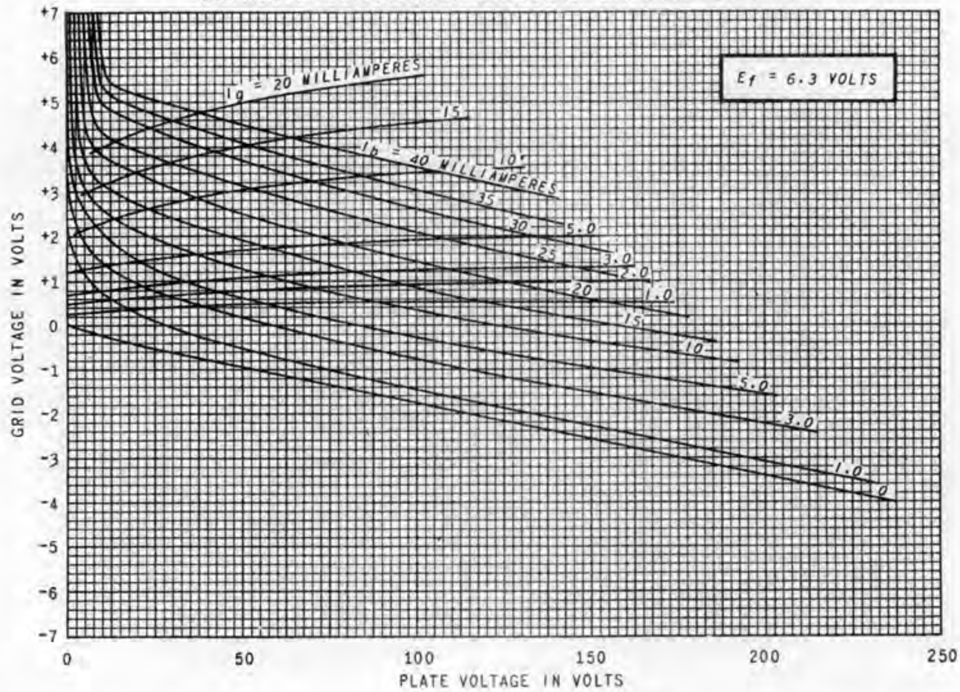
JUNE 3, 1959

AVERAGE TRANSFER CHARACTERISTICS



K-55611-T073-3 JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



CONSTANT-CURRENT CURVES

K-55611-T073-4 JUNE 3, 1959

TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7588 is a high-mu triode of ceramic-and-metal planar construction. The tube is intended for use as a broadband radio-frequency amplifier at frequencies up to 500 megacycles.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.4	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.8	pf
Input: g to (h+k)	6.5	pf
Output: p to (h+k)	0.075	pf
Heater to Cathode: (h to k)	2.6	pf

MECHANICAL

Mounting Position—Any§

See Physical Dimensions on page 4 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	300 Volts
Positive DC Grid-to-Cathode Voltage	0 Volts
Negative DC Grid Voltage	50 Volts
Plate Dissipation	5.5 Watts
DC Cathode Current	30 Milliamperes
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	50 Volts
Heater Negative with Respect to Cathode	50 Volts
Grid Circuit Resistance	
With Fixed Bias	0.025 Megohms
With Cathode Bias	0.1 Megohms
Envelope Temperature at Hottest Point	250 C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200 Volts
Positive Grid Voltage	6.0 Volts
Cathode-Bias Resistor	270 Ohms
Amplification Factor	175
Plate Resistance, approximate	3900 Ohms
Transconductance	45000 Micromhos
Plate Current	24 Milliamperes
Grid Voltage, approximate	
Ib = 100 Microamperes	−5 Volts
Noise Figure¶	3.0 Decibels

Supersedes 7588 D & R Sheet ET-T1620, dated 6-60

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ One method of mounting the 7588 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 4-40 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

¶ Measured at 200 megacycles in a grounded-grid amplifier and corrected for second-stage noise figure and diode temperature.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms	17	25	33	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 200 volts, Ec = +6 volts, Rk = 270 ohms (bypassed)	35000	45000	55000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 200 volts, Ec = +6 volts, Rk = 270 Ohms (bypassed)	140	175	210	
Transconductance Change with Heater Voltage				
Difference between transconductance at Ef = 6.3 volts and transconductance at Ef = 5.7 volts (other conditions the same) expressed as a percentage of transconductance at Ef = 6.3 volts	.....	.....	20	Percent
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 200 volts, Ib = 100 μa	.....	−5.0	−8.0	Volts
Noise Figure				
Ef = 6.3 volts, Ebb = 265 volts, Ec = 0 volts, R_L = 3300 ohms, (bypassed), Rk = 22 ohms, F = 200 ± 10 MC	.....	3.0	4.8	Decibels
Interelectrode Capacitances				
Grid to Plate: (g to p)	2.1	2.8	3.5	pf
Input: g to (h+k)	5.1	6.7	8.3	pf
Output: p to (h+k)	0.05	0.075	0.1	pf
Heater to Cathode: (h to k)	1.9	2.6	3.3	pf
Negative Grid Current				
Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 22 ohms (bypassed), Rg = 0.1 meg		.....	0.5	Microamperes
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode		.....	20	Microamperes
Heater Negative with Respect to Cathode		.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	50	.....	.....	Megohms
Plate to All at 300 volts d-c	50	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.1 meg		.....	2.0	Microamperes

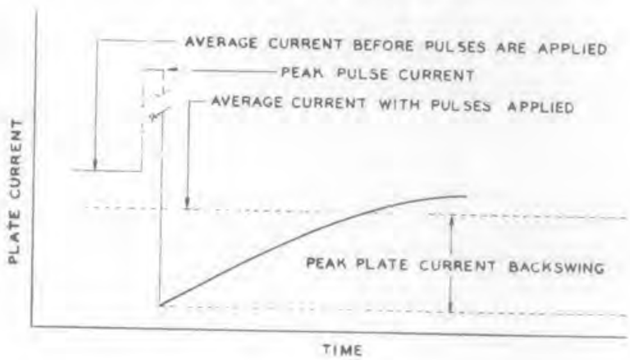
SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current		....	1.0	Milliamperes
Peak Plate Current Backswing		....	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type but is unimportant in many applications. In the majority of 7588 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. EC is adjusted for Ib = 10 ma.

Upon application to the grid of a pulse driving it 3 volts positive with respect to cathode (prr = 60 pps, duty cycle = 0.12%) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test:

PLATE CURRENT VS TIME —GRID RECOVERY TEST



	Min.	Bogey	Max.	
Low Frequency Vibrational Output Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms	....	......	25	Millivolts RMS
Variable Frequency Vibrational Output Statistical sample is subjected to vibration according to the procedure given below. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms	....	......	75	Millivolts RMS

The variable-frequency vibration test shall be performed as follows:

1. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.
2. The tube shall be vibrated with simple harmonic motion in each of two planes: first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug. At all frequencies from 100 to 2000 cps, the total harmonic distortion of the acceleration wave form shall be less than 5%.
3. The peak acceleration shall be maintained at 10 ± 1.0 G throughout the test.
4. The value of the alternating voltage produced across the load resistor (R_L), as a result of the vibration, shall be measured with a suitable device having a response to the RMS value of the voltage to within ±0.5 db of the response at 400 cps for the frequency range of 100 to 3000 cps, and having a band-pass filter with an attenuation rate of 24 db per octave below the low frequency cutoff point of 50 cps and above the high frequency cutoff point of 5000 cps. The meter shall have a dynamic response characteristic equivalent to or faster than a VU meter (operated in accordance with ASA Standard No. C16.5–1954).

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

DEGRADATION RATE TESTS (Continued)

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 250 volts, Ehk = +100 volts, Rg = 0.1 meg, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements, and transconductance, following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated 1000 hours under the following conditions: Ef = 6.3 volts, Eb = 200 volts, Ecc = +6 volts, Ehk = −70 volts, Rk = 270 ohms, Rg = 0.1 meg. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, negative grid current, noise figure, heater-cathode leakage, and interelectrode leakage resistance.

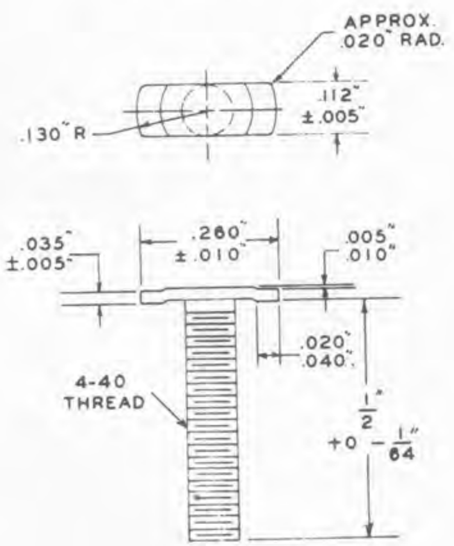
Interface Life Test

Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

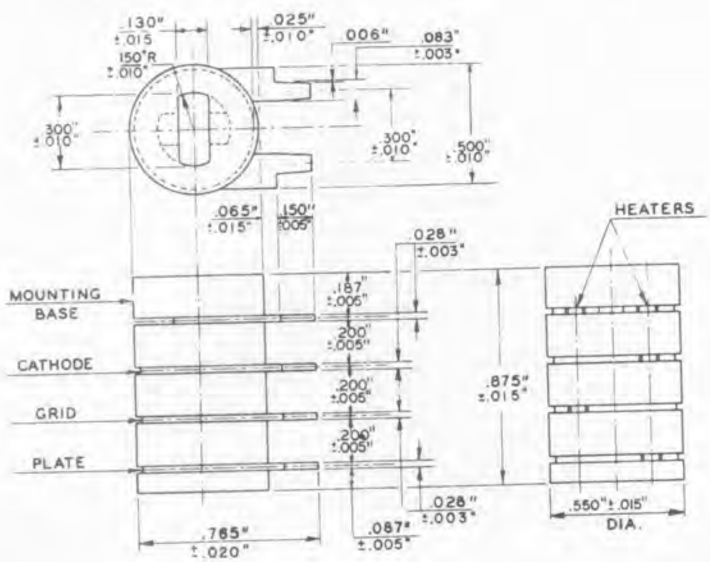
Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

MOUNTING BOLT

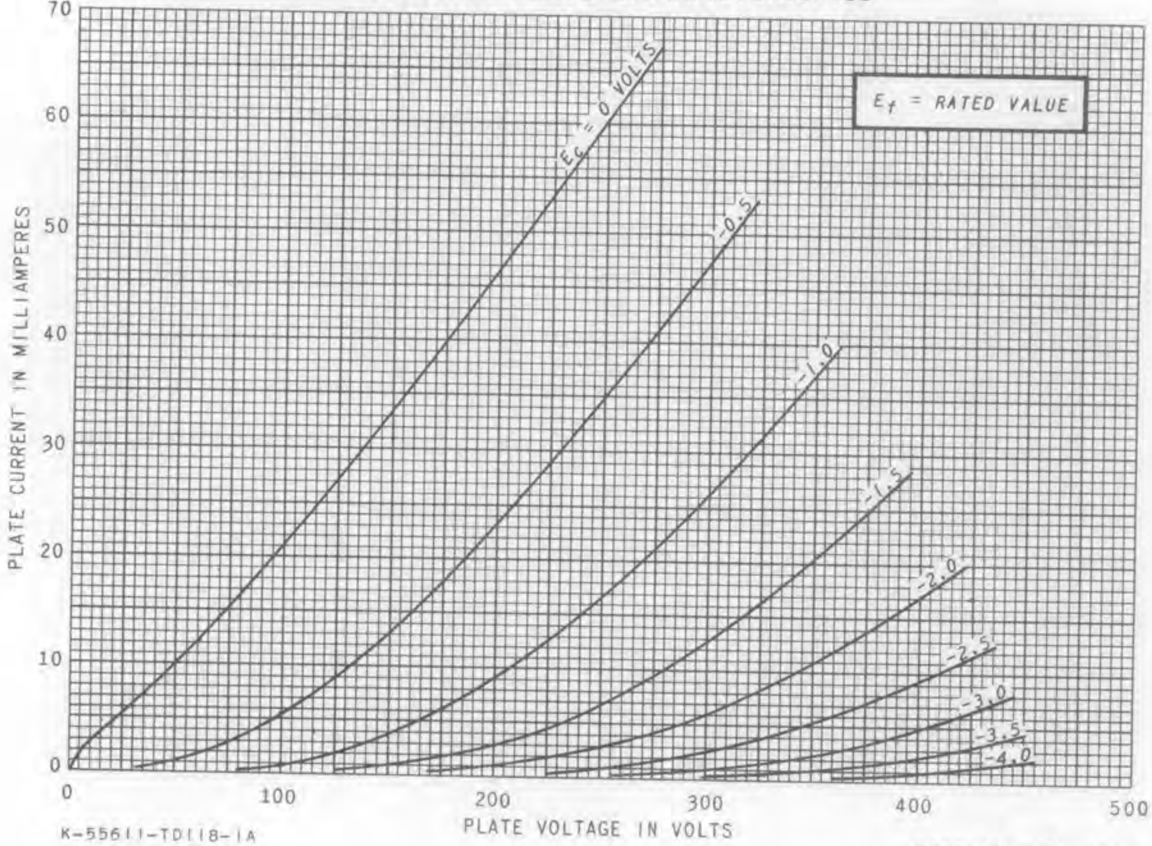


PHYSICAL DIMENSIONS



Maximum eccentricity of insulators 0.015 in. from center line.

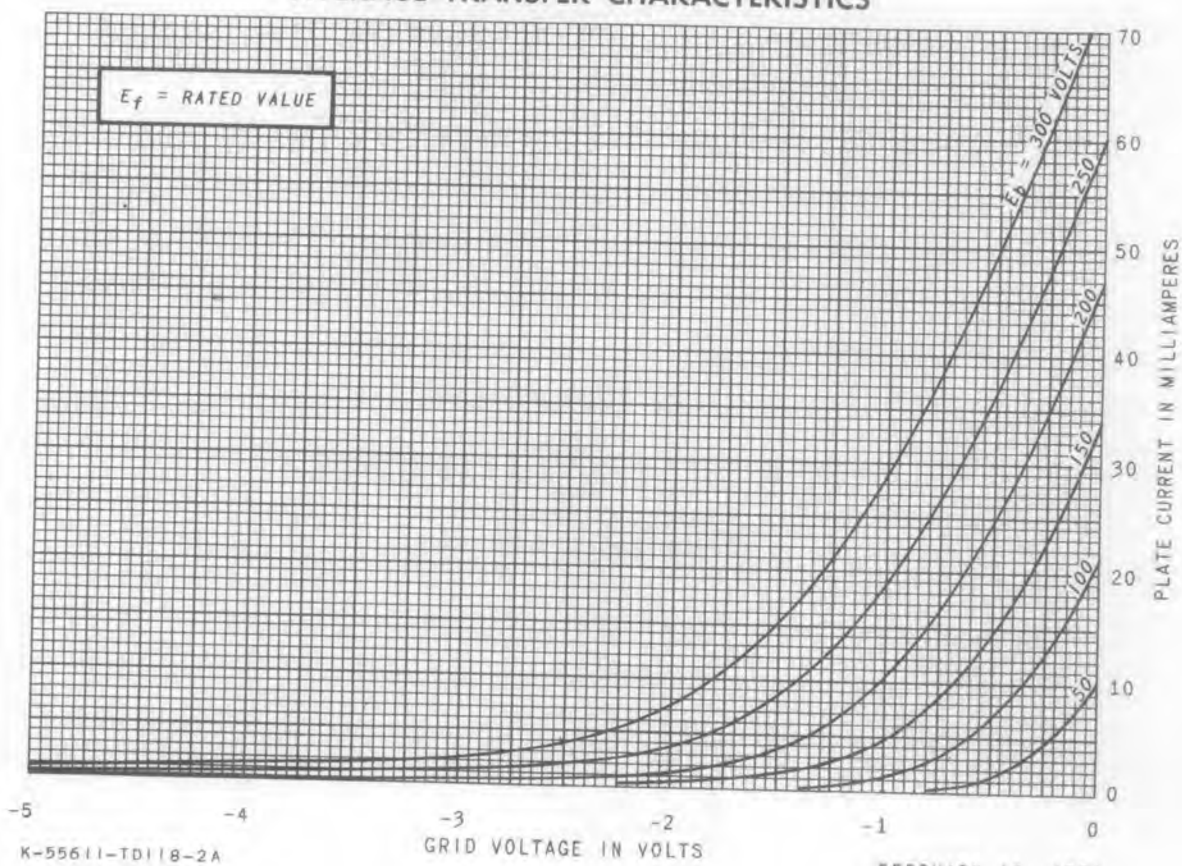
AVERAGE PLATE CHARACTERISTICS



K-55611-TD118-1A

FEBRUARY 17, 1961

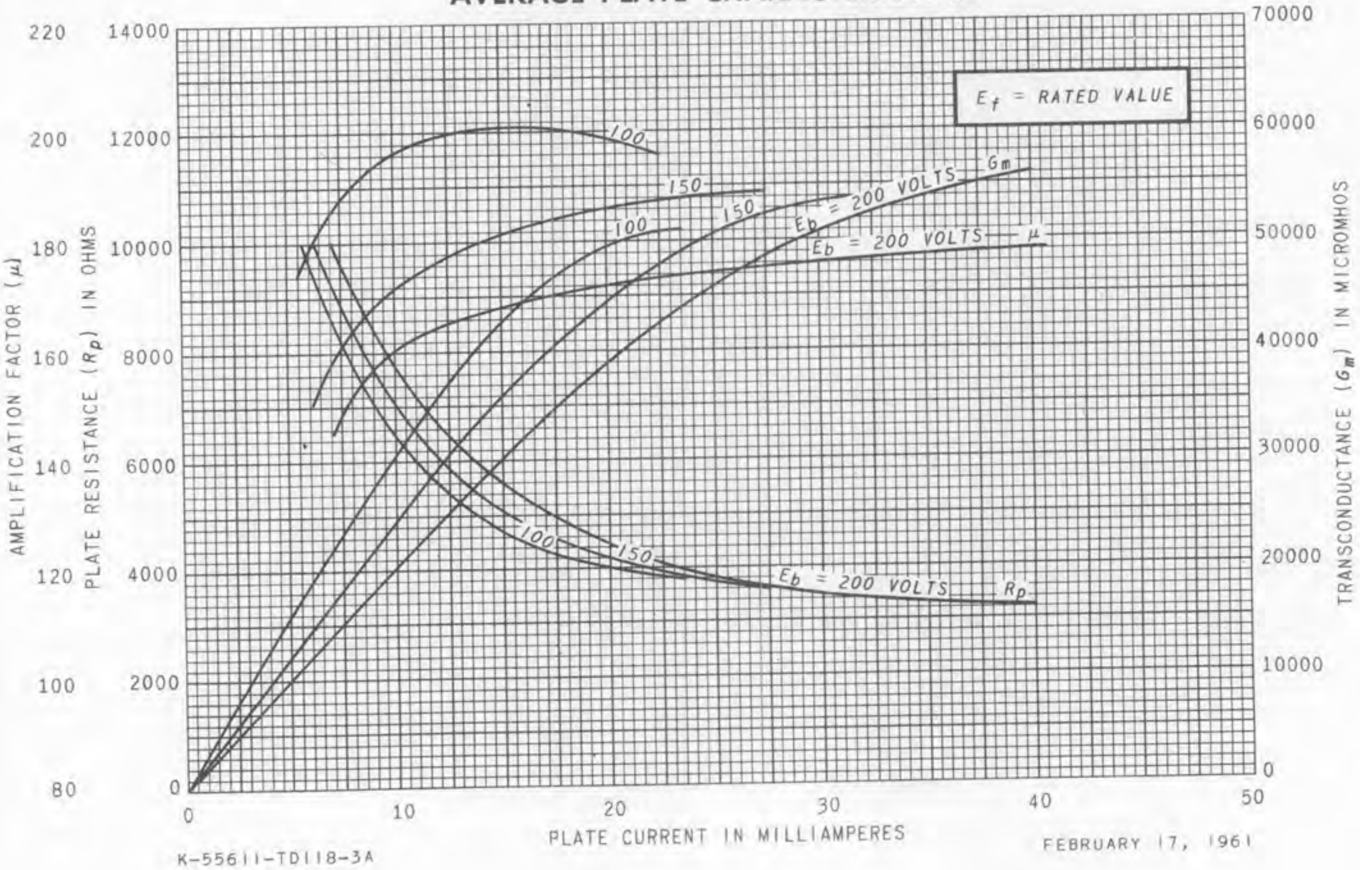
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD118-2A

FEBRUARY 17, 1961

AVERAGE PLATE CHARACTERISTICS



TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7720

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7720 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator in the ultra-high-frequency range.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.24	Amperes

Direct Interelectrode Capacitances§

Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any

See outline drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Peak Negative Grid Voltage	50	Volts
Plate Dissipation	1.0	Watt
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance	10,000	Ohms
Bulb Temperature at Hottest Point**	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	100	150	Volts
Grid Voltage	0	——	Volts
Cathode-Bias Resistor	——	82	Ohms
Amplification Factor	——	90	
Transconductance	11,500	10,500	Micromhos
Plate Current	9.0	7.5	Milliamperes

UHF OSCILLATOR SERVICE

Plate Voltage	150	Volts
Grid Resistor	7000	Ohms
Plate Current	4.0	Milliamperes
Frequency	450	Megacycles
Grid Current	0.5	Milliamperes
Power Output, approximate	100	Milliwatts

FOOTNOTES

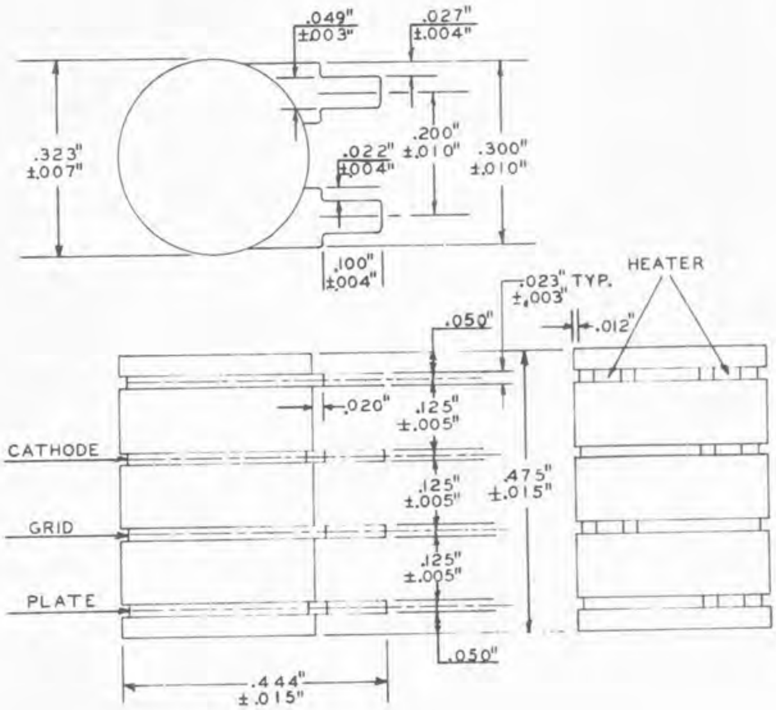
* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

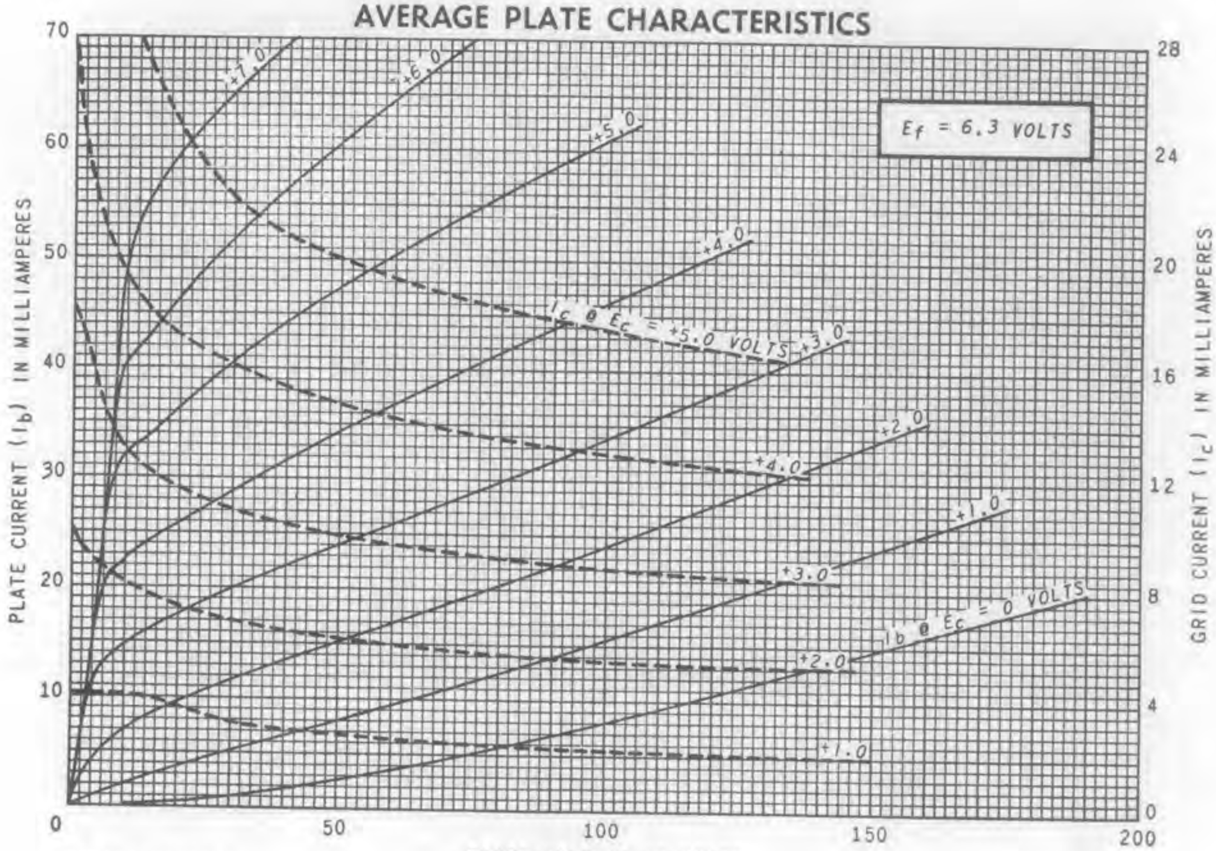
**For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.

OUTLINE DRAWING



NOTE: Maximum eccentricity of insulators 0.010 in. from center line.

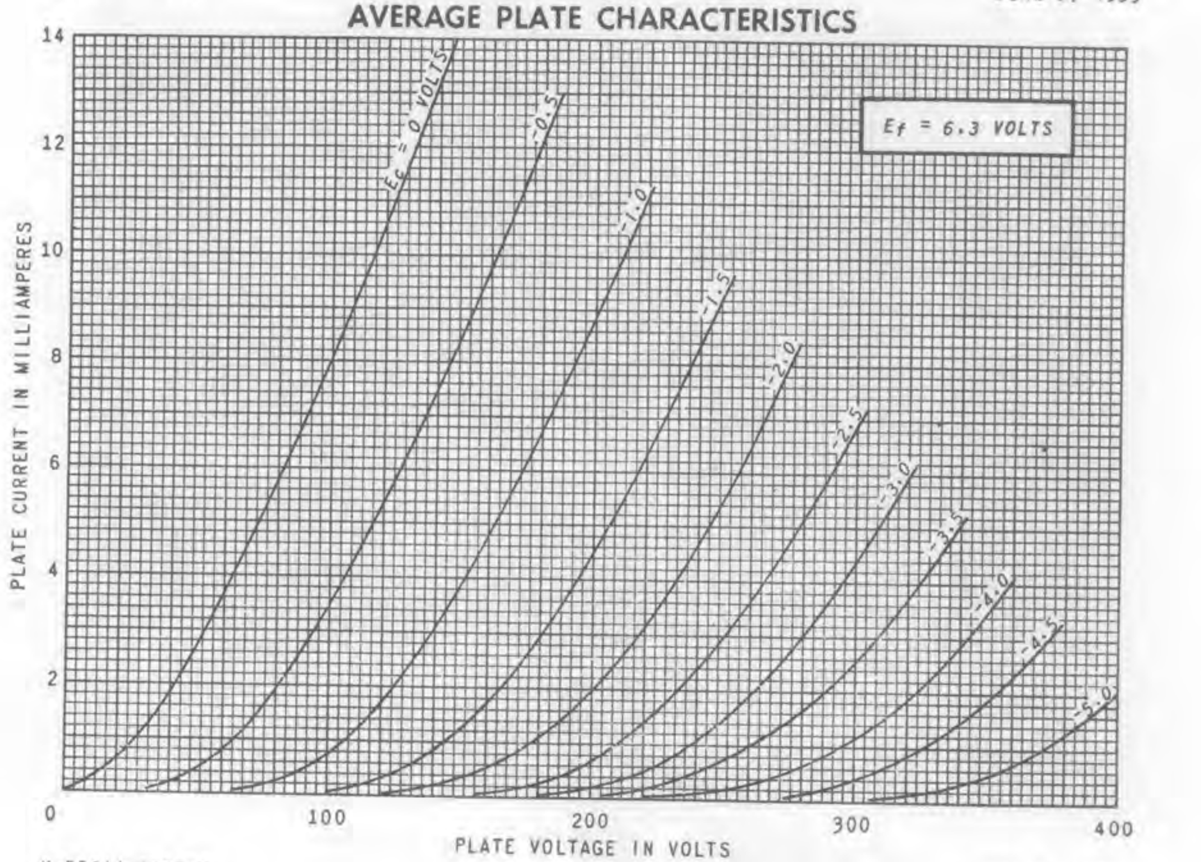
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

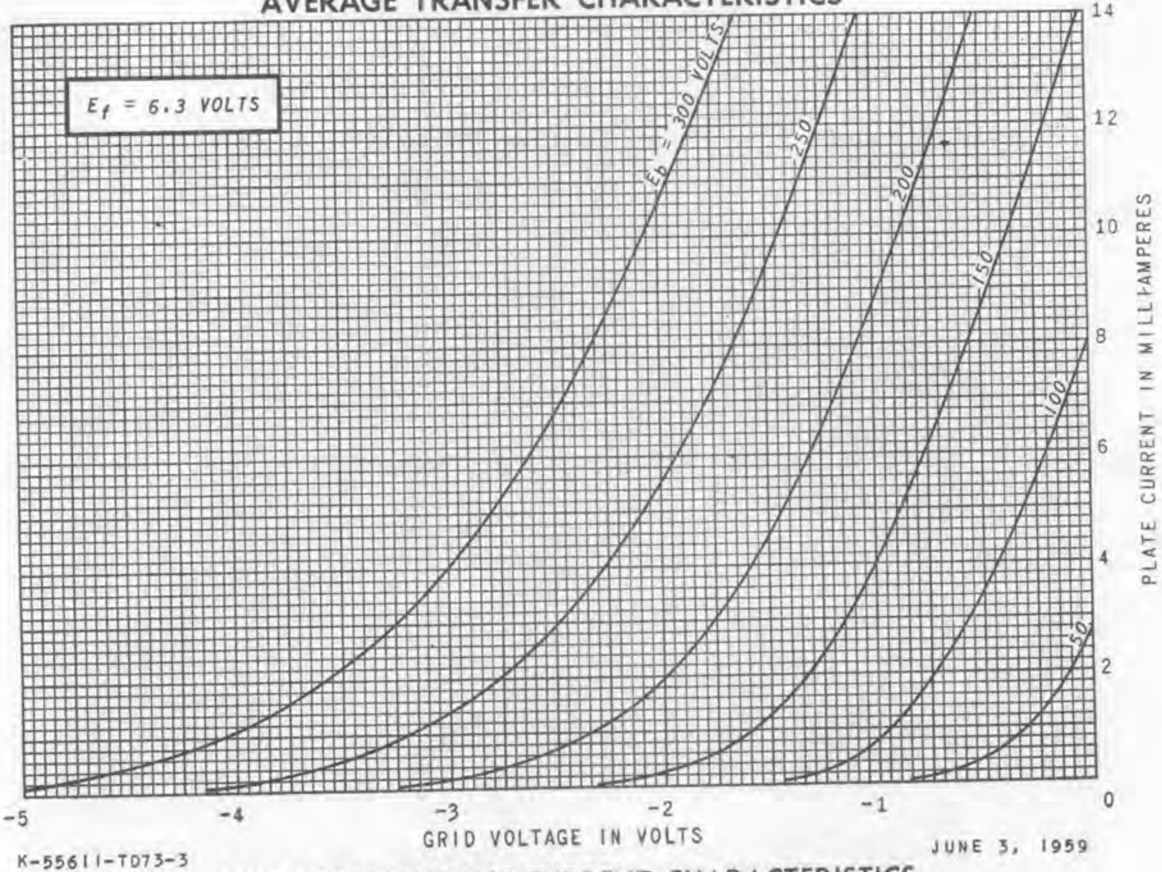
AVERAGE PLATE CHARACTERISTICS



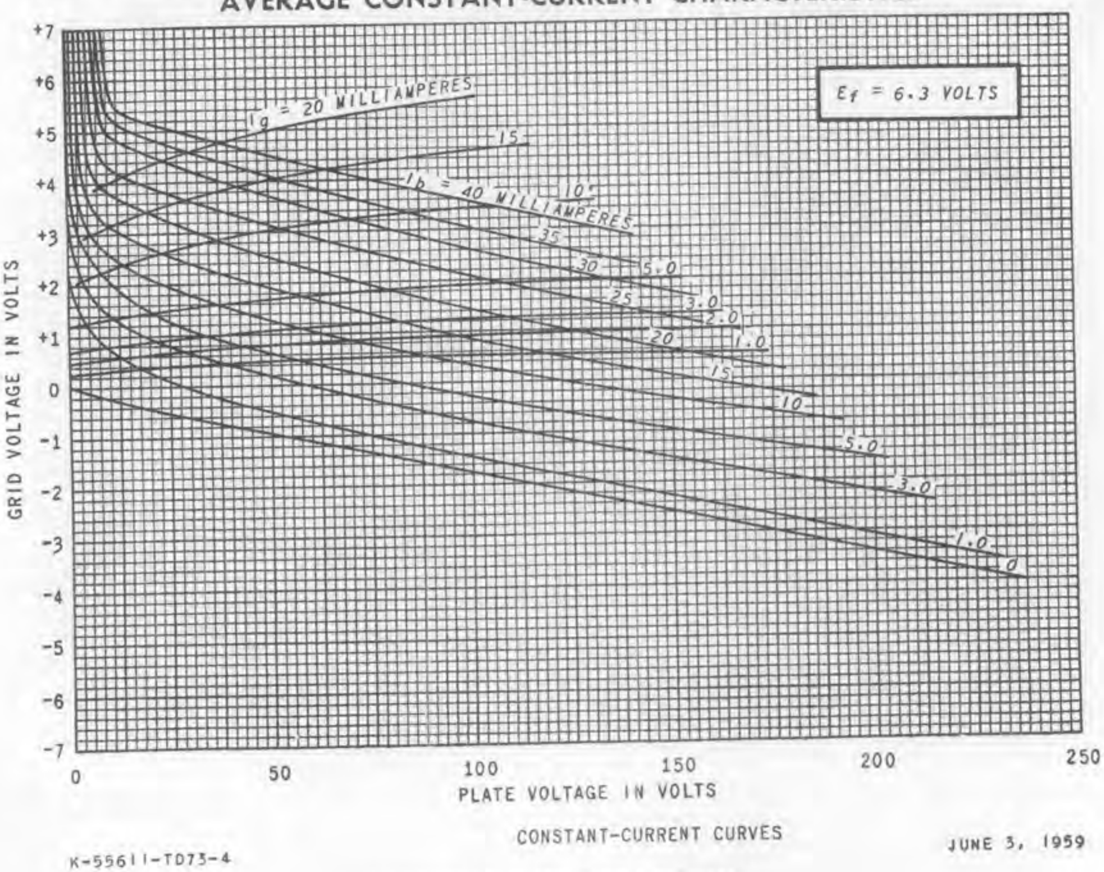
K-55611-TD73-2

JUNE 3, 1959

AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

FOR BROADBAND RADIO-FREQUENCY AMPLIFIER APPLICATIONS

The 7768 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as a broadband radio-frequency amplifier. The 7768 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.4	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.7	pf
Input: g to (h+k)	6.0	pf
Output: p to (h+k)	0.018	pf
Heater to Cathode: (h to k)	2.4	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	5.5	Watts
DC Cathode Current	30	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance With Cathode Bias	0.01	Megohms
Envelope Temperature at Hottest Point§	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	270	Ohms
Amplification Factor	225	
Plate Resistance, approximate	4500	Ohms
Transconductance	50000	Micromhos
Plate Current	24	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	−3	Volts

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	14	22	30	Milliamperes
Transconductance Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	40000	50000	60000	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	170	225	280	
Grid Voltage Cutoff Ef = 6.3 volts, Eb = 200 volts, Ib = 100 μa	.....	−3.0	−5.0	Volts
Noise Figure Ef = 6.3 volts, Ebb = 280 volts, R_L = 3300 ohms, Rk = 22 ohms (bypassed), F = 200 MC ± 10 mc	.....	3.0	4.8	Decibels
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.3	1.7	2.1	pf
Input: g to (h+k)	4.5	6.0	7.5	pf
Output: p to (h+k)	0.01	0.018	0.026	pf
Heater to Cathode: (h to k)	1.5	2.4	3.3	pf
Negative Grid Current Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 22 ohms (bypassed), Rg = 0.1 meg	.....	.....	0.5	Microamperes
Heater-Cathode Leakage Current Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to A11 at 100 volts d-c	50	.....	.....	Megohms
Plate to A11 at 300 volts d-c	50	.....	.....	Megohms
Grid Emission Current Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current	......	......	1.0	Milliamperes
Peak Plate Current Backswing	......	......	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7768 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 10 ma.

Upon application to the grid of a 3 volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

	Min.	Bogey	Max.	
Low Frequency Vibrational Output	......	......	50	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

OUTLINE DRAWING

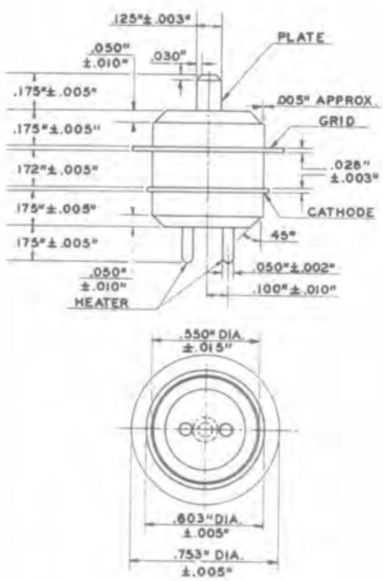
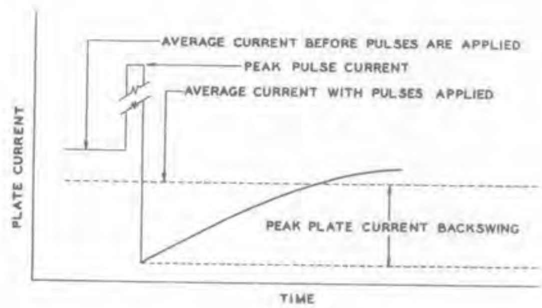


PLATE CURRENT VS. TIME —GRID RECOVERY TEST



DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, Ehk = +100 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements and transconductance following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Eb = 200 volts, Ecc = +7 volts, Ehk = −70 volts d-c, Rk = 270 ohms, and Rg = 0.01 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, grid current, transconductance, noise figure, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

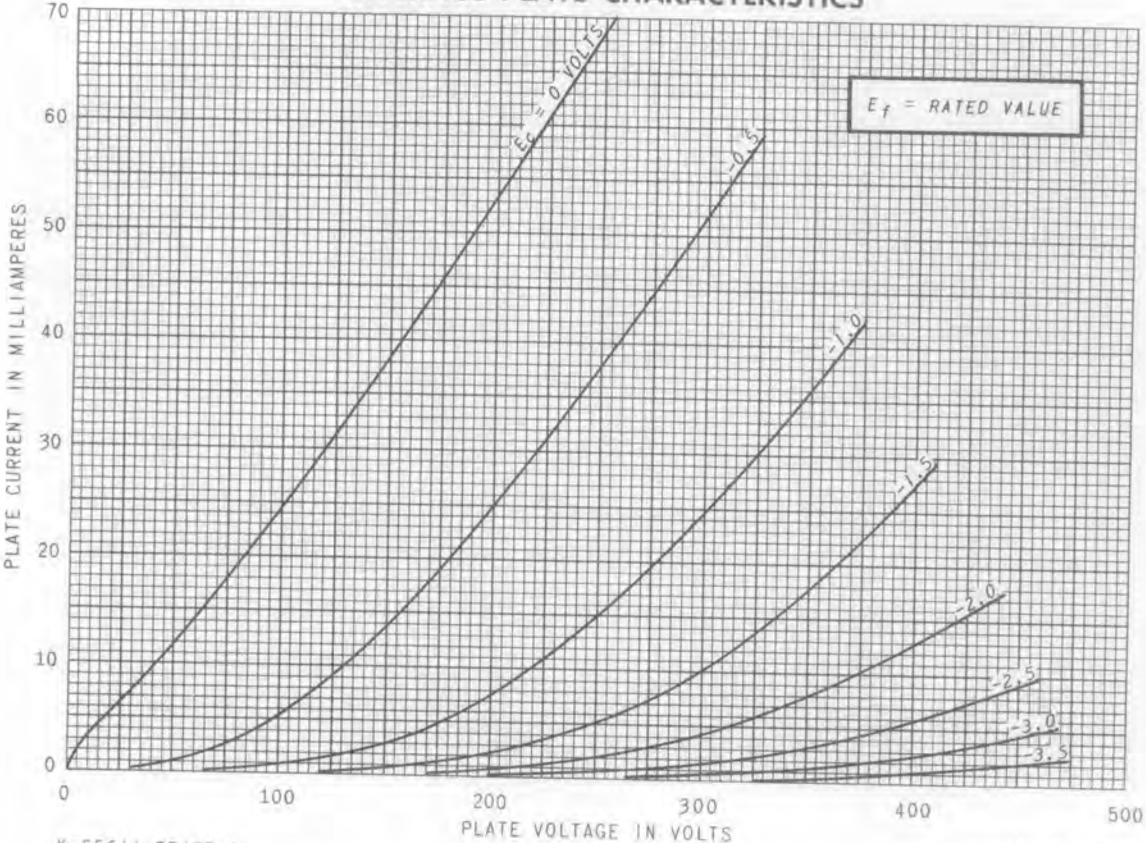
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

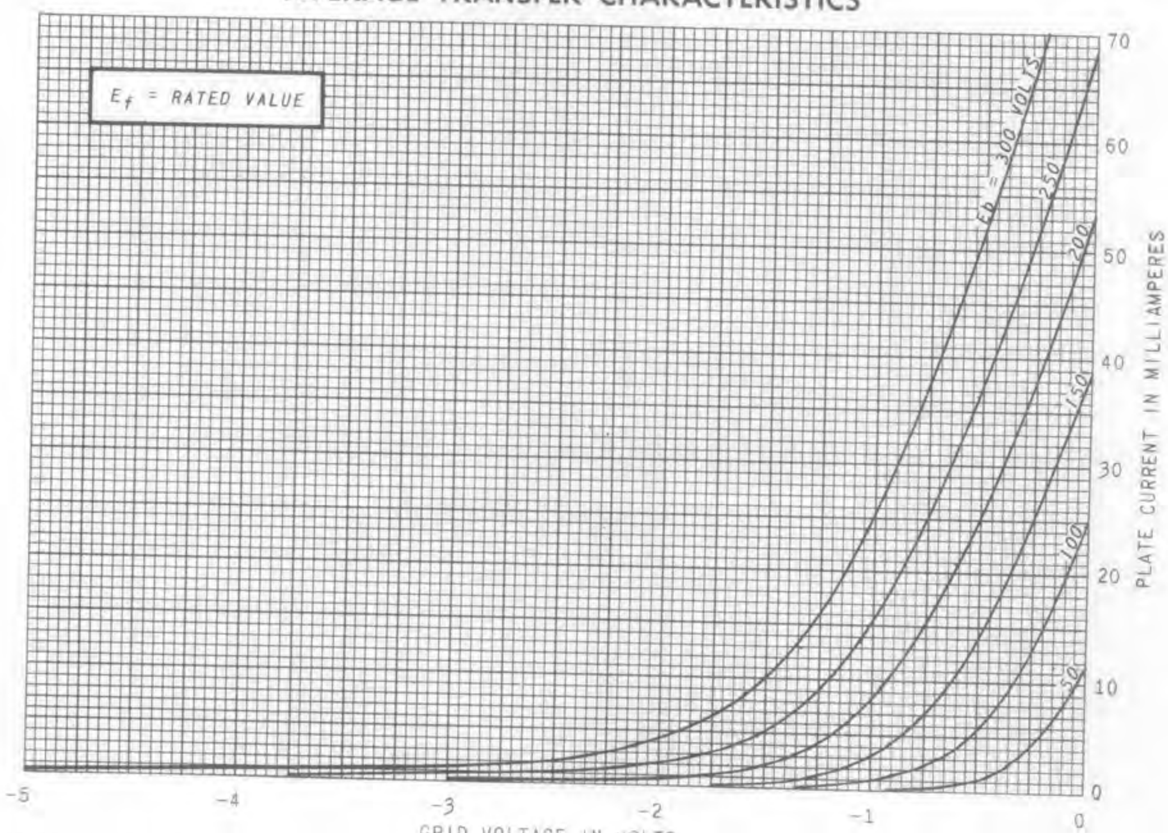
AVERAGE PLATE CHARACTERISTICS



K-55611-TD160-1

JANUARY 9, 1962

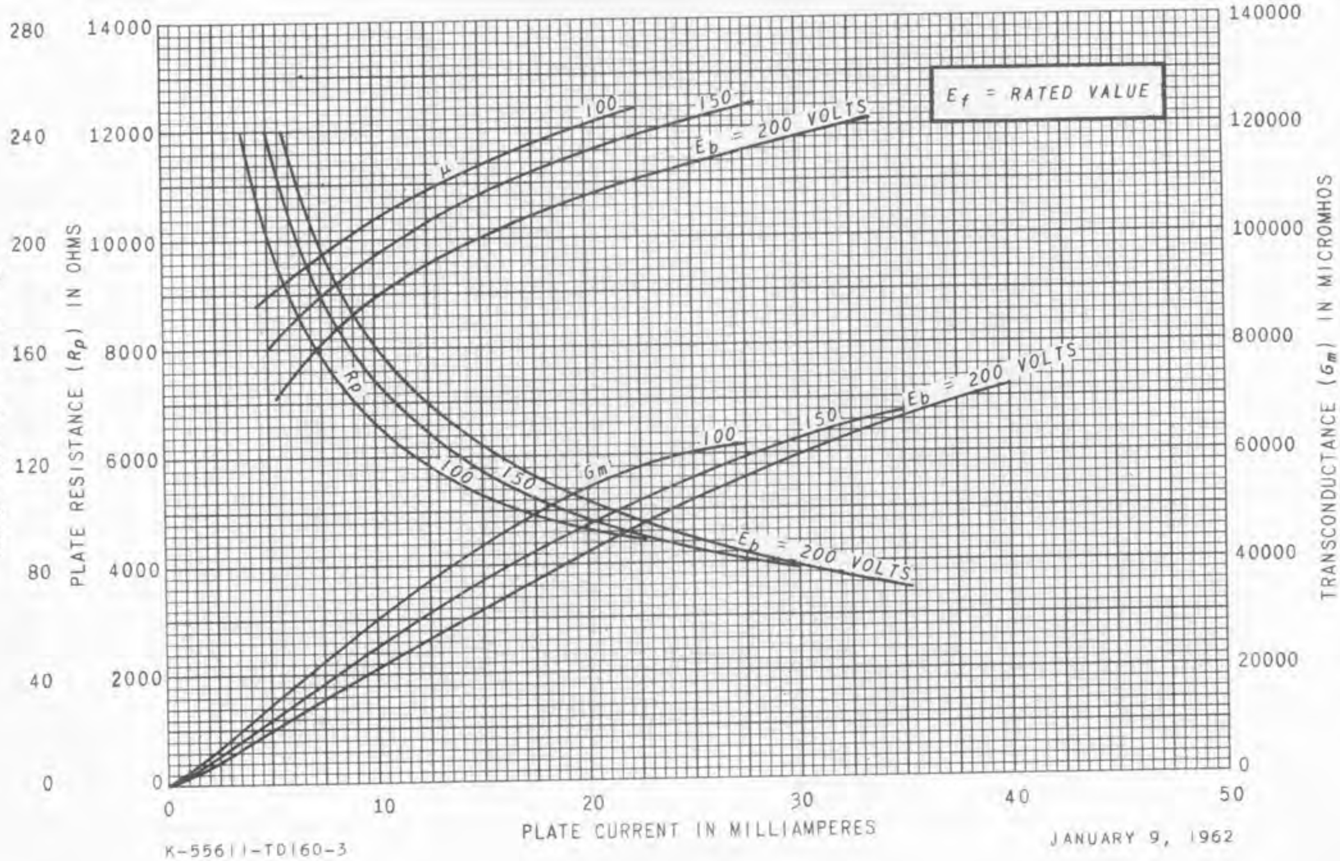
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD160-2

JANUARY 9, 1962

AVERAGE CHARACTERISTICS



GE ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

7815

Planar Triode

The 7815 is a high-mu, ceramic-and-metal, planar triode designed for use as a grid-pulsed or plate-pulsed oscillator, frequency multiplier, or power amplifier at frequencies up to 3000 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current‡	1.0	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.05	pf
Grid to Cathode: (g to k)	6.3	pf
Plate to Cathode: (p to k), Maximum	0.035	pf

MECHANICAL

Operating Position - Any

Cooling - Conduction and Convection

Net Weight, approximate	1.7	Ounces
Maximum Anode Temperature	250	C

MAXIMUM RATINGS AND TYPICAL OPERATION

PLATE-PULSED OSCILLATOR OR AMPLIFIER—CLASS C

MAXIMUM RATINGS—ABSOLUTE-MAXIMUM VALUES

Peak Pulse Plate-Supply Voltage	3500	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

TYPICAL OPERATION—OSCILLATOR AT 2500 MEGACYCLES

Heater Voltage	5.8	Volts
Peak Plate-Supply Voltage	3500	Volts
Pulse Length	5	Microseconds
Duty Factor	0.0030	
Peak Plate Current	3.0	Amperes
Average Plate Current	9.0	Milliamperes
Average Grid Current	3.0	Milliamperes
Peak Useful Power Output, approximate	2000	Watts

GENERAL ELECTRIC

Supersedes 7815 D and R Sheet dated 7-64

MAXIMUM RATINGS AND TYPICAL OPERATION (Continued)

GRID-PULSED OSCILLATOR OR AMPLIFIER—CLASS C

MAXIMUM RATINGS—ABSOLUTE-MAXIMUM VALUES

DC Plate Voltage	2000	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

TYPICAL OPERATION—AMPLIFIER AT 1100 MEGACYCLES

Heater Voltage	6.0	Volts
DC Plate Voltage	1700	Volts
DC Grid Voltage	-45	Volts
Pulse Length	3.5	Microseconds
Duty Factor	0.001	
Peak Plate Current	1.9	Amperes
Peak Grid Current	1.1	Amperes
Driving Power during Pulse, approximate	400	Watts
Peak Useful Power Output, approximate	1500	Watts

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

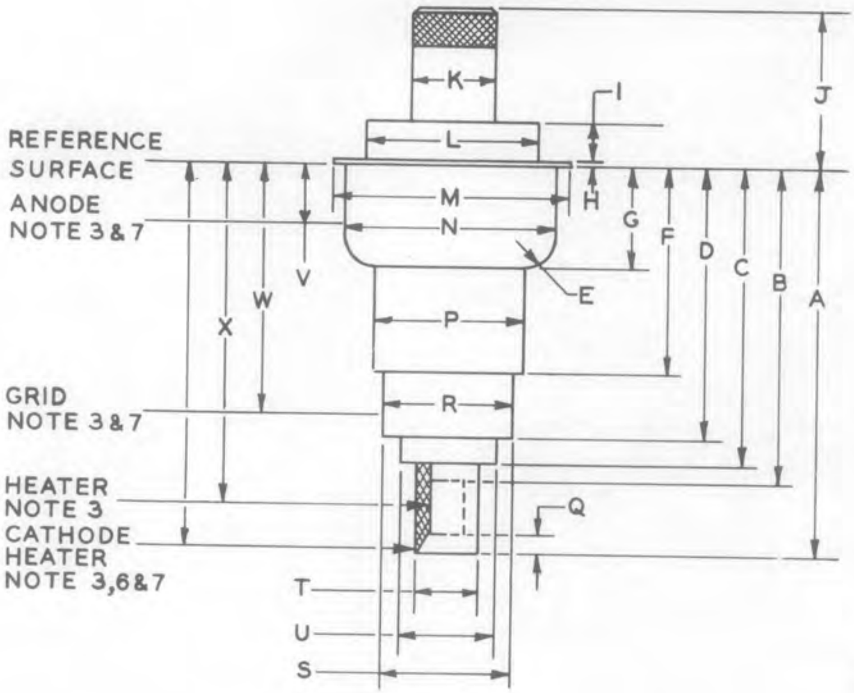
The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 5.0 to 6.0 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

‡ Heater Current of a bogey tube at Ef = 6.0 volts.

§ Measured without heater voltage.



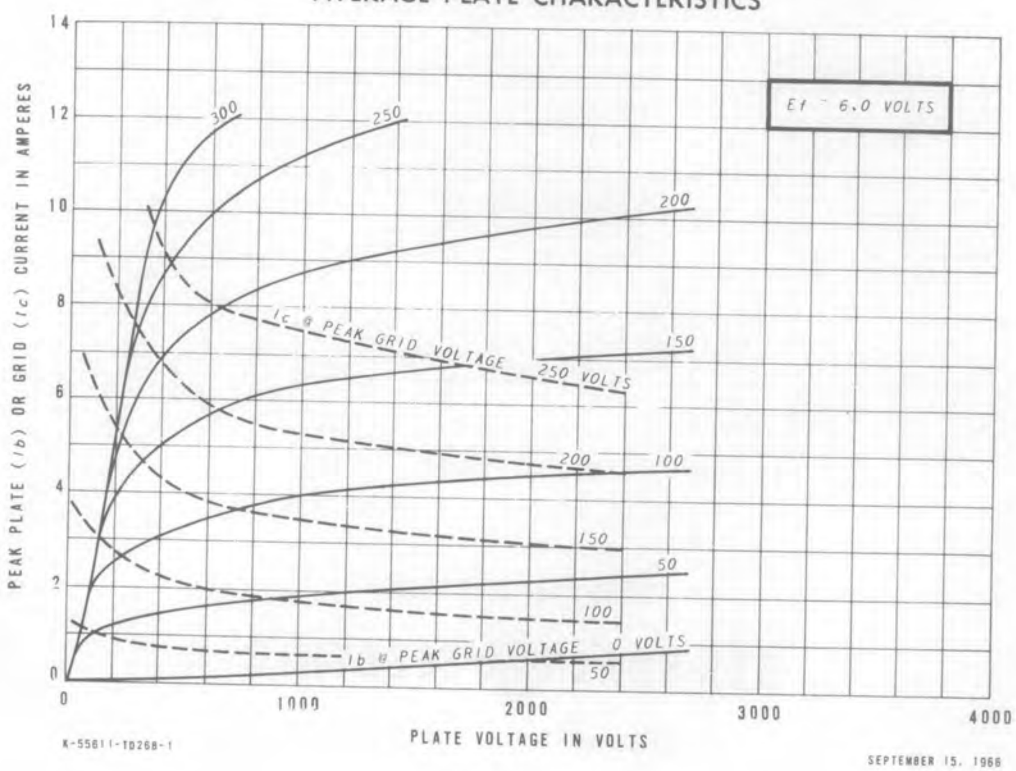
DIMENSIONS FOR OUTLINE (INCHES)

Ref.	Inches	
	Minimum	Maximum
A	1.815	1.875
B	---	1.534
C	---	1.475
D	1.289	1.329
E	---	0.100
F	0.970	1.010
G	0.462	0.477
H	---	0.040
I	---	0.185
J	0.766	0.826
K	0.427	0.447
L	0.840	0.860
M	1.180	1.195
N	1.025	1.035
P	0.752	0.792
Q	---	0.086
R	0.655	0.665
S	---	0.545
T	0.213	0.223
U	0.315	0.325

DIMENSIONS FOR ELECTRODE CONTACT AREA (INCHES)

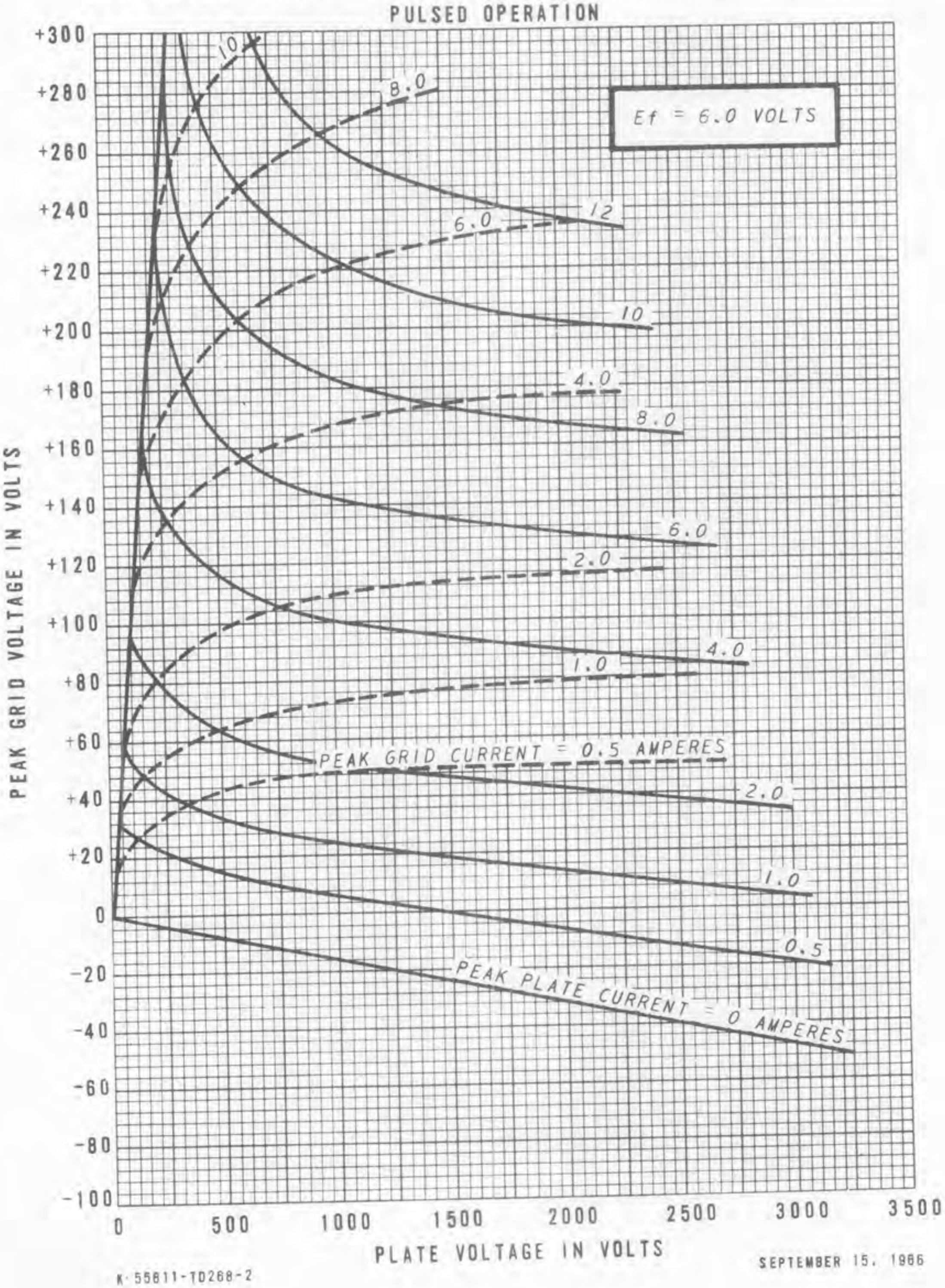
Ref.	Dimension	Contact
V	0.198±0.163	Anode
W	1.225±0.040	Grid
X	1.631±0.097	Heater
Y	1.645±0.170	Cathode

AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS

PULSED OPERATION



K-55811-TD268-2

SEPTEMBER 15, 1966

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

GE ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRODUCT INFORMATION

7815R

Planar Triode

The 7815R is a high-mu, ceramic-and-metal, planar triode designed for use as a grid-pulsed or plate-pulsed oscillator, frequency multiplier, or power amplifier at frequencies up to 3000 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current‡	1.0	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.05	pf
Grid to Cathode: (g to k)	6.3	pf
Plate to Cathode: (p to k), Maximum	0.035	pf

MECHANICAL

Operating Position - Any

Cooling - Conduction and Convection

Net Weight, approximate	2.5	Ounces
Maximum Anode Temperature	250	C

MAXIMUM RATINGS AND TYPICAL OPERATION

PLATE-PULSED OSCILLATOR OR AMPLIFIER—CLASS C

MAXIMUM RATINGS—ABSOLUTE-MAXIMUM VALUES

Peak Pulse Plate-Supply Voltage	3500	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10¶	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

TYPICAL OPERATION—OSCILLATOR AT 2500 MEGACYCLES

Heater Voltage	5.8	Volts
Peak Plate-Supply Voltage	3500	Volts
Pulse Length	5	Microseconds
Duty Factor	0.0030	
Peak Plate Current	3.0	Amperes
Average Plate Current	9.0	Milliamperes
Average Grid Current	3.0	Milliamperes
Peak Useful Power Output, approximate	2000	Watts

MAXIMUM RATINGS AND TYPICAL OPERATION (Continued)

GRID-PULSED OSCILLATOR OR AMPLIFIER—CLASS C

MAXIMUM RATINGS—ABSOLUTE-MAXIMUM VALUES

DC Plate Voltage	2000	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10¶	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

TYPICAL OPERATION—AMPLIFIER AT 1100 MEGACYCLES

Heater Voltage	6.0	Volts
DC Plate Voltage	1700	Volts
DC Grid Voltage	-45	Volts
Pulse Length	3.5	Microseconds
Duty Factor	0.001	
Peak Plate Current	1.9	Amperes
Peak Grid Current	1.1	Amperes
Driving Power during Pulse, approximate	400	Watts
Peak Useful Power Output, approximate	1500	Watts

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

NOTES

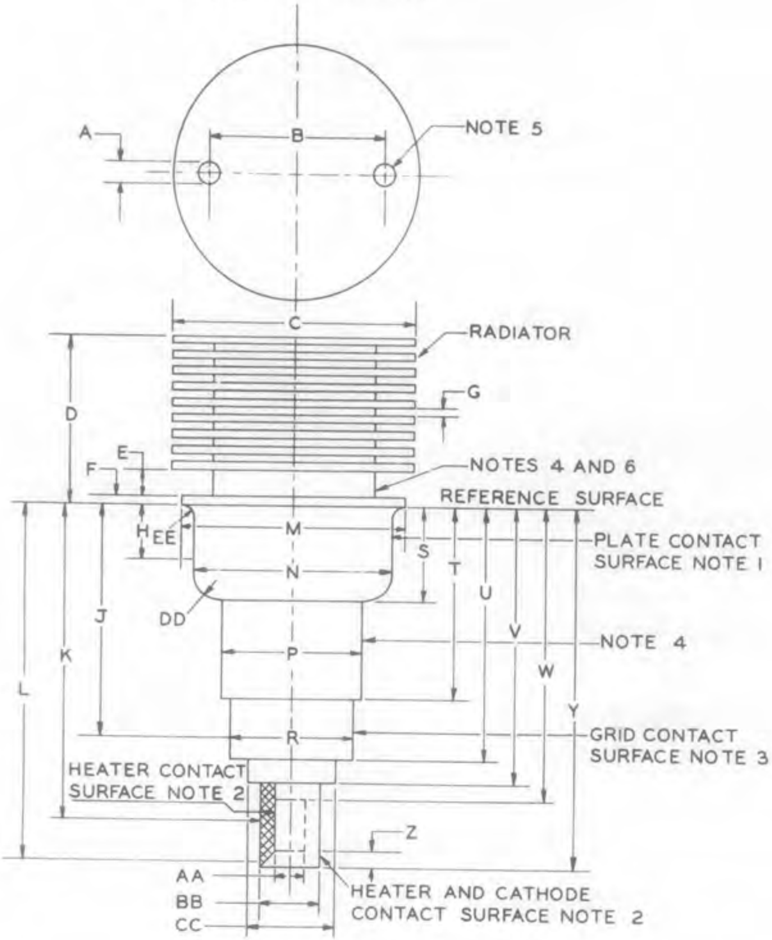
* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 5.0 to 6.0 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

‡ Heater current of a bogey tube at Ef = 6.0 volts.

§ Measured without heater voltage.

¶ Plate dissipation of 100 watts is permissible with forced-air cooling.

PHYSICAL DIMENSIONS



DIMENSIONS FOR OUTLINE (INCHES)

Ref.	Inches	
	Minimum	Maximum
A	0.105	0.145
B	0.650	0.850
C	1.234	1.264
D	0.766	0.826
E	0.125	0.185
F	---	0.040
G	0.025	0.046
M	1.180	1.195
N	1.025	1.035
P	0.752	0.792
R	0.655	0.665
S	0.462	0.477
T	0.970	1.010
U	1.289	1.329
V	---	1.475
W	---	1.534
Y	1.815	1.875
Z	---	0.086
AA	0.213	0.223
BB	0.315	0.325
CC	---	0.545

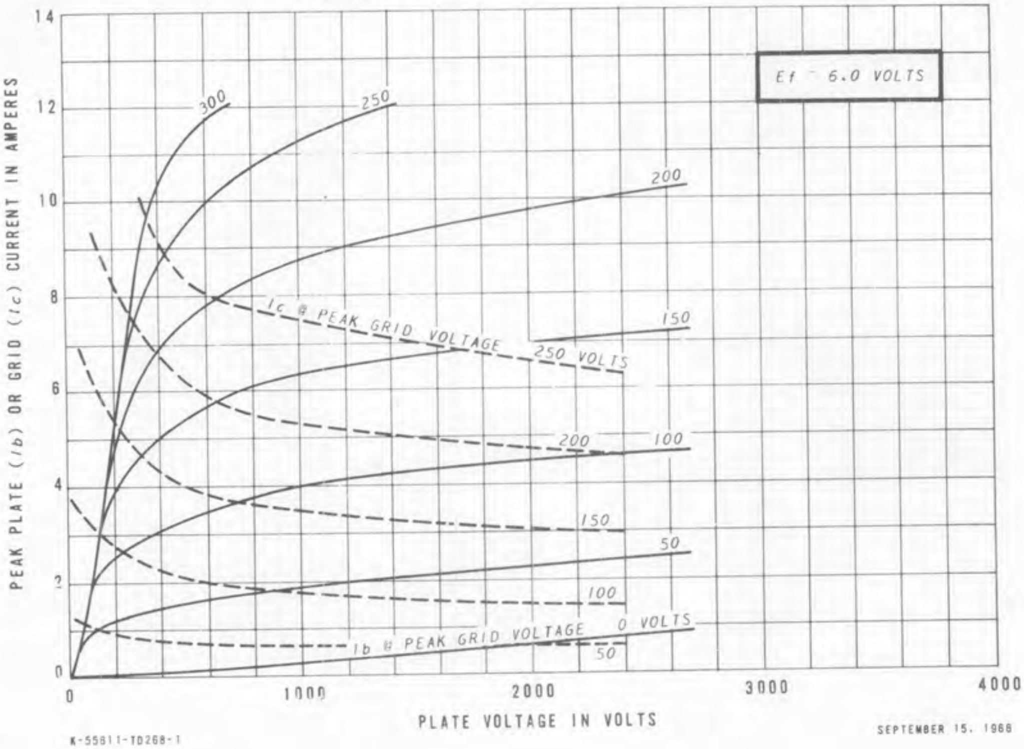
DIMENSIONS FOR ELECTRODE CONTACT AREA (INCHES)

Ref.	Dimension	Contact
H	0.198±0.163	Plate
J	1.225±0.040	Grid
K	1.631±0.097	Heater
L	1.645±0.170	Cathode

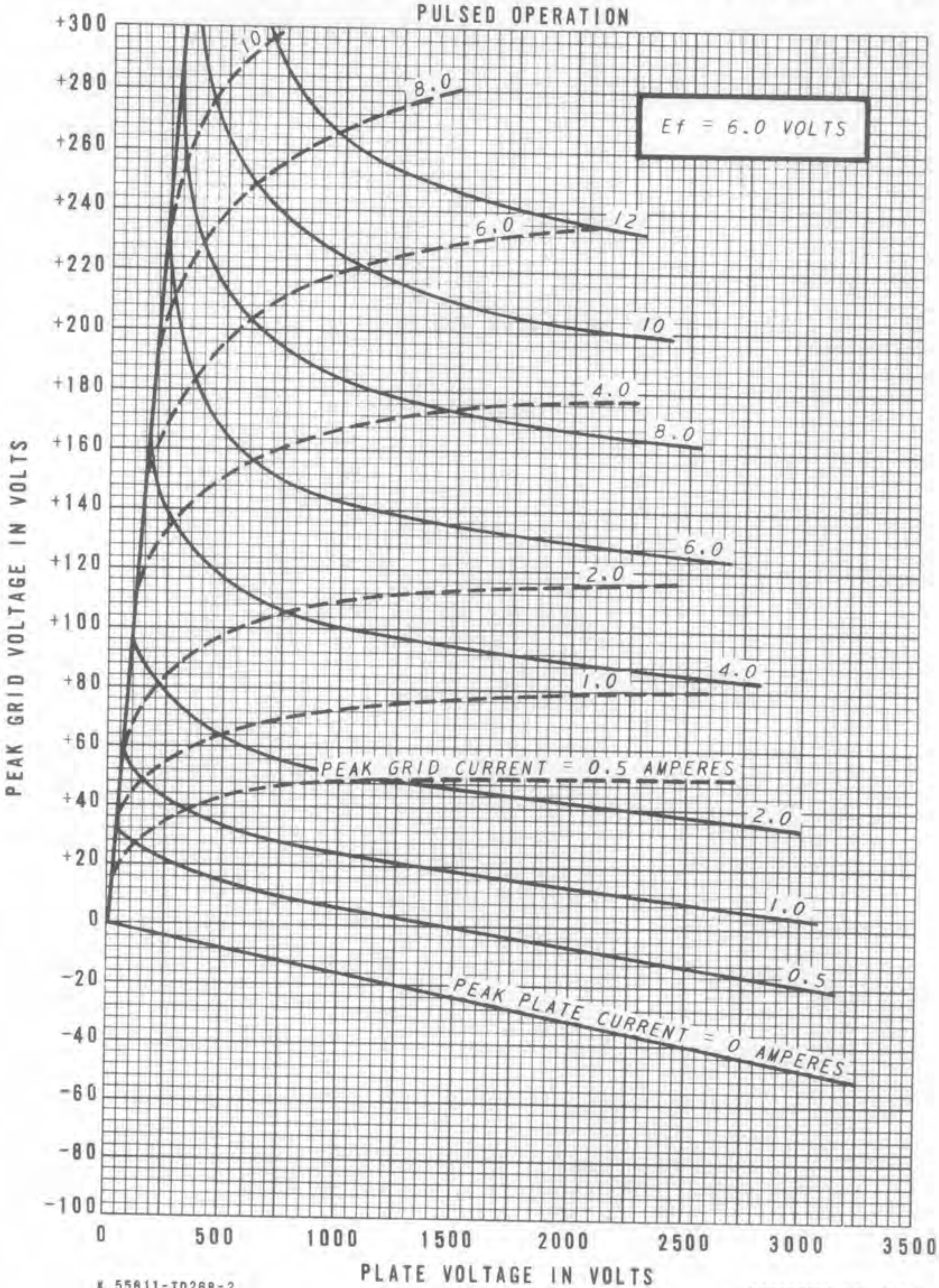
NOTES

1. The total indicated runout of the plate contact surface with respect to the cathode contact surfaces will not exceed 0.020 inch.
2. The total indicated runout of the cathode contact surface with respect to the heater contact surfaces will not exceed 0.012 inch.
3. The total indicated runout of the grid contact surface with respect to the cathode contact surface will not exceed 0.020 inch.
4. Do not clamp or locate on this surface.
5. Hole provided for tube extractor through the top fin only.
6. Measure plate shank temperature on this surface.

AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K 55811-TD268-2

SEPTEMBER 15, 1966

ELECTRONICS

7910

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7910 is a triode of ceramic-and-metal planar construction primarily intended for use as a plate-pulsed oscillator or amplifier at frequencies up to 7500 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.275	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h + k)	2.1	pf
Output: p to (h + k)	0.02	pf
Heater to Cathode: (h to k)	1.15	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

PLATE-PULSED OSCILLATOR OR AMPLIFIER SERVICE

Peak Positive-Pulse Plate Supply Voltage	1200	Volts
Duty Factor of Plate Pulse¶#	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average#	0.6	Milliamperes
Average During Plate Pulse∆	0.6	Amperes
Negative Grid Voltage		
Average During Plate Pulse	50	Volts
Grid Current		
Average#	0.2	Milliamperes
Average During Plate Pulse	0.2	Amperes
Plate Dissipation#	1.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	125	Volts
Cathode-Bias Resistor	82	Ohms
Amplification Factor	75	
Transconductance	16000	Micromhos
Plate Current	11.5	Milliamperes

PLATE-PULSED OSCILLATOR SERVICE

Frequency	5900	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	1000	Volts
Plate Current		
Average	0.6	Milliamperes
Average During Plate Pulse	600	Milliamperes
Grid Current		
Average	0.2	Milliamperes
Average During Plate Pulse	200	Milliamperes
Useful Power Output		
Average	0.1	Watts
Average During Plate Pulse	100	Watts

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

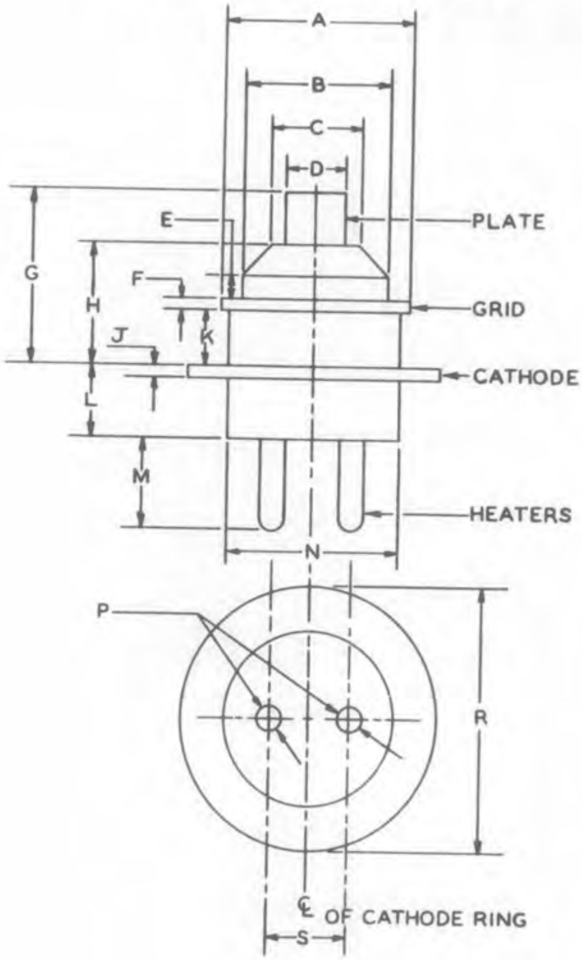
§ Measured with a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

In any 5000 microsecond interval.

Δ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered as short circuit, to a maximum of 6.0 amperes.

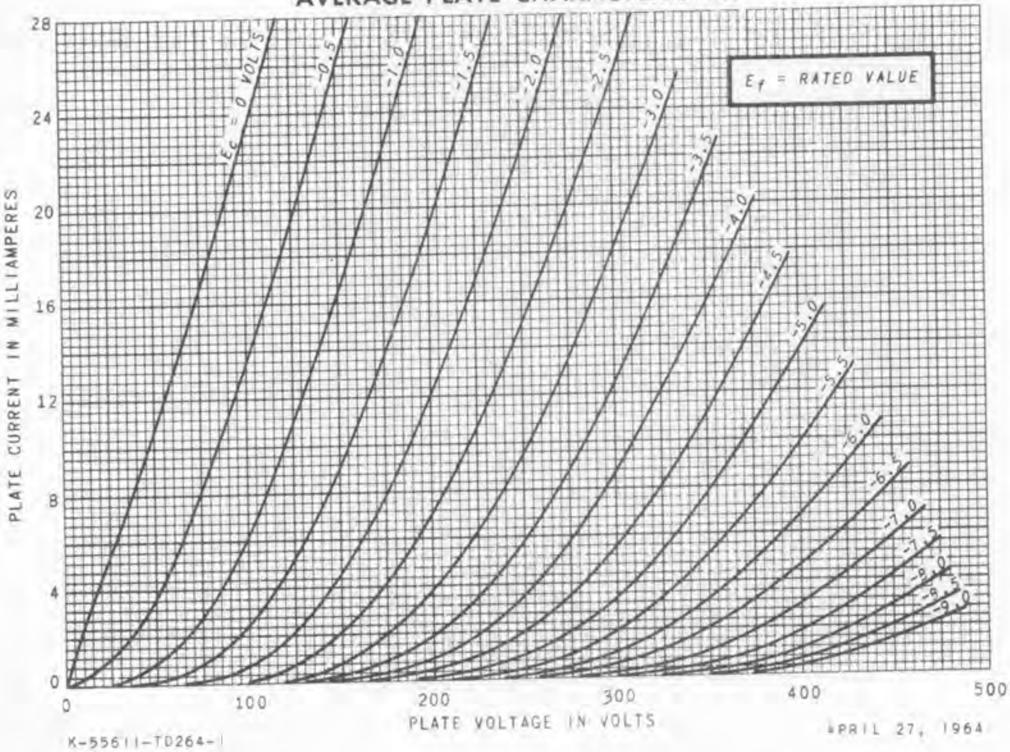
PHYSICAL DIMENSIONS



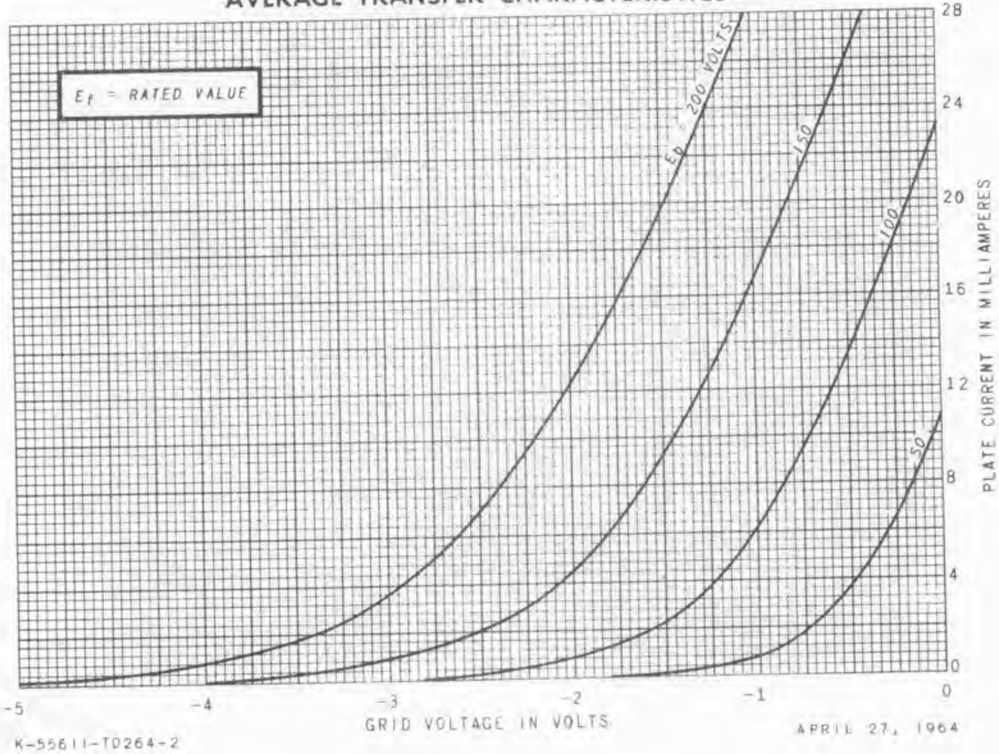
Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.357		0.363	9.068		9.220
B			0.285			7.24
C		0.180			4.57	
D	0.108		0.112	2.743		2.845
E		0.040			1.02	
F	0.025		0.031	0.635		0.787
G	0.315		0.335	8.00		8.51
H	0.216		0.232	5.49		5.89
J	0.025		0.031	0.635		0.787
K	0.094		0.102	2.388		2.591
L	0.143		0.157	3.63		3.99
M	0.165		0.185	4.19		4.70
N			0.330			8.38
P	0.048		0.054	1.219		1.372
R	0.476		0.484	12.090		12.294
S	0.130		0.142	3.30		3.61

Note: The millimeter dimensions are derived from the original inch dimensions.

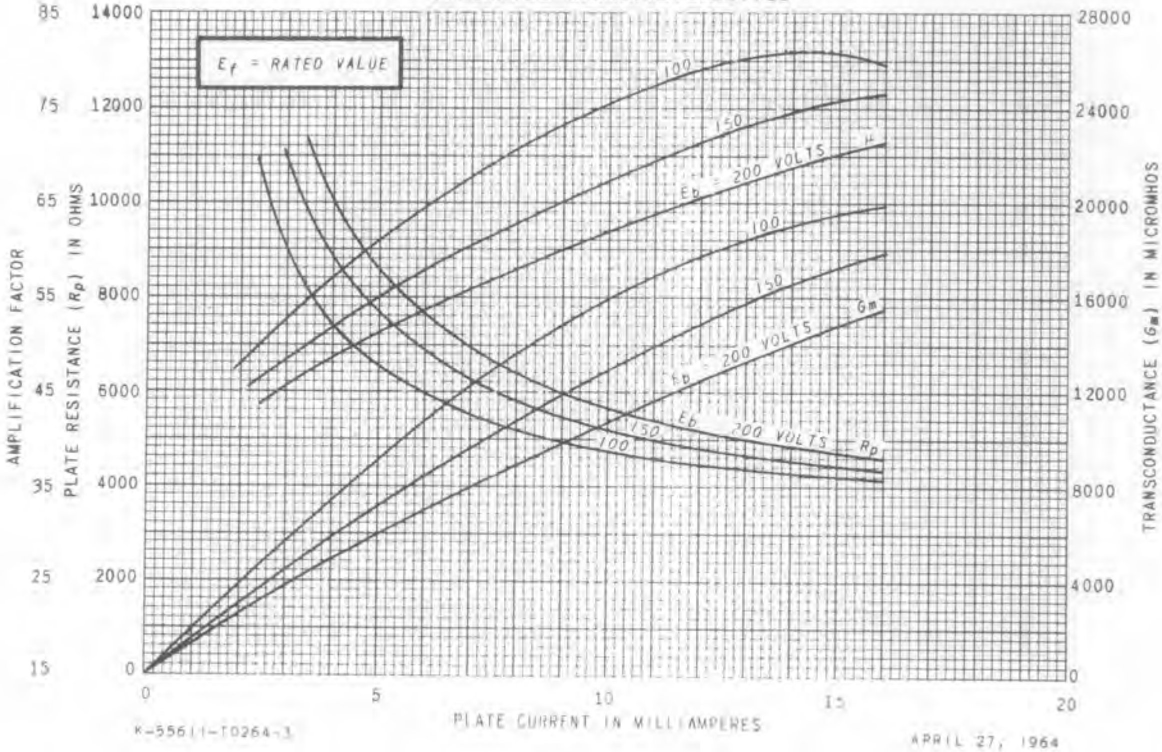
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS

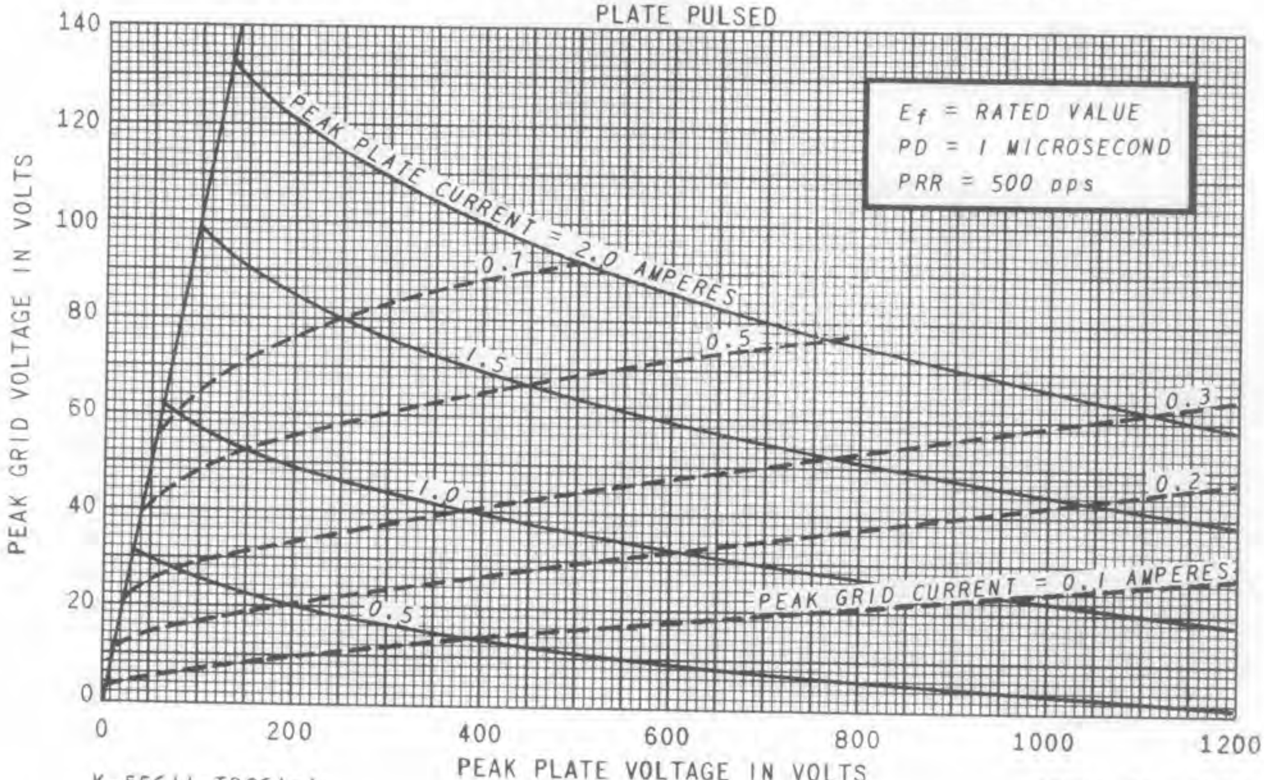


K-55611-TD264-3

APRIL 27, 1964

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

PLATE PULSED



K-55611-TD264-4

APRIL 27, 1964

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

Planar Triode

7911

FOR PLATE-PULSED OSCILLATOR OR AMPLIFIER APPLICATIONS

The 7911 is a high-mu triode of ceramic and metal planar construction intended for use as a plate-pulsed oscillator or amplifier at frequencies up to 6000 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.55	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.4	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.05	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

PLATE-PULSED OSCILLATOR OR AMPLIFIER SERVICE—ABSOLUTE-MAXIMUM VALUES

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶#	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average#	2.5	Milliamperes
Average During Plate Pulse∆	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average#	1.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
Cathode Current		
Average#	3.0	Milliamperes
Average During Plate Pulse∆	3.0	Amperes
Plate Dissipation#	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes Pages 1 and 2 of 7911 PI Sheet dated 8-65

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	58	
Plate Resistance, approximate	2300	Ohms
Transconductance	25000	Micromhos
Plate Current	23	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-5	Volts

PLATE-PULSED OSCILLATOR SERVICE

Frequency	4100	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Supply Voltage	3000	Volts
Plate Current		
Average	2.5	Milliamperes
Average During Plate Pulse	2.5	Amperes
Grid Current		
Average	0.3	Milliamperes
Average During Plate Pulse	0.3	Amperes
Useful Power Output		
Average	2.2	Watts
Average During Plate Pulse	2.2	Kilowatts

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

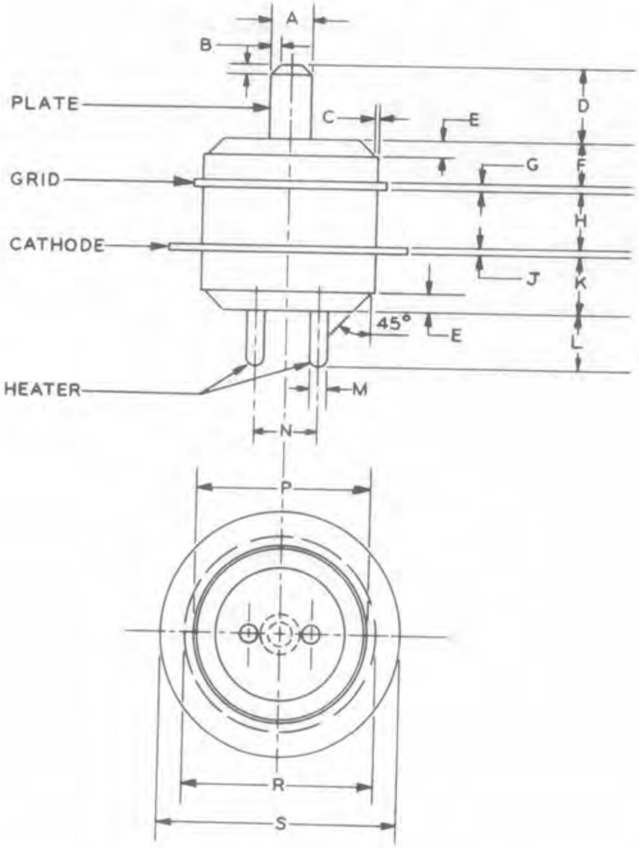
§ Measured using a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendation.

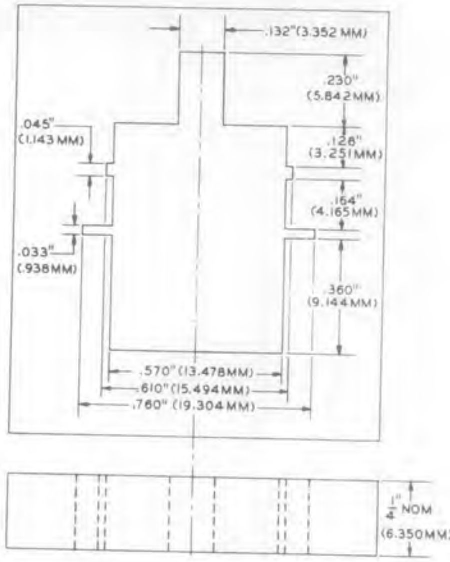
In any 5000 microsecond interval.

Δ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE

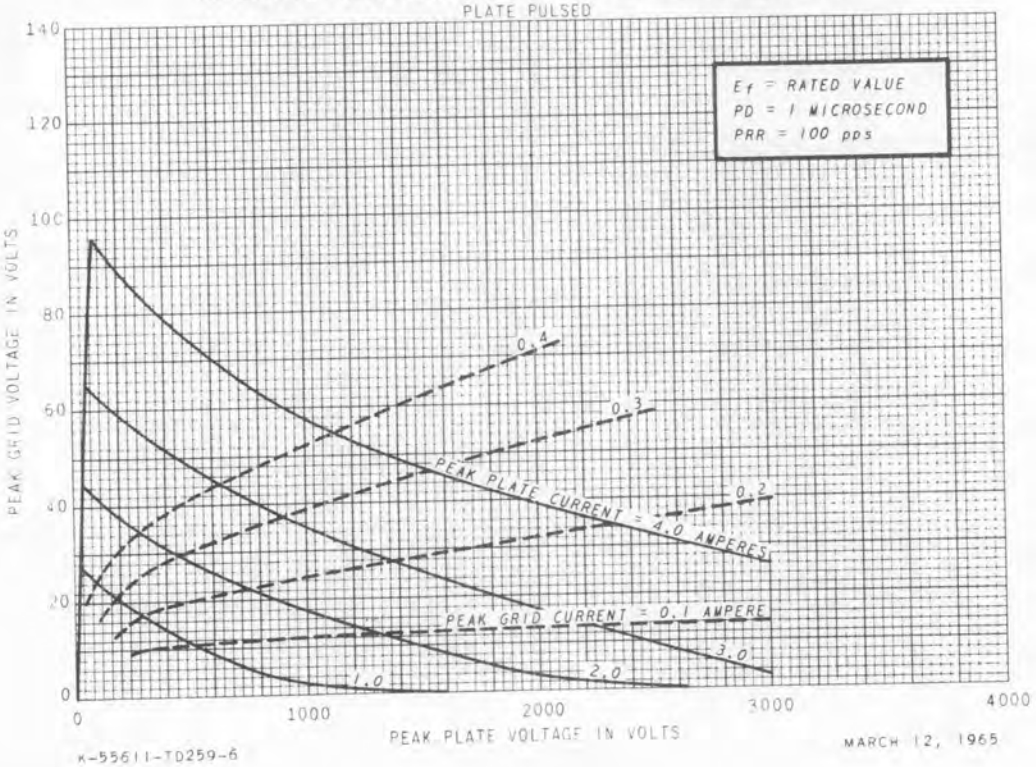


Note: Gauge tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

GE ELECTRONICS

7913

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7913 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator or radio-frequency power amplifier.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.4	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.4	pf
Input: g to (h + k)	6.0	pf
Output: p to (h + k)	0.03	pf
Heater to Cathode: (h to k)	2.4	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Plate Dissipation	5.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance		
With Fixed Bias	0.025	Megohms
With Cathode Bias	0.1	Megohms
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	47	Ohms
Amplification Factor	100	
Plate Resistance, approximate	2500	Ohms
Transconductance	40000	Micromhos
Plate Current	25	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-4.5	Volts

UHF OSCILLATOR SERVICE

Frequency	400	Megacycles
Plate Voltage	300	Volts
Grid Resistor	1500	Ohms
Plate Current	25	Milliamperes
Grid Current, approximate	5	Milliamperes
Power Output, approximate	4	Watts

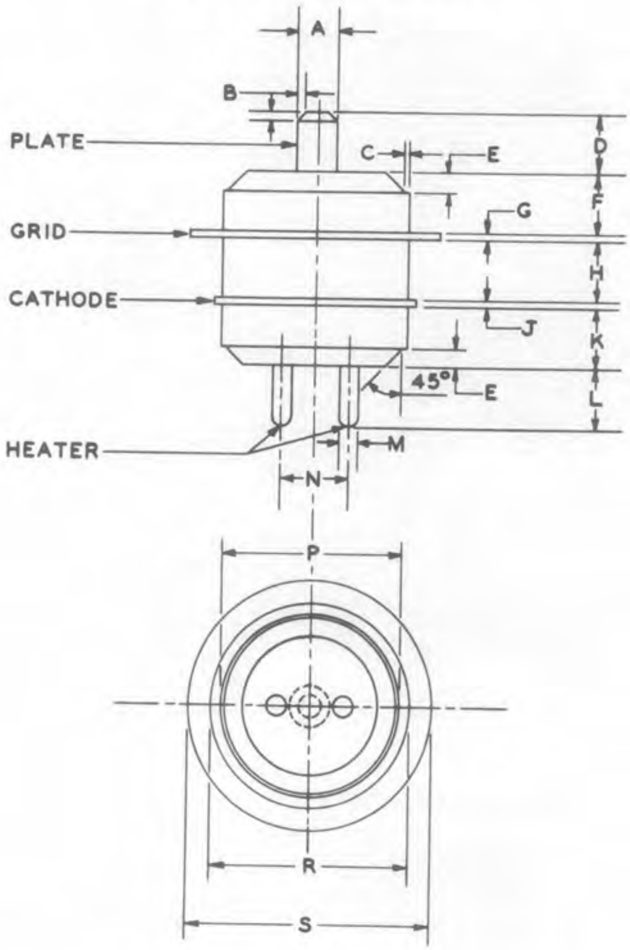
NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

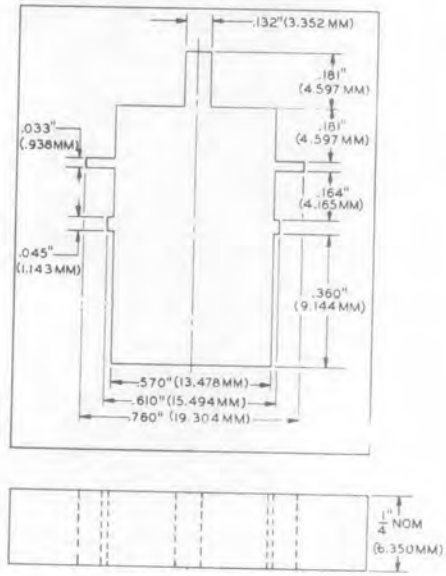
‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE

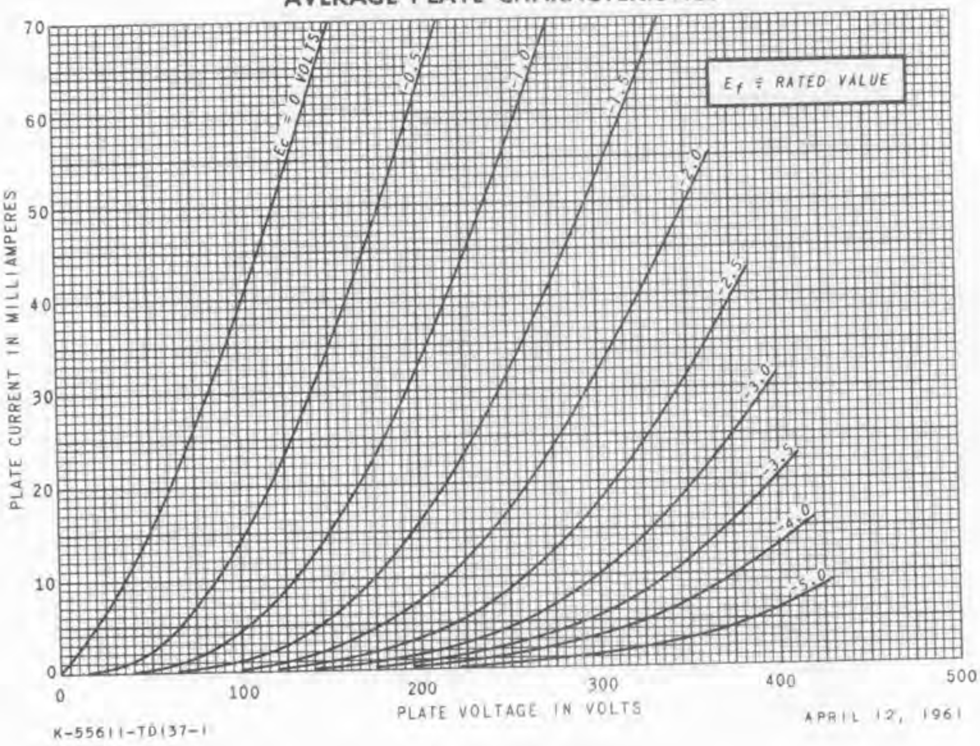


Note: Tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

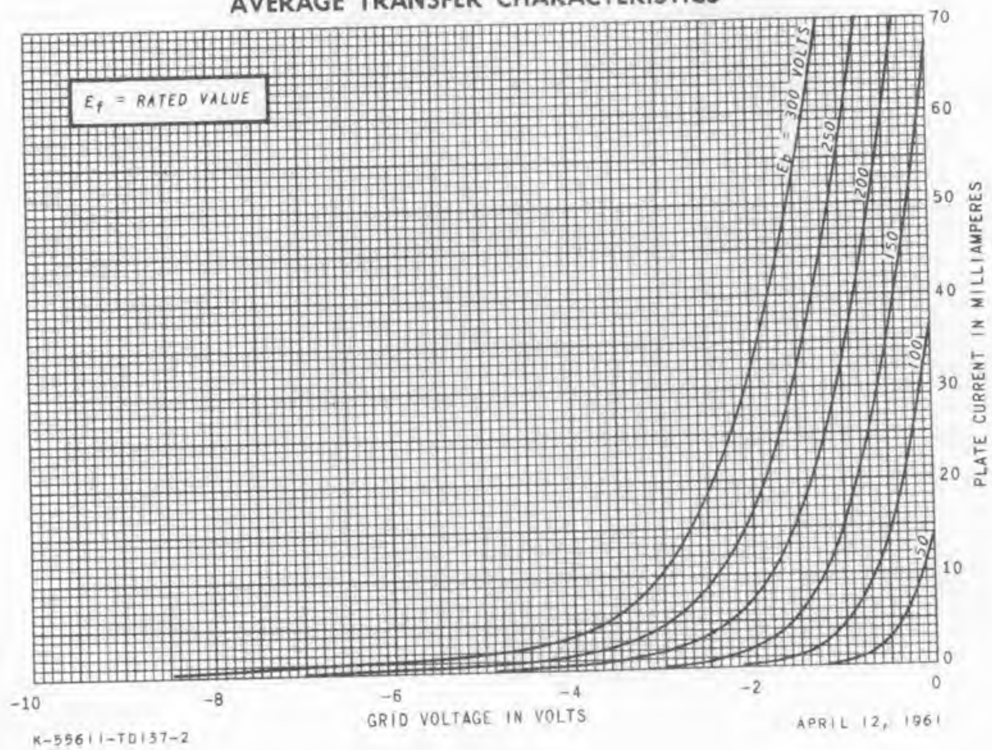
Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.170		0.180	4.32		4.57
E	0.040		0.060	1.02		1.52
F	0.165		0.175	4.19		4.45
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

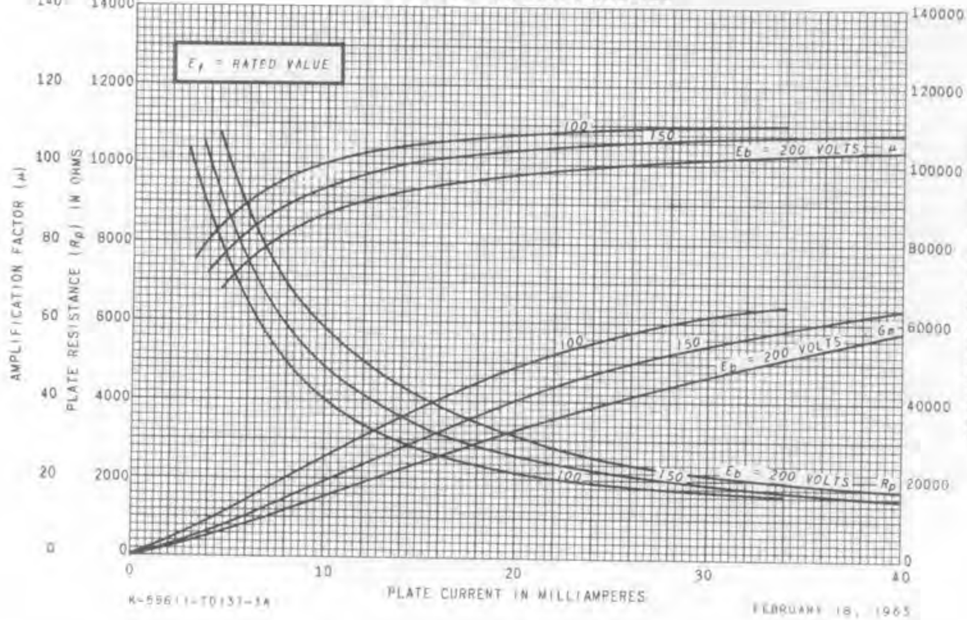
AVERAGE PLATE CHARACTERISTICS



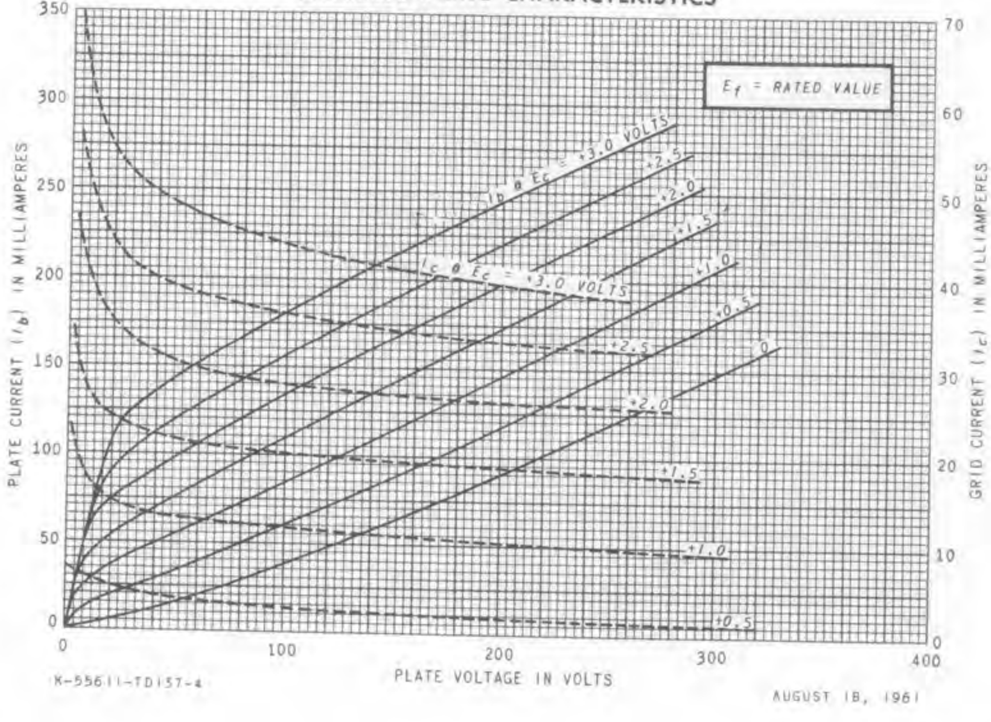
AVERAGE TRANSFER CHARACTERISTICS



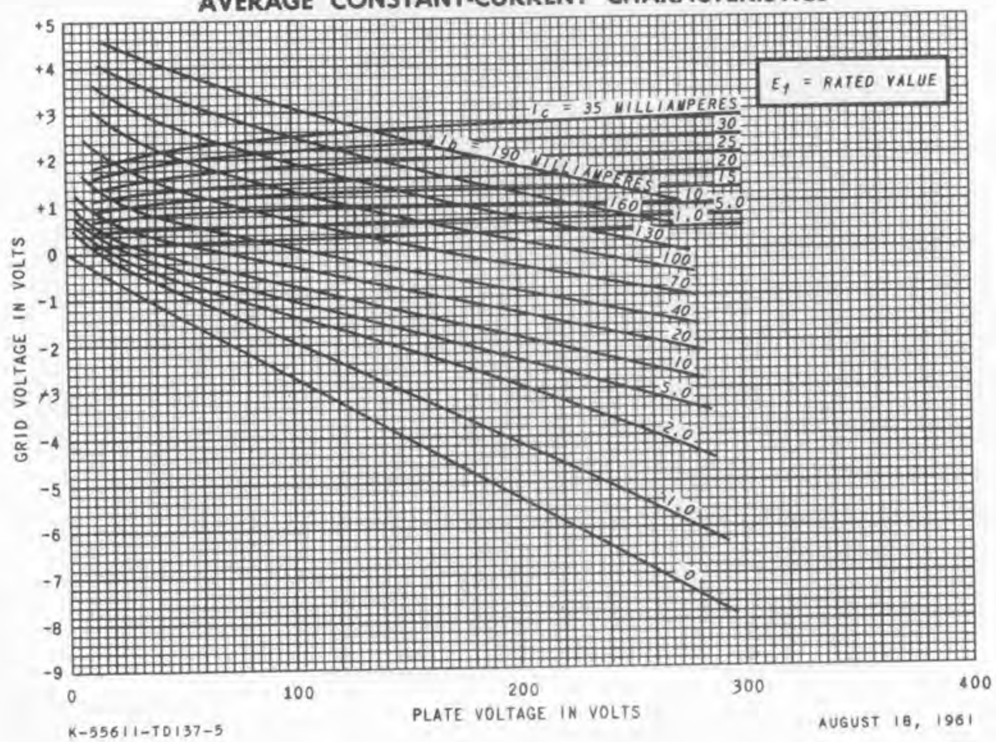
AVERAGE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



GL-7985
TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION
GROUNDED-GRID CIRCUIT

WATER COOLED
METAL AND CERAMIC
INTEGRAL WATER JACKET

The GL-7985 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 3½ kilowatts. Cooling is accomplished by water and forced air with the water jacket an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megaycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-7985 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

As a Class B radio-frequency power amplifier, the tube is capable of delivering 1100 watts of power with 20 watts of drive at carrier level.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	μμf
Input, G_2 tied to G_1	—	27.8	—	μμf
Output, G_2 tied to G_1¶	—	6.4	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate ... 2.0 Pounds

Thermal

Type of Cooling—Water and Forced Air

Water Flow
- Anode ... 3.0 Min Gallons per Minute
- Pressure Drop at Rated Flow ... 20 Max Pounds per Square Inch
- Water Pressure ... 80 Max Pounds per Square Inch
- Outlet Water Temperature ... 70 Max C

Air Flow
- Screen-grid to Control-grid Seals ... 15 Min Cubic Feet per Minute
- Heater-to-Cathode Seals ... 7.5 Min Cubic Feet per Minute
- Anode Ceramic ... 10 Min Cubic Feet per Minute

Temperature at Any Point ... 200 Max C

Water and forced-air cooling to be applied before and during the application of any voltages. Water cooling may be discontinued with removal of all voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	0.600	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage, approximate	−35	Volts
Peak RF Plate Voltage, approximate	5500	Volts
Peak RF Grid-No. 1 Voltage, approximate	105	Volts
DC Plate Current	0.475	Ampere
Zero Signal DC Plate Current	0.115	Ampere
$E_b = 7000$ volts, $E_{c2} = 600$ volts, E_{c1} adjusted for $I_b = 0.115$ amperes		
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.025	Ampere
Driving Power, approximate	80	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1100	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2300	Watts
Cathode Bombarding Power*	160	Watts
Cathode Bombarding Voltage	610	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	3.5	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-7985, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

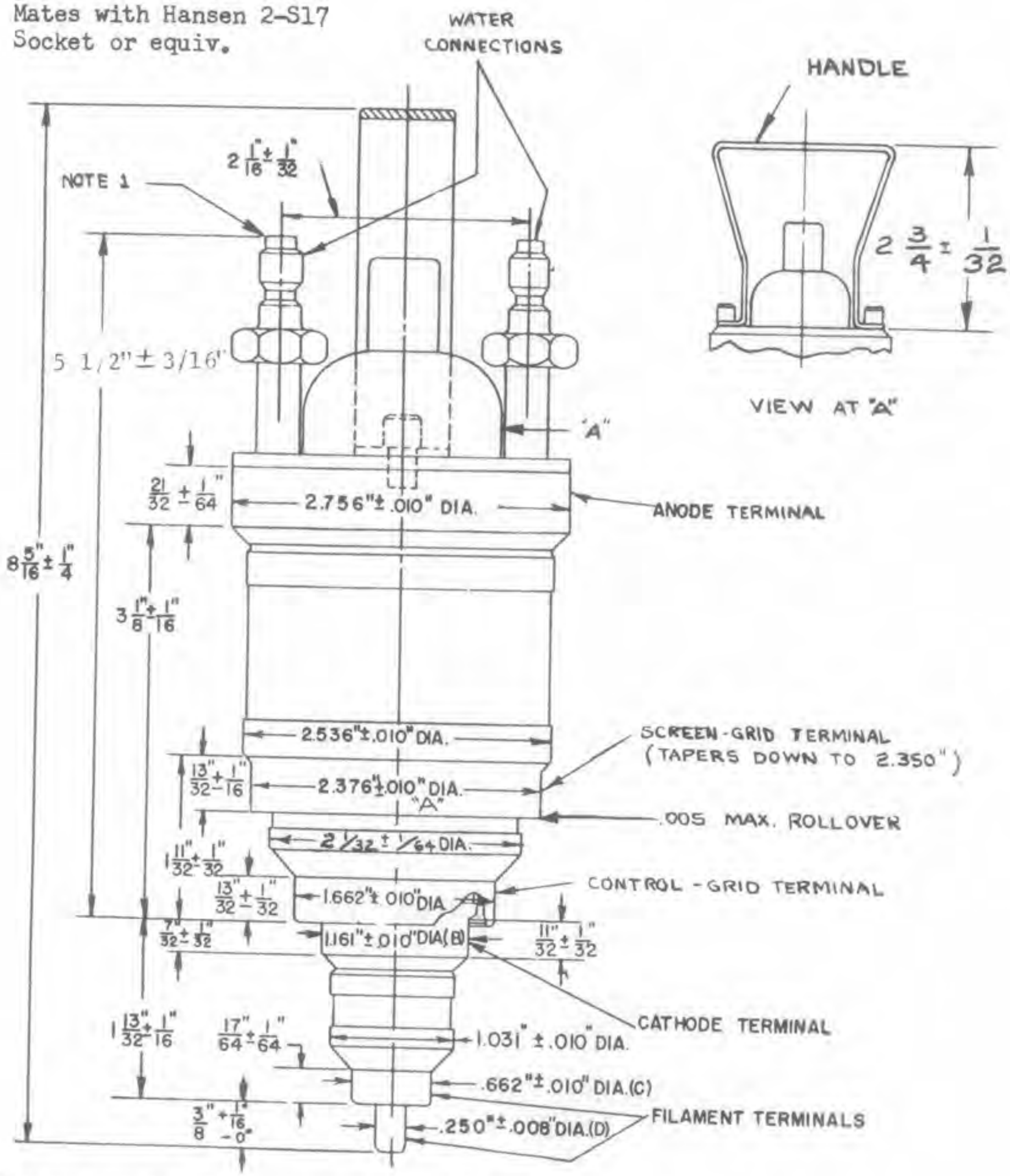
‡ Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.

NOTE 1: Top portion same as top portion of Hansen B2T16 Mates with Hansen 2-S17 Socket or equiv.



The following indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Total Indicator Readings -
Diameter A - 0.024 inches
Diameter B - 0.024 "
Diameter C - 0.030 "
Diameter D - 0.050 "

A-69087-72870

GL-8500
TETRODE

RADIO-FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-8500 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225–400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low—approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-8500 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	6.3	6.8	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, E_b=1000V DC; E_g2=275V DC; I_b=0.2 A DC	—	14	—	
Peak Cathode Current†	—	—	1.75	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	0.006	—	μμf
Input, G_2 tied to G_1	—	19.5	—	μμf
Output, G_2 tied to G_1♦	—	6.4	—	μμf

Mechanical

Mounting Position—Any		
Net Weight, approximate	1.0	Pounds

Thermal

Cooling—Forced Air§ Through Radiator, at Sea Level**				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	17.0	12.0	6.5	Cubic Feet per Minute
Static Pressure, approximate	0.9	0.5	0.2	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal	—	—	250	C
Seals				
Screen-Grid to Control-Grid, approximate	—	—	1	Cubic Feet per Minute
Heater to Cathode, approximate	—	—	1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum	—	—	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Amperes
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	500	Watts

Typical Operation

Grounded-Grid Circuit at 225–400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	−20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Amperes
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Amperes
DC Grid-No. 2 Current	0.005	Amperes
DC Grid-No. 1 Current	0.010	Amperes
Driving Power, approximate	5	Watts
Power Output♥	110	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

Maximum Ratings	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	−100	−100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	500	500	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles

DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	−40	−40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.

♦ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.

§ Forced-air cooling to be applied before and during the application of any voltages.

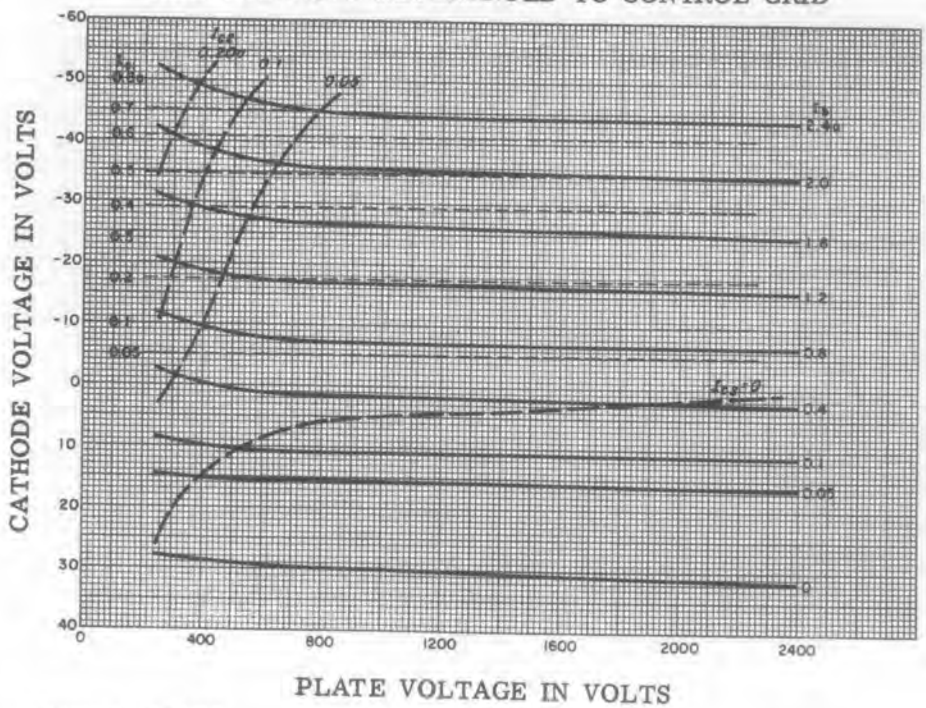
**Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.

♥Useful power output as measured in output-circuit load.

¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.

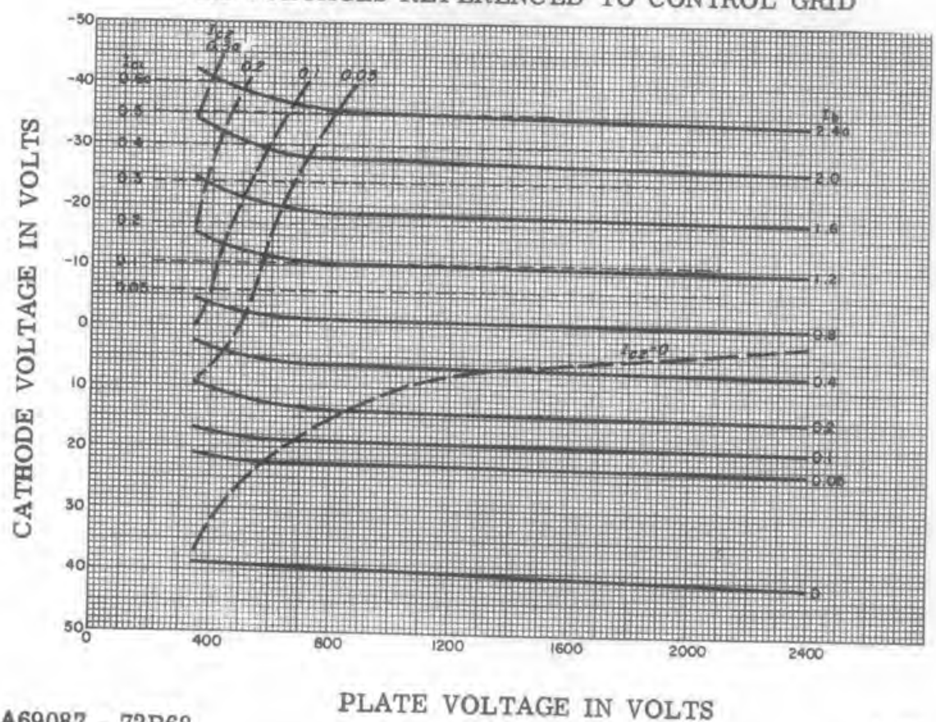
△Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



A69087 - 72B67 1-30-63

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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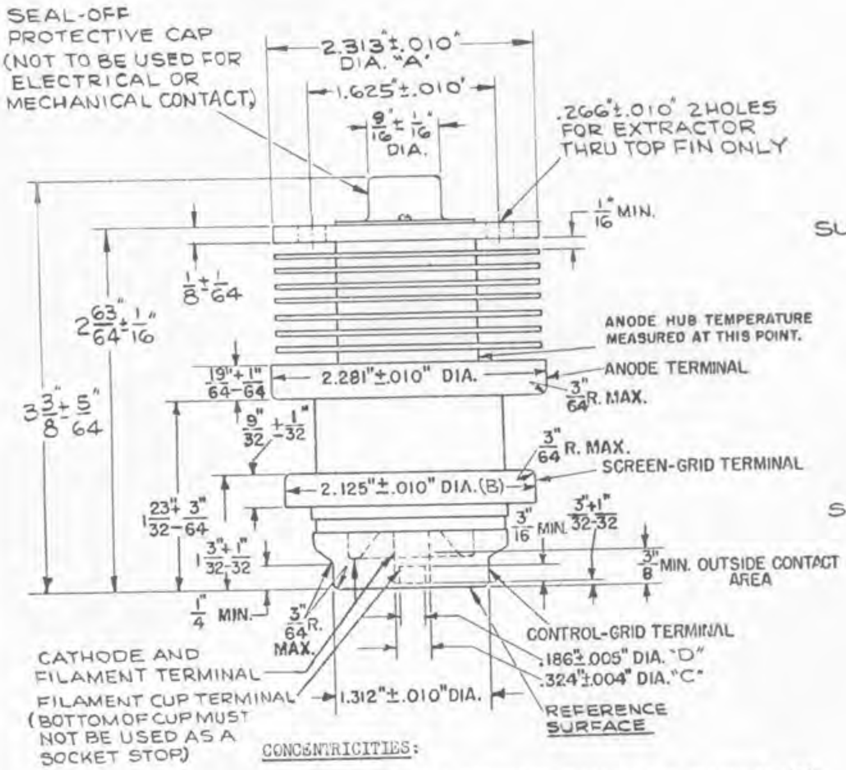
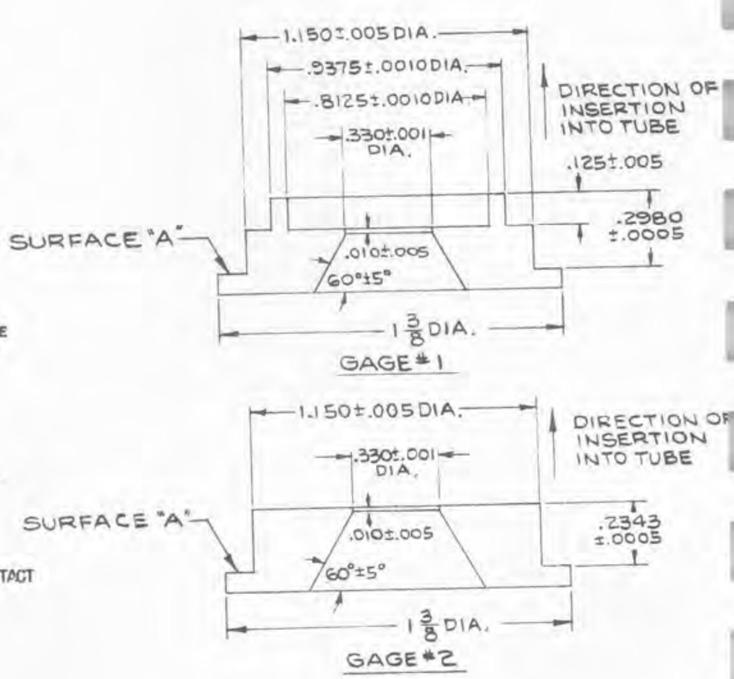


CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.



ZP-1030
CATHODE AND FILAMENT TERMINAL GAGES

When inserted over the cathode and filament terminal, gage #1 shall not contact the tube REFERENCE SURFACE at gage SURFACE "A".

When inserted over the cathode and filament terminal, gage #2 shall contact the tube REFERENCE SURFACE at gage SURFACE "A".

A-69087 - 72B58

12-31-62

GL-8513

TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION

GROUNDED-GRID CIRCUIT

FORCED-AIR COOLED
METAL AND CERAMIC

The GL-8513 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 4 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

As a Class B linear power amplifier the tube will deliver 1500 watts at carrier level.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-8513 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	–	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	–	14.5	—	Amperes
With 150 Watts Cathode Bombarding	–	13.5	—	Amperes
Heater Starting Current	–	—	25	Amperes
Heater Cold Resistance	–	0.041	—	Ohms
Cathode Bombarding Power*	–	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	–	650	—	Volts
For 195 Watts Bombarding Power	–	700	—	Volts
Cathode Heating Time	1	—	—	Minute
Amplification Factor, G_2 to G_1; $E_b=4000$ volts; $I_b=0.5$ ampere	–	20	—	
Peak Cathode Current†	–	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	–	0.01	—	μμf
Input, G_2 tied to G_1	–	27.8	—	μμf
Output, G_2 tied to G_1¶	–	6.7	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate . . . . 12.5 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
4.0 Kw	135 CFM	2.8 In.

Seals		
Screen-grid to Control-grid, minimum	15	Cubic Feet per Minute
Heater-to-cathode, minimum	7.5	Cubic Feet per Minute
Anode Ceramic, minimum	10	Cubic Feet per Minute
Incoming Air Temperature, maximum	55	C
Anode Hub Temperature, maximum	250	C
Temperature of Anode Ceramic and Seals, maximum	250	C
Temperature at Any Other Point, maximum	200	C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The radiator air ducting can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers and additional holes in the plate contact ring to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for Use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	9000	Volts
DC Grid-No. 2 Voltage	800	Volts
DC Plate Current	0.800	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	8000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 1 Voltage, approximate	−50	Volts
DC Plate Current	0.600	Ampere
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.060	Ampere
Driving Power, approximate	160	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1500	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2500	Watts
Cathode Bombarding Power*	170	Watts
Cathode Bombarding Voltage	650	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approximate	630	Volts
Cathode Bombarding Current, approximate	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	4.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-8513, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

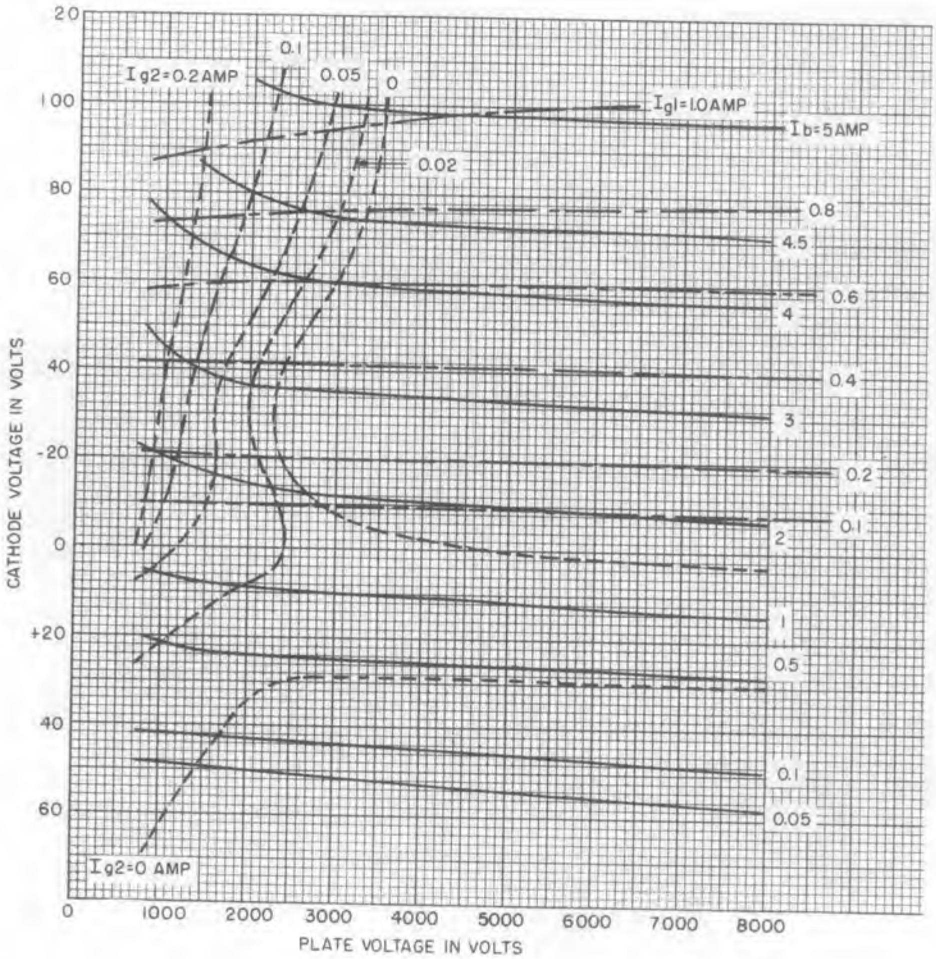
§ Measured with complete isolation between cathode and plate.

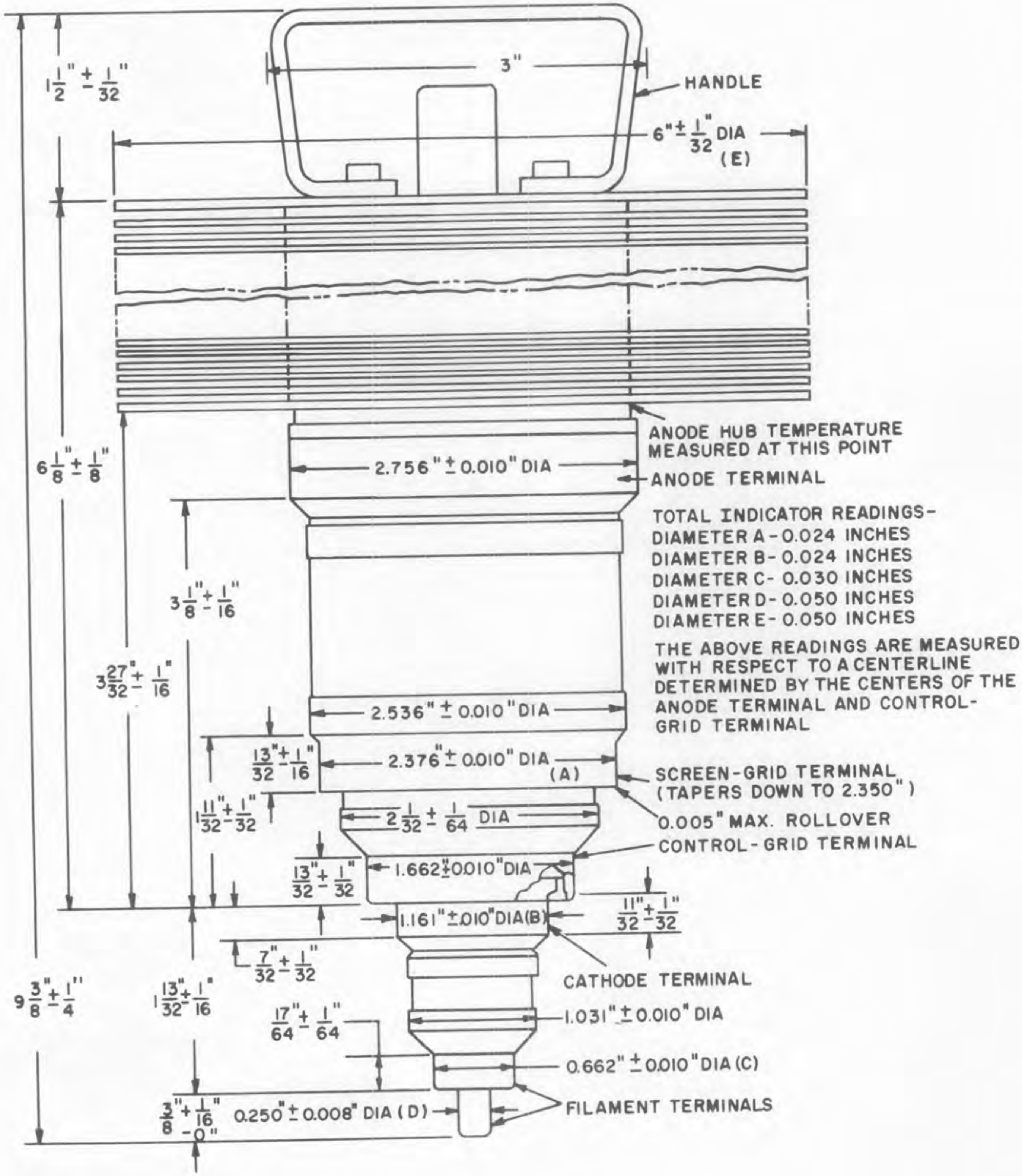
¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

\# Useful power output including power transferred from driver stage.

TYPICAL CHARACTERISTICS

Eg2 = 750 Volts, Ef = 7 Volts AC
Bombarding Power = 180 Watts
All Voltages Referenced to Grid




3"
HANDLE
6" ± 1/32" DIA (E)
1 1/2" ± 1/32"
6 1/8" ± 1/8"
ANODE HUB TEMPERATURE MEASURED AT THIS POINT
2.756" ± 0.010" DIA
ANODE TERMINAL
TOTAL INDICATOR READINGS-
DIAMETER A - 0.024 INCHES
DIAMETER B - 0.024 INCHES
DIAMETER C - 0.030 INCHES
DIAMETER D - 0.050 INCHES
DIAMETER E - 0.050 INCHES
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL
3 1/8" ± 1/16"
3 27/32" ± 1/16"
2.536" ± 0.010" DIA
13/32" ± 1/16"
2.376" ± 0.010" DIA (A)
SCREEN-GRID TERMINAL (TAPERS DOWN TO 2.350")
1 11/32" ± 1/32"
2 1/32 ± 1/64 DIA
0.005" MAX. ROLLOVER
CONTROL-GRID TERMINAL
13/32" ± 1/32"
1.662" ± 0.010" DIA
1.161" ± .010" DIA (B)
11/32" ± 1/32"
7/32" ± 1/32"
CATHODE TERMINAL
9 3/8" ± 1/4"
1 13/32" ± 1/16"
17/64" ± 1/64"
1.031" ± 0.010" DIA
0.662" ± 0.010" DIA (C)
3/8" + 1/16" - 0"
0.250" ± 0.008" DIA (D)
FILAMENT TERMINALS

GL-8866

Tetrode

GRID-PULSED SERVICE
GROUNDED-GRID OPERATION

HEAT-SINK AND FORCED-AIR COOLED
METAL AND CERAMIC

The GL-8866 is a reduced-size heat-sink-cooled version of the GL-6283 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne radar equipment such as IFF transponders.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the 8866 include long life and reliability, long pulse width and high gain.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	—	6.3	—	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate†	—	0.006	—	μμf
Input	—	20	—	μμf
Output	—	8.9	—	μμf

Mechanical

Mounting Position—Any

Net weight, approximate	9	Ounces

Thermal

Cooling—Heat-sink and Forced-Air‡

Anode Temperature§, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, aaximum	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

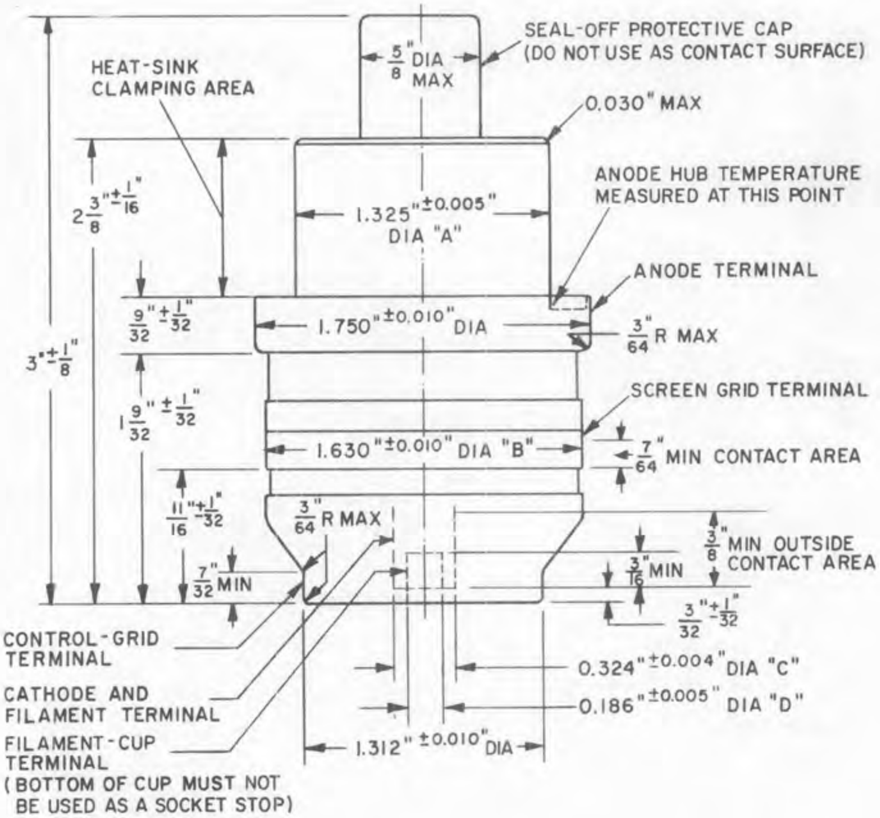
DC Plate Voltage	3.5	Kilovolts
DC Plate Current, during pulse	5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	−200	Volts
Plate Dissipation	150	Watts
Pulse Width♥♦	15	Microseconds
Duty Factor♥ϕ	.02	

Typical Operation

Grounded-Grid Service at 1100 Megacycles, ¼λ Output Circuit

DC Plate Voltage	2.5	2.5	Kilovolts
DC Plate Current, during pulse	1.4	1.0	Amperes
DC Grid-No. 2 Voltage	600	600	Volts
DC Grid-No. 2 Current, during pulse	50	0	Milliamperes
DC Grid-No. 1 Voltage	−70	−70	Volts
DC Grid-No. 1 Current, during pulse	90	80	Milliamperes
Driving Power at the Tube, during pulse	165	95	Watts
Power Output, during pulse (useful)	1.6	1.0	Kilowatts
Pulse Width	6	6	Microseconds
Duty Factor	.02	.02	

Note 1: Under the typical operating conditions shown the heater voltage should be reduced to approximately 6.0 volts because of back-heating resulting from transit-time effects.
* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced air cooling should be applied during the application of any voltages.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
♦ Pulse duration measured between points at 70 percent of peak 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.
ϕ Maximum ratio of on-time to elapsed time during any 7.5-millisecond period.



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER "A" — 0.030 INCH
DIAMETER "B" — 0.016 INCH
DIAMETER "C" — 0.036 INCH
DIAMETER "D" — 0.042 INCH

TOTAL INDICATOR READING OF FILAMENT CUP-TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (C) 0.016 INCH.

DATA FOR DEVELOPMENTAL TYPES

DATA FOR DEVELOPMENTAL TYPES

NOTE:

Both electrical and mechanical characteristics of developmental types are subject to change: therefore, it is recommended that designers consult with their General Electric field representative before designing equipment around development types. (See inside back cover)

A-0897

PLANAR TRIODE

DESCRIPTION AND RATING

For Grounded-Grid Oscillator And Amplifier Service

The A-0897 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03‡	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

Mechanical

Operating Position - Any

Net Weight, approximate	2	Ounces

MAXIMUM RATINGS

Absolute-Maximum Values

Radio-Frequency Power Amplifier and Oscillator - Class C Telegraphy

Key-down Conditions per Tube Without Amplitude Modulation¶		
Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation#	10	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point‡‡	250	C

MAXIMUM RATINGS (Continued)

Radio-Frequency Power Amplifier and Oscillator - Class C Telephony

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage**	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation∆	7.0	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point‡‡	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics§§

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage¶¶	---	Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

Radio-Frequency Oscillator - Class C§§

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	-40	-22	Volts
Useful Power Output	40	17	Watts

A-0897

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	-1.3	-2.5	-3.5	Volts
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	-7.0	-9.5	-15	Volts
Transconductance				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	---	---	3.0	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 500 volts d-c	50	---	---	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min; Eb = 1000 volts; Ib = 90 ma	15	---	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Measured in a special shielded socket.

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

With an adequate heat sink, the maximum dissipation rating is 100 watts.

Δ With an adequate heat sink, the maximum dissipation rating is 70 watts.

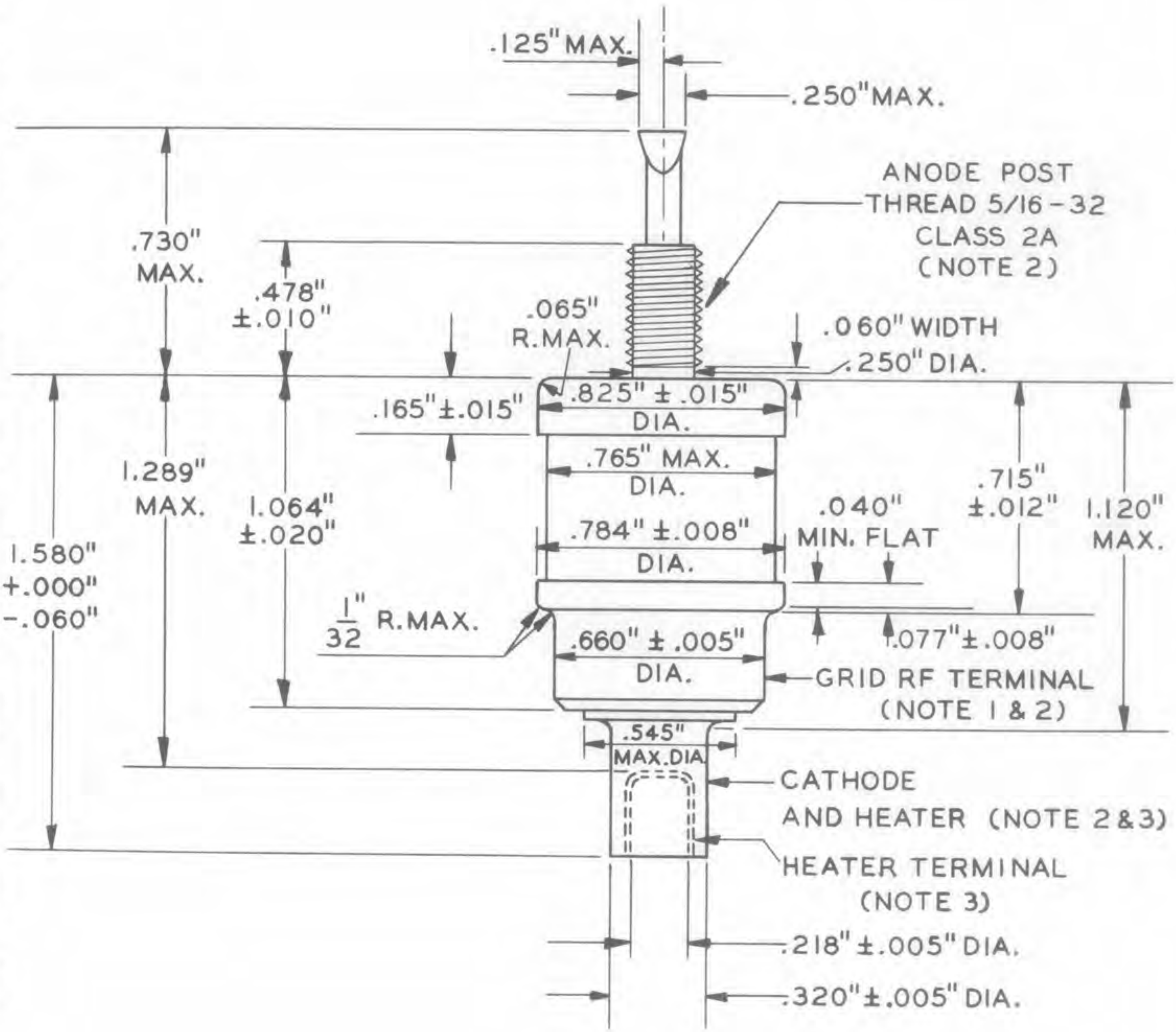
§§ An adequate heat sink must be provided.

‡‡ Where long life and reliable operation are important, lower envelope temperatures should be used.

** For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

¶¶ Adjusted for Ib = 75 milliamperes.

OUTLINE
A-0897



NOTES:

1. Solder not to extend radially beyond grid RF terminal.
2. Axis of threaded section shall be concentric with surface of Cathode-Fil. and Grid to within .020" T.I.R.. T.I.R. to be measured on cathode and grid contact areas within ±.040" of center of each area.
3. Total indicated runout of the heater-contact surface with respect to the cathode-contact surface shall not exceed 0.012".

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1015

Tetrode

Grid-Pulsed Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1015 is a heat-sink-cooled version of the GL-7399 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne IFF radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1015 include long life and reliability, long pulse width and high gain.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Amplification Factor, G_2 to G_1	–	10.5	–	
E_{g2}=275 Volts DC, E_b=1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	–	0.012	–	μμf
Input	–	24	–	μμf
Output	–	9.3	–	μμf

MECHANICAL

Mounting Position – Any
Net Weight, approximately . . . . . 11 Ounces

THERMAL

Cooling – Heat-sink and Forced-Air ‡
Anode Temperature §, maximum . . . . . 250 C
Seals
Screen and Control Grid, approximate . . . . . 1 Cubic Foot per Minute
Heater and Cathode, approximate . . . . . 1 Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum . . . . . 200 C

RADIO-FREQUENCY POWER AMPLIFIER – CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage**	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes

The specifications of this type are subject to change. This device is now under development and is made available for experimental purposes only. For the most recent information concerning the status of this development, please consult your local Power Tube Department Regional Sales Office, or current Preliminary Technical Information for the same catalog number.

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C (CONT'D)

Maximum Ratings (Cont'd)

Pulsed Drive, 1250 Megacycles (Cont'd)

Plate Dissipation	150	Watts
Pulse Width ♥ ◊	15	Microseconds
Duty Factor ♥ ϕ	0.01	

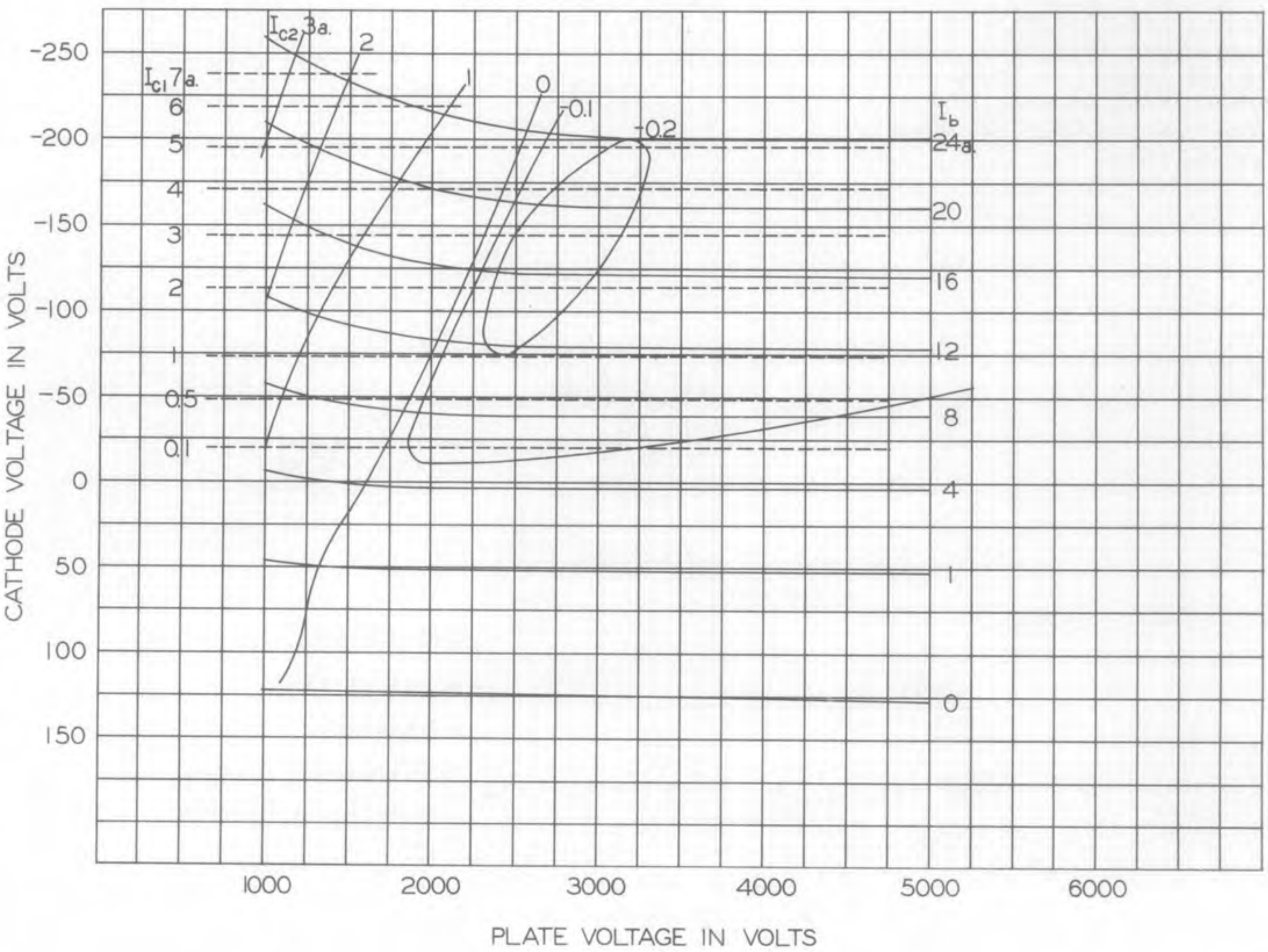
Typical Operation

Grounded-grid Service at 1100 Megacycles, 3/4λ Output Circuit

DC Plate Voltage	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ◊	15	Microseconds
Duty Factor ϕ	0.01	

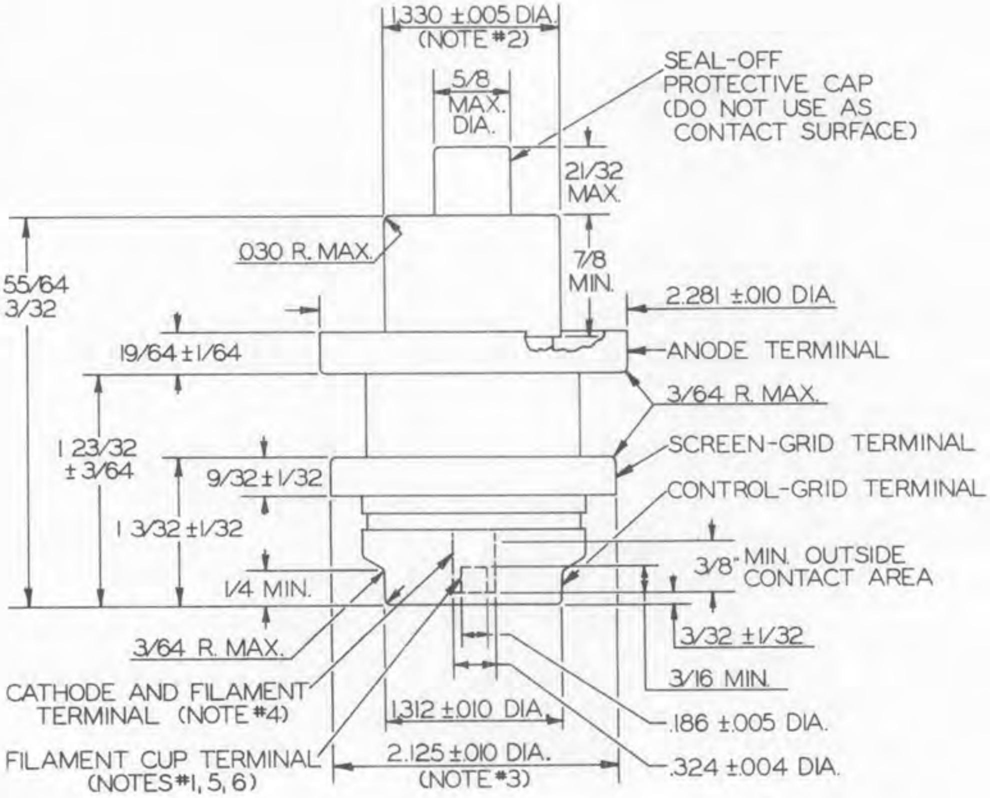
* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced-air cooling should be applied during the application of any voltages.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.
**** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.**
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak 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.
ϕ Maximum ratio of on-time to elapsed time during any 15 millisecond period.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



NOTES:

1. Bottom of cup must not be used as a socket stop.
2. Max. eccentricity 0.015"
3. Max. eccentricity 0.008"
4. Max. eccentricity 0.018"
5. Max. eccentricity 0.021" with respect to centerline determined by centers of anode and control-grid terminals.
6. Max. eccentricity 0.008" with respect to cathode terminal.



ZP-1016-B

TRIODE

High Voltage Series-Regulator Service — Metal and Ceramic

The ZP-1016-B is a metal-ceramic triode for high voltage series regulator service. Its features make this tube very desirable for use in regulation of DC voltages up to 10,000 volts. An average power handling capability of 300 watts helps fill a void in the power spectrum of tubes available for this type of service.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage	–	6.3	–	Volts
Heater Current	–	3.8	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances				
Output	–	6.7	–	μμf
Input	–	8	–	
Plate to Cathode	–	–	.35	μμf
Amplification Factor	–	10	–	
Plate Current @ $E_g = 0$; $E_b = 600$ volts	–	0.300	–	Ampere
Grid Voltage @ $E_b = 10{,}000$ volts; $I_b = 0.001$ ampere	–	1300	–	Volts

MECHANICAL

Mounting Position – Any

Net Weight, approximate	1.0	Pound

THERMAL

Cooling – Forced Air

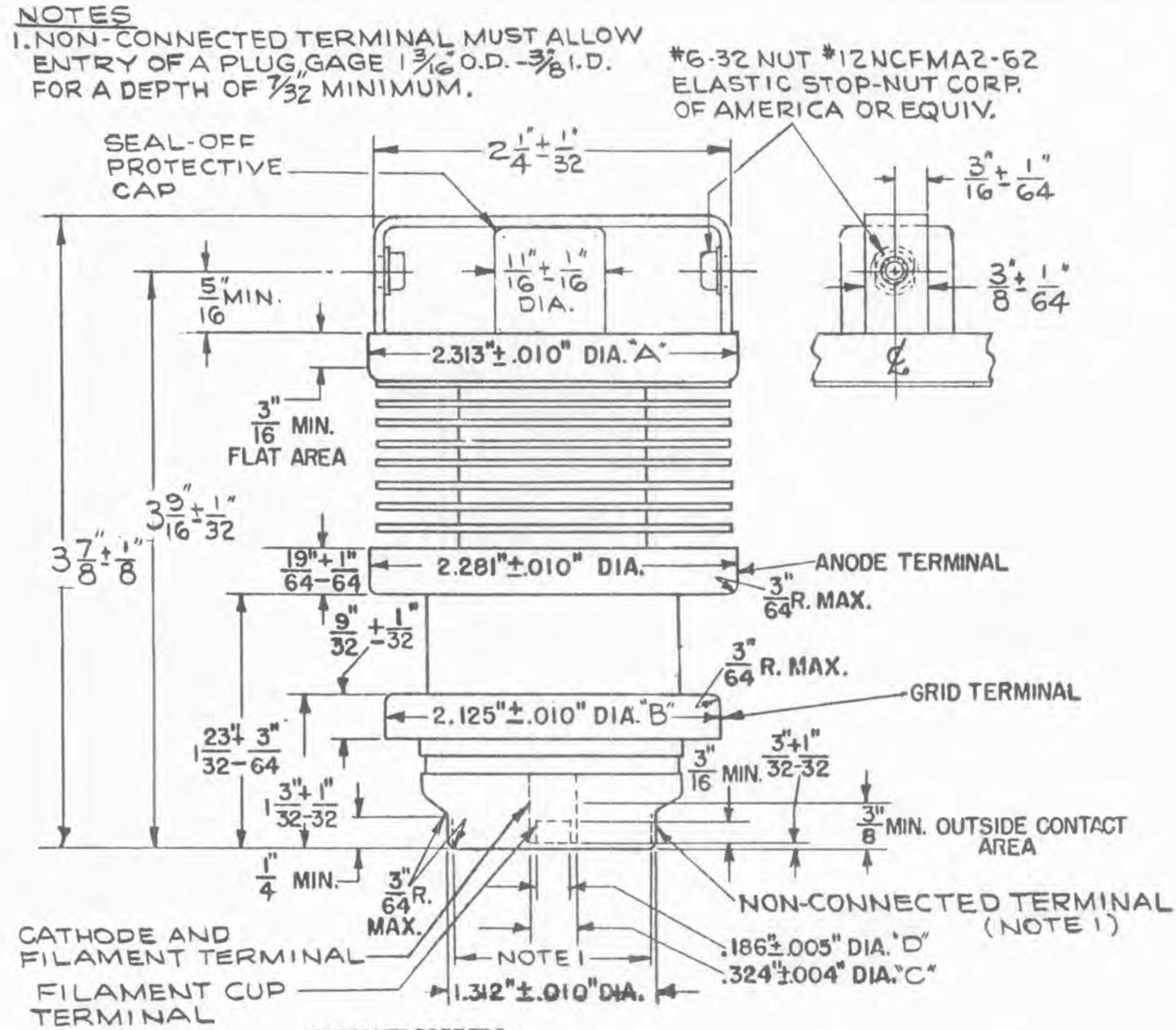
Anode Temperature, maximum	180	C
Seals and Tube Temperature at Any Point, maximum	200	C

HIGH VOLTAGE SERIES REGULATOR

Maximum Ratings

DC Plate Holdoff Voltage*	10	Kilovolts
DC Grid Voltage**	-4	Kilovolts
Plate Dissipation	300	Watts
DC Plate Current	250	Milliamperes

* Minimum circuit impedance in combined cathode and anode circuits equals 4000 ohms.
** Equivalent series $R_g = 0.25$ to 1.0 megohms.



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and non-connected terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) 0.016 inches.

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1024

TRIODE

Internal Feedback for Oscillator Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1024 is a heat-sink-cooled triode especially designed for pulsed-oscillator service in L-band, providing useful output at frequencies up to approximately 1700 megacycles.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service.

Other features of the ZP-1024 are long life and reliability, long pulse width and high power output capability.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage	–	6.3	–	Volts
Heater Current	–	3.8	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances				
Cathode to Plate †	–	0.5	–	μμf
Input	–	20	–	μμf
Output	–	7.8	–	μμf

MECHANICAL

Mounting Position – Any		
Net Weight, approximately	9	Ounces

THERMAL

Cooling – Heat-sink and Forced-Air ‡		
Anode Temperature §, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	200	C

PLATE-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage, during pulse	6.5	Kilovolts
DC Plate Current, during pulse	6.5	Amperes
DC Grid Voltage, during pulse	-400	Volts
Plate Dissipation	150	Watts
Pulse Width◊	1	Microsecond
Duty Factor♥ φ	.001	

PLATE-PULSED OSCILLATOR – CLASS C (Cont'd)

Typical Operation

Grounded-Grid Service at 1100 Megacycles, 3/4 λ Output Circuit

DC Plate Voltage, during pulse	6.0	Kilovolts
DC Plate Current, during pulse	6.25	Amperes
DC Grid Current, during pulse	2.5	Amperes
Power Output, during pulse (useful)	15	Kilowatts
Pulse Width	1	Microsecond
Duty Factor	.001	

† Complete external shielding between cathode and plate.

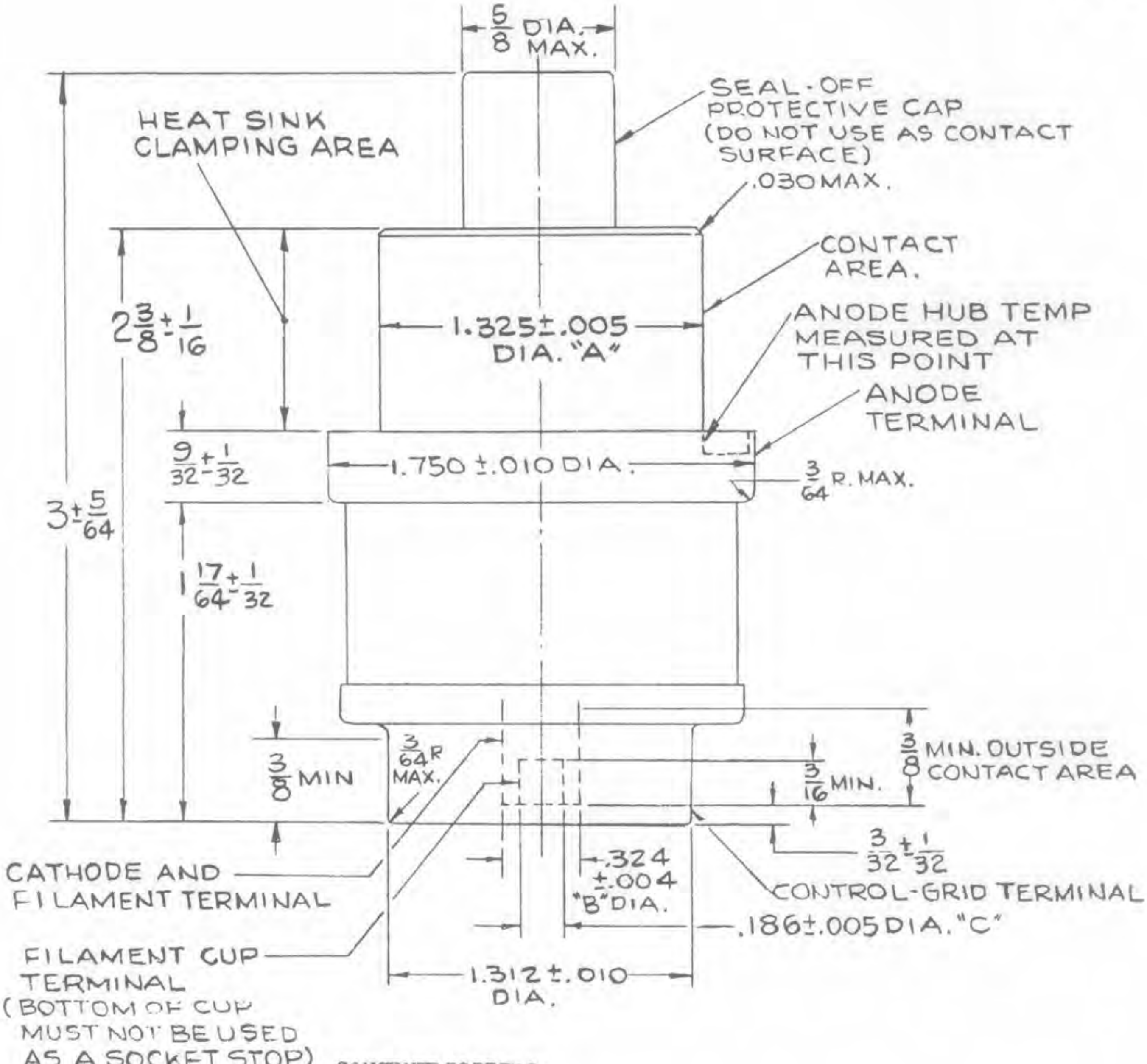
‡ Forced-air cooling should be applied during the application of any voltages.

§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.

∇ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.

◊ Pulse duration is measured between points at 70 percent of the peak 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.

ϕ Maximum ratio of on-time to elapsed time during any 1-millisecond period.



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1025

TRIODE

Internal Feedback for Oscillator Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1025 is a heat-sink-cooled triode especially designed for pulsed oscillator service in L-band. This tube is particularly well suited for use in airborne or ground-based radar equipment.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service.

Other features include small size, high peak power, long-pulse-width capability, long life and reliability.

	Minimum	Bogey	Maximum	
ELECTRICAL				
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Cathode to Plate	-	0.45	-	μμf
Input	-	15.5	-	μμf
Output	-	5.9	-	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximate	3 1/4	Ounces

THERMAL

Cooling – Heat-Sink and Forced Air

Anode Temperature§	250	C
Ceramic Temperature at Any Point, maximum	200	C

PLATE-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage, During Pulse	8.0	Kilovolts
DC Plate Current, During Pulse	10.0	Amperes
DC Grid Voltage, During Pulse	-400	Volts
DC Grid Current, During Pulse	5.0	Amperes
Plate Dissipation §	110	Watts
Grid Dissipation	3.5	Watts
Pulse Width ◊	10	Microseconds
Duty Factor ø	0.003	

TYPICAL OPERATION

Grounded-Grid Service at 1300 Megacycles, 3/4 λ Output Circuit

DC Plate Voltage, During Pulse	8.0	6.0	Kilovolts
DC Plate Current, During Pulse	9.0	7.0	Amperes
DC Grid Current, During Pulse (Grid Resistor = 50 Ohms)	4.0	4.3	Amperes
Power Output, During Pulse (useful)	40.0	24.0	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.003	0.001	

GRID-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, During Pulse	3.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	100	Watts
Pulse Width ◇	15	Microseconds
Duty Factor øø	0.02	

Typical Operation

Grounded-Grid Circuit at 1100 Megacycles, 1/4 λ Output

DC Plate Voltage	1750	1950	2200	Volts
DC Plate Current, During Pulse	2.2	2.6	2.7	Amperes
DC Grid Voltage Supply**	-97	-104	-104	Volts
DC Grid Current, During Pulse	1.05	1.2	1.25	Amperes
Power Output, During Pulse (useful)	1.5	2.0	2.4	Kilowatts
Pulse Width	10	10	10	Microseconds
Duty Factor	0.02	0.02	0.02	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage. For the 1100 mcs, 2 kw, 0.02 duty condition, the typical heater voltage is 5.5 volts. The optimum heater voltage for any application should be determined by RF performance testing.

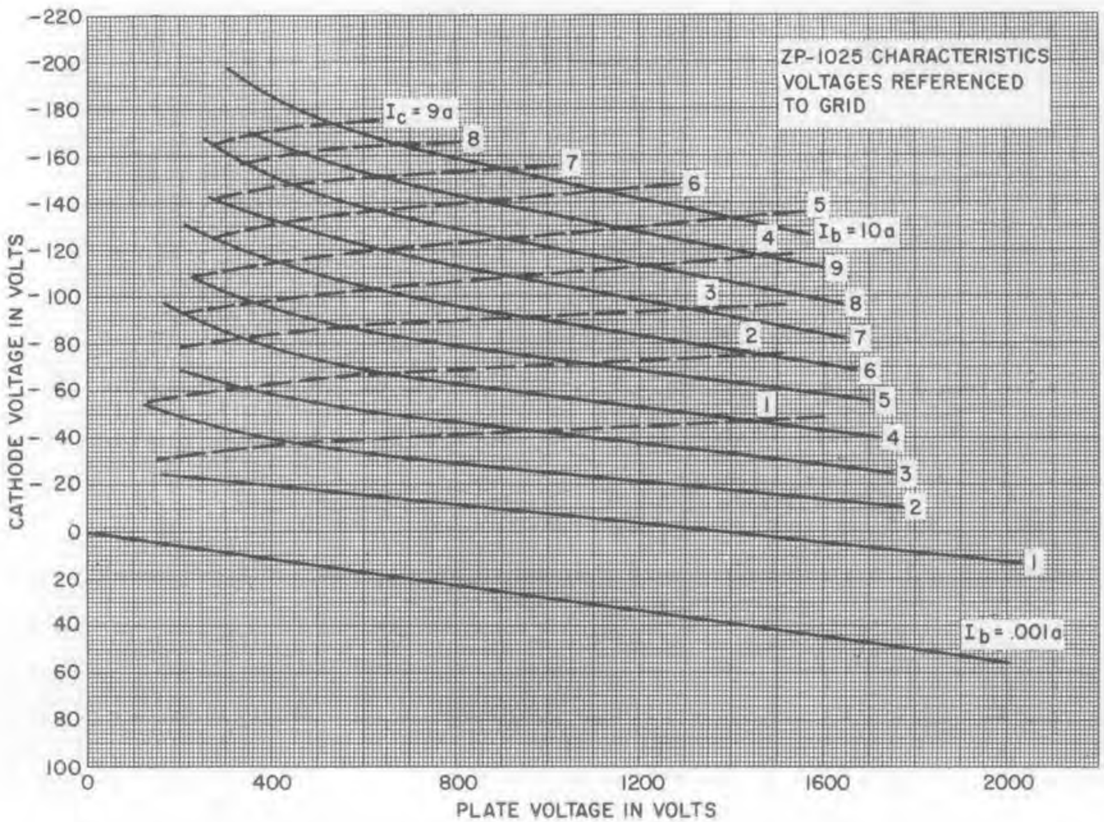
§ A suitable clamp-on radiator or heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified. Higher plate dissipation is allowable with provision for proper cooling.

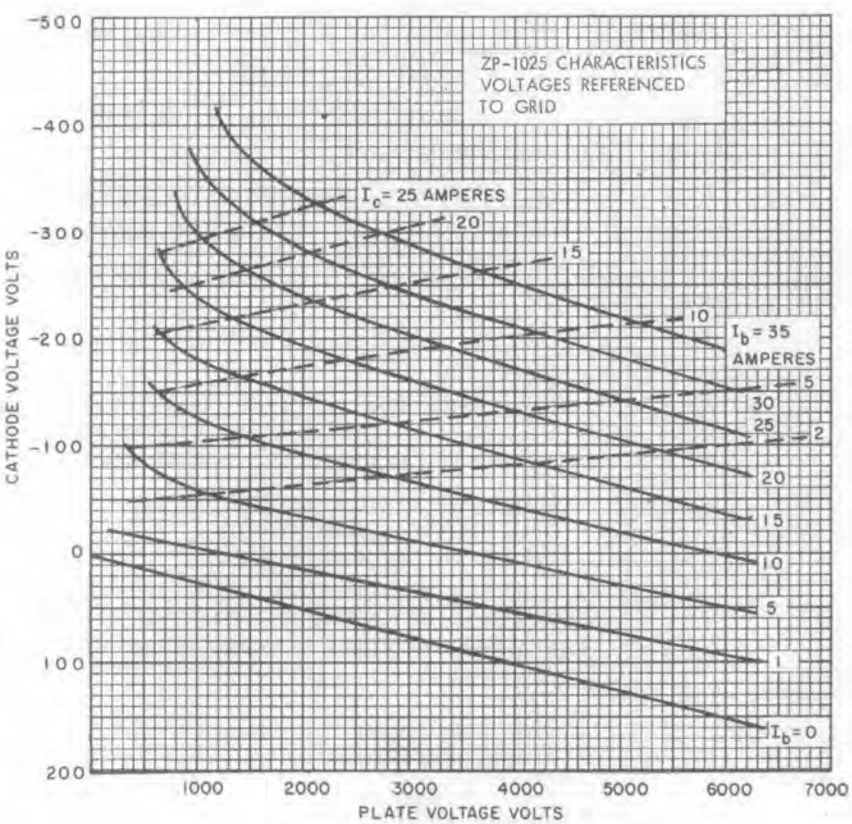
◇ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse. For applications requiring longer pulses, refer to the tube manufacturer.

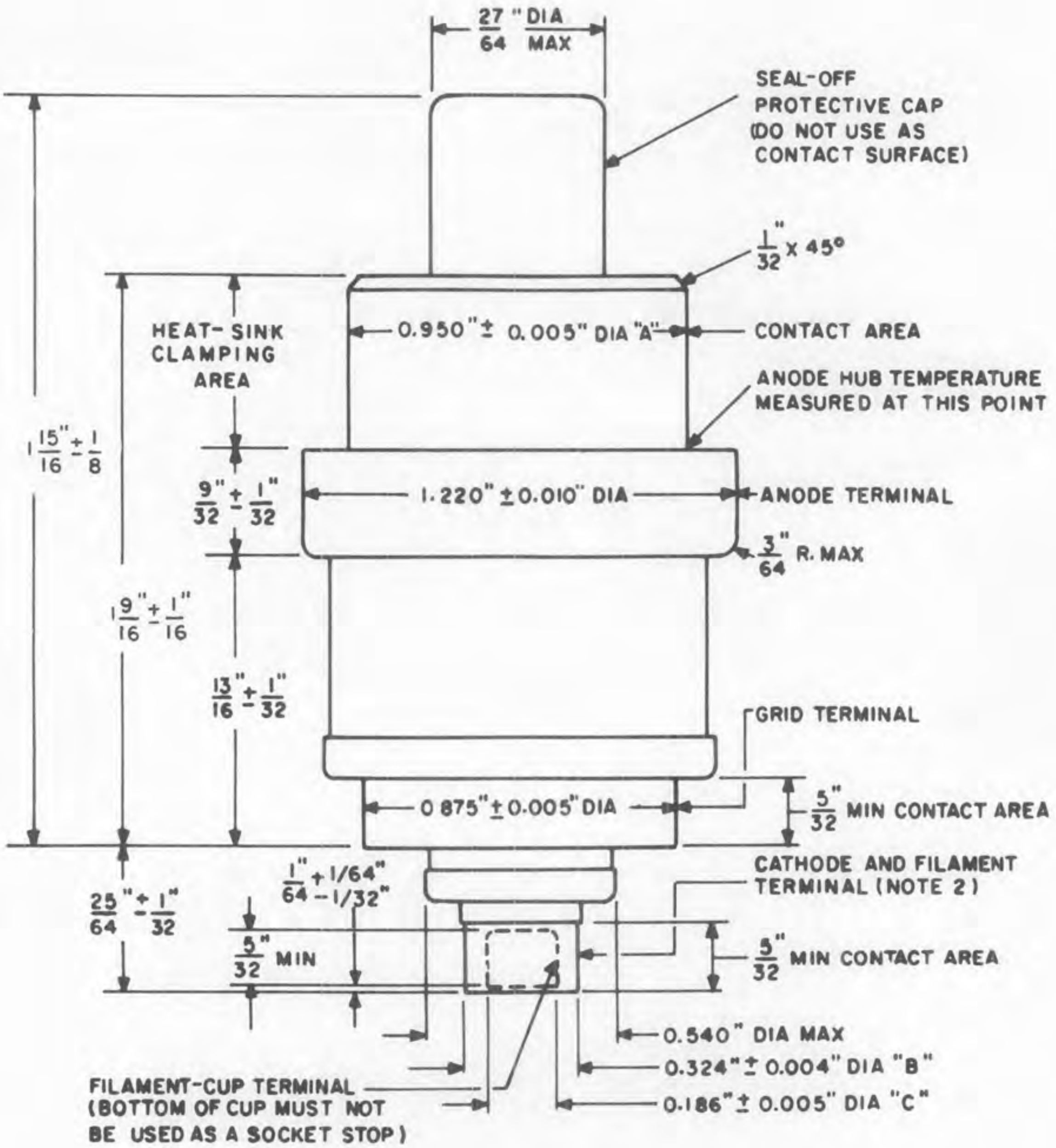
ø Maximum ratio of on-time to elapsed time during any 3.3-millisecond period.

øø Maximum ratio of on-time to elapsed time during any 75-millisecond period.

** With a series grid resistance of 50 ohms.


ZP-1025 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_c = 9a
I_b = 10a
I_b = .001a
-220
-200
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
0
400
800
1200
1600
2000


ZP-1025 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
CATHODE VOLTAGE VOLTS
PLATE VOLTAGE VOLTS
I_c = 25 AMPERES
I_b = 35 AMPERES
I_b = 0
-500
-400
-300
-200
-100
0
100
200
1000
2000
3000
4000
5000
6000
7000



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER A-0.030 INCHES
DIAMETER B-0.036 INCHES
DIAMETER C-0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B)-0.016 INCHES.

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1026
TRIODE

Grid-Pulsed Amplifier Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1026 is a heat-sink-cooled triode especially designed for grid-pulsed amplifier service in L-band. This tube is particularly well suited for use in navigational aid beacons (TACAN). Features include small size, high gain, long pulse width and high duty capability, long life and reliability.

ELECTRICAL

Heater Voltage*	6.3	Volts
Heater Current	3.8	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	15.5	μμf
Output	5.9	μμf
Plate-Cathode	0.13	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximately	3 1/4	Ounces

THERMAL

Cooling – Heat-sink and Forced-air

Anode Temperature §	250	C
Ceramic Temperature at Any Point	200	C

GRID-PULSED AMPLIFIER – CLASS AB_2

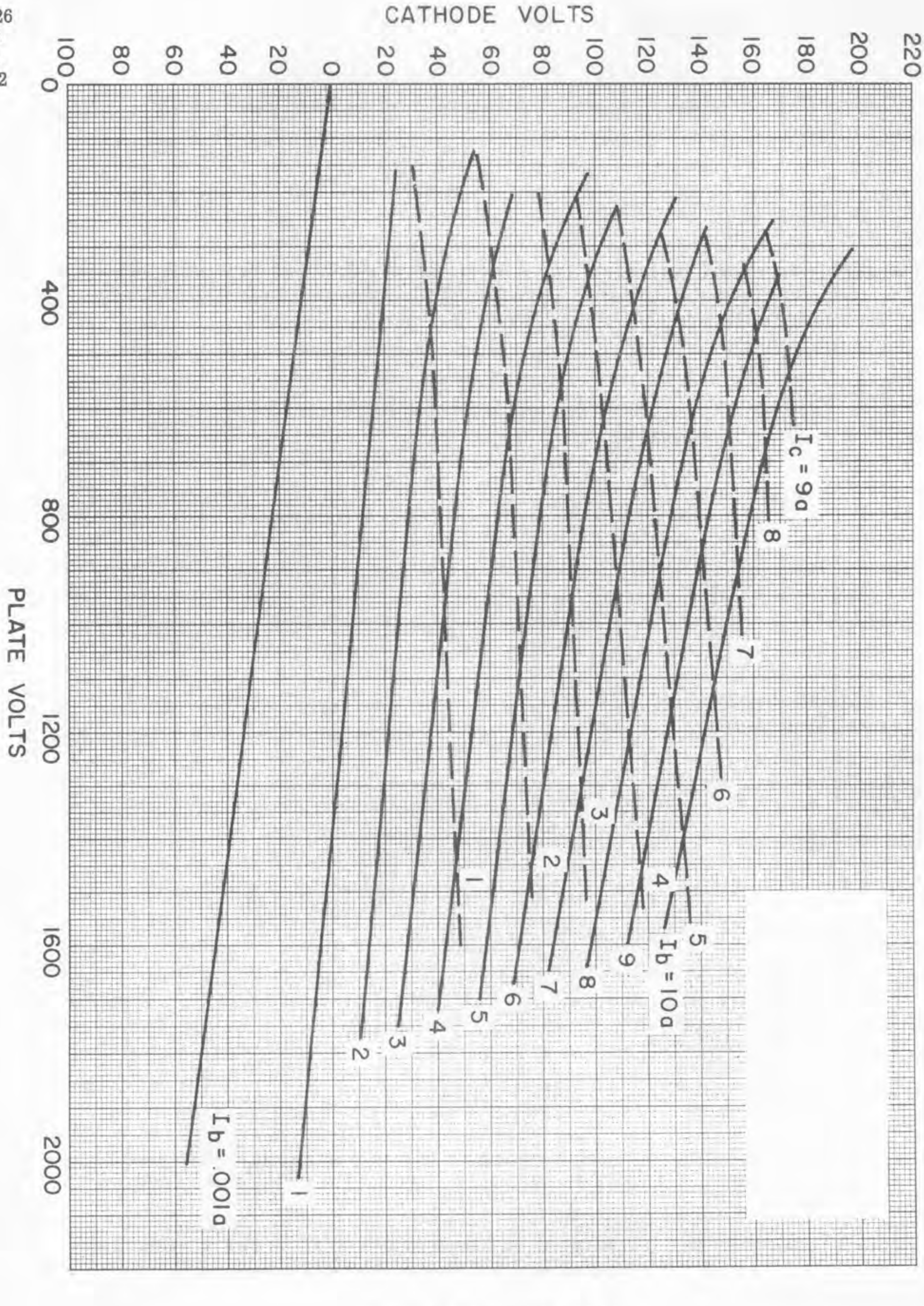
Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	2.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	110	Watts
Pulse Width	10	Microseconds
Duty Factor ø	.04	

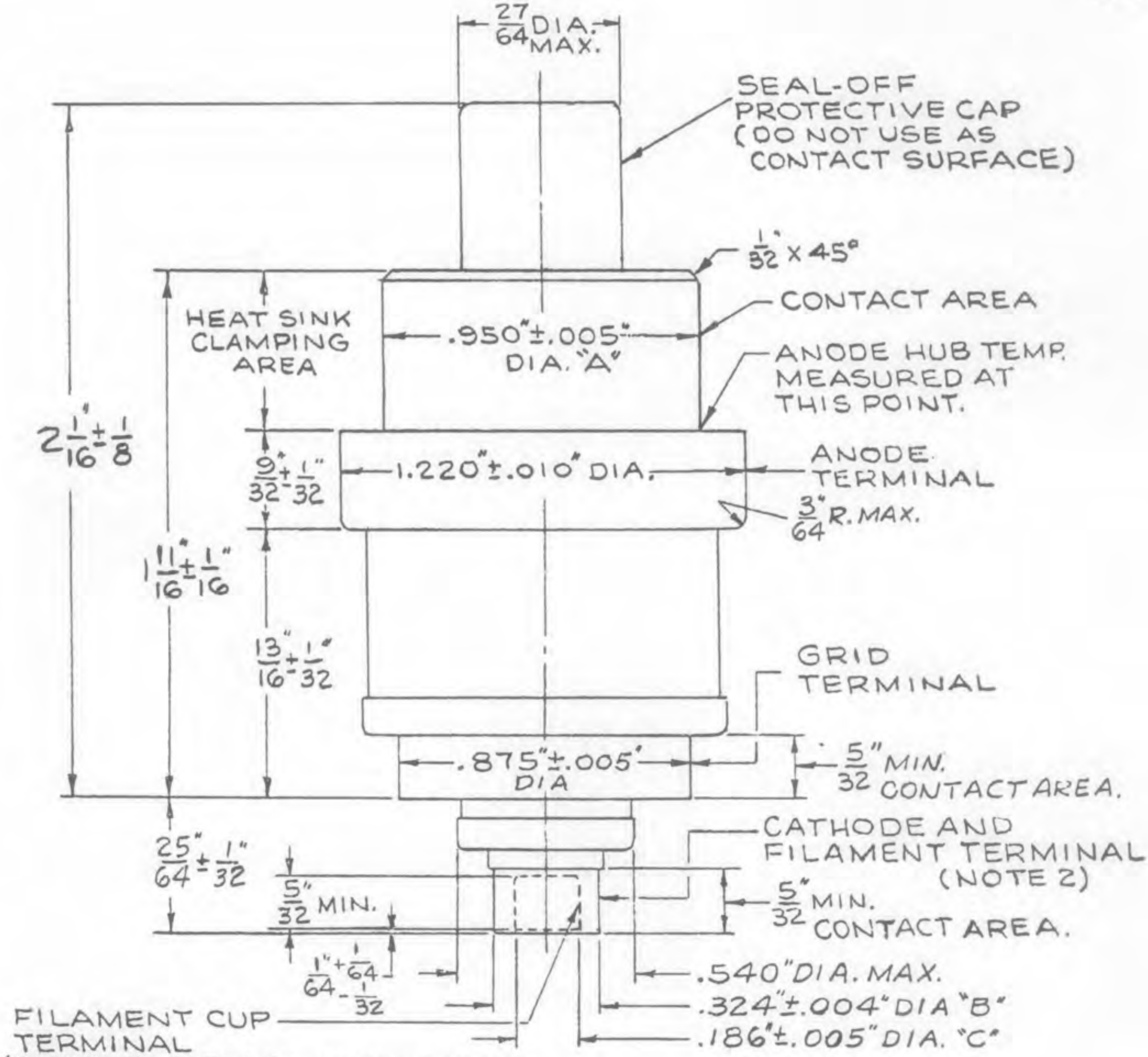
Typical Operation
Grounded-Grid Circuit at 1215 mcs, 3/4 λ Output

DC Plate Voltage	2000	Volts
DC Plate Current, during pulse	1.6	Amperes
DC Grid Voltage	-75	Volts
DC Grid Voltage, during pulse	0	Volts
DC Grid Current, during pulse	.5	Amperes
Power Output, during pulse (useful)	750	Watts
Drive Power, during pulse	95	Watts
Pulse Width ◊	8	Microseconds
Duty Factor	.03	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.
ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.
◊ Pulse duration is measured between points at 70 percent of the peak 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.



Voltages Referenced to Grid



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

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ZP-1029

HIGH-FREQUENCY DIODE

The ZP-1029 is a heat-sink-cooled diode especially designed for r-f switching service at UHF frequencies.

ELECTRICAL

Heater Voltage	6.3	Volts
Heater Current	3.8	Amperes
Cathode Heating Time, minimum	1	Minute
Plate-Cathode Capacitance	15	μμf

MECHANICAL

Mounting Position – Any

THERMAL

Cooling – Heat-Sink and Forced-Air		
Maximum temperature	250	C

RF SWITCHING DIODE

Maximum Ratings

Peak Plate Current	10	Amperes
DC Plate Current	0.300	Amperes
Peak Inverse Voltage*	5500	Volts
Plate Dissipation**	110	Watts

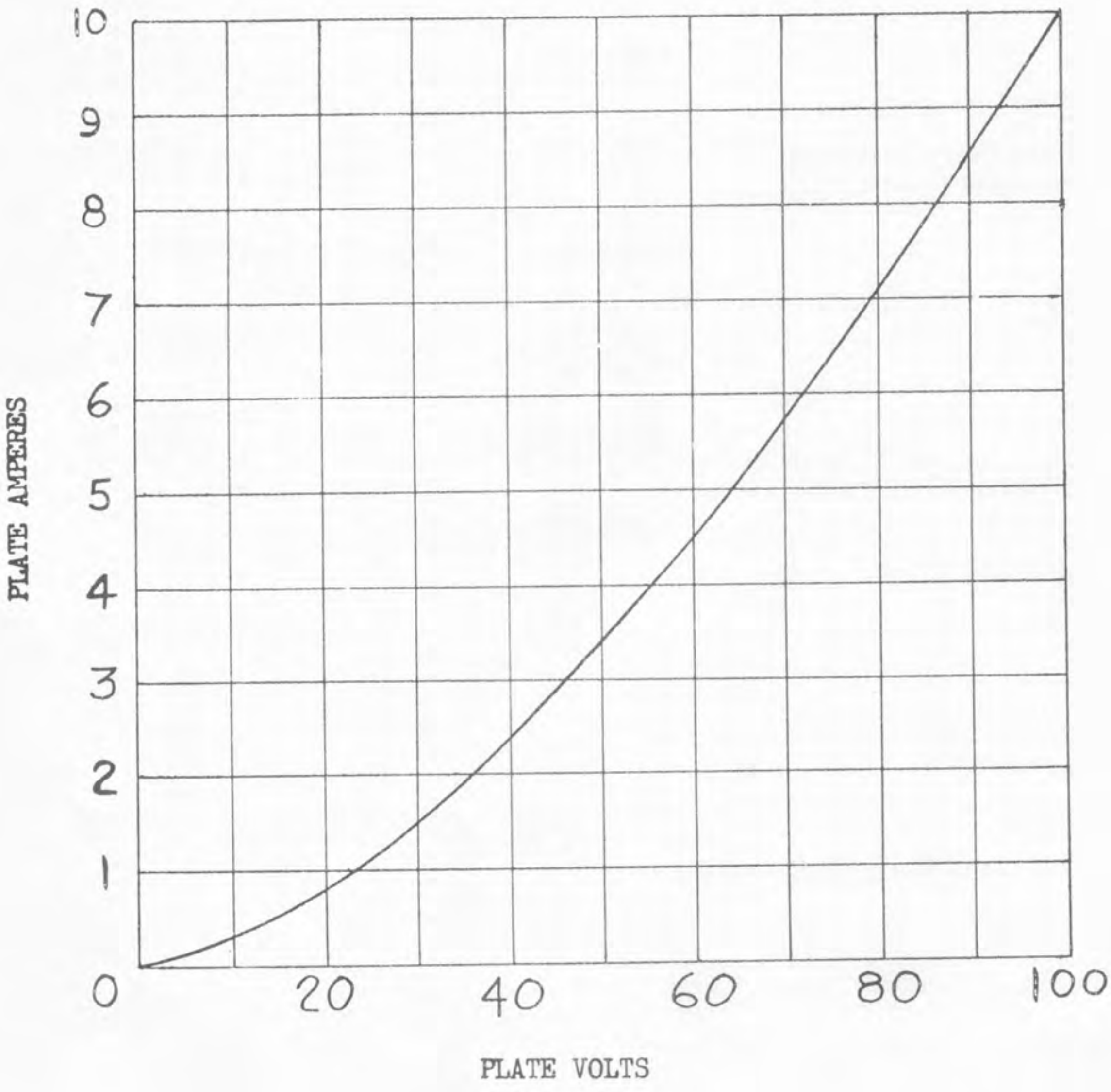
Typical Operation

Peak Forward Plate Voltage @ 10 amperes	100	Volts

* Maximum duration of inverse pulse – 1.5 microseconds.
** Determined by efficiency of heat-sink; maximum temperature limitation applies.

ZP-1029

TENTATIVE CHARACTERISTIC



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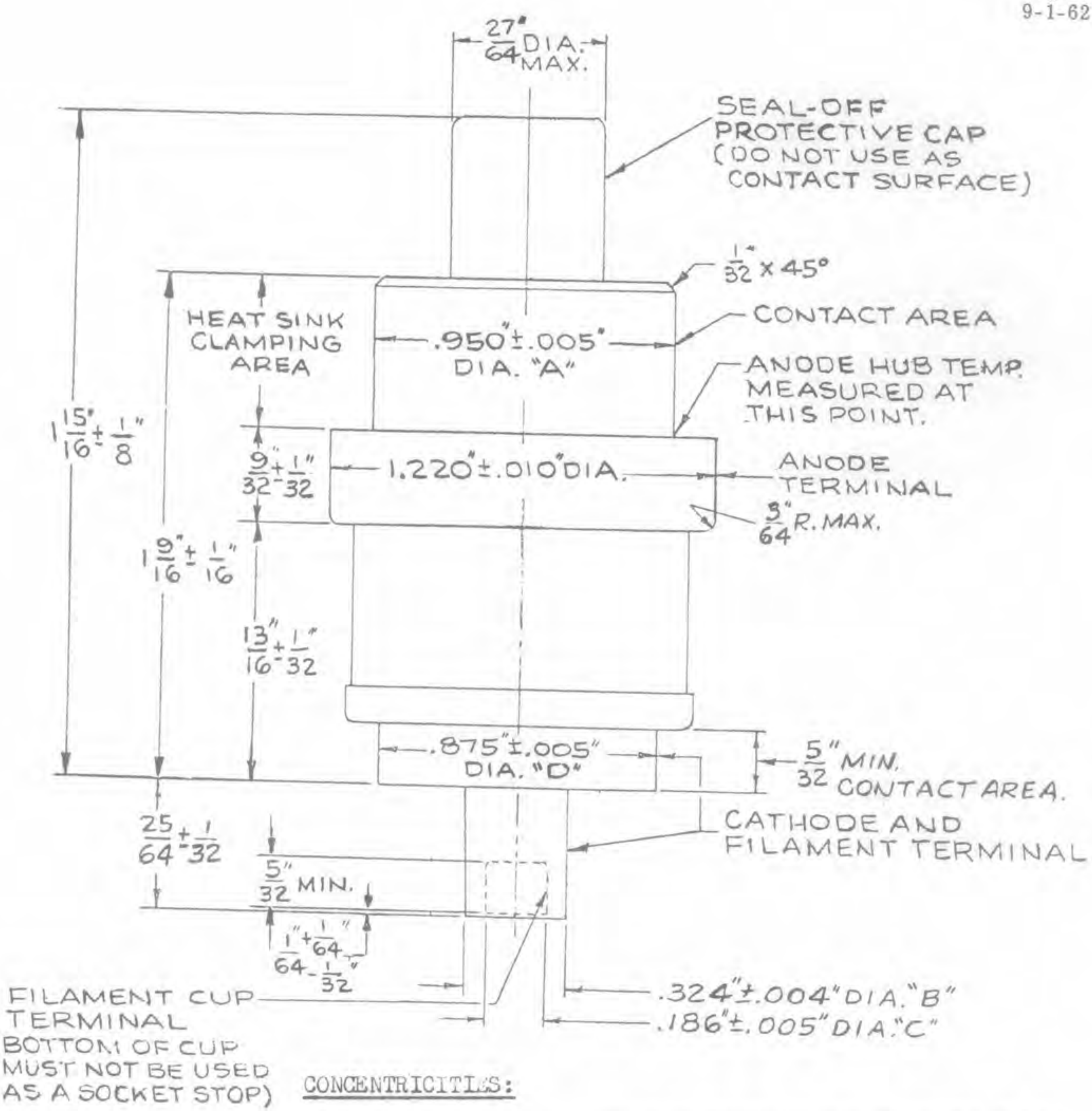


CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and diameter "D".

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1032*

PLANAR TRIODE

The Y-1032 is a medium-mu triode of ceramic and metal planar construction primarily intended for radio-frequency amplifier service well into the UHF range. A feature of the tube is its operation at low values of plate voltage.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.24	Amperes
Direct Interelectrode Capacitances		
→ Grid to Plate	1.5	pf
Input	1.7	pf
Output	0.02	pf
Heater to Cathode	1.1	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	60	Volts
Positive DC Grid Voltage	0	Volts
Plate Dissipation	0.6	Watts
→ DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	0.01	Megohms
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	50	26.5	Volts
Cathode-Bias Resistor	68	33	Ohms
Amplification Factor	37	36	
Plate Resistance, approximate	3400	3600	Ohms
Transconductance	11000	10000	Micromhos
Plate Current	7.5	4.7	Milliamperes

→ Typical Operation

Grounded-Grid Amplifier - 200 Megacycles

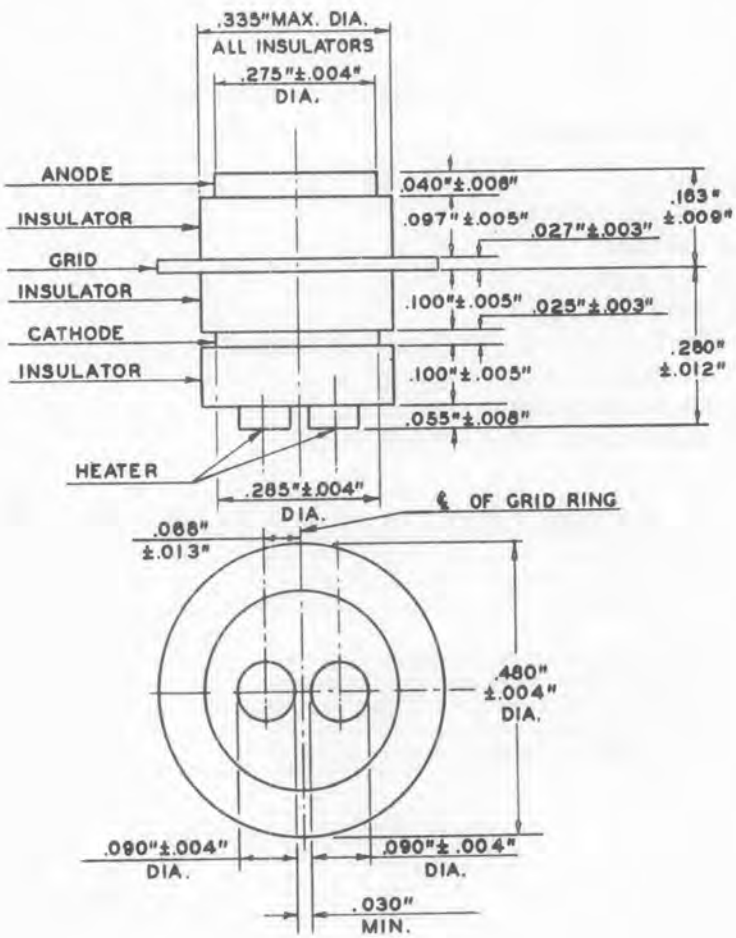
Plate Voltage	50	Volts
Cathode-Bias Resistor	68	Ohms
Plate Current	7.5	Milliamperes
Bandwidth, approximate	7.5	Megacycles
Noise Figure, approximate	4.0	Decibels

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

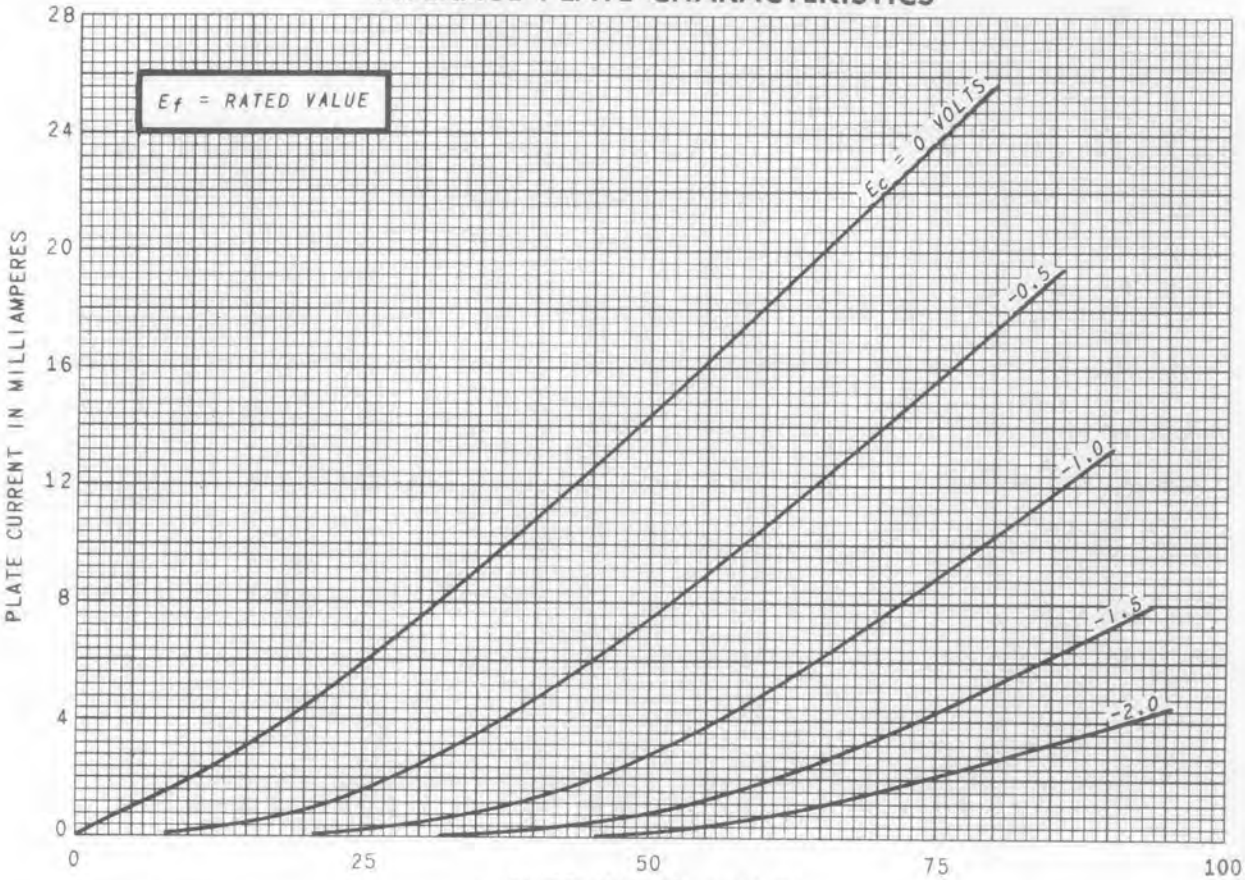
\+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

Outline Drawing



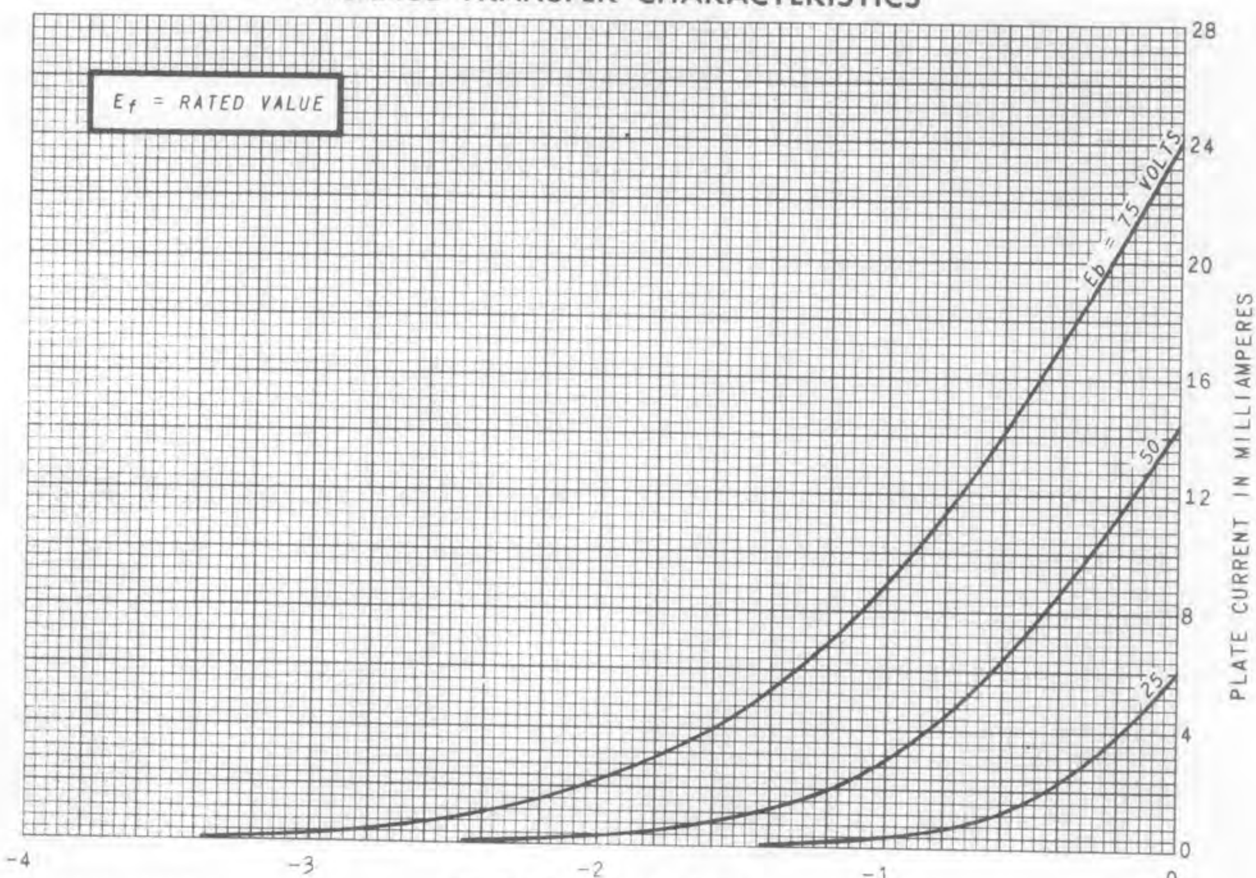
AVERAGE PLATE CHARACTERISTICS



K-55611-TD256-1

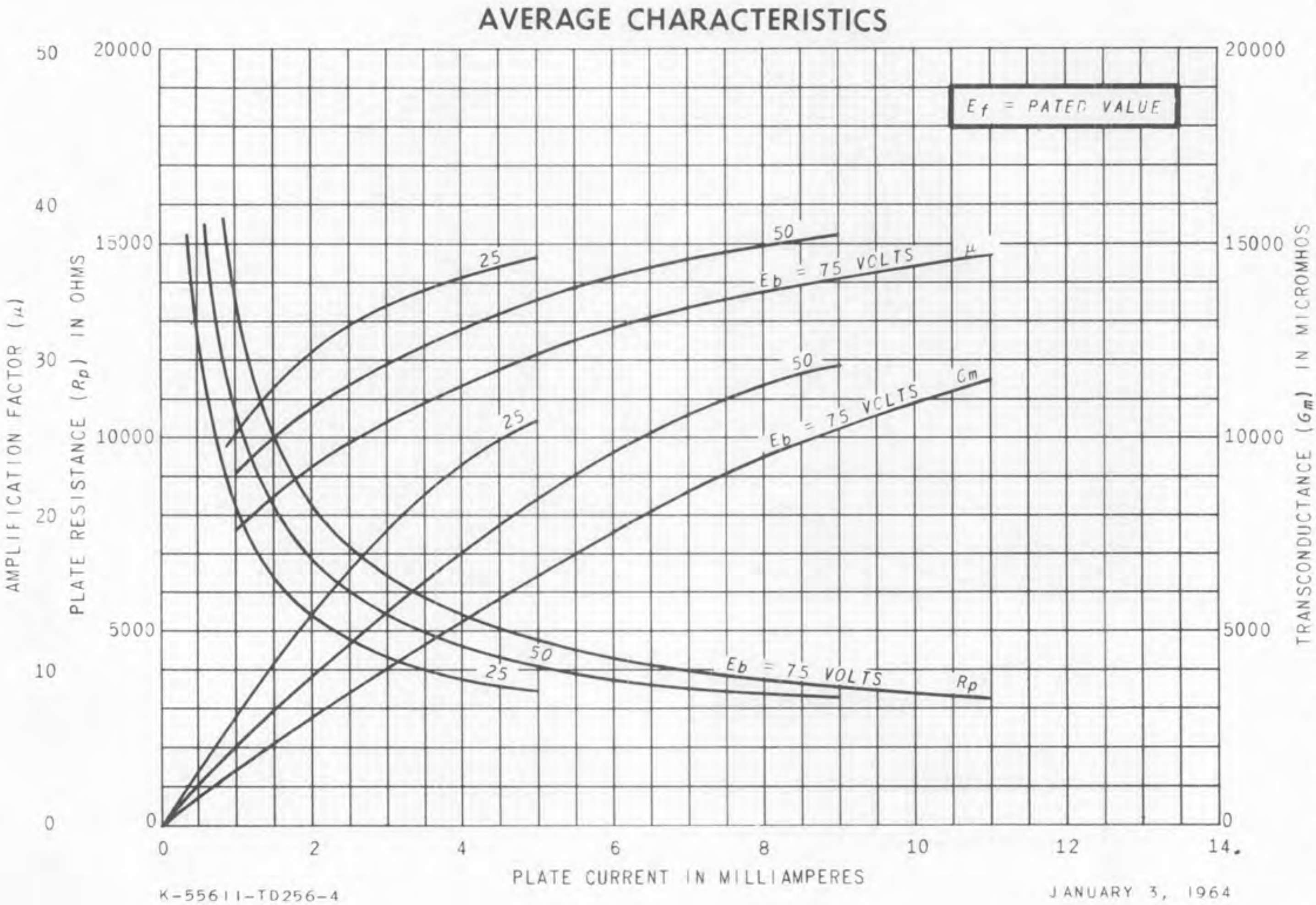
JANUARY 3, 1964

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD252-2

JANUARY 3, 1964



4/27/64 (B)
Supersedes 1/7/64 (B)

ELECTRONIC INNOVATIONS IN ACTION

TUBES

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1034

TETRODE

Pulsed Service
Grounded-Grid Operation

Water Cooled
Metal and Ceramic

Integral Water Jacket

The ZP-1034 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier service at L-band frequencies. This tetrode is particularly well suited for use in ground-based equipment such as steerable array radar.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1034 include long life and reliability, long pulse width, high gain and broad-banding capability.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	--	5.5	--	Amperes
Amplification Factor, G_2 to G_1	--	10.5	--	
E_{g2} = 275 Volts DC, E_b = 1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	--	--	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	--	0.012	--	uuf
Input	--	24.0	--	uuf
Output	--	9.8	--	uuf

MECHANICAL

Mounting Position – Any		
Net Weight, approximate	13	Ounces

THERMAL

Cooling – Water and Forced Air ø		
Water Flow		
Anode	0.5	Minimum Gallons per Minute
Outlet Temperature	70	Maximum C

THERMAL (Cont'd.)

Air Flow		
Anode Ceramic, approximate	1	Cubic Foot per Minute
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at any Point	200	Maximum C

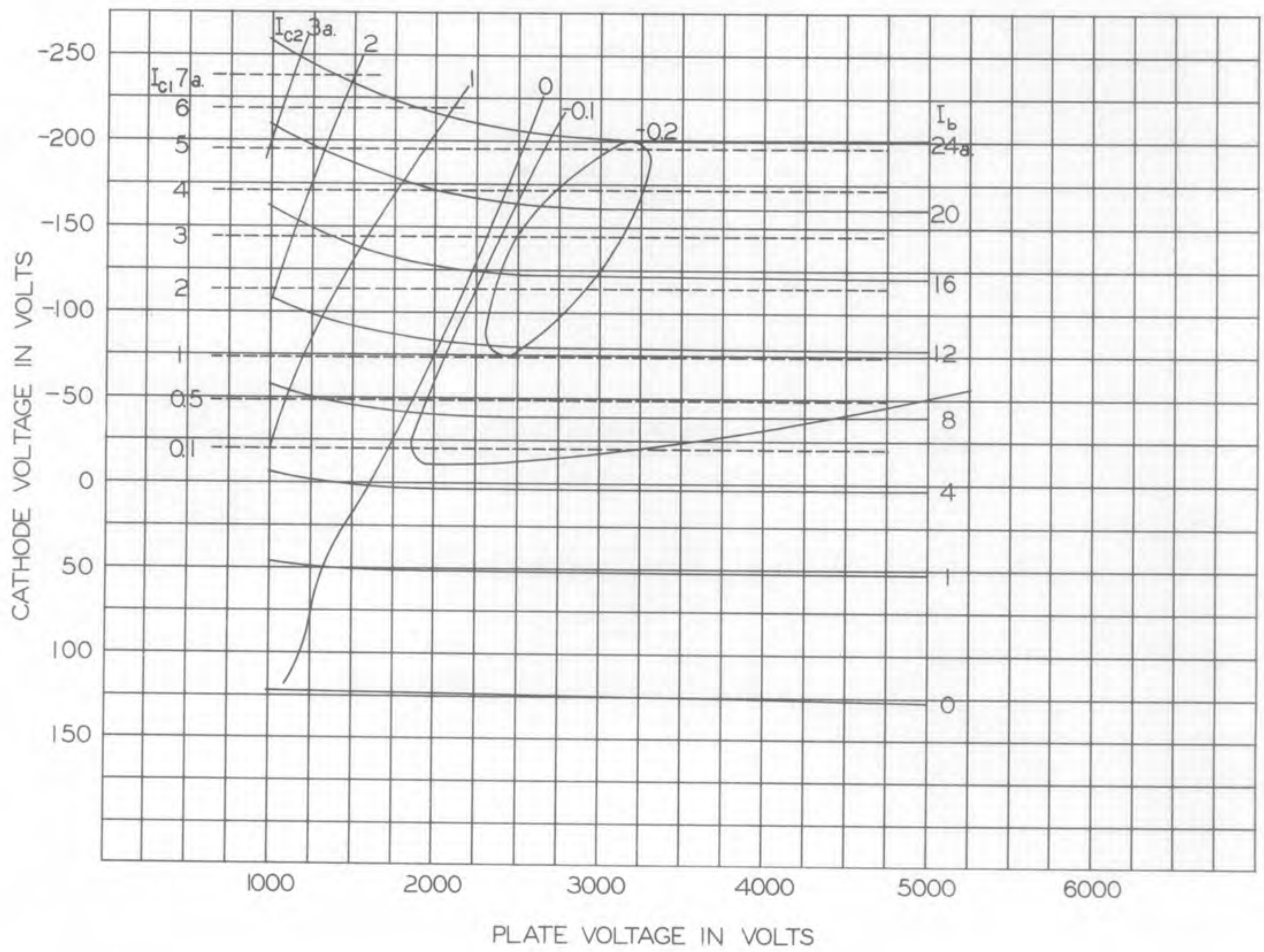
RADIO-FREQUENCY POWER AMPLIFIER - CLASS C

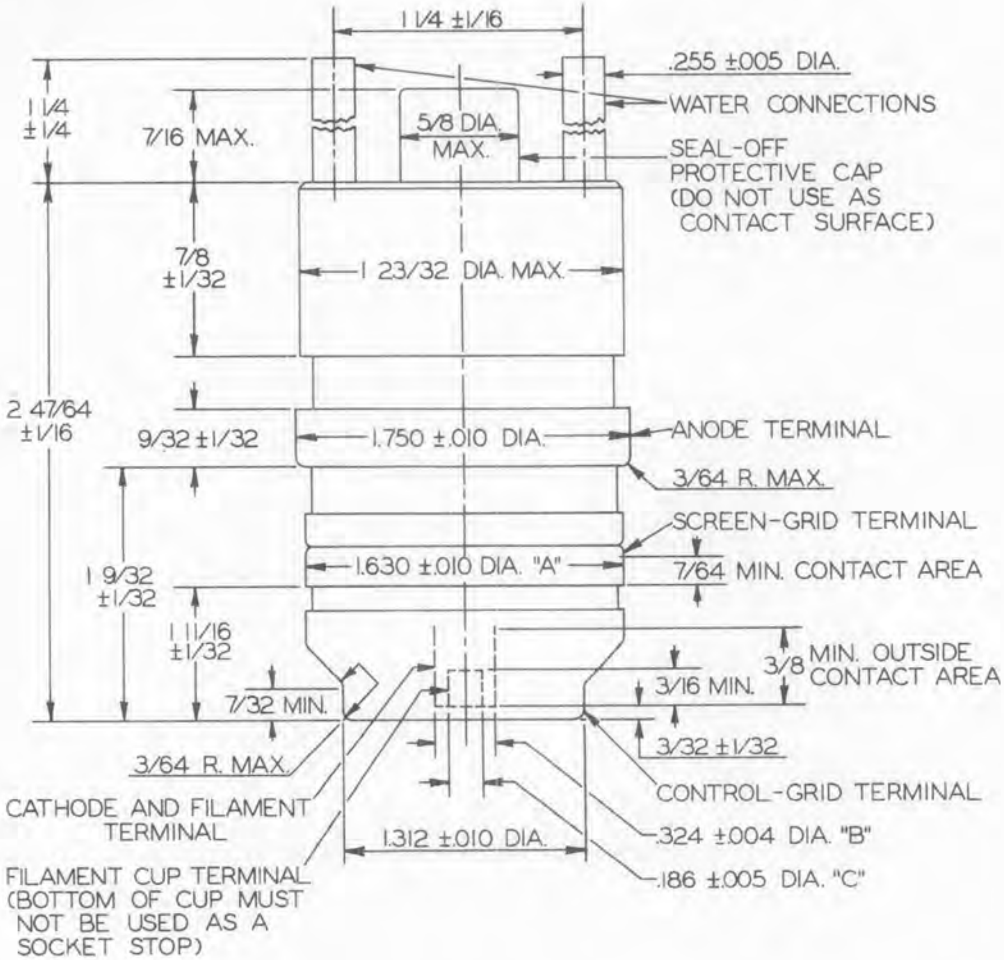
Maximum Ratings		
Pulsed Drive, 1300 Megacycles		
DC Plate Voltage	4	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input #	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation #	750	Watts
Pulse Width ** ††	15	Microseconds
Duty Factor ** øø	0.01	

Typical Operation		
Grounded-grid Circuit at 1300 Megacycles, λ/4 Output Circuit		
DC Plate Voltage ##	4.0	Kilovolts
DC Plate Current during pulse	3.5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Current, during pulse	75	Milliamperes
DC Grid-No. 1 Voltage	-150	Volts
DC Grid-No. 1 Current, during pulse	150	Milliamperes
Driving Power at Tube, during pulse	750	Watts
Power Output, during pulse (useful)	7.5	Kilowatts
Pulse Width ††	15	Microseconds
Duty Factor	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
ø Water and forced air cooling to be applied during the application of any voltages.
\# Maximum average value.
** For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
†† Pulse duration measured between points at 70 percent of peak 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.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
\## A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES: The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A – 0.016 inches
Diameter B – 0.036 inches
Diameter C – 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) – 0.016 inches.

GE ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

DEVELOPMENTAL TYPE

ZP-1038
PTI-162A
Page 1
9-67

ZP-1038

TETRODE

Pulsed Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

Integral Radiator

The ZP-1038 is a small-size, four-electrode transmitting tube especially designed for RF grid-pulsed or plate-and-screen pulsed amplifier service at L-band frequencies. This tetrode is particularly well suited for use in air-borne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1038 include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where high performance and reliability are important.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	–	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Input	–	24	–	$\mu\mu$f
Output	–	9	–	$\mu\mu$f

MECHANICAL

Mounting Position – Any		
Net Weight	0.8	Pounds

THERMAL

Cooling – Forced Air‡				
Radiator§				
Plate Dissipation	600	400	–	Watts
Air Flow, 45 C incoming air temperature, at sea level	9	4.5	–	Min Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2	–	Inches-Water
Anode Hub Temperature △			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

RADIO-FREQUENCY POWER AMPLIFIER - CLASS B

Maximum Ratings
Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	-175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ ø	0.0012	

Typical Operation
Grounded-grid Circuit, 500 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	-125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.001	

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C

Maximum Ratings
Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ øø	0.01	

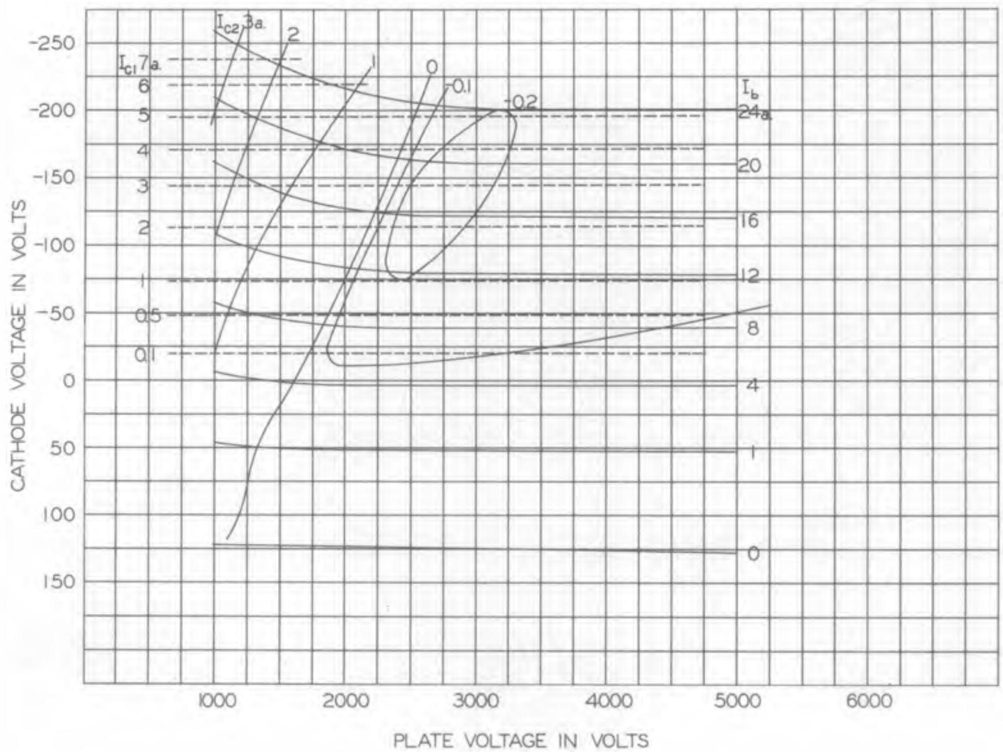
Typical Operation

Grounded-grid Circuit at 1100 Megacycles, 3/4λ Output Circuit

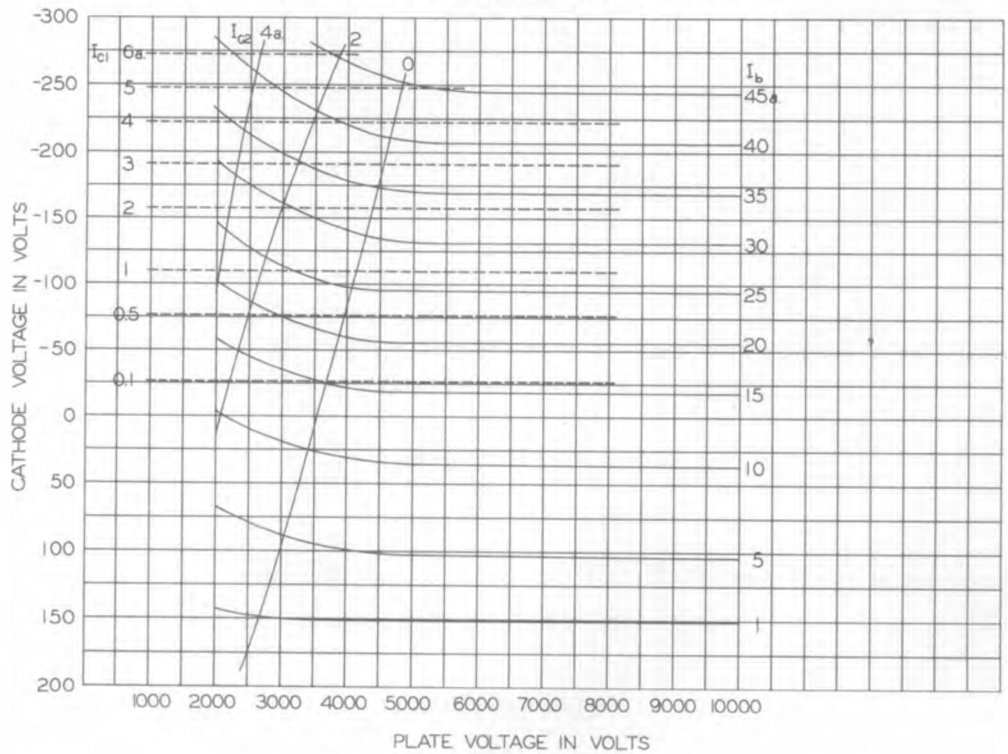
DC Plate Voltage **	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.01	

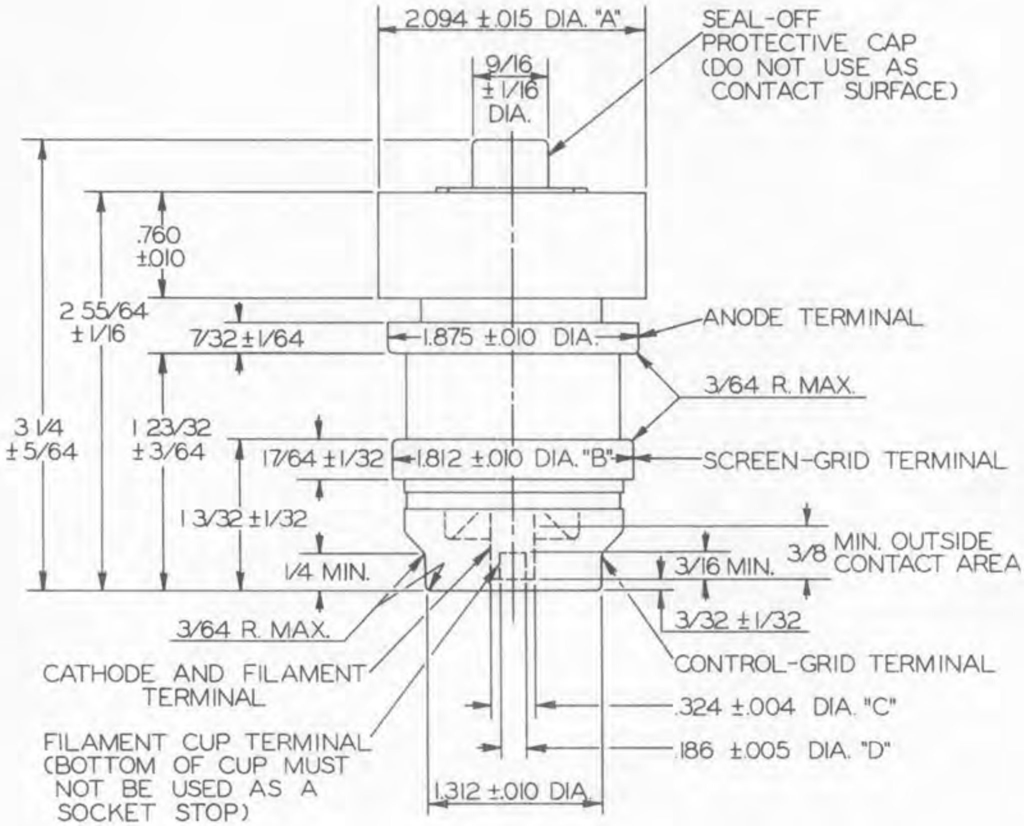
* Control grid connected directly to screen grid.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air through the radiator fins, and between the anode terminal and adjacent portion of the radiator.
△ Measured at the base of the radiator and adjacent to the plate terminal.
♣ Maximum average value.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak 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.
ø Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A – 0.030 inches
Diameter B – 0.016 inches
Diameter C – 0.036 inches
Diameter D – 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) – 0.016 inches.

ZP-1039

VHF-UHF
Ring-Seal Construction

TETRODE
Grounded-Grid Circuit

Forced-Air Cooled
Metal and Ceramic

The ZP-1039 is a high-performance four-electrode tube for use as an RF power amplifier in grounded-grid circuits with both grids maintained at RF ground potential. This tube features a high-efficiency, axial-flow radiator for minimum forced-air-cooling requirements. The anode is capable of dissipating 5000 watts. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply to 800 megacycles, although higher-frequency operation is possible.

As a Class B linear power amplifier the tube will deliver 1500 watts at the carrier level with high power gain and high linearity.

In narrow band, plate-modulated Class C telephony service, the ZP-1039 has a useful carrier power output in excess of 1000 watts. In Class C telegraphy service, it has a useful power output in excess of 3000 watts of continuous power as an RF power amplifier or oscillator.

ELECTRICAL

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	–	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	–	14.5	–	Amperes
With 150 Watts Cathode Bombarding	–	13.5	–	Amperes
Heater Starting Current	–	–	25	Amperes
Heater Cold Resistance	–	0.041	–	Ohms
Cathode Bombarding Power*	–	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	–	650	–	Volts
For 195 Watts Bombarding Power	–	700	–	Volts
Cathode Heating Time	1	–	–	Minute
Amplification Factor, G_2 to G_1;				
E_b = 4000 Volts; I_b = 0.5 ampere	–	20	–	
Direct Interelectrode Capacitances				
Cathode to Plate §	–	0.01	–	μμf
Input, G_2 tied to G_1	–	27.8	–	μμf
Output, G_2 tied to G_1 ¶	–	6.7	–	μμf

MECHANICAL

Mounting Position – Vertical, Anode-end Up
Net Weight, approximate . . . . . 9.5 Pounds

THERMAL

Type of Cooling – Forced Air
Air Flow Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
4.0 Kw	80 CFM	0.9 In.
5.0 Kw	150 CFM	2.5 In.

Seals

Screen-grid to Control-grid, minimum	15	Cubic Feet per Minute
Heater-to-cathode, minimum	7.5	Cubic Feet per Minute
Anode Ceramic, minimum	10	Cubic Feet per Minute

THERMAL (CONT'D)

Incoming Air Temperature, maximum	25	C
Anode Hub Temperature, maximum	250	C
Temperature of Anode Ceramic and Seals, maximum	250	C
Temperature at Any Other Point, maximum	200	C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The radiator air ducting can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers and additional holes in the plate contact ring to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

RADIO-FREQUENCY POWER AMPLIFIER - CLASS B

Carrier Conditions per Tube for Use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	9000	Volts
DC Grid-No. 2 Voltage	800	Volts
DC Plate Current	0.800	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	5.0	Kilowatts

Typical Operation

Grounded-grid Circuit, 225-400 Megacycles

DC Plate Voltage	8000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 1 Voltage, approximate	-50	Volts
DC Plate Current	0.600	Ampere
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.060	Ampere
Driving Power, approximate	160	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output #	1500	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2500	Watts
Cathode Bombarding Power *	170	Watts
Cathode Bombarding Voltage	650	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER - CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	-120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	5.0	Kilowatts

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER – CLASS C TELEPHONY (CONT'D)

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	-100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output #	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power *	165	Watts
Cathode Bombarding Voltage, approximate	630	Volts
Cathode Bombarding Current, approximate	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR – CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	5.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	-120	-100	Volts
Peak RF Plate Voltage, approximate	3000	–	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate #	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power *	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY (CONT'D)

Key Down Conditions per Tube Without Amplitude Modulation

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	-120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate #	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power *	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the ZP-1039, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

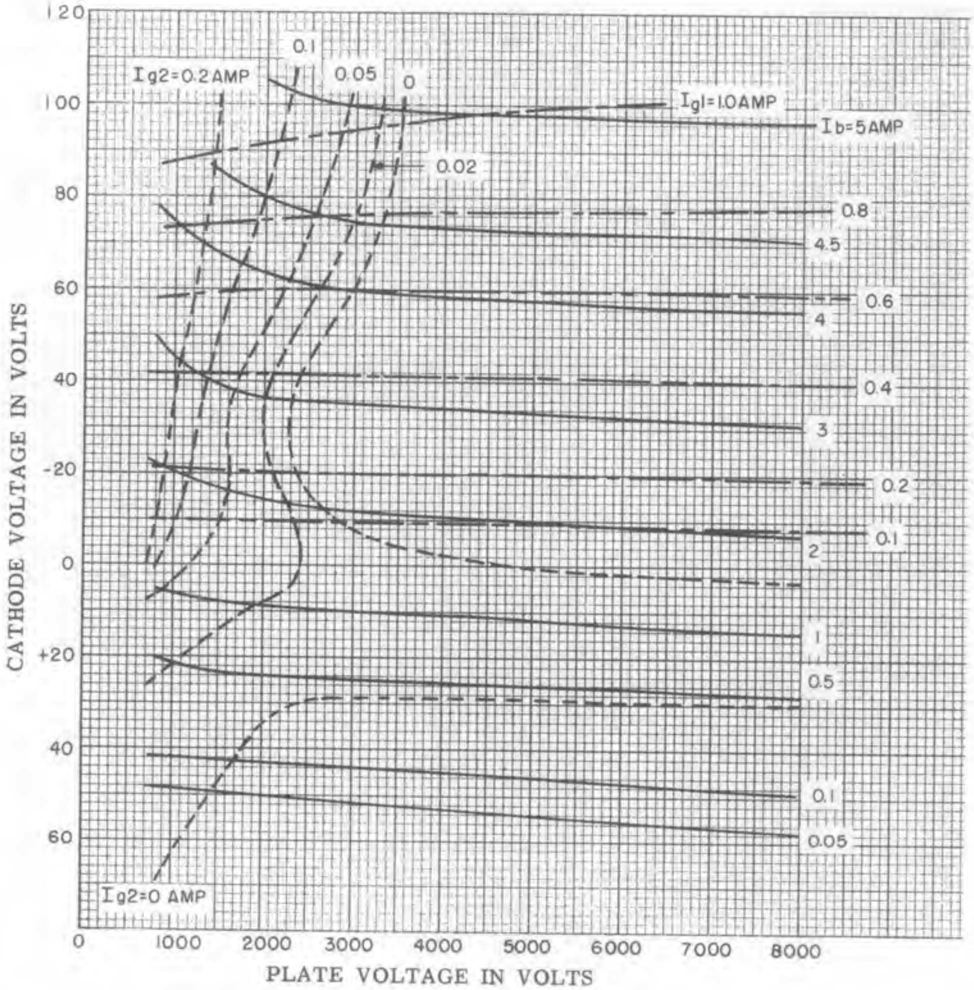
§ Measured with complete isolation between cathode and plate.

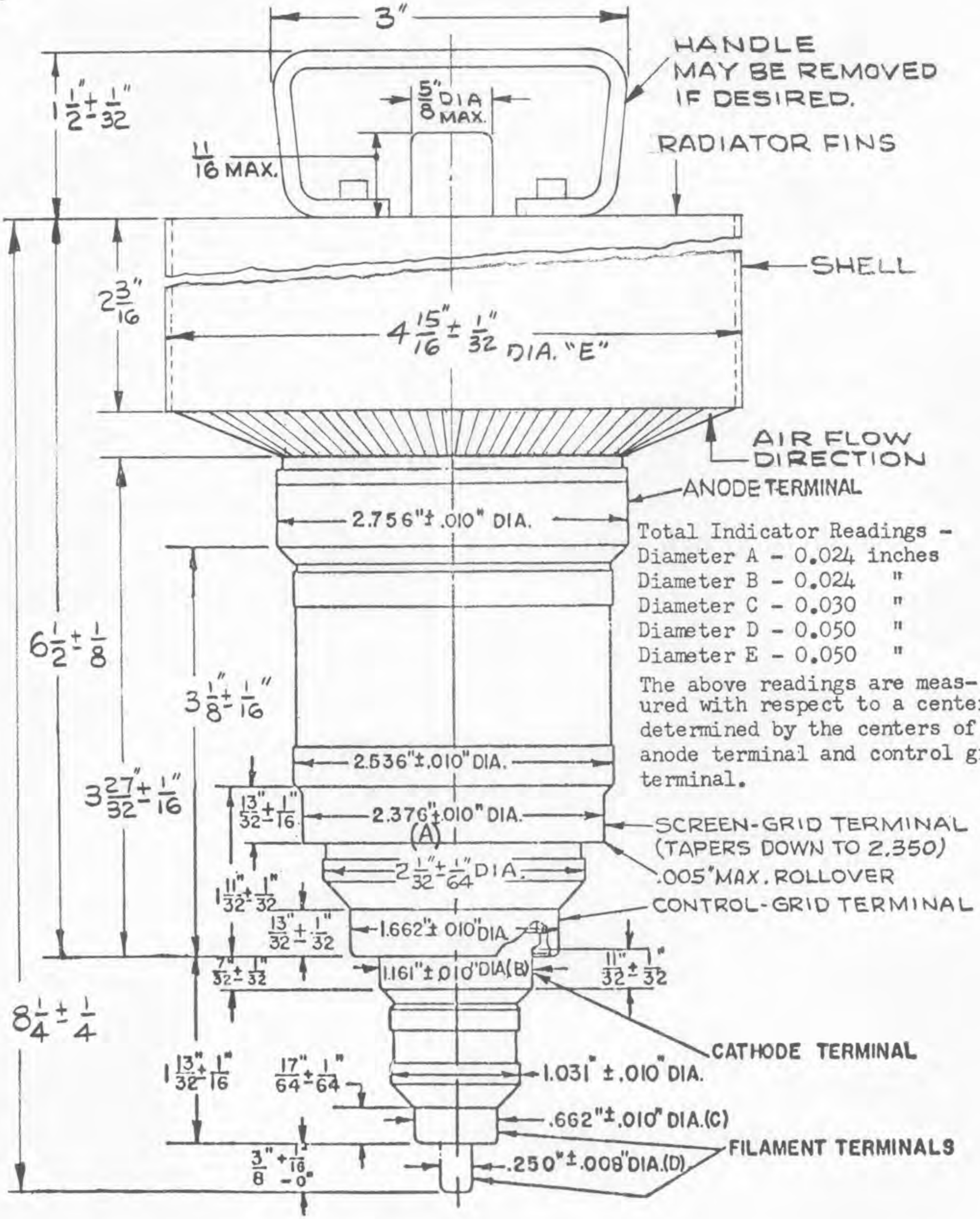
¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.

TYPICAL CHARACTERISTICS

Ef = 7 Volts AC
Eg2 = 750 Volts
Bombarding Power = 180 Watts
All Voltages Referenced to Grid





Total Indicator Readings -
Diameter A - 0.024 inches
Diameter B - 0.024 "
Diameter C - 0.030 "
Diameter D - 0.050 "
Diameter E - 0.050 "

The above readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

A-69087-72B120 (12-2-64)

GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1043

TRIODE

Grid-Pulsed Amplifier Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1043 is a heat-sink-cooled triode especially designed for grid-pulsed amplifier service in L-band. This tube is particularly well suited for use in navigational aid application. Features include small size, long pulse width and high duty capability, long life and reliability.

ELECTRICAL

Heater Voltage*	5.0	Volts
Heater Current	2.4	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	16.5	μμf
Output	4.0	μμf
Plate-Cathode	0.1	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximately	2-1/2	Ounces

THERMAL

Cooling – Heat-sink or Forced air

Maximum Anode Temperature §	250	C
Maximum Ceramic Temperature at Any Point	200	C

GRID-PULSED AMPLIFIER – CLASS C

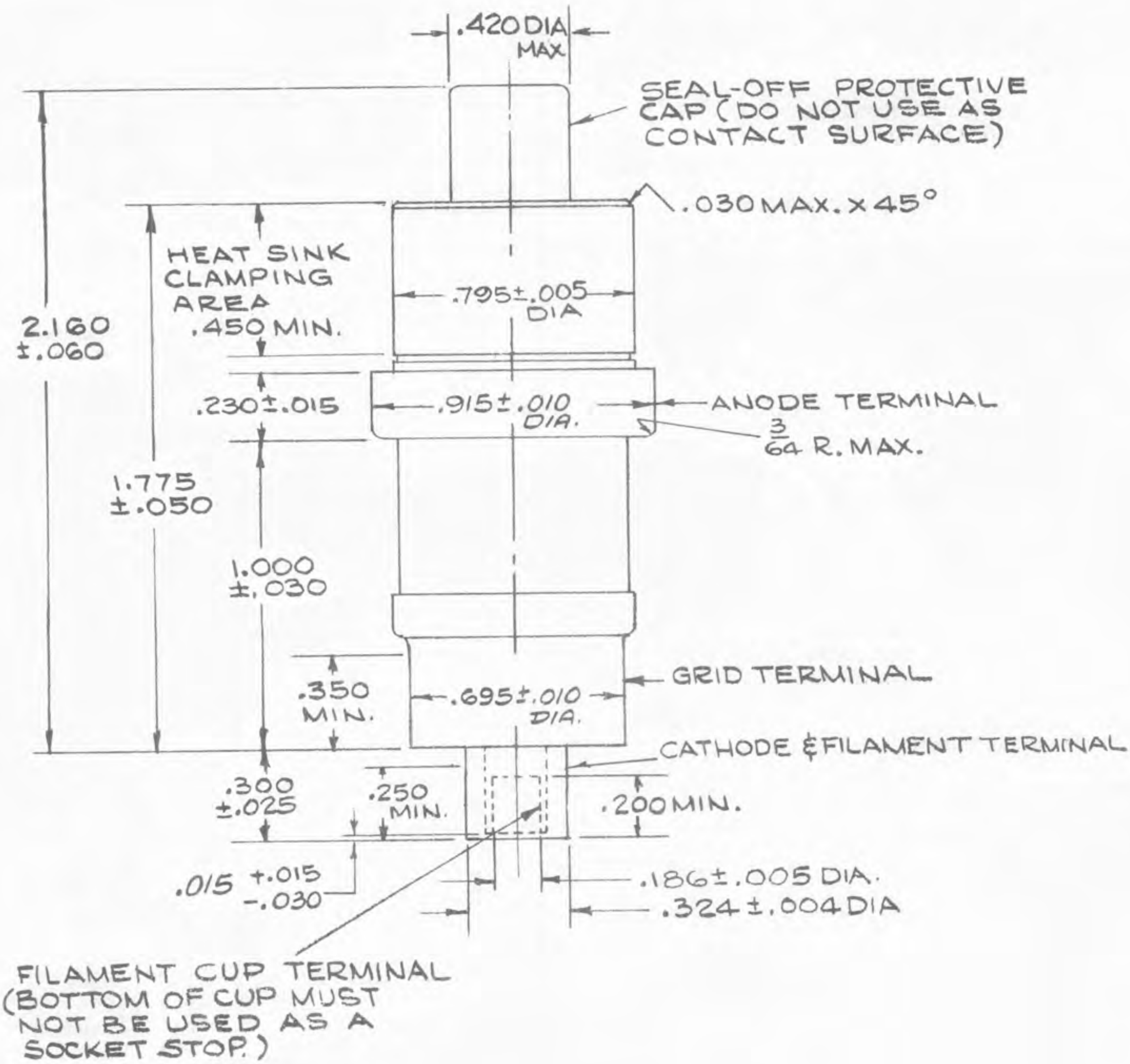
Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	3.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	50	Watts
Pulse Width ¶	10	Microseconds
Duty Factor ø¶	0.01	

Typical Operation
Grounded-Grid Circuit at 1150 mcs, 1/4 λ Output

DC Plate Voltage	2000	2000	Volts
DC Plate Current, during pulse	1.1	2.25	Amperes
DC Grid Voltage	-80	-80	Volts
DC Grid Current, during pulse	0.35	0.75	Amperes
Power Output, during pulse (useful)	1000	2000	Watts
Drive Power, during pulse	200	350	Watts
Pulse Width ◊	10	10	Microseconds
Duty Factor	0.01	0.004	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.
ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.
◊ Pulse duration is measured between points at 70 percent of the peak 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.
¶ For recommendations on longer pulse width and higher duty factor refer to the manufacturer.


.420 DIA MAX
SEAL-OFF PROTECTIVE CAP (DO NOT USE AS CONTACT SURFACE)
.030 MAX. x 45°
HEAT SINK CLAMPING AREA .450 MIN.
.795±.005 DIA
2.160 ±.060
.230±.015
.915±.010 DIA.
ANODE TERMINAL
3/64 R. MAX.
1.775 ±.050
1.000 ±.030
GRID TERMINAL
.350 MIN.
.695±.010 DIA.
CATHODE & FILAMENT TERMINAL
.300 ±.025
.250 MIN.
.200 MIN.
.015 +.015 -.030
.186±.005 DIA.
.324±.004 DIA
FILAMENT CUP TERMINAL (BOTTOM OF CUP MUST NOT BE USED AS A SOCKET STOP.)

ZP-1044

TETRODE

Internal Feedback for CW Oscillator Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1044 is a forced-air cooled power tetrode especially designed for CW oscillator service through approximately 1250 megacycles. This tube is particularly well suited for use in special applications such as a high level RF power source operating over the range of 200 to 1000 megacycles.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service. This special feature greatly simplifies cavity design, construction, and operation, particularly where very broad frequency coverage is required.

Other features include metal and ceramic construction, an integral radiator capable of dissipating 1500 watts and an indirectly heated thoriated tungsten cathode.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage*	–	5.7	6.0	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	–	–	36	Amperes
Heater Cold Resistance	–	0.02	–	Ohms
Cathode Heating Time	1	–	–	Minutes
Direct Interelectrode Capacitances				
Input, G_2 tied to G_1	–	17.0	–	μμf
Output, G_2 tied to G_1 §	–	5.5	–	μμf

MECHANICAL

Mounting Position		Any
Net Weight, approximate	3.6	Pounds

THERMAL

Air Flow¶		
Through Radiator, at Sea Level		
Plate Dissipation	1.5	Kilowatts
Air Flow, 45 C Incoming Air Temperature, Minimum	60 Min	Cubic Feet per Minute
Static Pressure	1.5	Inches-Water
Heater-to-Cathode Seals	8 Min	Cubic Feet per Minute
Screen-Grid to Control-Grid Seals	4 Min	Cubic Feet per Minute
Anode to Screen-Grid Ceramic Insulator	6 Min	Cubic Feet per Minute
Radiator Hub Temperature at Fin Adjacent to Anode Seal	180 Max C	
Ceramic Temperature at Any Point	200 Max C	

CW RADIO-FREQUENCY OSCILLATOR - CLASS C

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	-150 Max	Volts

CW RADIO-FREQUENCY OSCILLATOR - CLASS C (CONT'D)

Maximum Ratings, Absolute Values (Cont'd)

DC Plate Current	0.7 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

Typical Operation - Grounded-Grid Circuit up to 1000 Megacycles

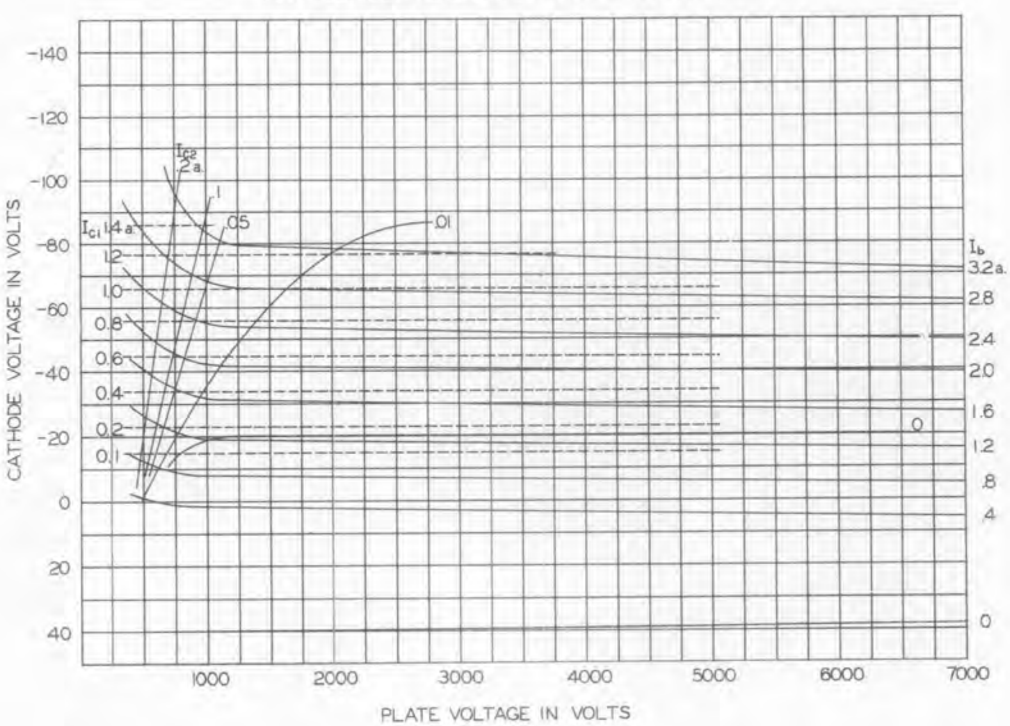
DC Plate Voltage	3800	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	-120	Volts
DC Plate Current	0.500	Amperes
DC Grid-No. 2 Current	0.022	Amperes
DC Grid-No. 1 Current, approximate	0.075	Amperes
Power Output, approximate (useful)	1100	Watts

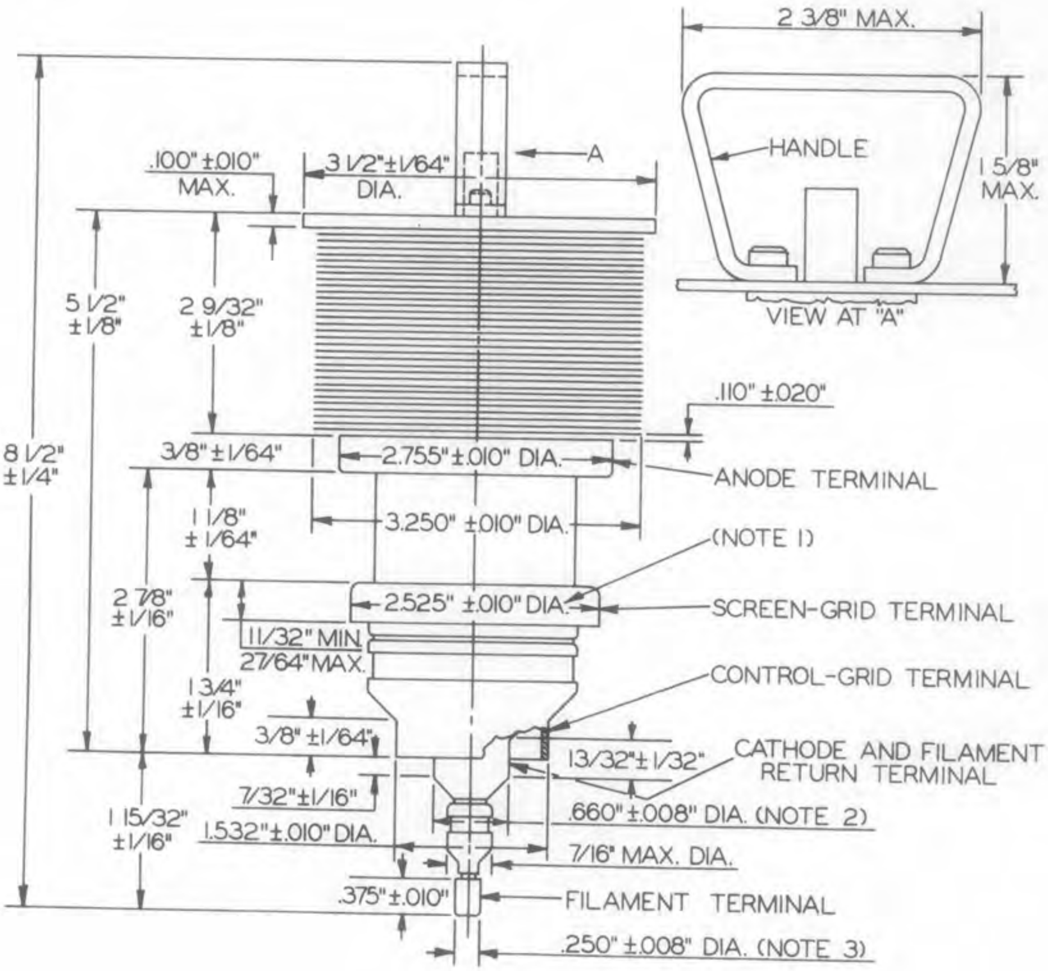
* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions.

§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

¶ The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most satisfactory operation the maximum temperature of any point on the tube should be below 200 C. Cooling is to be provided before and during the application of any voltages.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 500 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





Total Indicator Readings

Note 1: 0.020 in.
Note 2: 0.030 in.
Note 3: 0.060 in.

The above readings are measured with respect to a centerline determined by the centers of the anode terminal and control-grid terminal.

ZP-1057
TRIODE

Internal Feedback for CW Oscillator Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1057 is a forced-air cooled triode especially designed for CW oscillator service through approximately 2000 megacycles. This tube is particularly well suited for use in special applications such as high level microwave signal generators operating over an extremely wide frequency range.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service. This special feature greatly simplifies cavity design, construction and operation, particularly where very broad frequency coverage is required.

Other features include small size metal and ceramic construction, a high efficiency radiator, and an oxide-coated cathode with inherent long life..

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Input	-	15.5	-	μμf
Output	-	6.5	-	μμf

MECHANICAL

Mounting Position - Any
Net Weight, approximately .... 5 3/4 Ounces

THERMAL

Cooling - Forced Air
Through Radiator, at Sea Level
Plate Dissipation .... 300 Watts
Air Flow, 45 C Incoming Air Temperature, minimum .... 7 Cubic Feet per Minute
Static Pressure, approximate ..... 0.7 Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal ℓ .... 250 C
Ceramic Temperature at Any Point, maximum 200 C

CW RADIO-FREQUENCY OSCILLATOR - CLASS C

Maximum Ratings

DC Plate Voltage	1750	Volts
DC Plate Current	0.300	Amperes
DC Grid Voltage	-150	Volts
DC Grid Current	0.050	Amperes
Plate Dissipation	300	Watts

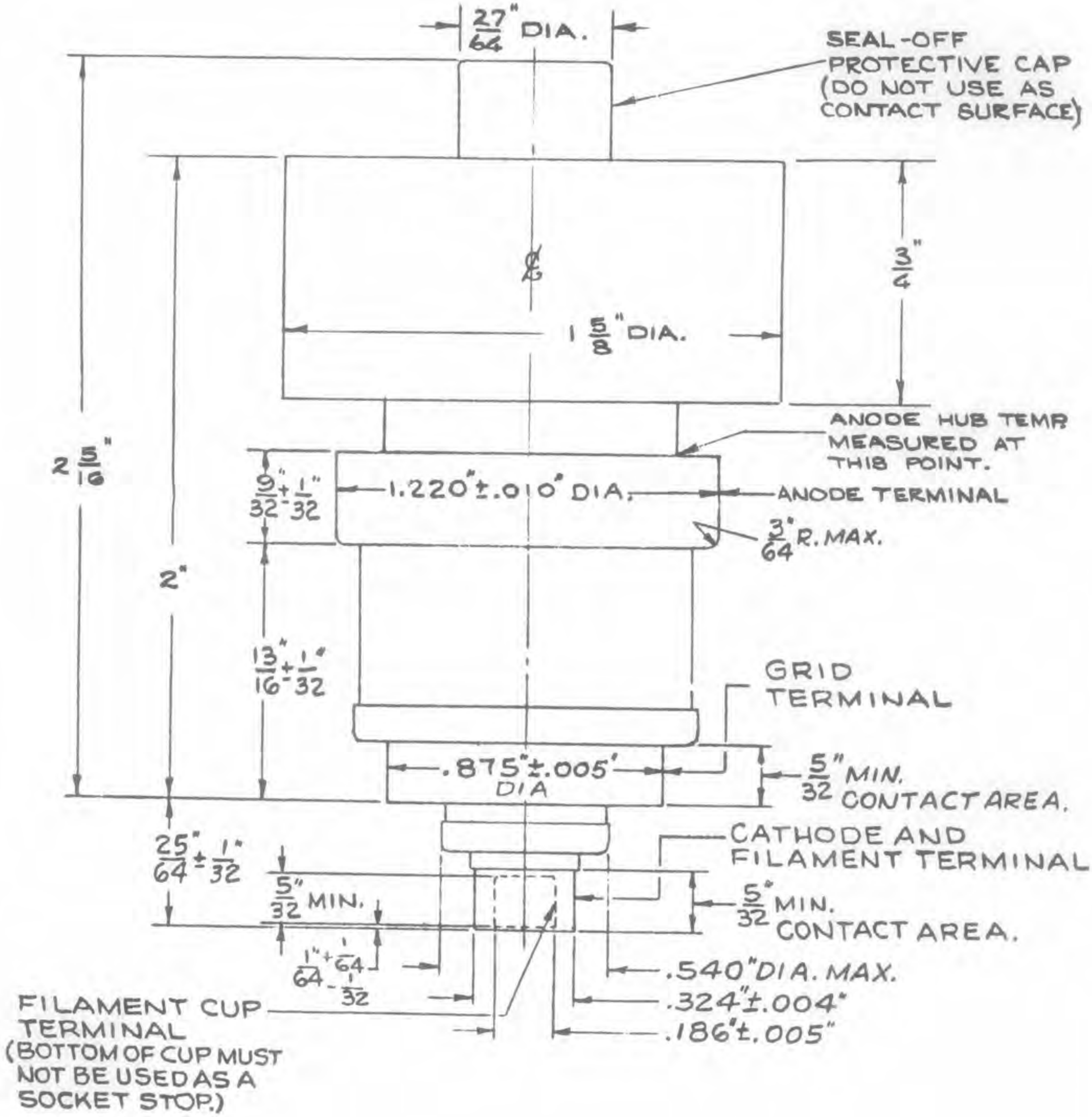
Typical Operation

Grounded-Grid Circuit at 1200 Megacycles, 3/4λ Output

DC Plate Voltage	1500	Volts
DC Plate Current	0.275	Amperes
DC Grid Voltage	-125	Volts
DC Grid Current	0.045	Amperes
Power Output, approximate (useful)	200	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

? Forced-air cooling to be provided before and during the application of any voltages to limit the anode hub temperature to the value specified.



A-69087-72B116

GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady 5, N. Y.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1061 TRIODE

Internal Feedback for Oscillator Service
Grid-Pulsed or Plate-Pulsed Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1061 is a heat-sink-cooled triode especially designed for grid-pulsed oscillator service in L-band. The tube is particularly well suited for use in navigational aid applications.

The ZP-1061 features all necessary feedback within the tube envelope, which eliminates the need for the complicated external-circuit arrangements normally required in oscillator service.

Other features include small size, long pulse width, high duty capability, and long life and reliability.

ELECTRICAL

Heater Voltage*	5.0	Volts
Heater Current	2.5	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	17.0	μμf
Output	4.0	μμf

MECHANICAL

Mounting Position – Any		
Net Weight, approximate	2-1/2	Ounces

THERMAL

Cooling – Heat-sink or Forced Air		
Maximum Anode Temperature #	250	C
Maximum Ceramic Temperature at Any Point	200	C

GRID-PULSED OSCILLATOR – CLASS C **

Maximum Ratings		
DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	2.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	50	Watts
Pulse Width &	10	Microseconds
Duty Factor ø &	0.01	
Typical Operation		
Grounded-Grid Circuit at 1090 mcs, 1/4 λ Output		
DC Plate Voltage	1800	Volts
DC Plate Current, during pulse	1.75	Amperes
DC Grid Voltage	-90	Volts
DC Grid Current, during pulse	1.0	Amperes
Power Output, during pulse (useful)	1000	Watts
Pulse Width ¢	0.5	Microseconds
Duty Factor	0.01	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.

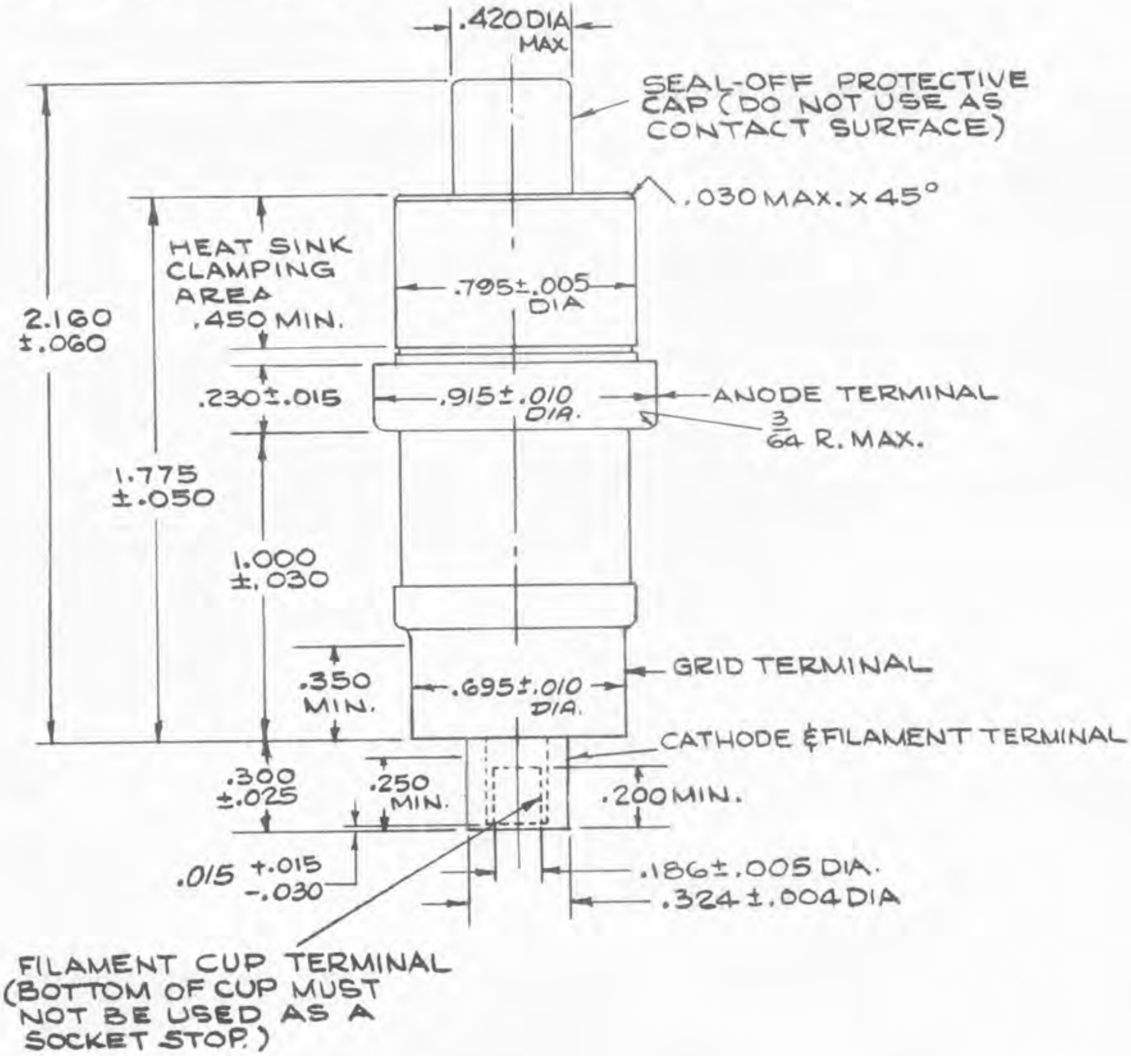
A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.

ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.

¢ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined at the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

& For recommendations on longer pulse width and higher duty factor refer to the manufacturer.

** Plate-pulsed oscillator operation may be used for considerably higher peak power output than that indicated under typical operation. For recommendations refer to the manufacturer.



PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1064
TETRODE

VHF-UHF Metal Ceramic Tetrode
4 Kilowatts Useful CW Output
750 Watts Class B Linear Output

Forced Air Cooled
Integral Radiator
Thoriated-Tungsten Cathode

The ZP-1064 is a forced-air cooled power tetrode that delivers useful output to approximately 1250 megacycles. This tube is particularly suitable for application as an AM or FM power amplifier in the final output or driver stage of VHF-UHF military communications systems.

The tube features high power gain, as much as 14 db, while delivering up to 4000 watts of useful CW power as a grounded-grid Class C amplifier at 400 megacycles. An output capacitance of only 6.0 uuf, which is significantly low for a tube of its power handling capability, makes the ZP-1064 well suited for application in equipments requiring broad electronic bandwidth.

Other features include metal-ceramic construction, a high efficiency axial flow radiator capable of dissipating 2750 watts, and an indirectly heated thoriated tungsten cathode.

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage *	...	5.7	...	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	...	...	36	Amperes
Heater Cold Resistance	...	0.02	...	Ohms
Cathode Heating Time	1	...	...	Minute
Amplification Factor, G_2 to G_1				
E_b = 2000 Volts, I_b = 0.200 Ampere, E_{c2} = 475 Volts	12	17	22	
Direct Interelectrode Capacitances				
Cathode to Plate ‡	...	...	0.006	uuf
Input, G_2 tied to G_1	15.5	17.0	18.5	uuf
Output, G_2 tied to G_1 §	...	6.0	...	uuf

Mechanical

Mounting Position		Vertical
Net Weight, approximate	5.0	Pounds

Thermal

Cooling-Forced Air ¶
Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
2.75 Kilowatts	140 Min CFM	1.9 Inches Water
2.0 Kilowatts	90 Min CFM	0.8 Inches Water
1.5 Kilowatts	55 Min CFM	0.4 Inches Water

Seals	
Screen-Grid to Control-Grid	4 Min CFM
Heater-to-Cathode	8 Min CFM
Anode to Screen-Grid Ceramic Insulator	6 Min CFM
Incoming Air Temperature	25 Max C
Radiator Hub Temperature (Adjacent to Anode Seal)	180 Max C
Temperature at Any Other Point	200 Max C

Forced-air cooling to be applied before and during the application of any voltages. Forced-air cooling must be maintained for one minute after the removal of all voltages.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS
RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR – CLASS C

Maximum Ratings, Absolute Values	420 mcs	1000 mcs	
DC Plate Voltage	8000	6000	Max Volts
DC Grid-No. 2 Voltage	650	650	Max Volts
DC Grid-No. 1 Voltage	-175	-175	Max Volts
DC Plate Current	0.700	0.700	Max Amperes
DC Grid-No. 1 Current	0.175	0.175	Max Amperes
Plate Input	5.6	4.2	Max Kilowatts
Grid-No. 2 Input	25	25	Max Watts
Plate Dissipation	2.75	2.75	Max Kilowatts

Typical Operation – Grounded-Grid Circuit @ 400 mcs

DC Plate Voltage	5500	7500	Volts
DC Grid-No. 2 Voltage	600	600	Volts
DC Grid-No. 1 Voltage	-100	-100	Volts
DC Plate Current	0.450	0.650	Amperes
DC Grid-No. 2 Current	0.012	0.016	Amperes
DC Grid-No. 1 Current	0.085	0.155	Amperes
Driving Power, approx	90	150	Watts
Power Output, useful ø	2000	4000	Watts
Power Gain, approx	13.5	14.3	db

RADIO FREQUENCY POWER AMPLIFIER – CLASS B LINEAR SERVICE

Maximum Ratings at 420 Megacycles, Absolute Values

DC Plate Voltage	8000	Max Volts
DC Grid-No. 2 Voltage	650	Max Volts
DC Plate Current	585	Max Milliamperes
Plate Input	4150	Max Watts
Grid-No. 2 Input	16	Max Watts
Plate Dissipation	2750	Max Watts

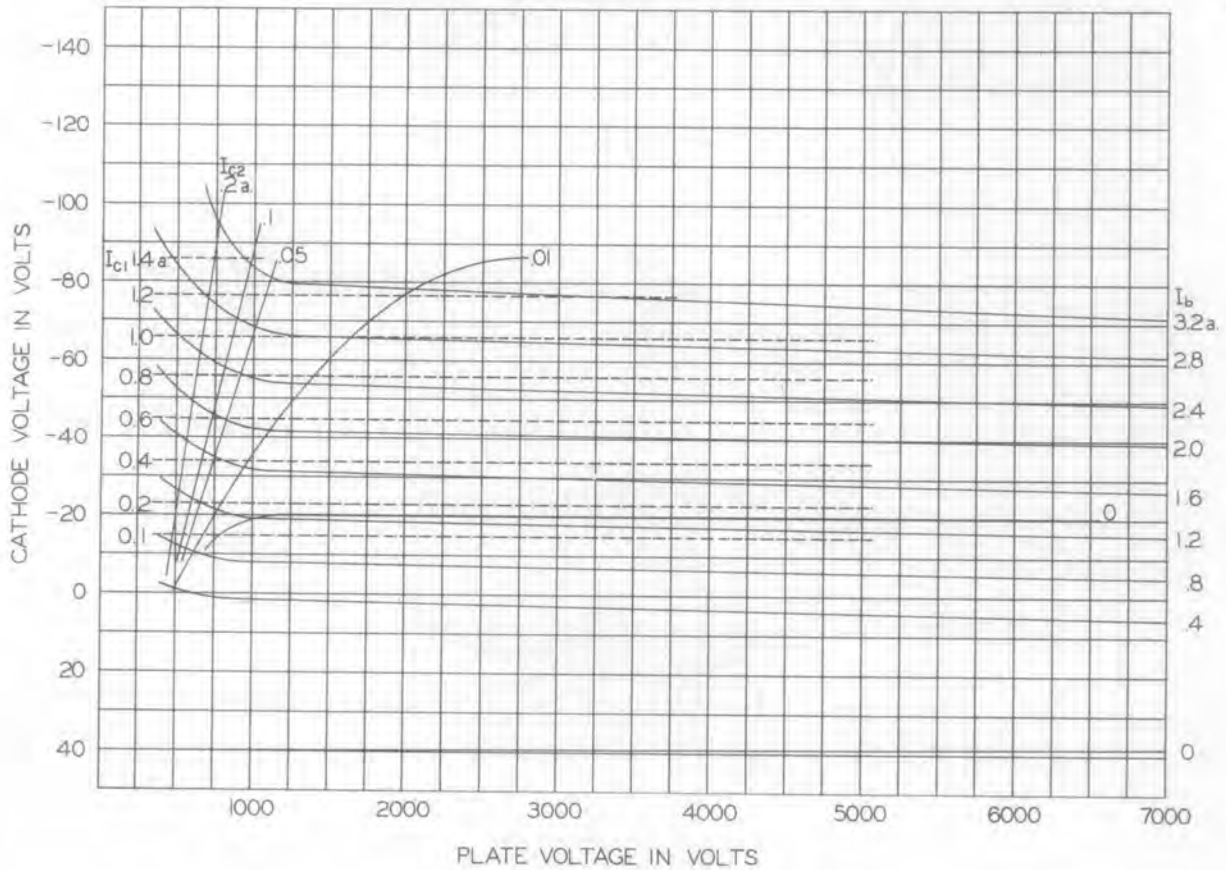
Typical Operation at 400 Mcs, Carrier Conditions for Maximum Modulation Factor of 1.0

DC Plate Voltage	7500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage, approx	-50	Volts
DC Plate Current	330	Milliamperes
DC Grid-No. 2 Current	5	Milliamperes
DC Grid-No. 1 Current	30	Milliamperes
Driving Power, approx	17.5	Watts
Power Output, useful ø	750	Watts
Power Gain, approx	16	db

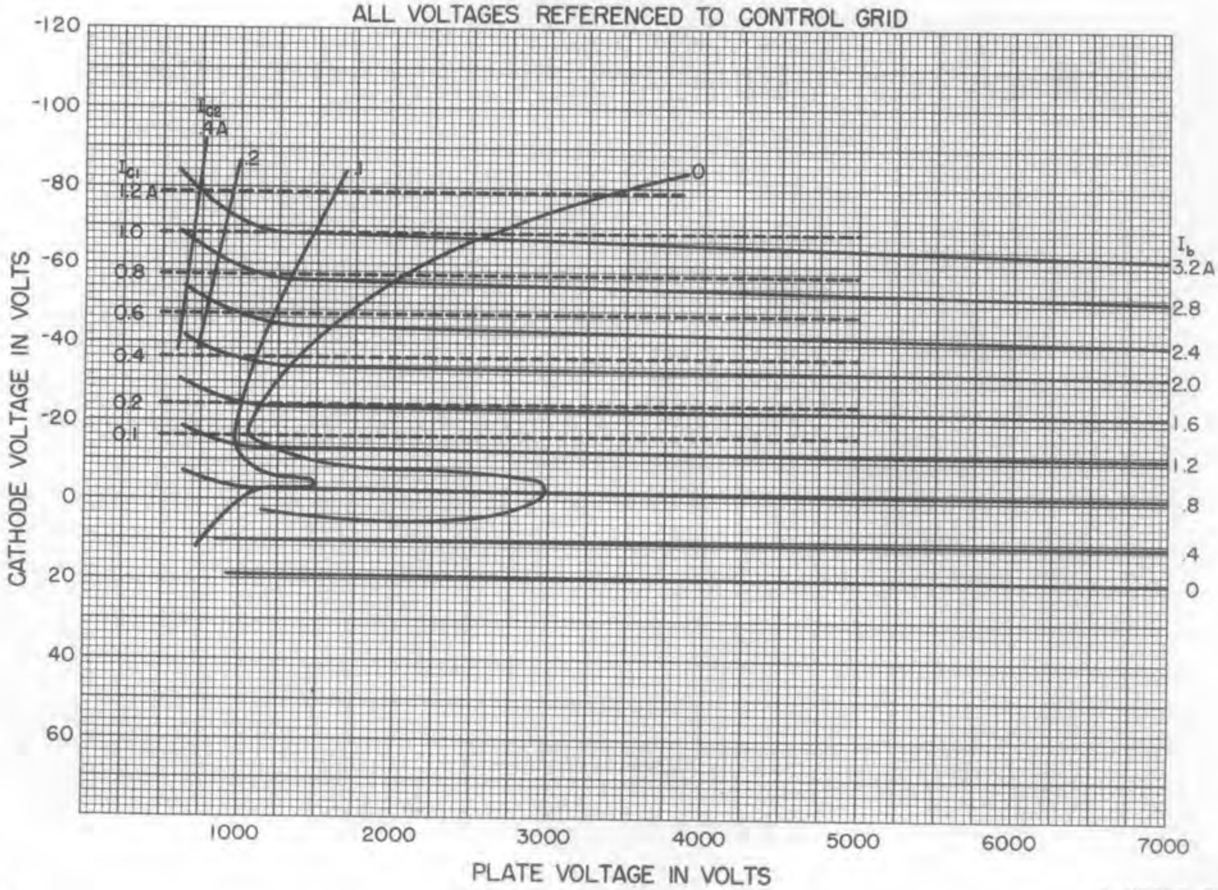
*Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions.

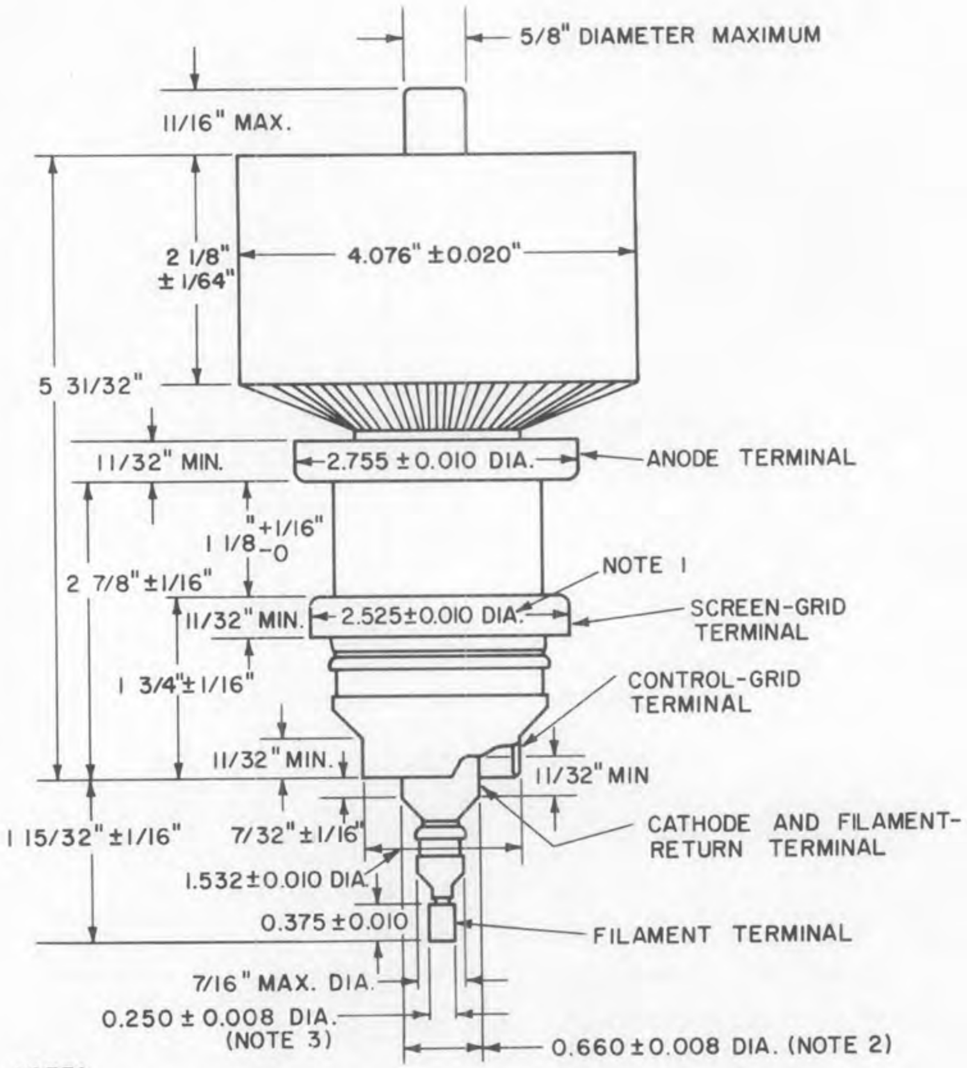
‡ Measured with complete external shielding between cathode and anode.
§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.
¶ The volume of cooling air indicated for the various seals is for sea-level conditions and approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most satisfactory operation the maximum temperature of any point on the tube should be below specified limits.
ø Useful power output including power transferred from driver stage.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 500 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 650 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





NOTES
1. MAXIMUM ECCENTRICITY 0.010
2. MAXIMUM ECCENTRICITY 0.015
3. MAXIMUM ECCENTRICITY 0.030
WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE TERMINAL AND CONTROL-GRID TERMINAL

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1065

TETRODE

Grid-Pulsed Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1065 is a high-performance, forced-air cooled, metal-ceramic tetrode especially designed for grid-pulsed amplifier service (pulsed RF drive only) at L-band frequencies. This tetrode is particularly well suited for use in radar equipment such as advanced ground-based, ship-board or airborne IFF interrogators. It is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1065 include long life and reliability, high gain with pulsed RF drive only, long pulse width, and high-duty capability.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	-	3.8	-	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances**				
Cathode to Plate †	-	0.006	-	uuf
Input	-	20	-	uuf
Output	-	7.5	-	uuf

MECHANICAL

Mounting Position		Any
Net Weight, approximate	13	Ounces

THERMAL

Cooling – Forced-Air‡			
Through Radiator, at Sea Level			
Plate Dissipation	600	400	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	9	4.5	Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2	Inches Water
Radiator Hub Temperature at Point Adjacent to Anode Seal, maximum§		250	C
Seals			
Screen and Control Grid, approximate		1	Cubic Feet per Minute
Heater and Cathode, approximate		1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum		200	C

RADIO-FREQUENCY POWER AMPLIFIER

Maximum Ratings

Pulsed Drive, 1250 Megacycles		
DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-200	Volts
Plate Dissipation	600	Watts
Pulse Width ◊	10	Microseconds
Duty Factor ø	0.01	

RADIO-FREQUENCY POWER AMPLIFIER (CONT'D)

Typical Operation

Grounded-Grid Service at 1030 Megacycles, 1/4λ Output Circuit

DC Plate Voltage øø	4.5	3.5	Kilovolts
DC Plate Current, during pulse	5.3	3.0	Amperes
DC Grid-No. 2 Voltage	750	750	Volts
DC Grid-No. 2 Current, during pulse	0.110	0.065	Amperes
DC Grid-No. 1 Voltage, approximate	-115	-75	Volts
DC Grid-No. 1 Current, during pulse	0.850	0.400	Amperes
Driving Power at the Tube, during pulse	1.5	0.5	Kilowatts
Power Output, during pulse (useful)	11.0	4.5	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.01	0.03	

* Under the typical operating conditions shown the filament voltage should be reduced to approximately 6.0 volts because of back-heating resulting from transit time effects.

** Control grid connected directly to screen grid.

† Complete external shielding between cathode and plate.

‡ Forced-air cooling should be applied during the application of any voltages.

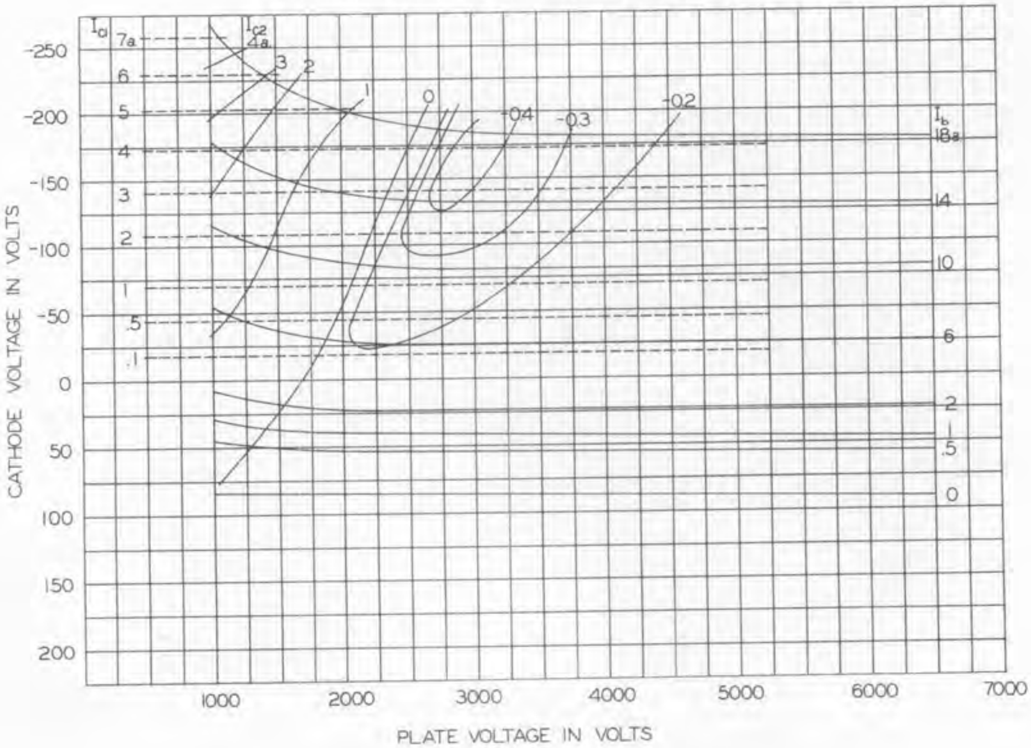
§ Provision must be made for unobstructed passage of cooling air to limit the anode hub temperature to the value specified.

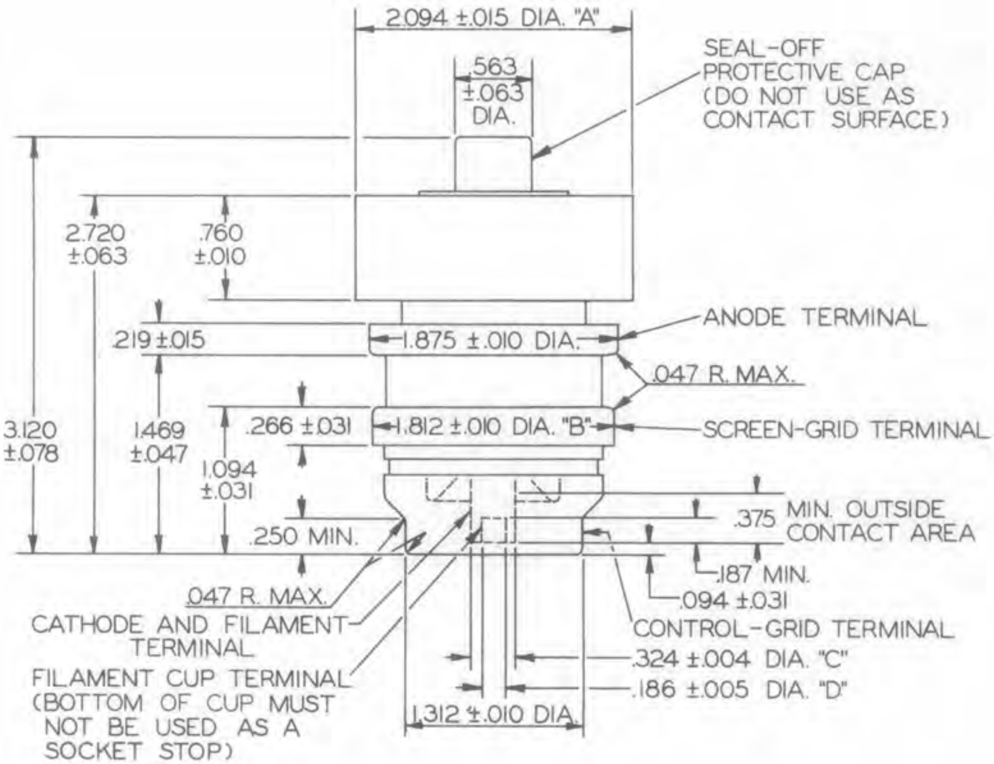
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

ø Maximum ratio of on-time to elapsed time during any 1-millisecond period. Higher duty may be allowed with lower tube input as indicated under typical operation at 0.03 duty. For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.

øø A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1070

TETRODE

Radio-Frequency Amplifier
CW Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic
Integral Radiator

The ZP-1070 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225-400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low – approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the ZP-1070 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage *	–	6.3	6.8	Volts
Heater Current	–	3.8	–	Amperes
Cathode Heating Time	1	–	–	Minutes
Amplification Factor, G_2 to G_1, E_b = 1000 Volts DC; E_{g2}=275 Volts DC; I_b = 0.2 A DC	–	14	–	
Direct Interelectrode Capacitances				
Cathode to Plate ‡	–	0.006	–	μμf
Input, G_2 tied to G_1	–	20	–	μμf
Output, G_2 tied to G_1 ◊	–	7.5	–	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximate			13	Ounces

THERMAL

Cooling – Forced Air §
Through Radiator, at Sea Level **

Plate Dissipation	600	400		Watts
Air Flow, 45 C Incoming Air Temperature, minimum	9	4.5		Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2		Inches-Water
Radiator Hub Temperature at Point Adjacent to Anode Seal	–	–	250	C

THERMAL (CONT'D)

Seals				
Screen-Grid to Control-Grid, approximate	–	–	1	Cubic Foot per Minute
Heater to Cathode, approximate	–	–	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	–	–	200	C

RADIO-FREQUENCY POWER AMPLIFIER – CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Ampere
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	600	Watts

Typical Operation

Grounded-Grid Circuit at 225-400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	-20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Ampere
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Ampere
DC Grid-No. 2 Current	0.005	Ampere
DC Grid-No. 1 Current	0.010	Ampere
Driving Power, approximate	5	Watts
Power Output♥	110	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR – CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation Δ

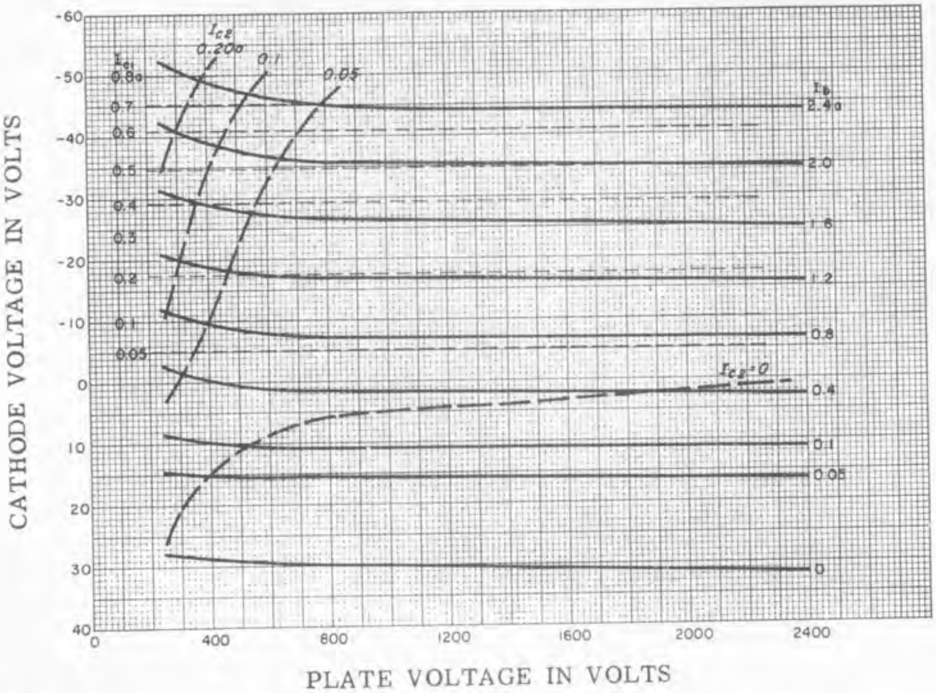
Maximum Ratings	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	-100	-100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	600	600	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles			
DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	-40	-40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate ¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.
‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.
◊ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.
§ Forced-air cooling to be applied before and during the application of any voltages.
** Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.
♥ Useful power output as measured in output-circuit load.
¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.
Δ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.
Measured at the crest of the audio-frequency cycle with a modulation factor of 1.0.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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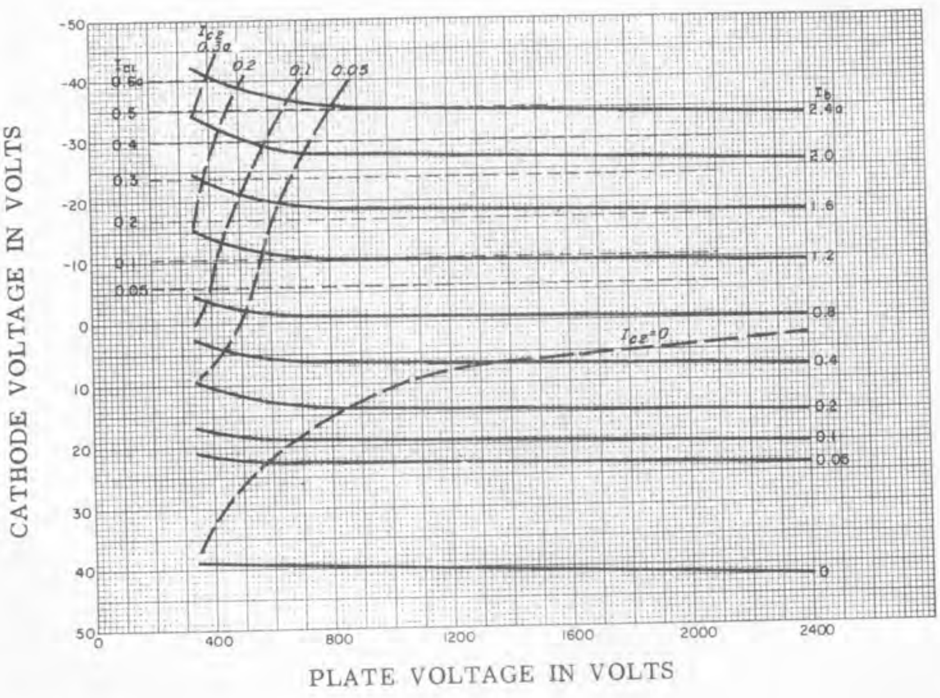
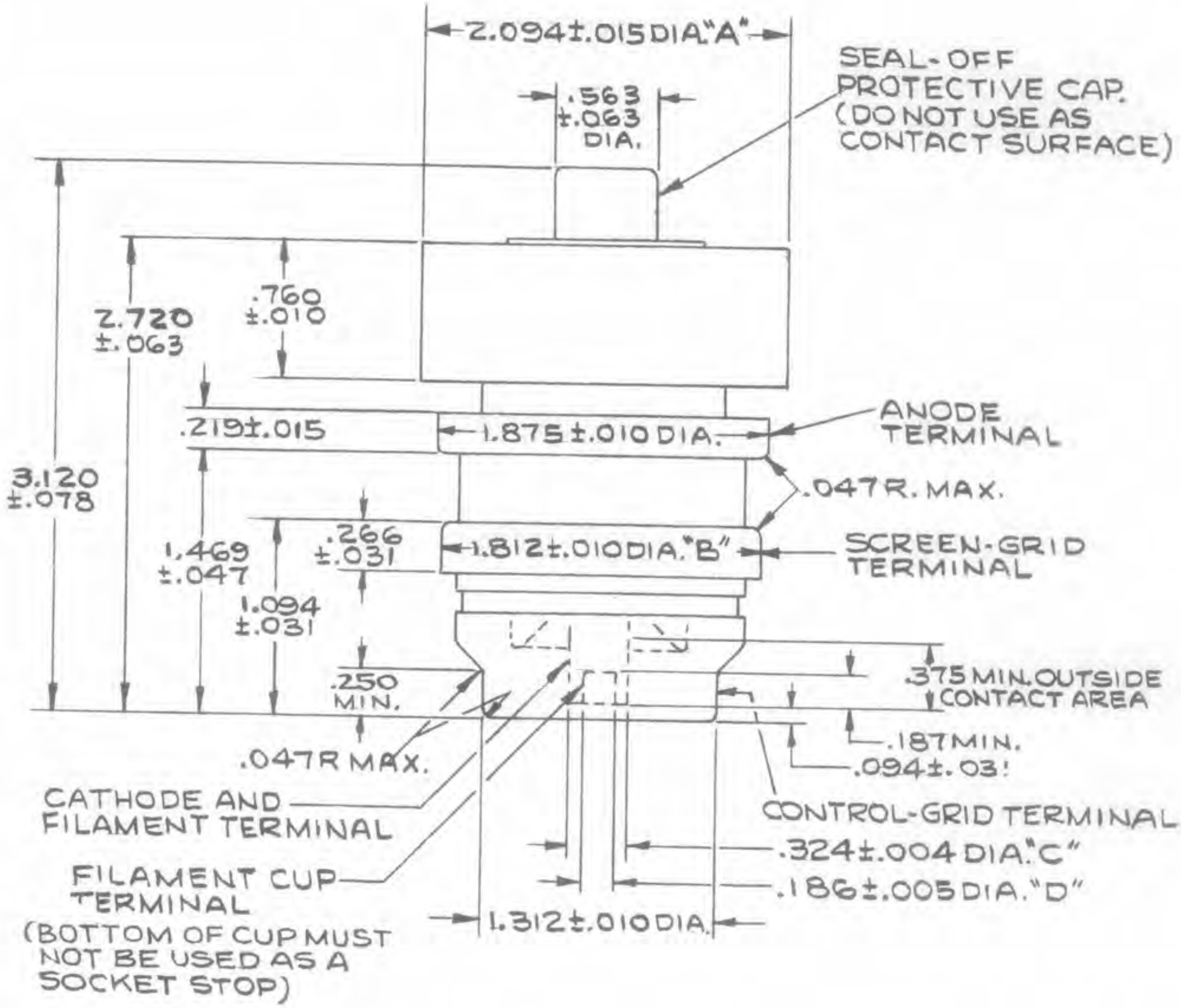
CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



A69087 - 72B68 (1-30-63)



CONCENTRICITIES:
The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

DEVELOPMENTAL TYPE

ZP-1074

TRIODE

Internal Feedback for Oscillator Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1074 is a heat-sink-cooled triode that features internal feedback. It is especially designed for pulsed oscillator service in L-band. Applications for which it is particularly well suited include airborne or ground-based radar, and high level signal generators.

The ZP-1074 is a higher-voltage version of the ZP-1025. Ratings include a DC plate voltage of 3500 volts under grid-pulsed-oscillator service for 5 kilowatts of peak power output at 0.005 duty.

Other features include small size, high peak power as a plate-pulsed oscillator, long-pulse-width capability, long life and reliability.

	Minimum	Bogey	Maximum	
ELECTRICAL				
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Cathode to Plate	-	0.5	-	μμf
Input	-	15.5	-	μμf
Output	-	5.9	-	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximate	3 1/4	Ounces

THERMAL

Cooling – Heat-Sink and Forced Air

Anode Temperature§	250	C
Ceramic Temperature at Any Point, maximum	200	C

PLATE-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage, During Pulse	8.0	Kilovolts
DC Plate Current, During Pulse	10.0	Amperes
DC Grid Voltage, During Pulse	-400	Volts
DC Grid Current, During Pulse	5.0	Amperes
Plate Dissipation§	110	Watts
Grid Dissipation	3.5	Watts
Pulse Width ◇	10	Microseconds
Duty Factor ø	0.003	

TYPICAL OPERATION

Grounded-Grid Service at 1300 Megacycles, 3/4λ Output Circuit

DC Plate Voltage, During Pulse	8.0	6.0	Kilovolts
DC Plate Current, During Pulse	9.0	7.0	Amperes
DC Grid Current, During Pulse (Grid Resistor = 50 Ohms)	4.0	4.3	Amperes
Power Output, During Pulse (useful)	40.0	24.0	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.003	0.001	

GRID-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage	3.75	Kilovolts
DC Plate Current, During Pulse	3.7	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	110	Watts
Pulse Width ◇	15	Microseconds
Duty Factor øø	0.02	

Typical Operation

Grounded-Grid Circuit at 1100 Megacycles, 1/4 λ Output

DC Plate Voltage	3500	2200	Volts
DC Plate Current, During Pulse	3.5	2.7	Amperes
DC Grid Voltage Supply**	-110	-104	Volts
DC Grid Current, During Pulse	1.7	1.25	Amperes
Power Output, During Pulse (useful)	5.0	2.4	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.005	0.02	

* Because of back-heating due to transit-time effects, it may be necessary to reduce the heater voltage. For the 1100 mcs, 2 kw, 0.02 duty condition, the typical heater voltage is 5.5 volts. The optimum heater voltage for any application should be determined by RF performance testing.

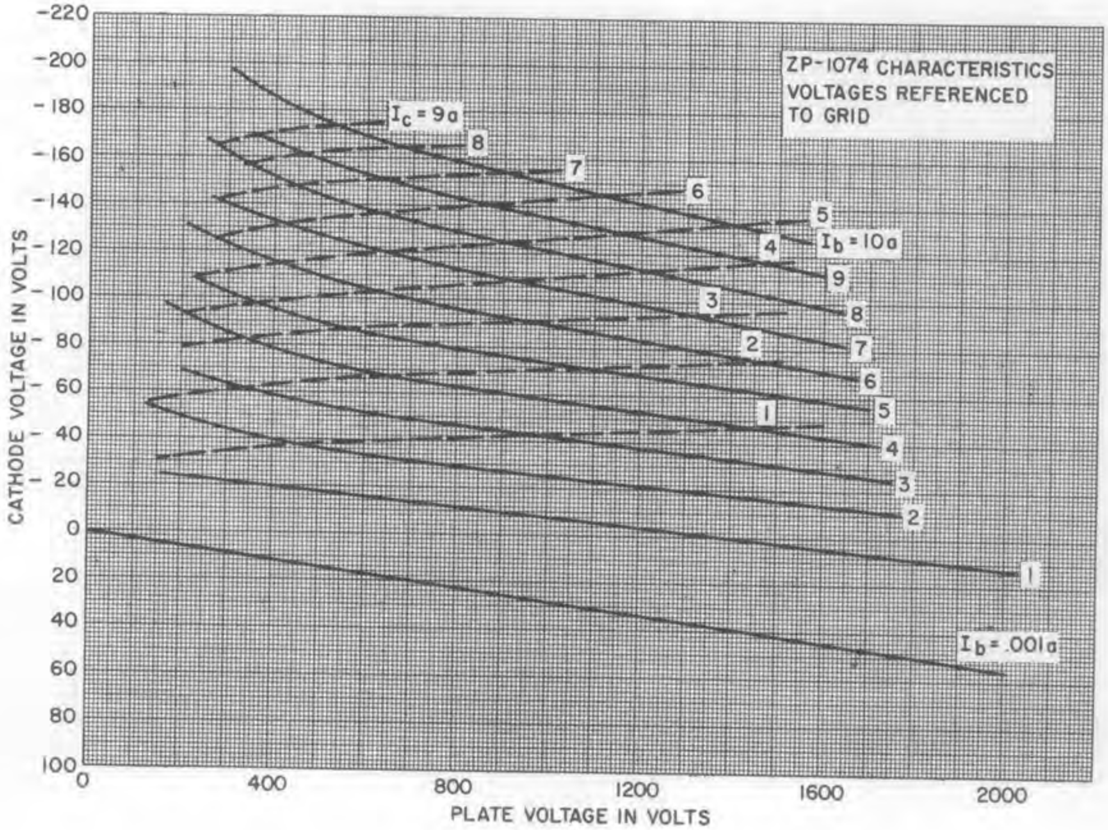
§ A suitable clamp-on radiator or heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified. Higher plate dissipation is allowable with provision for proper cooling.

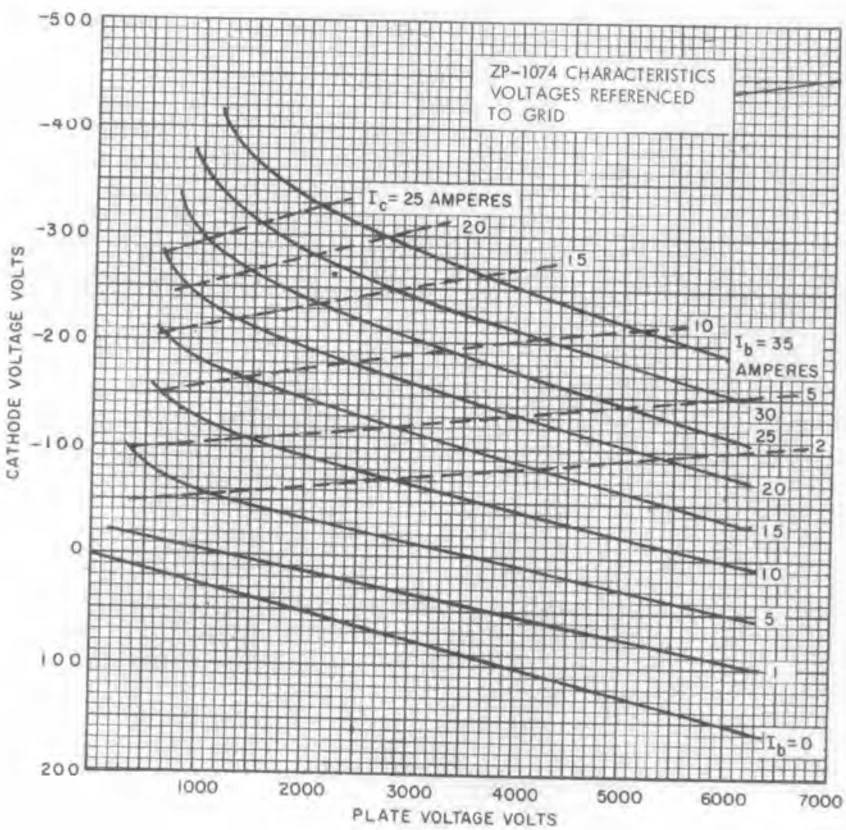
◇ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse. For applications requiring longer pulses, refer to the tube manufacturer.

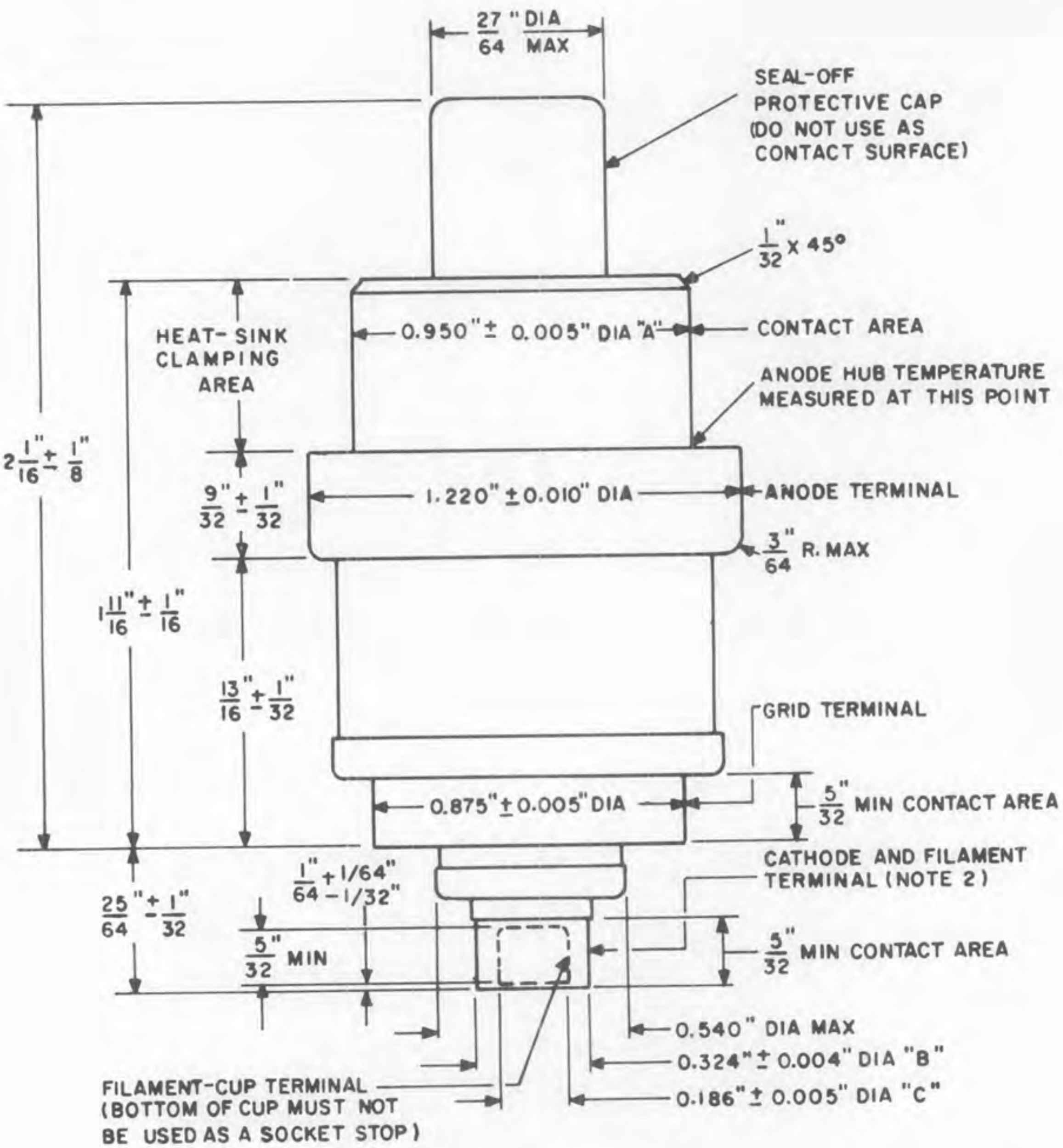
ø Maximum ratio of on-time to elapsed time during any 3.3-millisecond period.

øø Maximum ratio of on-time to elapsed time during any 75-millisecond period.

** With a series grid resistance of 50 ohms.


ZP-1074 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
I_c = 9a
8
7
6
5
4
3
2
1
I_b = 10a
9
8
7
6
5
4
3
2
1
I_b = .001a
CATHODE VOLTAGE IN VOLTS
-220
-200
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
0
400
800
1200
1600
2000
PLATE VOLTAGE IN VOLTS


ZP-1074 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
I_c = 25 AMPERES
20
15
10
5
2
I_b = 35
AMPERES
30
25
20
15
10
5
1
I_b = 0
CATHODE VOLTAGE VOLTS
-500
-400
-300
-200
-100
0
100
200
1000
2000
3000
4000
5000
6000
7000
PLATE VOLTAGE VOLTS



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER A-0.030 INCHES
DIAMETER B-0.036 INCHES
DIAMETER C-0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B)-0.016 INCHES.

GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady 5, N. Y.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1079

TETRODE

Pulsed Service
Grounded-Grid Operation

Water Cooled
Metal and Ceramic

Integral Water Jacket

The ZP-1079 is a small-size, four-electrode transmitting tube especially designed for RF grid-pulsed or plate-and-screen pulsed amplifier service at VHF-UHF frequencies. This tetrode is particularly well suited for use in ground-based radar equipment such as steerable array radar.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

The features of the ZP-1079 include long life and reliability, long pulse width, high peak power, high gain and broad-banding capability.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where high performance and reliability are important.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage §	–	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Input	–	24	–	μuf
Output	–	9	–	μuf

MECHANICAL

Mounting Position – Any
Net Weight . . . . . . 14 Ounces

THERMAL

Cooling – Water and Forced Air ‡
Water Flow

Anode	0.5	Minimum Gallons per Minute
Pressure Drop at Rated Flow, approx	1	Pound per Square Inch
Outlet Temperature	70	Maximum C
Anode Hub Temperature Δ	250	Maximum C

Air Flow

Anode Ceramic, approximate	1	Cubic Foot per Minute
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at any Point	200	Maximum C

RADIO-FREQUENCY POWER AMPLIFIER – Class B

Maximum Ratings
Plate-and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts

RADIO-FREQUENCY POWER AMPLIFIER – Class B (Continued)

Plate Dissipation ♣	750	Watts
DC Grid-No. 1 Voltage, not pulsed	-175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width ♡◊	15	Microseconds
Duty Factor ♡ø	0.0012	

Typical Operation
Grounded-grid Circuit, 500 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	-125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width ◊	15	Microseconds
Duty Factor	0.001	

RADIO-FREQUENCY POWER AMPLIFIER – Class C

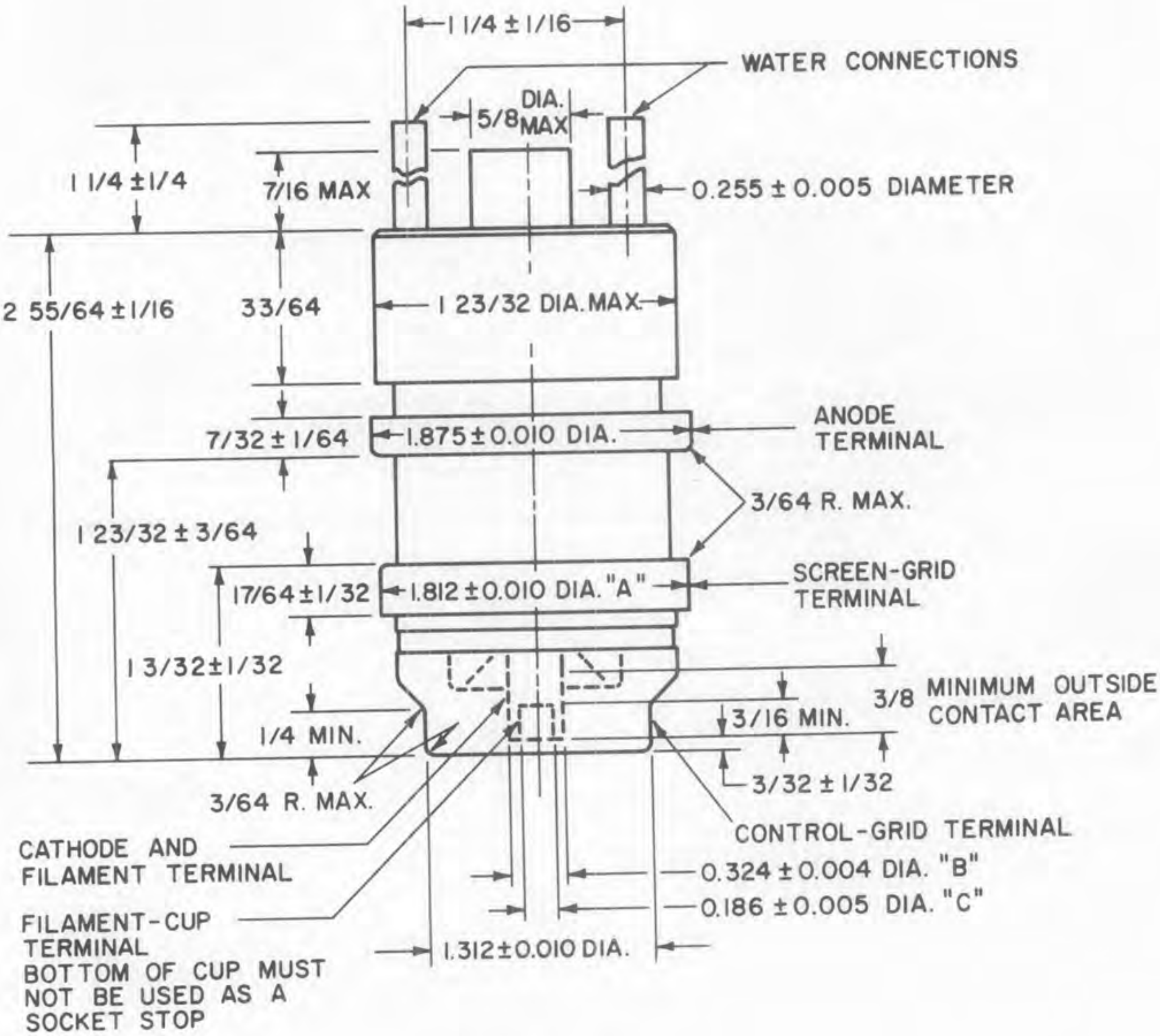
Maximum Ratings
Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	750	Watts
Pulse Width ♡ ◊	15	Microseconds
Duty Factor ♡ øø	0.01	

Typical Operation
Grounded-grid Circuit at 1100 Megacycles, 3/4 λ Output Circuit

DC Plate Voltage**	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ◊	15	Microseconds
Duty Factor	0.01	

§ Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.
* Control grid connected directly to screen grid.
‡ Water and forced air cooling should be applied during the application of any voltages.
Δ Measured at the base of the water jacket and adjacent to the plate terminal.
♣ Maximum average value.
♡ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◇ Pulse duration measured between points at 70 percent of peak 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.
ø Maximum ratio of on-time to elapsed time during any 12.5 millisecond period.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B^+ power supply at steady-state voltages greater than 3.5 kilovolts.



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER A- 0.016 INCHES
DIAMETER B- 0.036 INCHES
DIAMETER C- 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP-TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B)=0.016 INCHES.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1124*

TRIODE

The Y-1124 is a triode of ceramic and metal planar construction primarily intended for use as a grid-pulsed oscillator at frequencies up to 6000 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.215	Amperes
Cathode Warm-up Time§	3	Seconds
Direct Interelectrode Capacitances¶		
Grid to Plate	1.1	pf
Input	2.1	pf
Output	0.018	pf
Heater to Cathode	1.7	pf

Mechanical

Mounting Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	400	Volts
Peak Positive Grid Voltage#	100	Volts
Plate Dissipation	3.5	Watts
DC Plate Current	10	Milliamperes
DC Grid Current	5.0	Milliamperes
Peak Grid Current	300	Milliamperes
Peak Plate Current#	600	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics		
Plate Voltage	125	Volts
Cathode-Bias Resistor	82	Ohms
→ Amplification Factor	75	
→ Transconductance	16000	Micromhos
→ Plate Current	12.5	Milliamperes
Grid-Pulsed Oscillator Service		
Frequency	5700	Megacycles
Duty Factor	0.016	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	16000	Pulses per Second
Plate Voltage	400	Volts
Plate Current		
Average	9.6	Milliamperes
Average During Grid Pulse	600	Milliamperes
Power Output		
Average During Grid Pulse	40	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

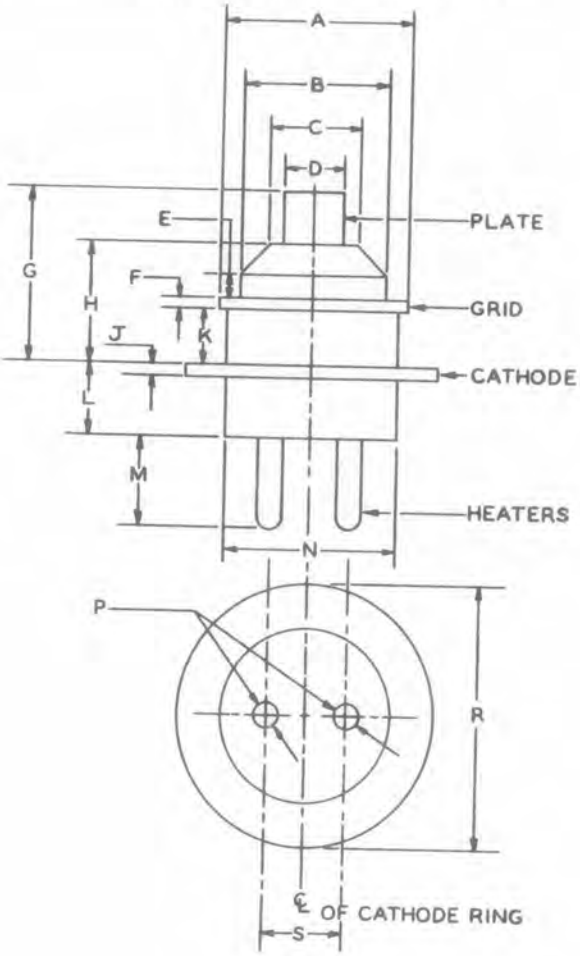
§ Time required for plate current to reach 80% of its steady-state value.

¶ Measured using a grounded adapter that provides shielding between external terminals to tube.

\# One microsecond pulse, 16000 pulses per second.

8/18/67 (B)
Supersedes 6/29/67 (B)

PHYSICAL DIMENSIONS



Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.357		0.363	9.068		9.220
B			0.285			7.24
C		0.180			4.57	
D	0.108		0.112	2.743		2.845
E		0.040			1.02	
F	0.025		0.031	0.635		0.787
G	0.315		0.335	8.00		8.51
H	0.216		0.232	5.49		5.89
J	0.025		0.031	0.635		0.787
K	0.094		0.102	2.388		2.591
L	0.143		0.157	3.63		3.99
M	0.165		0.185	4.19		4.70
N			0.330			8.38
P	0.048		0.054	1.219		1.372
R	0.476		0.484	12.090		12.294
S	0.130		0.142	3.30		3.61

Note: The millimeter dimensions are derived from the original inch dimensions.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1171*

METAL-CERAMIC TRIODE

The Y-1171 is a metal-ceramic, planar triode intended for use as a CW oscillator at frequencies through X-band.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC†	6.3±0.3	Volts
→ Heater Current‡	0.27	Amperes
→ Direct Interelectrode Capacitances§		
Grid to Plate	1.1	pf
Input	1.95	pf
Output	Ø	pf
Heater to Cathode	Ø	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	200	Volts
Negative DC Grid Voltage	Ø	
→ Plate Dissipation¶	4.5	Watts
DC Grid Current	Ø	
→ DC Cathode Current	30	
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
→ Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

→ Average Characteristics

Plate Voltage	100	Volts
Grid Voltage	0	Volts
Amplification Factor	55	
Plate Resistance, approximate	2750	Ohms
Transconductance	20000	Micromhos
Plate Current	30	Milliamperes

→ Oscillator at 10GC

Plate Voltage	150	Volts
Grid Resistor	2200	Ohms
Plate Current	30	Milliamperes
Power Output, approximate	10	Milliwatts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

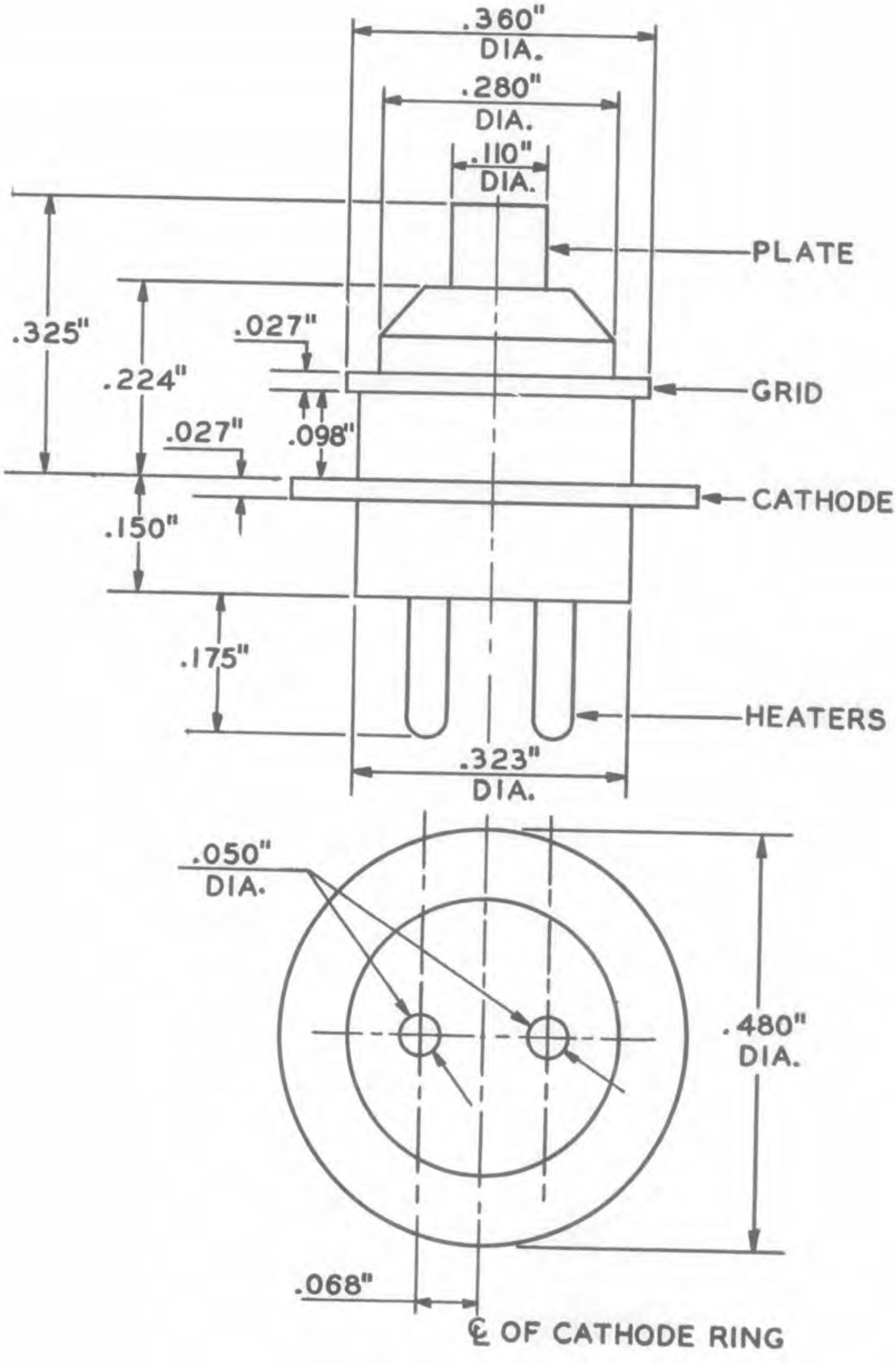
† The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ When used in a cavity that provides adequate heat-sink capacity.

∅ To be determined.


.360"
DIA.
.280"
DIA.
.110"
DIA.
PLATE
.325"
.224"
.027"
GRID
.027"
.098"
CATHODE
.150"
.175"
HEATERS
.323"
DIA.
.050"
DIA.
.480"
DIA.
.068"
℄ OF CATHODE RING

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1223*

PLANAR TRIODE

The Y-1223 is a triode of ceramic-and-metal planar construction intended for use as a radio-frequency CW amplifier or oscillator at frequencies up to 2500 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.4	Amperes
Direct Interelectrode Capacitances¶		
→ Grid to plate: (g to p)	2.4	pf
→ Input: g to (h+k)	6.8	pf
Output: p to (h+k)	0.03	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	600	Volts
→ Peak Grid Voltage	∅	
Plate Dissipation#	30	Watts
Grid Current	∅	
Cathode Current	100	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

→ CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	300	Volts
Cathode-Bias Resistor	10	Ohms
Amplification Factor	125	
Plate Resistance, approximate	1550	Ohms
Transconductance	80000	Micromhos
Plate Current	95	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-5.5	Volts

Class C Amplifier

→ Frequency	2300	Megacycles
→ DC Plate Voltage	500	Volts
DC Grid Voltage	Ø	
→ DC Plate Current	80	Milliamperes
DC Grid Current, approximate	Ø	
Driving Power, approximate	Ø	
Power Output, minimum	10	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Without external shield.

With adequate heat sink attached to threaded plate stud.

Ø To be determined.

3/13/66 (B)

Supersedes 2/10/66 (B)

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1236*

PLANAR TRIODE

The Y-1236 is a triode of ceramic and metal planar construction intended for use as a grid or plate-pulsed oscillator at frequencies up to 4300 megacycles. In addition, it may be used as a CW oscillator at frequencies up to 2500 megacycles. Features of the Y-1236 are small size and high plate dissipation capability.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.5	Amperes
Direct Interelectrode Capacitances§		
→ Grid to Plate: (g to p)	2.0	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.05	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS (Continued)

Absolute-Maximum Values

Plate-Pulsed Oscillator or Amplifier Service

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶	0.01	
Pulse Duration	2.0	Microseconds
Plate Current		
Average	20	Milliamperes
Average During Plate Pulse#	2.0	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average	10	Milliamperes
Average During Plate Pulse	1.0	Amperes
Plate Dissipation∆	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

CW Oscillator Service

Plate Voltage	600	Volts
Plate Current	90	Milliamperes
Grid Current	30	Milliamperes
Cathode Current	120	Milliamperes
Plate Dissipation ∆	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	55	
Plate Resistance, approximate	2040	Ohms
Transconductance	27000	Micromhos
Plate Current	25	Milliamperes

Plate-Pulsed Oscillator Service

Frequency	1200	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.01	
Pulse Duration	1.0	Microseconds
Pulse Repetition Plate	10000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	2000	Volts

CHARACTERISTICS AND TYPICAL OPERATION (Continued)

Plate Current		
Average	20	Milliamperes
Average During Plate Pulse	2.0	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	Ø	Amperes
Useful Power Output		
Average	20	Watts
Average During Plate Pulse	2.0	Kilowatts

CW Oscillator Service

Frequency	2300	Megacycles
Plate Voltage	600	Volts
Grid Voltage	Ø	
Plate Current	80	Milliamperes
Grid Current	25	Milliamperes
Power Output, approximate	20	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

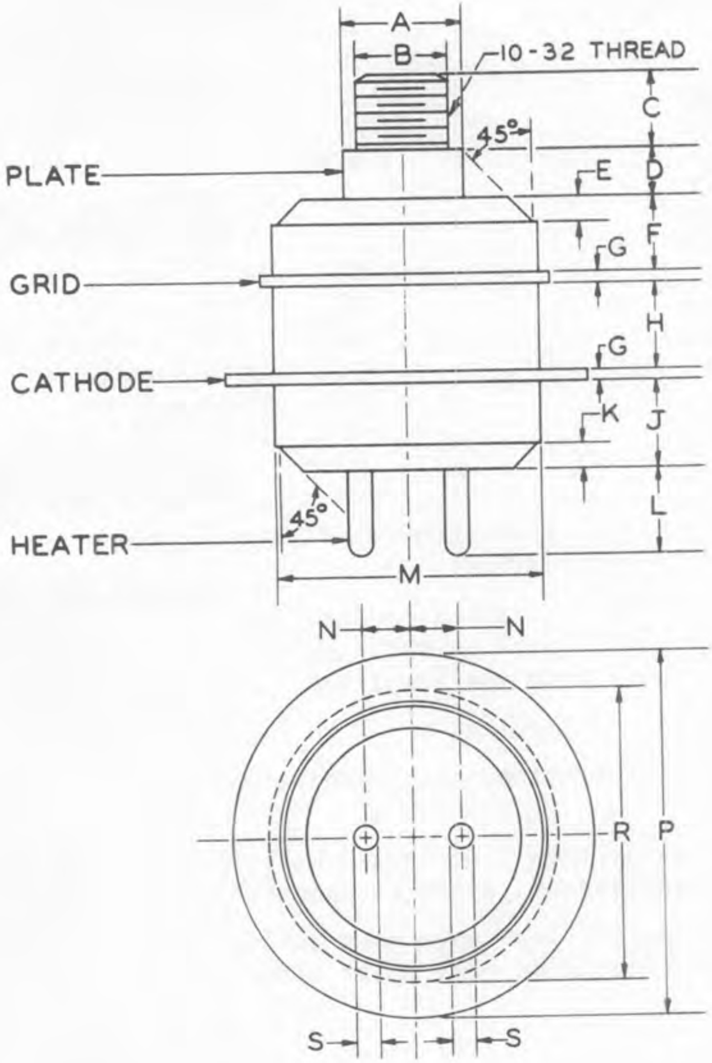
§ Measured using a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.01 should be referred to your General Electric tube sales representative for recommendation.

\# The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

Δ With adequate heat sink attached to threaded plate stud.

Ø To be determined.



Ref.	Inches	
	Minimum	Maximum
A	0.247	0.253
B	0.184	0.190
C	0.145	0.155
D	0.095	0.105
E	0.040	0.060
F	0.145	0.155
G	0.025	0.031
H	0.170	0.180
J	0.170	0.180
K	0.040	0.060
L	0.170	0.180
M	0.535	0.565
N	0.093	0.107
P	0.748	0.758
R	0.598	0.608
S	0.047	0.053

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1251*

PLANAR TRIODE

The Y-1251 is a high-mu triode of ceramic-and-metal planar construction intended for use as an oscillator or radio-frequency power amplifier up to 6000 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.24	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.1	pf
Input: g to (h + k)	1.2	pf
Output: p to (h + k)	0.012	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	200	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	2.5	Watts
DC Grid Current	5.0	Milliamperes
DC Cathode Current	20	Milliamperes
Peak Cathode Current	80	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (Continued)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	100	150	Volts
Grid Voltage	0	---	Volts
Cathode-Bias Resistor	---	82	Ohms
Amplification Factor	---	65	
→ Transconductance	15500	12500	Micromhos
→ Plate Current	18	13.5	Milliamperes

Oscillator Service

Plate Voltage	150	Volts
Grid Resistor - Adjusted for a plate current of 15 milliamperes		
Plate Current	15	Milliamperes
Grid Current	Ø	Milliamperes
Frequency	5900	Megacycles
Power Output, approximate	20	Milliwatts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

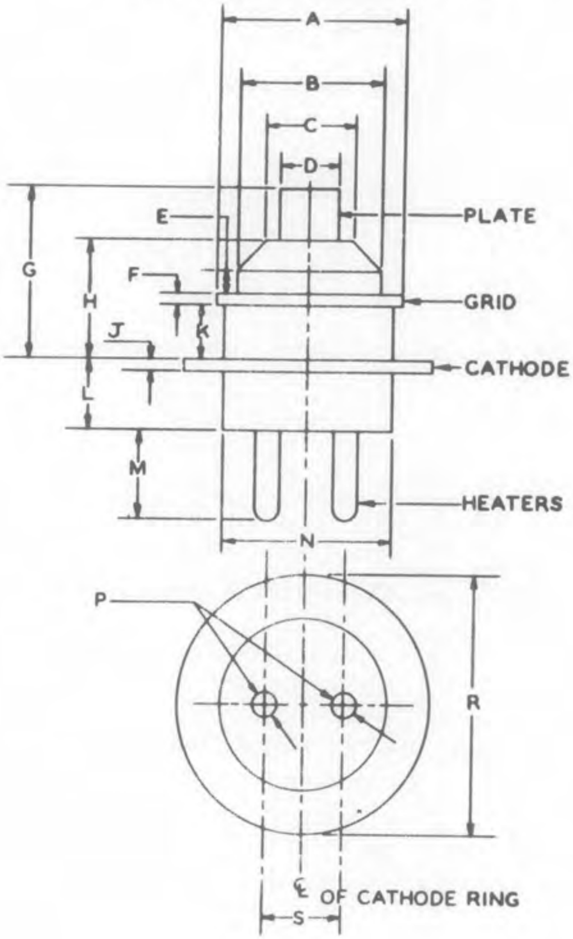
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

Ø To be determined.

Y-1251

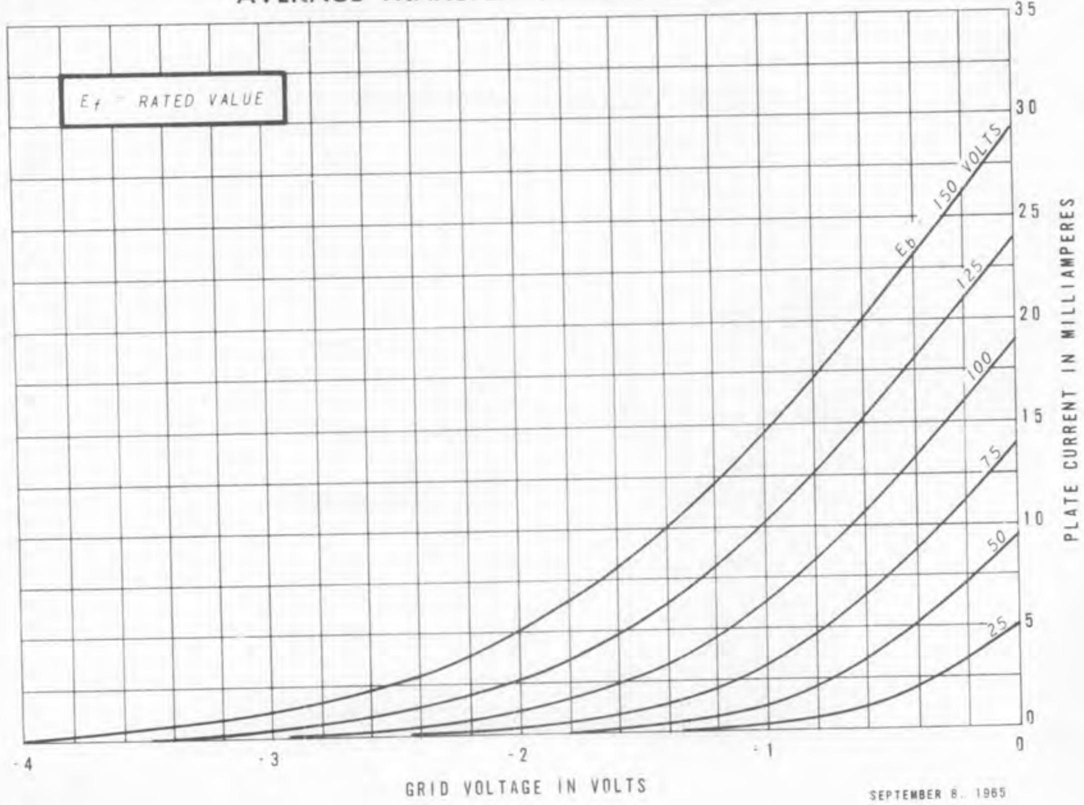
PHYSICAL DIMENSIONS



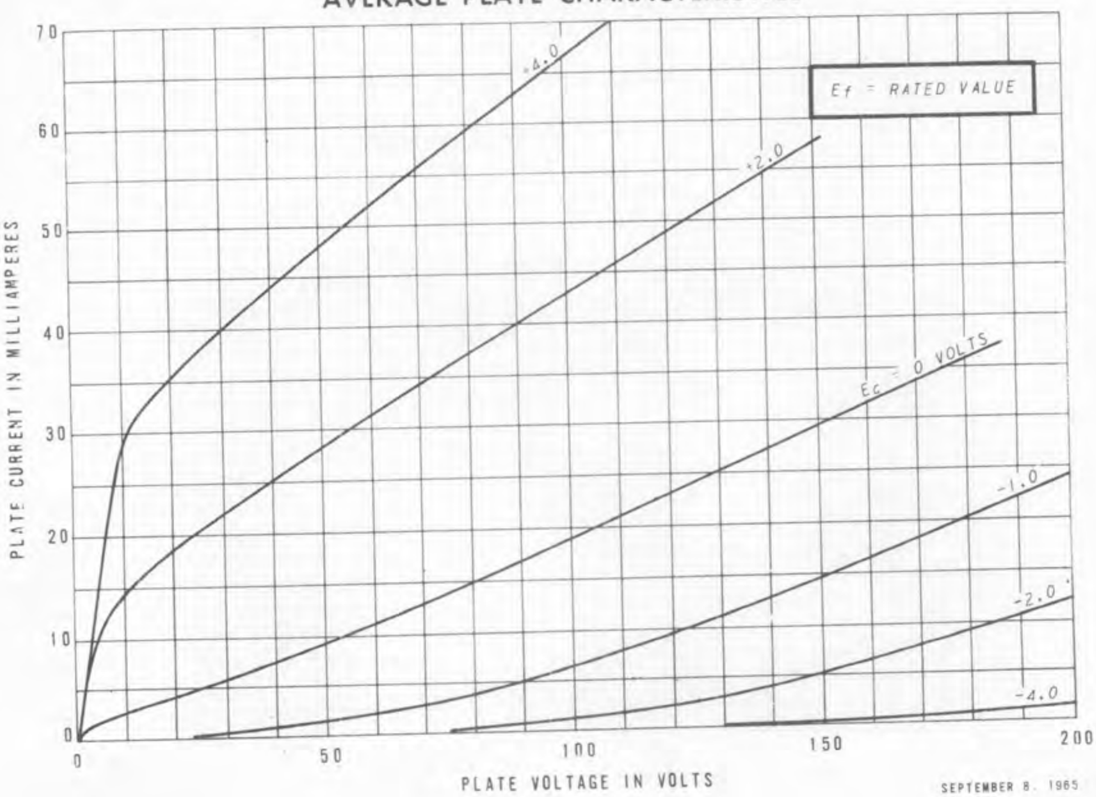
Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.357		0.363	9.068		9.220
B			0.285			7.24
C		0.180			4.57	
D	0.108		0.112	2.743		2.845
E		0.040			1.02	
F	0.025		0.031	0.635		0.787
G	0.315		0.335	8.00		8.51
H	0.216		0.232	5.49		5.89
J	0.025		0.031	0.635		0.787
K	0.094		0.102	2.388		2.591
L	0.143		0.157	3.63		3.99
M	0.165		0.185	4.19		4.70
N			0.330			8.38
P	0.048		0.054	1.219		1.372
R	0.476		0.484	12.090		12.294
S	0.130		0.142	3.30		3.61

Note: The millimeter dimensions are derived from the original inch dimensions.

AVERAGE TRANSFER CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1266*

METAL-CERAMIC TRIODE

For UHF Oscillator Applications

The Y-1266 is a medium-mu triode of ceramic-and-metal planar construction primarily intended for use as a UHF oscillator.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.24	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.4	pf
Input: g to (h + k)	1.7	pf
Output: p to (h + k)	0.016	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	350	Volts
Plate Dissipation	4.0	Watts
DC Grid Current	15	Milliamperes
DC Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	ø	
Envelope Temperature at Hottest Point	250	C

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	150	Volts
Grid Voltage	0	Volts
Amplification Factor	40	
Transconductance	8500	Micromhos
→ Plate Current	35	Milliamperes

UHF Oscillator Service

→ Plate Voltage	300	Volts
Grid Resistor	1500	Ohms
Plate Current	30	Milliamperes
Grid Current	10	Milliamperes
Frequency	400	Megacycles
Power Output, approximate	5	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Without external shield.

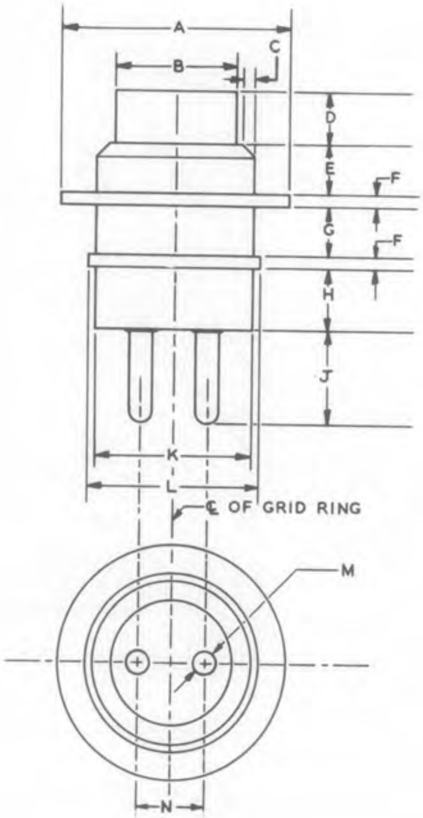
∅ To be determined.

11-22-67 (B)
Supersedes 11-4-65 (B)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

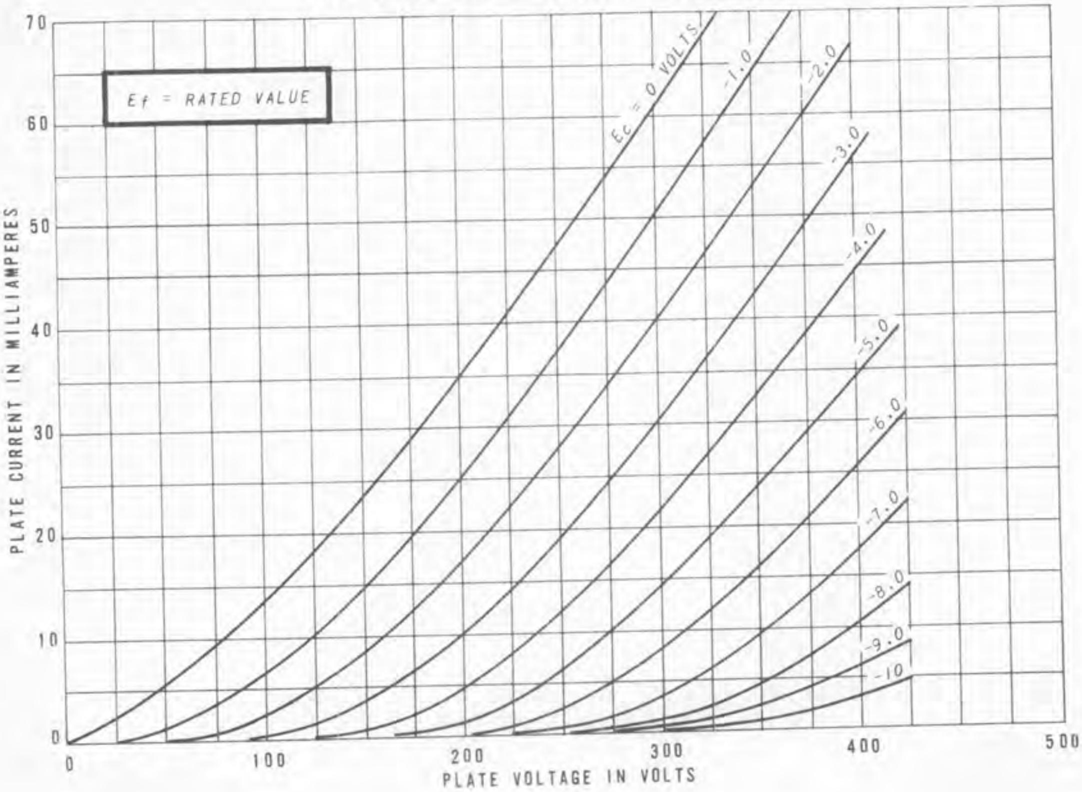
The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

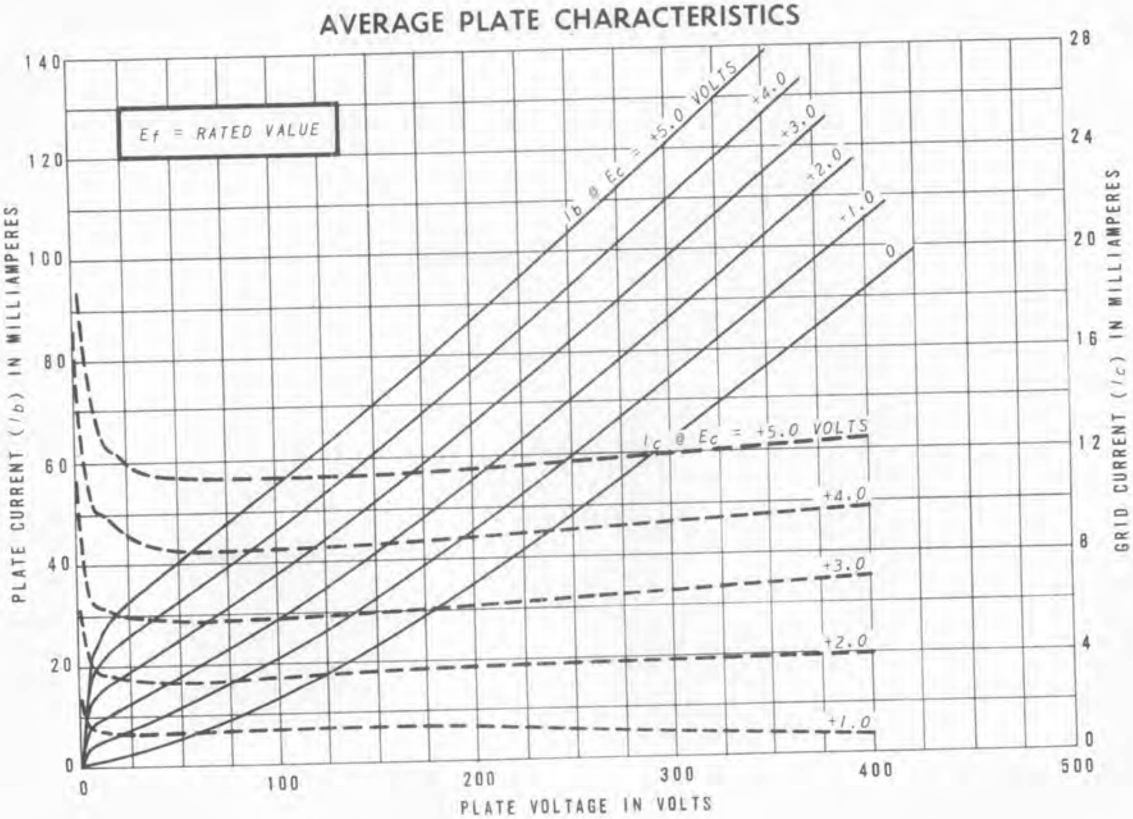


Ref.	Inches		
	Minimum	Nominal	Maximum
A	0.476		0.484
B	0.246		0.254
C	---	0.030	---
D	0.092		0.108
E	0.095		0.103
F	0.025		0.031
G	0.094		0.102
H	0.120		0.128
J	0.165		0.185
K	---		0.330
L	0.357		0.363
M	0.048		0.054
N	0.130		0.142

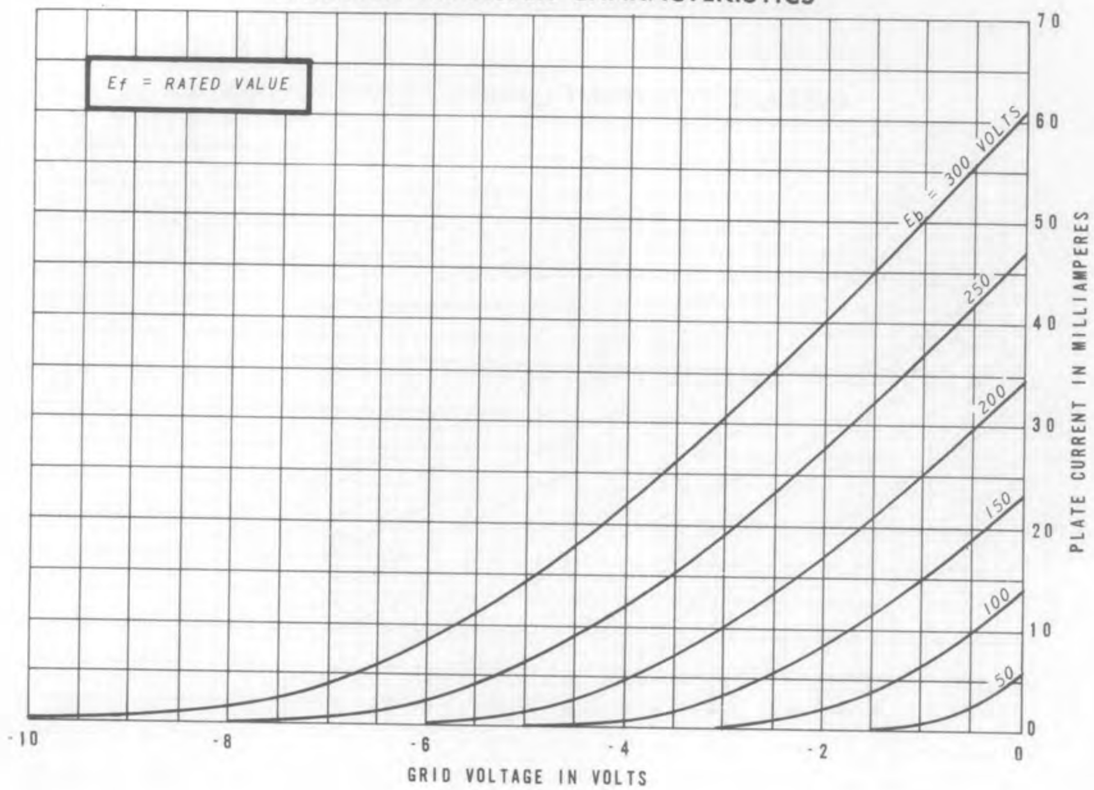
AVERAGE PLATE CHARACTERISTICS



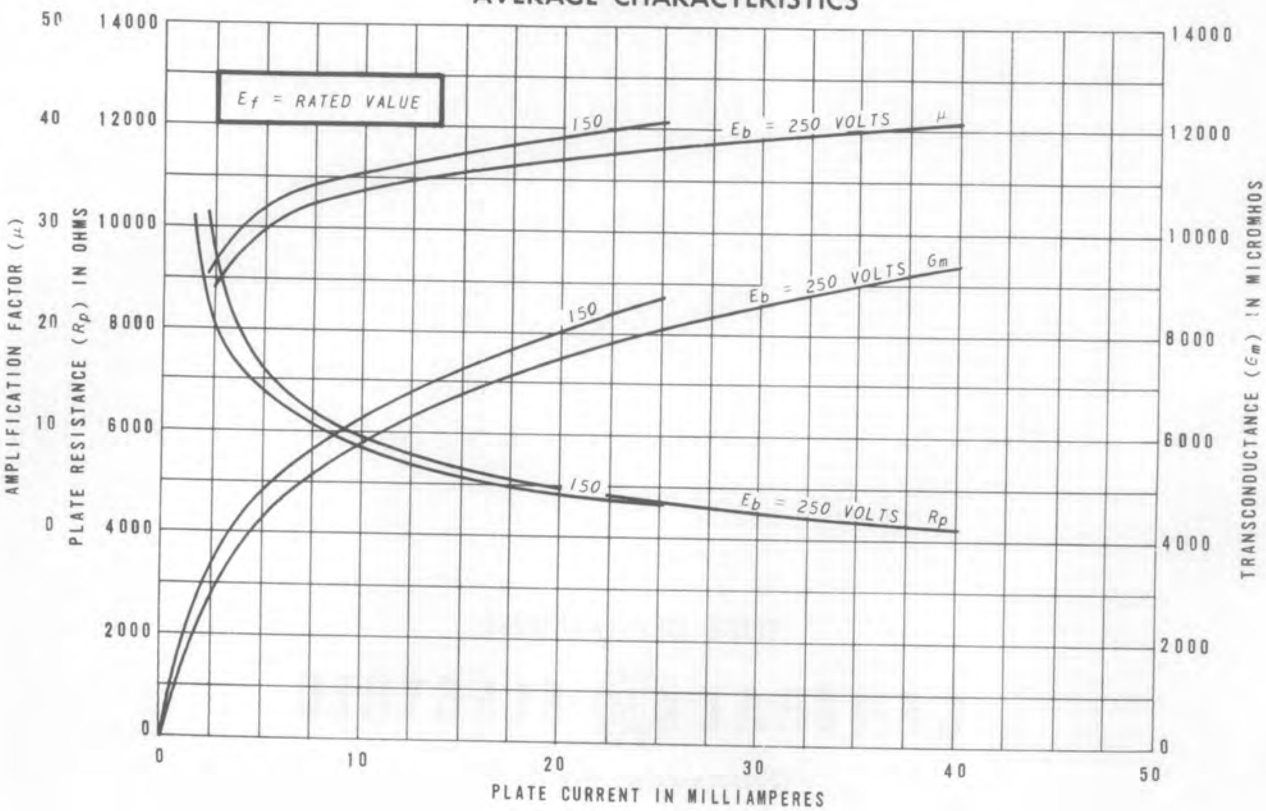
AVERAGE PLATE CHARACTERISTICS



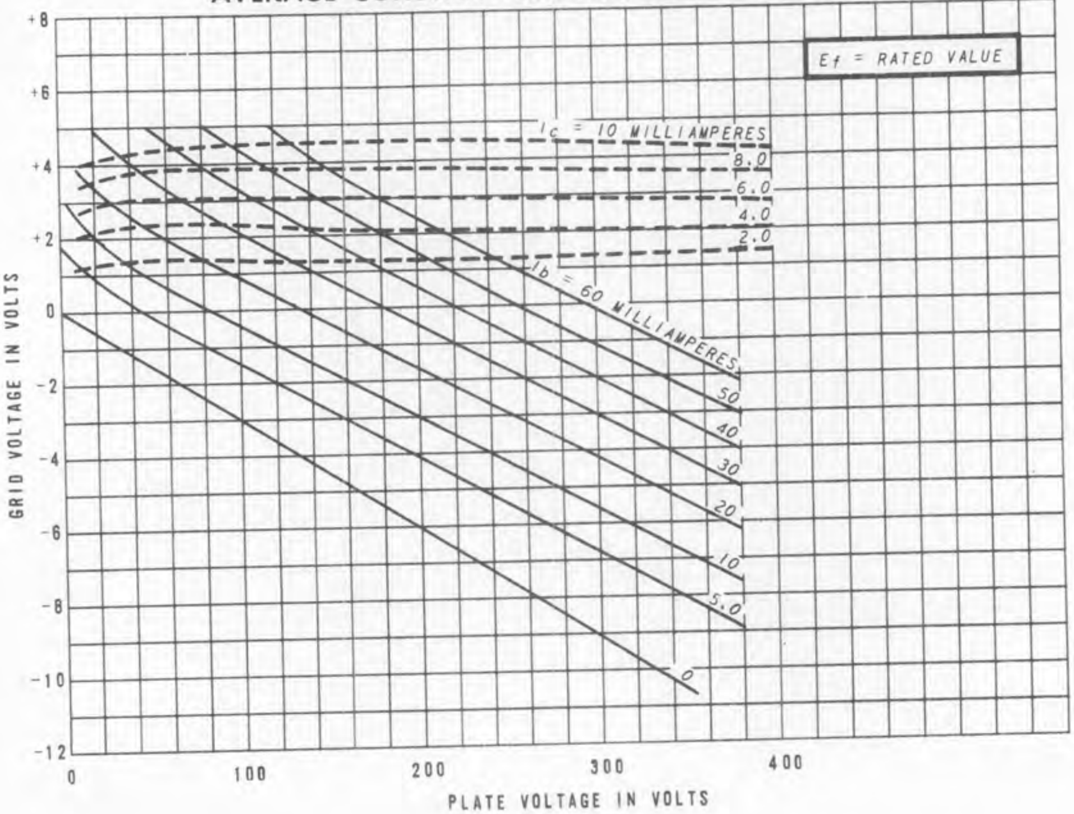
AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1397*

PLANAR TRIODE

The Y-1397 is a high-mu triode of ceramic and metal planar construction intended for use as a plate-pulsed oscillator or amplifier at frequencies up to 6000 megahertz.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.55	Amperes
Direct Interelectrode Capacitances		
Grid to Plate: (g to p)	1.5	pf
Input: g to (h + k)	4.8	pf
Output: p to (h + k)	0.05	pf

Mechanical

Operating Position - Any

→ MAXIMUM RATINGS

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage		
4 Microseconds Pulse Duration	2000	Volts
1 Microsecond Pulse Duration	3000	Volts
Duty Factor of Plate Pulse#	0.004	
Plate Current		
Average#	8.0	Milliamperes
Average During Plate Pulse	2.0	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average#	4.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
Plate Dissipation#	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (CONTINUED)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	58	
Plate Resistance, approximate	2300	Ohms
Transconductance	25000	Micromhos
Plate Current	23	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-5	Volts

→ Plate-Pulsed Oscillator Service

Frequency	1200	Megahertz
Heater Voltage	6.3	Volts
Duty Factor	0.004	
Pulse Duration	4.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Supply Voltage	1500	Volts
Plate Current		
Average	6.0	Milliamperes
Average During Plate Pulse	1.5	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	1.25	Amperes
Useful Power Output		
Average	3.6	Watts
Average During Plate Pulse	800	Watts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

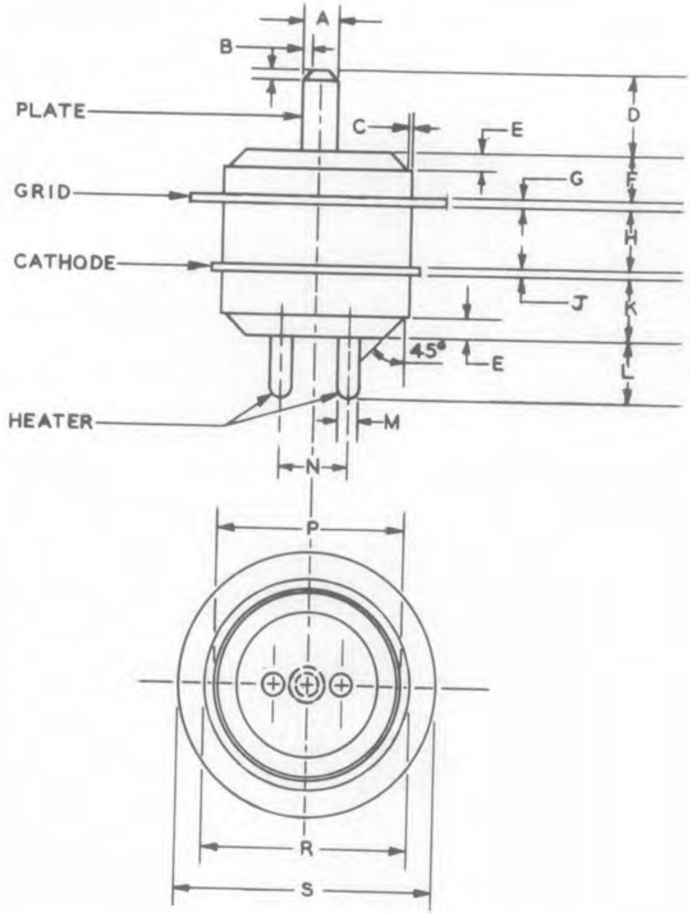
‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

\# In any 5000 microsecond interval.

Ø To be determined.

Y-1397

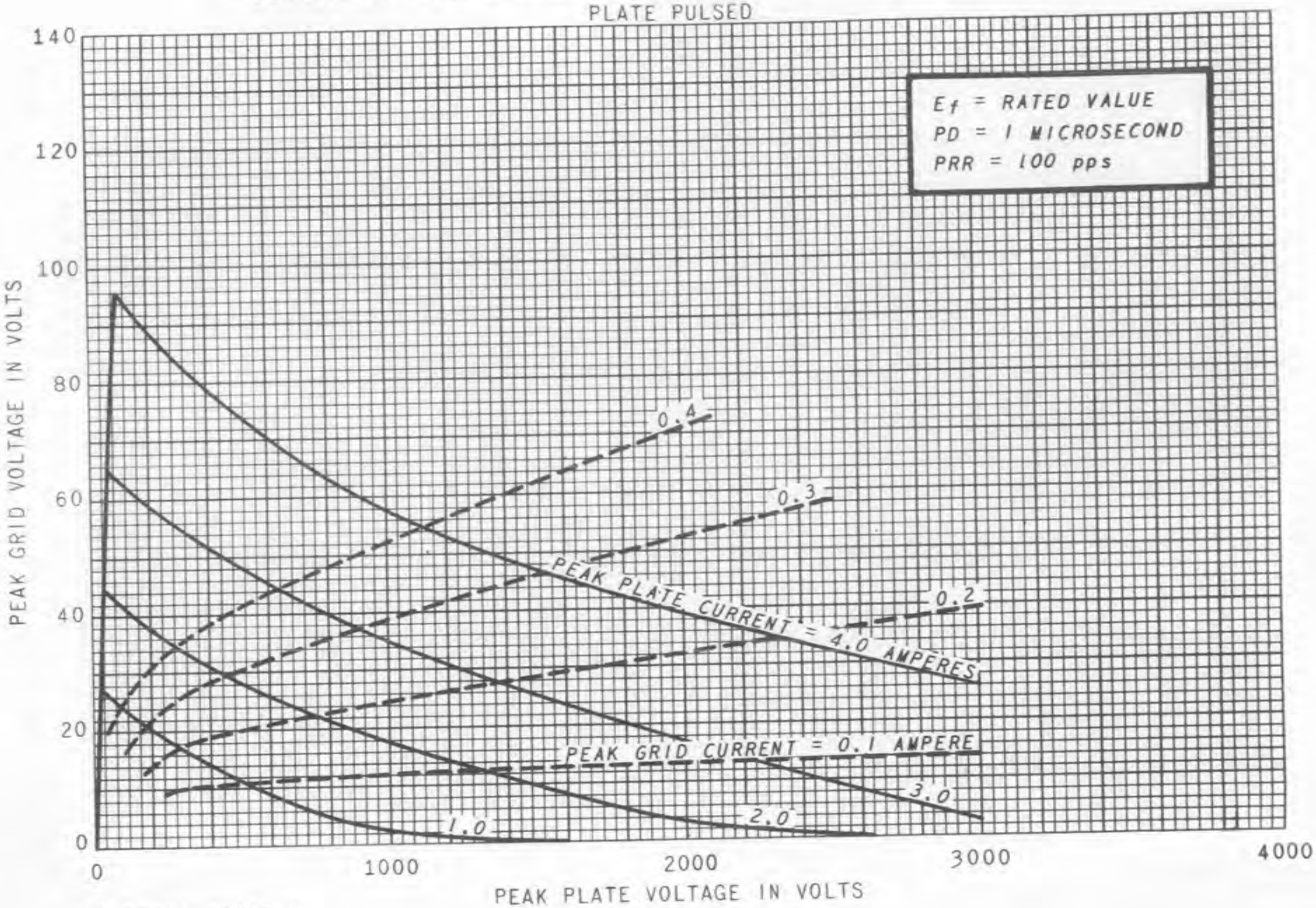


Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

Y-1397

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD259-6

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1481*

METAL-CERAMIC PLANAR TRIODE

For Plate-Pulsed Oscillator Applications

The Y-1481 is a planar triode intended for use as a plate-pulsed, C-band oscillator at relatively low plate voltage levels.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
→ Heater Current§	0.38	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.7	pf
Input: g to (h + k)	4.5	pf
Output: p to (h + k)	0.035	pf

Mechanical

Operating Position - Any

See Outline Drawing for dimensions and electrical connections.

MAXIMUM RATINGS

PLATE-PULSED OSCILLATOR SERVICE - ABSOLUTE-MAXIMUM VALUES

Cathode Heating Time minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage	1200	Volts
→ Duty Factor of Plate Pulse	0.001	
→ Peak Cathode Current	1.5	Amperes
Plate Dissipation	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics	200	Volts
Cathode-Bias Resistor	100	Ohms
→ Amplification Factor	60	
Plate Resistance, approximate	2100	Ohms
→ Transconductance	29000	Micromhos
→ Plate Current	27	Milliamperes
Grid Voltage, approximate		
Ib = 100 Microamperes	-6.5	Volts
Plate-Pulsed Oscillator		
Frequency	4300	Megacycles
Duty Factor	0.001	
Pulse Duration	0.1	Microseconds
Pulse Repetition Rate	10000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	800	Volts
Plate Current		
Average	1.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
Grid Current		
Average	0.2	Milliamperes
Average During Plate Pulse	0.2	Amperes
→ Useful Power Output		
Average	0.190	Watts
Average During Plate Pulse	190	Watts

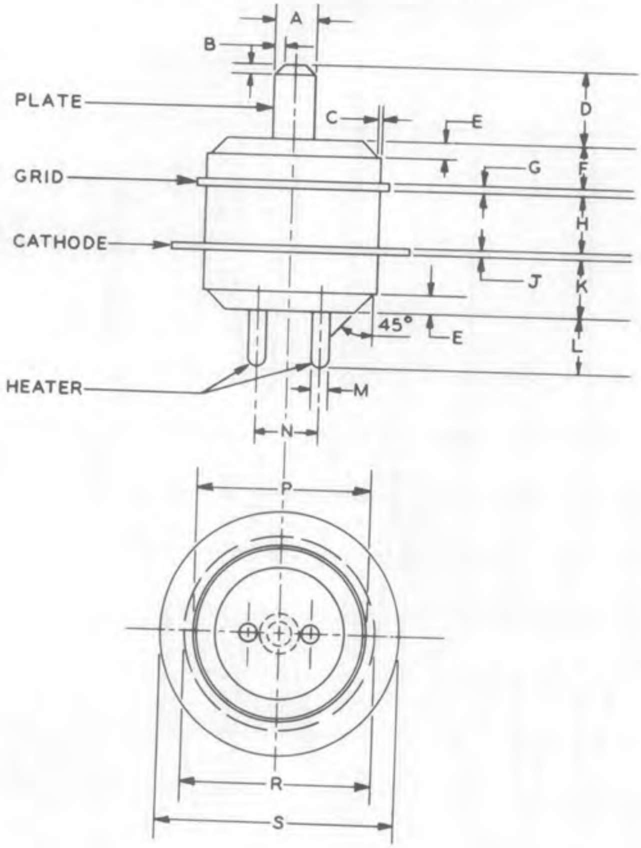
* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

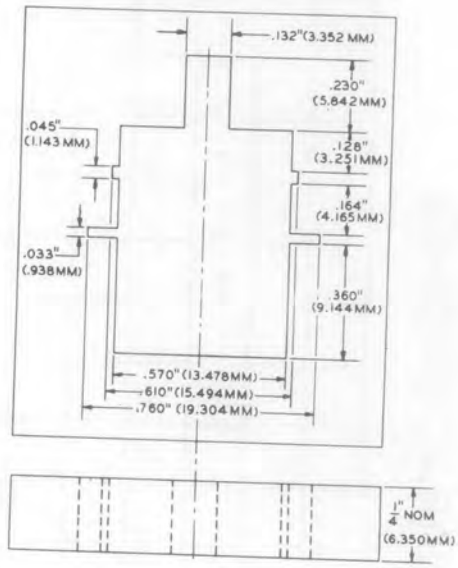
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



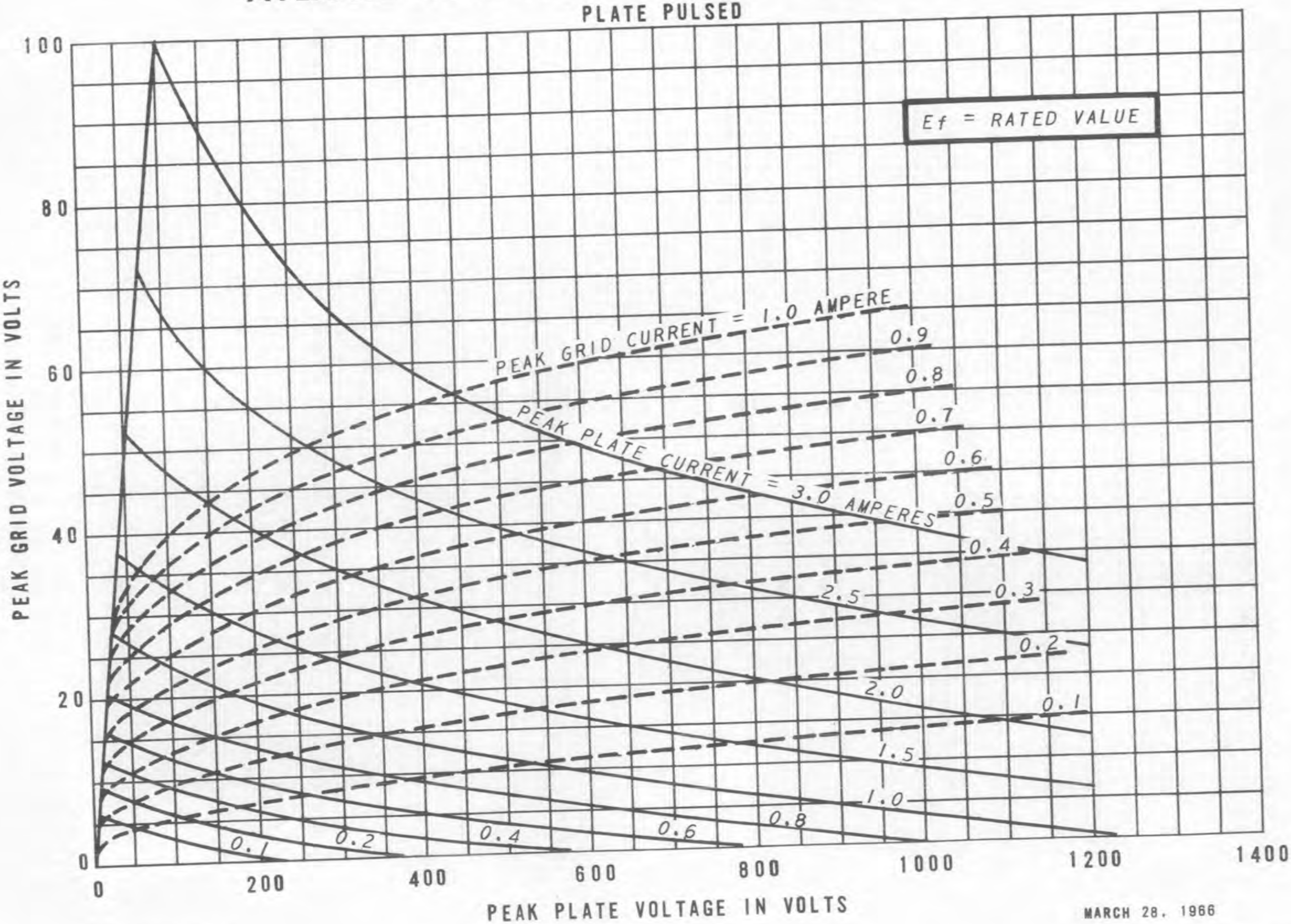
Note: Gauge tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

PLATE PULSED



Y-1481

MARCH 28, 1966

K-55611-TD322-1

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1530*

METAL-CERAMIC PLANAR TRIODE

The Y-1530 is a planar triode primarily intended for use as a broadband radio-frequency amplifier. A feature of the Y-1530 is fast warm-up; the time required to reach a plate current level of 80% of the steady-state value is 4 seconds.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.5	Amperes
→ Cathode Heating Time¶	5	Seconds
Direct Interelectrode Capacitances#		
Grid to Plate: (g to p)	1.7	pf
Input: g to (h + k)	6.0	pf
Output: p to (h + k)	0.018	pf

Mechanical

Operating Position - Any

See Outline Drawing for dimensions and electrical connections.

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
→ Plate Dissipation	6.5	Watts
DC Cathode Current	30	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts

MAXIMUM RATINGS (Continued)

Grid Circuit Resistance With Cathode Bias	0.01	Megohms
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	270	Ohms
Amplification Factor	225	
Plate Resistance, approximate	4500	Ohms
Transconductance	50000	Micromhos
Plate Current	24	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-3	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

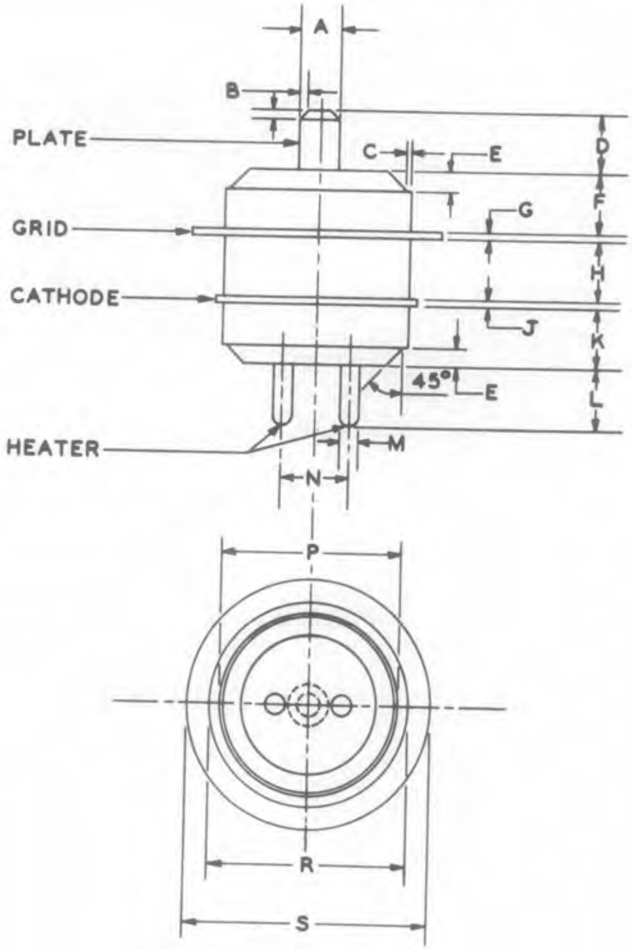
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Time required for plate current to reach 80% of its steady-state value.

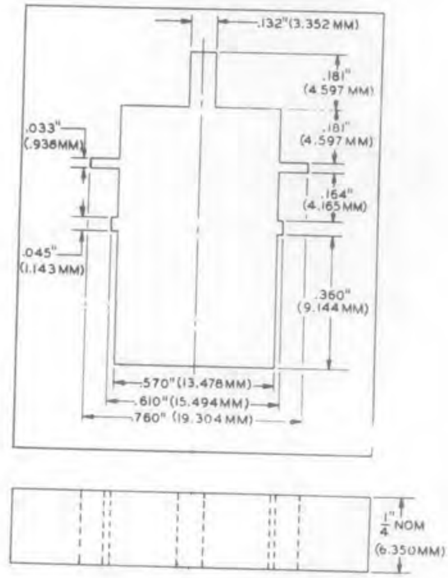
Without external shield.

11-22-67 (B)
Supersedes 9-1-65 (B)

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



Note: Tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.170		0.180	4.32		4.57
E	0.040		0.060	1.02		1.52
F	0.165		0.175	4.19		4.45
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5:46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1536*

PLANAR TRIODE

The Y-1536 is a metal-ceramic triode intended for use as a plate-pulsed oscillator or amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	1.05	Amperes
Direct Interelectrode Capacitances		
Grid to Plate: (g to p)	2.3	pf
Input: g to (h + k)	7.3	pf
Output: p to (h + k)	0.1	pf

Mechanical

Operating Position - Any

→ MAXIMUM RATINGS

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

→ Cathode Heating Time, minimum	5	Seconds
Peak Positive-Pulse Plate Supply Voltage		
4 Microsecond Pulse Duration	2500	Volts
1 Microsecond Pulse Duration	3000	Volts
Duty Factor of Plate Pulse#	0.004	
Plate Current		
Average#	20	Milliamperes
Average During Plate Pulse	5.0	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average#	6.0	Milliamperes
Average During Plate Pulse	1.5	Amperes
Plate Dissipation#	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (CONTINUED)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

→ CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	400	Volts
Cathode-Bias Resistor	33	Ohms
Amplification Factor	90	
Plate Resistance, approximate	2550	Ohms
Transconductance	35000	Micromhos
Plate Current	60	Milliamperes

→ Plate-Pulsed Oscillator Service

Frequency	1200	Megahertz
Heater Voltage	6.3	Volts
Duty Factor	0.004	
Pulse Duration	4.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Supply Voltage	2000	Volts
Plate Current		
Average	20	Milliamperes
Average During Plate Pulse	5.0	Amperes
Grid Current		
Average	4.8	Milliamperes
Average During Plate Pulse	1.2	Amperes
Useful Power Output		
Average	12	Watts
Average During Plate Pulse	3.0	Kilowatts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

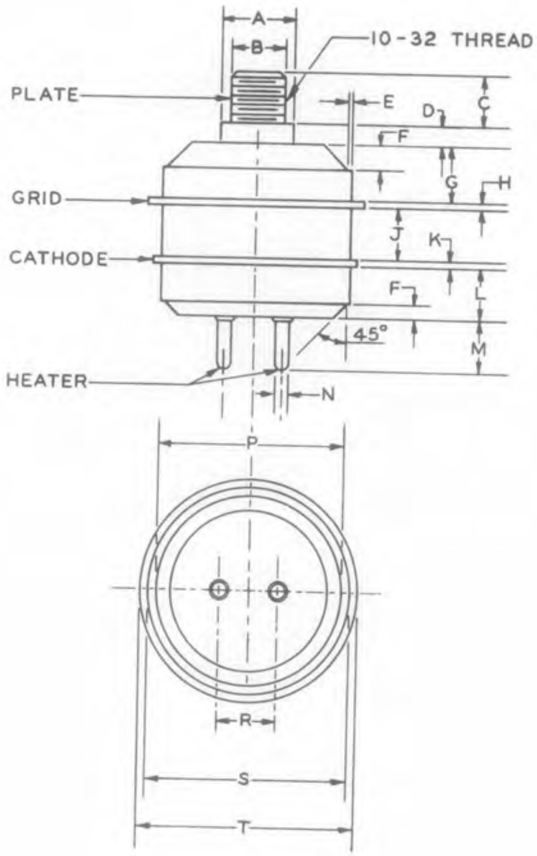
‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

In any 5000 microsecond interval.

Ø To be determined.

Y-1536



Ref.	Inches		
	Minimum	Nominal	Maximum
A	0.247		0.253
B			0.190
C	0.130		0.170
D	0.070		0.090
E		0.005	
F	0.075		0.095
G	0.182		0.192
H	0.025		0.031
J	0.170		0.180
K	0.025		0.031
L	0.170		0.180
M	0.170		0.180
N	0.047		0.053
P	0.635		0.665
R	0.186		0.214
S	0.698		0.708
T	0.748		0.758

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1537*

PLANAR TRIODE

The Y-1537 is a metal-ceramic triode intended for grid-pulsed or plate-pulsed oscillator and amplifier service.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.5	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	2.0	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.055	pf

Mechanical

Operating Position - Any

→ MAXIMUM RATINGS

Grid-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Plate Voltage	1200	Volts
Plate Dissipation#	10	Watts
Peak Plate Current	1.5	Amperes
Peak Grid Current	0.7	Amperes
Duty Factor	0.01	
Pulse Duration	1	Microseconds
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (CONTINUED)

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Peak Positive-Pulse Plate Supply Voltage		
4 Microsecond Pulse Duration	2000	Volts
1 Microsecond Pulse Duration	2500	Volts
Plate Dissipation#	10	Watts
Peak Plate Current	2.5	Amperes
Peak Grid Current	0.8	Amperes
Duty Factor	0.001	
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
→ Amplification Factor	85	
Transconductance	22000	Micromhos
Plate Current	17	Milliamperes

Grid-Pulsed Radio-Frequency Oscillator

Frequency	1200	Megahertz
DC Plate Voltage	1000	Volts
Peak Plate Current	1.2	Amperes
Peak Grid Current	0.4	Amperes
Pulse Repetition Frequency	20000	PPS
Pulse Duration	0.5	Microseconds
Peak Power Output	450	Watts

Plate-Pulsed Radio-Frequency OscillatorØ

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

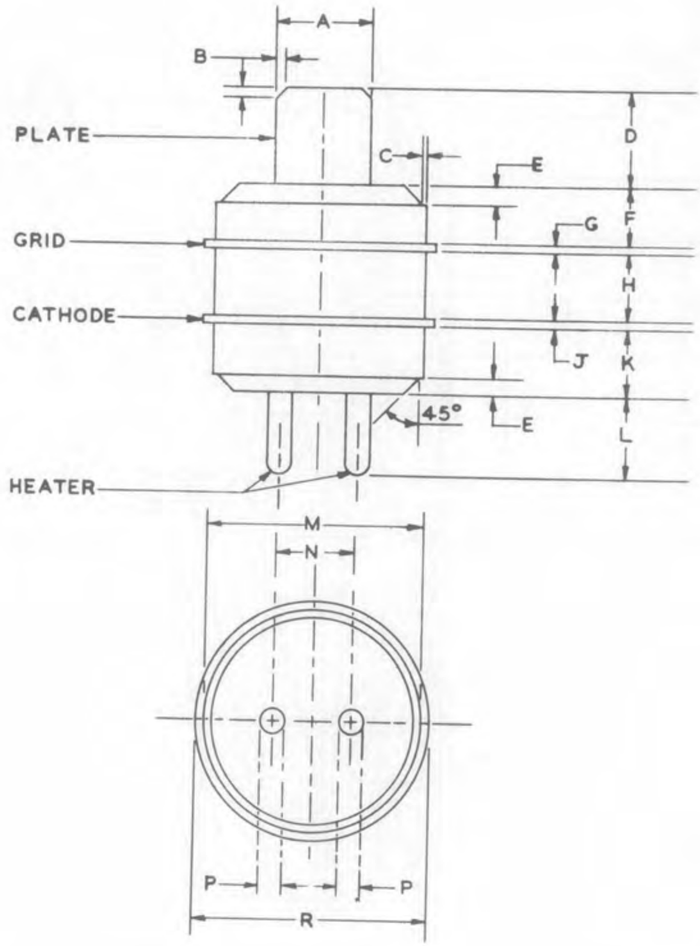
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Without external shield.

With adequate heat sink.

Ø To be determined.

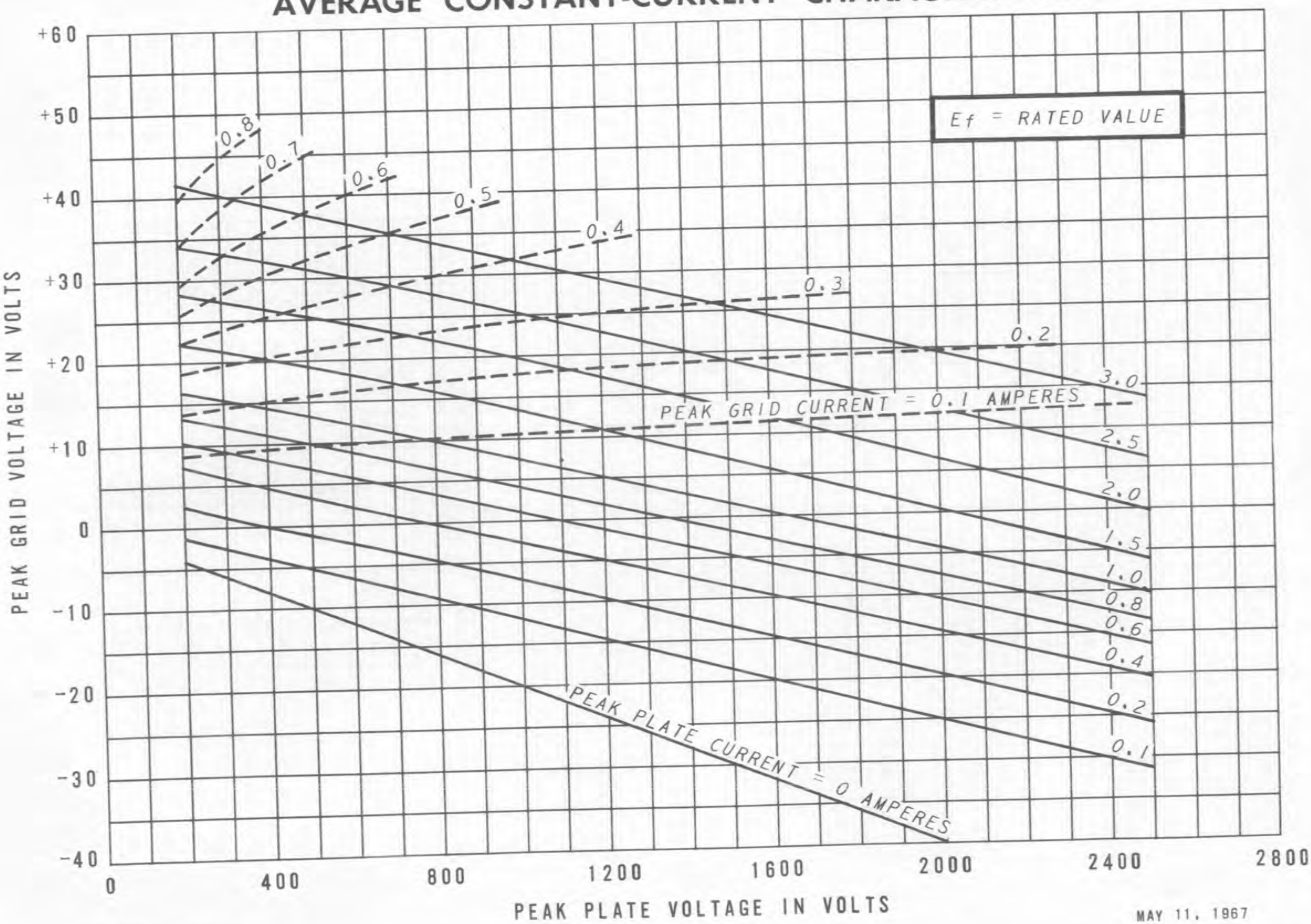
Y-1537



Ref.	Inches		
	Minimum	Nominal	Maximum
A	0.245		0.255
B		0.030	
C		0.005	
D	0.245		0.255
E	0.040		0.060
F	0.145		0.155
G	0.025		0.031
H	0.167		0.177
J	0.025		0.031
K	0.170		0.180
L	0.170		0.180
M	0.535		0.565
N	0.185		0.215
P	0.047		0.053
R	0.598		0.608

TYPE Y-1537

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD341-1A

MAY 11, 1967

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1540*

PLANAR TRIODE

The Y-1540 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as a broadband radio-frequency amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.4	Amperes
→ Cathode Heating Time#	5	Seconds
Direct Interelectrode Capacitances∅		

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation¶	30	Watts
DC Cathode Current	100	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	∅	
Envelope Temperature at Hottest Point	∅	

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	270	Ohms
Amplification Factor	225	
Plate Resistance, approximate	4500	Ohms
Transconductance	50000	Micromhos
Plate Current	24	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-3	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

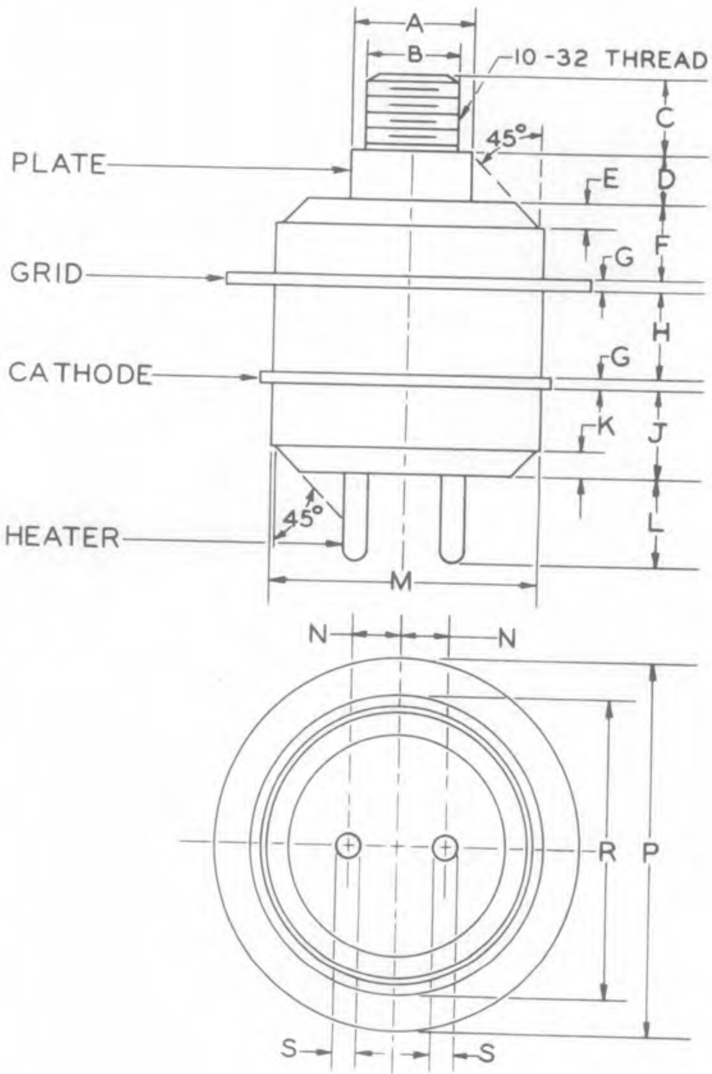
‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

Time required for plate current to reach 80% of its steady-state value.

Ø To be determined.

11-22-67 (B)
Supersedes 4-19-65 (B)



Ref.	Inches	
	Minimum	Maximum
A	0.247	0.253
B	0.184	0.190
C	0.145	0.155
D	0.095	0.105
E	0.040	0.060
F	0.145	0.155
G	0.025	0.031
H	0.170	0.180
J	0.170	0.180
K	0.040	0.060
L	0.170	0.180
M	0.535	0.565
N	0.093	0.107
P	0.748	0.758
R	0.598	0.608
S	0.047	0.053

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1541*

METAL-CERAMIC PLANAR TRIODE

The Y-1541 is a high-mu triode of ceramic and metal planar construction intended for use as a grid-pulsed oscillator or amplifier at frequencies up to 6000 megacycles.

A feature of the Y-1541 is rapid warm-up: the time required to reach a plate current level of 80% of the steady-state value is 5 seconds.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.61	Amperes
→ Cathode Heating Time¶	5	Seconds
Direct Interelectrode Capacitances#		
Grid to Plate: (g to p)	1.5	pf
Input: g to (h + k)	4.5	pf
Output: p to (h + k)	0.045	pf

Mechanical

Operating Position - Any

See Outline Drawing for dimensions and electrical connections.

MAXIMUM RATINGS

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Peak Positive-Pulse Plate Supply Voltage	1500	Volts
Duty Factor of Plate Pulse∆**	0.001	
Pulse Duration	2.0	Microseconds

MAXIMUM RATINGS (Continued)

Plate Current		
Average**	2.5	Milliamperes
Average During Plate Pulse‡‡	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average**	1.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
DC Cathode Current	20	Milliamperes
Plate Dissipation‡‡	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics		
Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	58	
Plate Resistance, approximate	2300	Ohms
Transconductance	25000	Micromhos
Plate Current	23	Milliamperes
Grid Voltage, approximate		
Ib = 100 Microamperes	-5	Volts

→ Grid-Pulsed Oscillator Service		
Frequency	4300	Megacycles
Heater	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	1500	Volts
Plate Current		
Average	1.5	Milliamperes
Average During Plate Pulse	1.5	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	Ø	Amperes
Useful Power Output		
Average	0.6	Watts
Average During Plate Pulse	0.6	Kilowatts

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1541*

METAL-CERAMIC PLANAR TRIODE

The Y-1541 is a high-mu triode of ceramic and metal planar construction intended for use as a grid-pulsed oscillator or amplifier at frequencies up to 6000 megacycles.

A feature of the Y-1541 is rapid warm-up: the time required to reach a plate current level of 80% of the steady-state value is 5 seconds.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.61	Amperes
→ Cathode Heating Time¶	5	Seconds
Direct Interelectrode Capacitances#		
Grid to Plate: (g to p)	1.5	pf
Input: g to (h + k)	4.5	pf
Output: p to (h + k)	0.045	pf

Mechanical

Operating Position - Any

See Outline Drawing for dimensions and electrical connections.

MAXIMUM RATINGS

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Peak Positive-Pulse Plate Supply Voltage	1500	Volts
Duty Factor of Plate Pulse∆**	0.001	
Pulse Duration	2.0	Microseconds

MAXIMUM RATINGS (Continued)

Plate Current		
Average**	2.5	Milliamperes
Average During Plate Pulse‡‡	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average**	1.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
DC Cathode Current	20	Milliamperes
Plate Dissipation‡‡	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics		
Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	58	
Plate Resistance, approximate	2300	Ohms
Transconductance	25000	Micromhos
Plate Current	23	Milliamperes
Grid Voltage, approximate		
Ib = 100 Microamperes	-5	Volts

→ Grid-Pulsed Oscillator Service		
Frequency	4300	Megacycles
Heater	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	1500	Volts
Plate Current		
Average	1.5	Milliamperes
Average During Plate Pulse	1.5	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	Ø	Amperes
Useful Power Output		
Average	0.6	Watts
Average During Plate Pulse	0.6	Kilowatts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Time required for plate current to reach 80% of its steady-state value.

\# Measured using a grounded adapter that provides shielding between external terminals of tube.

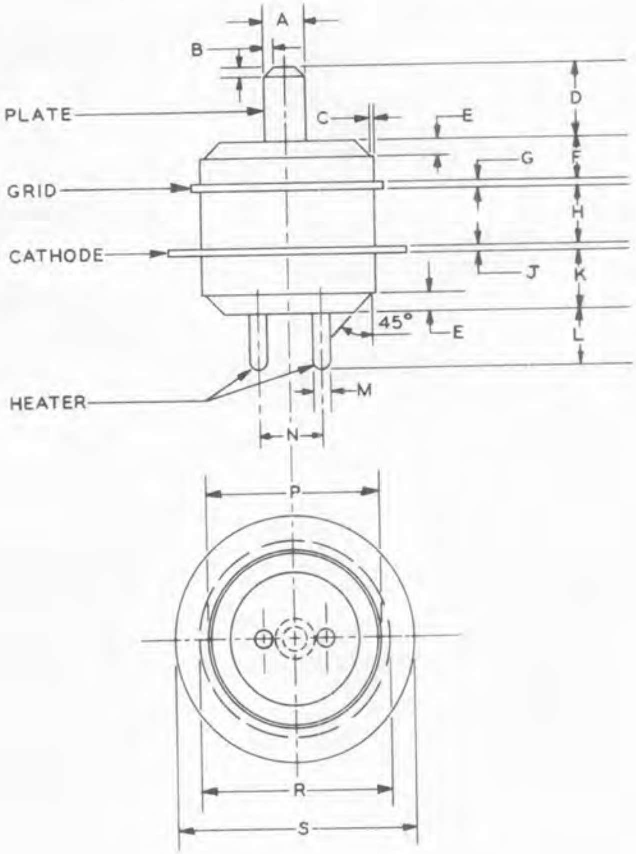
Δ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendation.

** In any 5000 microsecond interval.

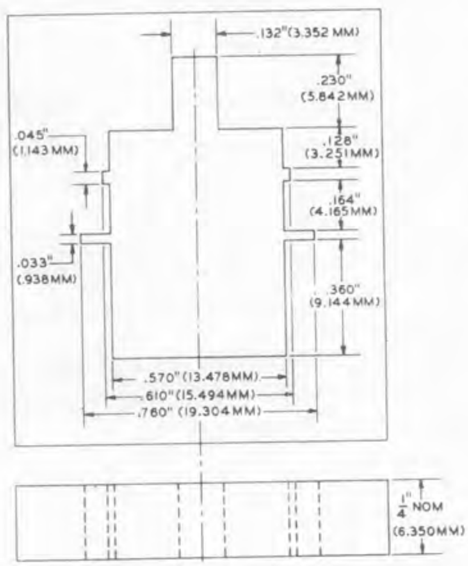
‡‡ The regulation and/or plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

11-22-67 (B)
Supersedes 8-26-65 (B)

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



Note: Gauge tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1549*

METAL-CERAMIC TRIODE

For Grid-Pulsed Oscillator or Amplifier Applications

The Y-1549 is a triode of ceramic and metal planar construction intended for use as a grid-pulsed oscillator or amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
→ Heater Current§	0.55	Amperes
Direct Interelectrode Capacitances∅		

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Grid-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Plate Voltage	1500	Volts
Plate Dissipation	6.5	Watts
Duty Factor of Grid Pulse	∅	
DC Cathode Current	∅	
Peak Cathode Current	∅	
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	100	Volts
Heater Negative with Respect to Cathode	100	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics∅

→ Grid-Pulsed Oscillator

Frequency	1200	Megacycles
Duty Factor	0.001	
Pulse Width	1.0	Microseconds
Plate Voltage	1500	Volts
Grid Voltage	-80	Volts
Peak Grid Voltage	∅	
Plate Current		
Average	1.5	Milliamperes
Average During Grid Pulse	1.5	Amperes
Grid Current	∅	
Useful Power Output		
Average	1.0	Watts
Average During Grid Pulse	1.0	Kilowatts
Frequency	4300	Megacycles
Duty Factor	0.001	
Pulse Width	1.0	Microseconds
Plate Voltage	1500	Volts
Grid Voltage	∅	
Peak Grid Voltage	∅	
Plate Current		
Average	1.5	Milliamperes
Average During Grid Pulse	1.5	Amperes
Grid Current	∅	
Useful Power Output		
Average	0.6	Watts
Average During Grid Pulse	600	Watts

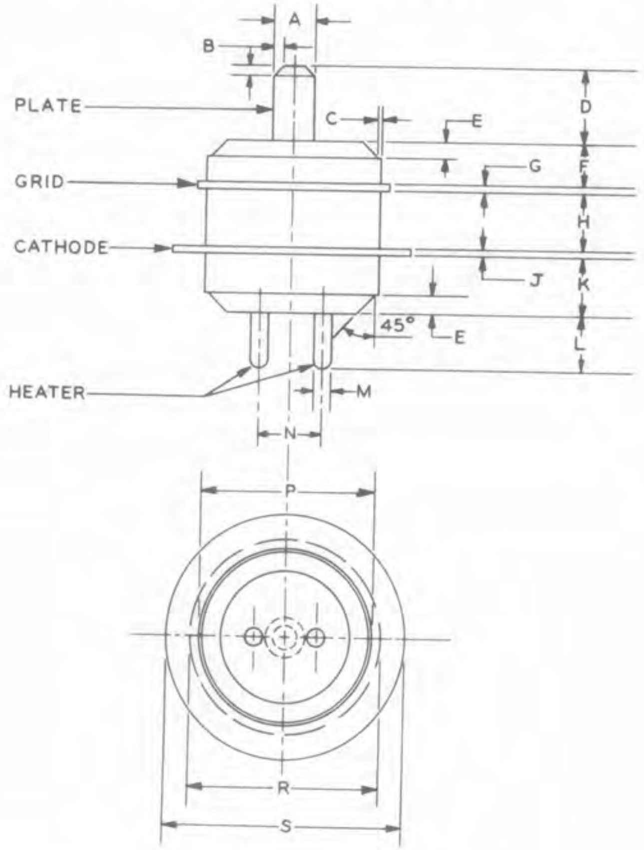
* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

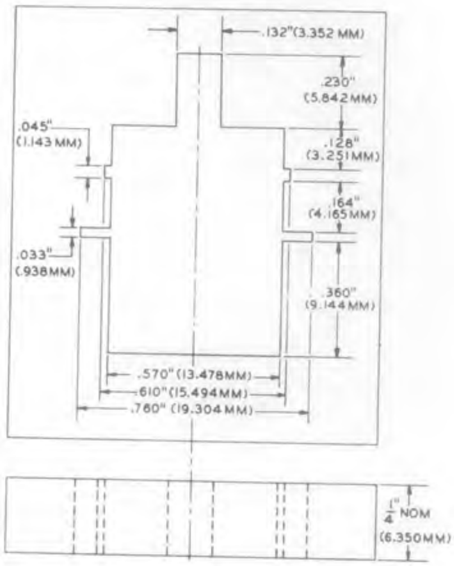
§ Heater current of a bogey tube at Ef = 6.3 volts.

∅ To be determined.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



Note: Gauge tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1600*

PLANAR TRIODE

The Y-1600 is a triode of ceramic and metal planar construction intended for use as a CW oscillator at frequencies up to 3000 megacycles. Features of the Y-1600 are small size and high plate dissipation capability.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.61	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.65	pf
Input: g to (h + k)	4.8	pf
Output: p to (h + k)	0.045	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

CW Oscillator Service

Plate Voltage	400	Volts
Plate Current	135	Milliamperes
Grid Current	30	Milliamperes
Cathode Current	160	Milliamperes
Plate Dissipation#	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (Continued)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	300	Volts
Cathode-Bias Resistor	20	Ohms
Amplification Factor	60	
Plate Resistance, approximate	1580	Ohms
→ Transconductance	38000	Micromhos
Plate Current	93	Milliamperes

CW Oscillator Service

Frequency	2300	Megacycles
Plate Voltage	300	Volts
Plate Current	135	Milliamperes
Grid Current	25	Milliamperes
Power Output, approximate	10	Watts

NOTES

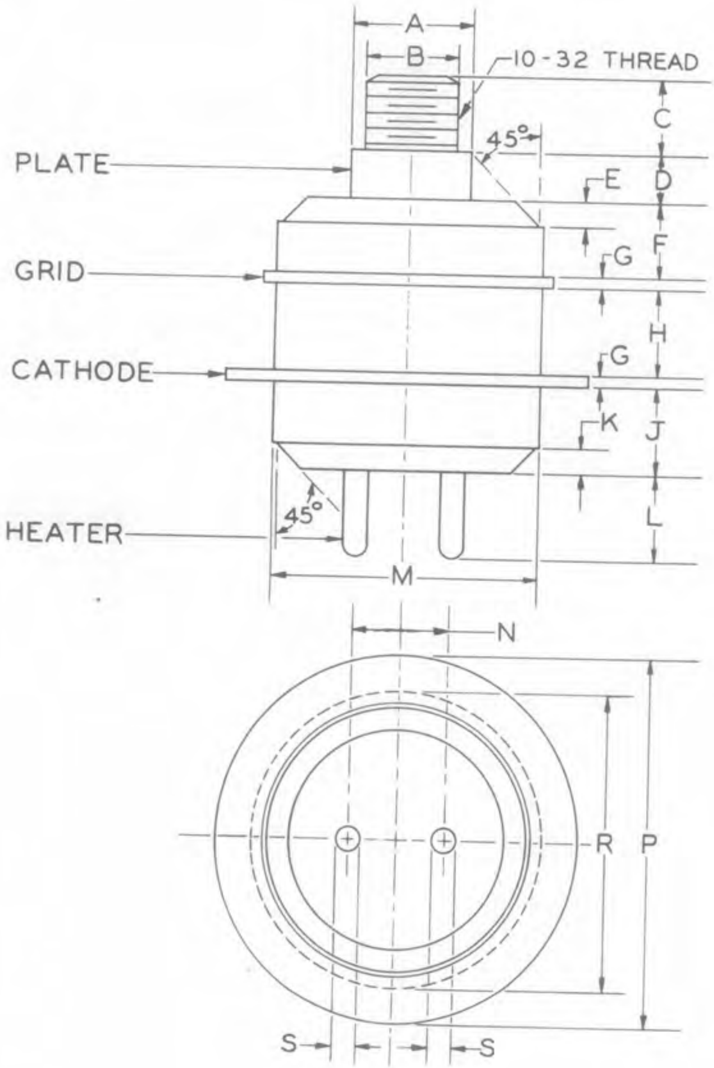
* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

With adequate heat sink attached to threaded plate stud.



Ref.	Inches	
	Minimum	Maximum
A	0.247	0.253
B	0.184	0.190
C	0.145	0.155
D	0.105	0.115
E	0.040	0.060
F	0.145	0.155
G	0.025	0.031
H	0.167	0.177
J	0.170	0.180
K	0.040	0.060
L	0.170	0.180
M	0.535	0.565
N	0.186	0.214
P	0.748	0.758
R	0.598	0.608
S	0.047	0.053

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1623*

PLANAR TRIODE

The Y-1623 is a metal-ceramic triode intended for use as a plate-pulsed oscillator or amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡.	6.3±0.3	Volts
Heater Current§	0.4	Amperes
Direct Interelectrode Capacitances		
Grid to Plate: (g to p)	1.7	pf
Input: g to (h + k)	6.0	pf
Output: p to (h + k)	0.018	pf

Mechanical

Operating Position - Any

→MAXIMUM RATINGS

Plate-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage		
4 Microsecond Pulse Duration.	1500	Volts
1 Microsecond Pulse Duration.	2000	Volts
Duty Factor of Plate Pulse#	0.004	
Plate Current		
Average#	2.0	Milliamperes
Average During Plate Pulse	0.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	50	Volts
Grid Current		
Average#	0.8	Milliamperes
Average During Plate Pulse	0.2	Amperes
Plate Dissipation#	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point.	250	C

MAXIMUM RATINGS (CONTINUED)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	270	Ohms
Amplification Factor	225	
Plate Resistance, approximate	4500	Ohms
Transconductance	50000	Micromhos
Plate Current	24	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-3	Volts

Plate-Pulsed Oscillator Service

Frequency	1200	Megahertz
Heater Voltage	6.3	Volts
Duty Factor	0.004	
Pulse Duration	4.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Supply Voltage	1250	Volts
Plate Current		
Average	1.6	Milliamperes
Average During Plate Pulse	0.4	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	Ø	Amperes
Useful Power Output		
Average	Ø	Watts
Average During Plate Pulse	Ø	Kilowatts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

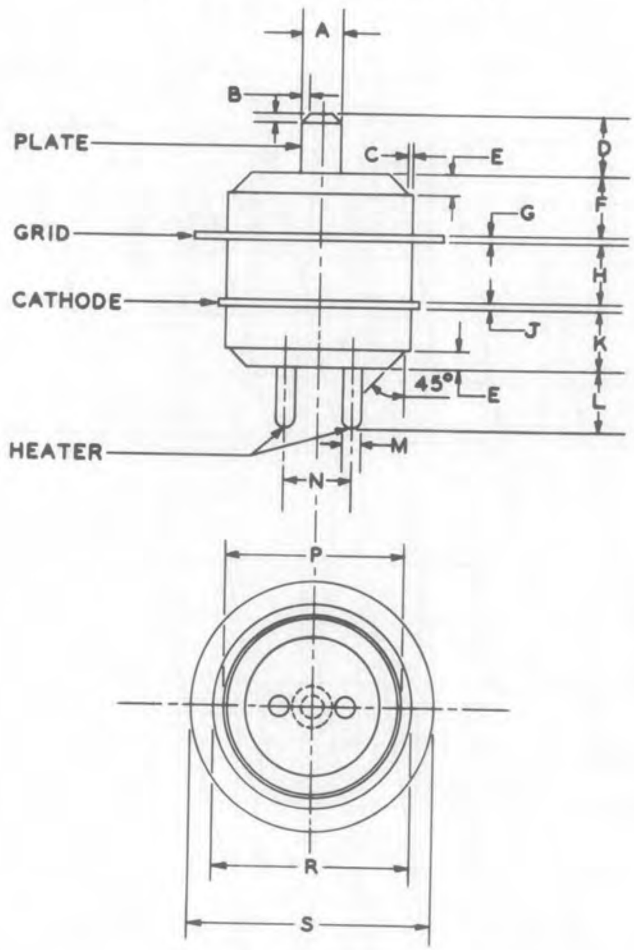
§ Heater current of a bogey tube at Ef = 6.3 volts.

In any 5000 microsecond interval.

Ø To be determined.

5-10-67 (B)
Supersedes 3-1-67 (B)

PHYSICAL DIMENSIONS

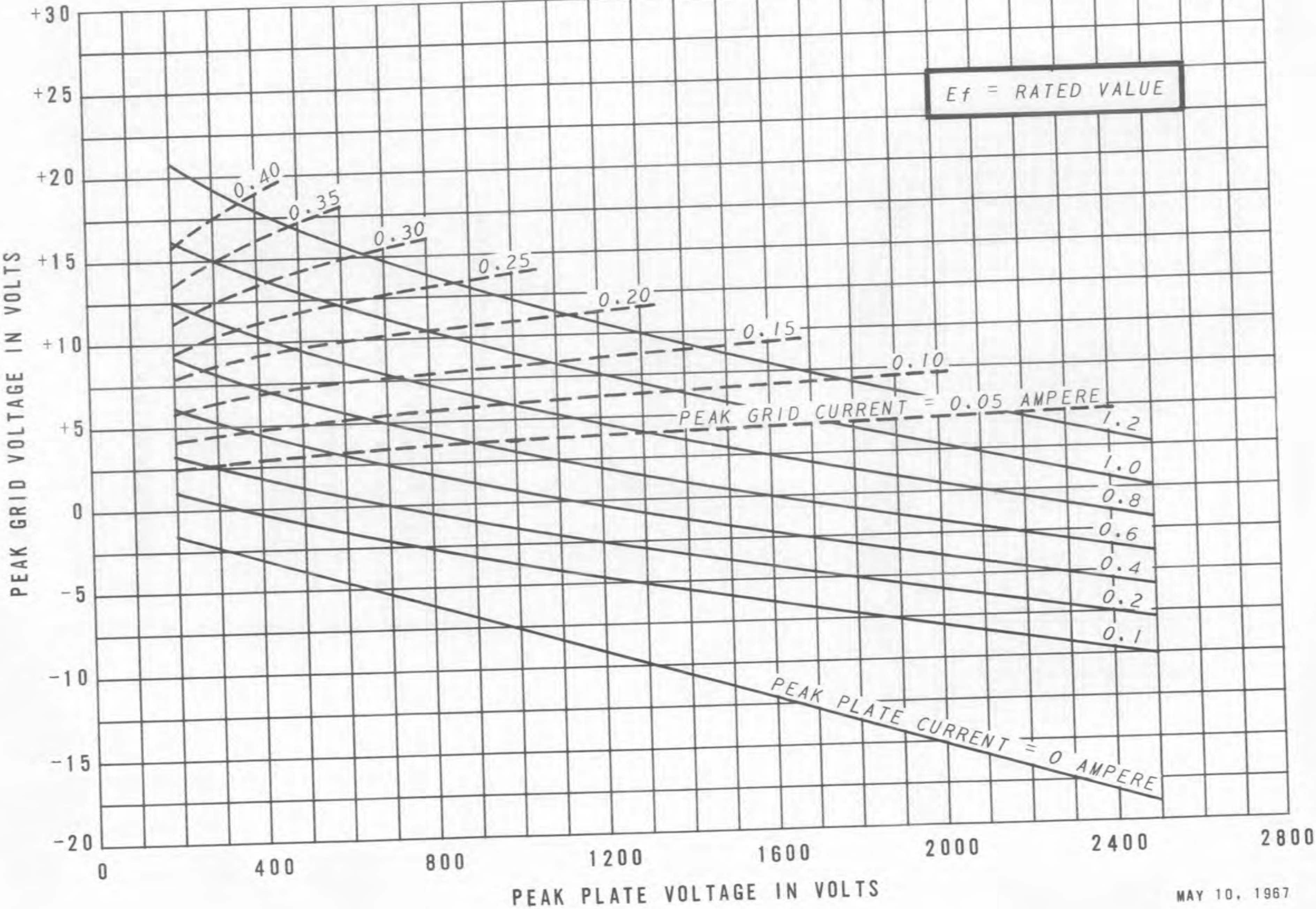


Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.170		0.180	4.32		4.57
E	0.040		0.060	1.02		1.52
F	0.170		0.180	4.32		4.57
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

Y-1623

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



MAY 10, 1967

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1636*

PLANAR TRIODE

The Y-1636 is a metal-ceramic triode intended for use as a plate-pulsed and grid-pulsed oscillator or amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
→ Heater Current§	1.2	Amperes
Direct Interelectrode Capacitances		
Grid to Plate: (g to p)	2.8	pf
Input: g to (h + k)	7.3	pf
Output: p to (h + k)	0.05	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Grid-Pulsed Oscillator or Amplifier Service - Absolute-Maximum Values

→ Cathode Heating Time, minimum¶	5	Seconds
Plate Supply Voltage	2500	Volts
Duty Factor of Grid Pulse#	0.01	
Pulse Duration	1.0	Microseconds
Plate Current		
Average#	50	Milliamperes
Average During Grid Pulse	5.0	Amperes
Negative Grid Voltage		
Average During Grid Pulse	100	Volts
Grid Current		
Average#	20	Milliamperes
Average During Grid Pulse	2.0	Amperes
Plate Dissipation¢	50	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (CONTINUED)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	400	Volts
Cathode-Bias Resistor	33	Ohms
Amplification Factor	90	
Plate Resistance, approximate	2800	Ohms
Transconductance	32000	Micromhos
Plate Current	70	Milliamperes

→ Grid-Pulsed Oscillator Service

Frequency	2000	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.0075	
Pulse Duration	0.2	Microseconds
Pulse Repetition Rate	37500	Pulses per Second
Plate Voltage	1500	Volts
Plate Current		
Average	3.0	Milliamperes
Average During Grid Pulse	3.0	Amperes
Grid Current		
Average	1.2	Milliamperes
Average During Grid Pulse	1.2	Amperes
Useful Power Output		
Average	1.0	Watts
Average During Grid Pulse	1.0	Kilowatts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

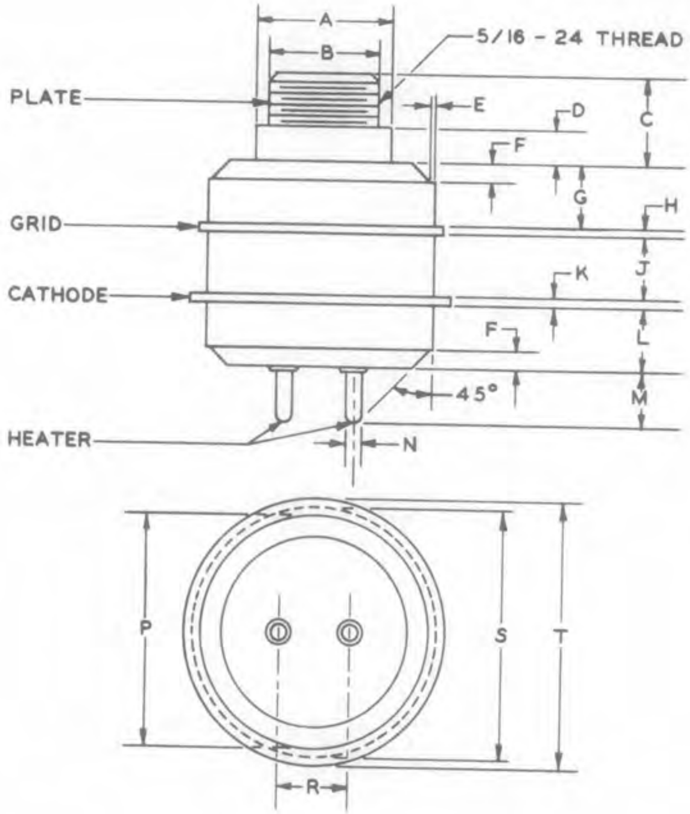
\# In any 5000 microsecond interval.

¶ Time required for plate current to reach 80% of its steady-state value.

¢ With adequate heat sink attached to threaded plate stud.

Ø To be determined.

Y-1636



Ref.	Inches		
	Minimum	Nominal	Maximum
A	0.387		0.393
B			0.318
C	0.240		0.260
D	0.095		0.105
E		0.005	
F	0.040		0.060
G	0.182		0.192
H	0.025		0.031
J	0.169		0.179
K	0.025		0.031
L	0.170		0.180
M	0.170		0.180
N	0.047		0.053
P	0.635		0.665
R	0.186		0.214
S	0.698		0.708
T	0.748		0.758

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1641*

METAL-CERAMIC TRIODE

For UHF Oscillator and Power Amplifier Applications

The Y-1641 is a high-mu triode of ceramic-and-metal planar construction intended for use as an oscillator or radio-frequency power amplifier in the ultra-high-frequency range. The Y-1641 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.15	Amperes
→ Cathode Warm-up Time, minimum¢	5	Seconds
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.2	pf
→ Input: g to (h + k)	1.5	pf
Output: p to (h + k)	0.01	pf
Heater to Cathode: (h to k)	1.4	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	1.0	Watts
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point#	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	100	150	Volts
Grid Voltage	0	---	Volts
Cathode-Bias Resistor	---	82	Ohms
→ Amplification Factor	---	95	
Transconductance	11500	10500	Micromhos
→ Plate Current	8.0	10	Milliamperes

UHF Oscillator Service

Plate Voltage	150	150	Volts
Grid Resistor	1000	1000	Ohms
Plate Current	8.0	8.0	Milliamperes
Grid Current	2.0	2.0	Milliamperes
Frequency	450	1200	Megacycles
Power Output, approximate	450	300	Milliwatts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer snould design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

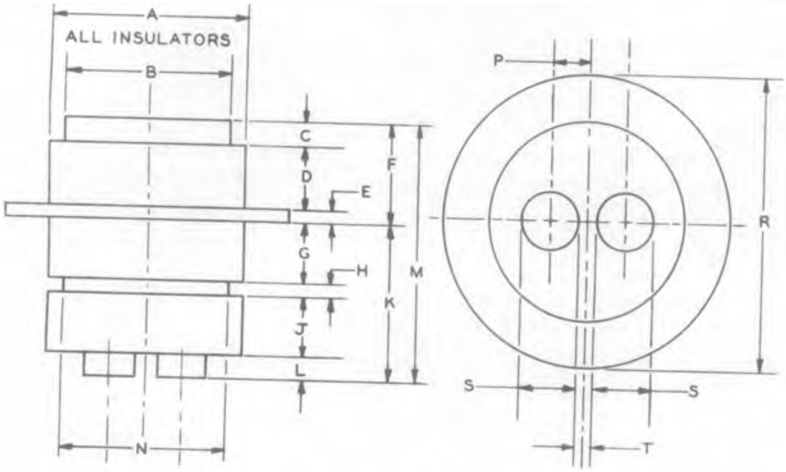
¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The Y-1641 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

¢ Time required for plate current to reach 80% of its steady-state value.

Ø To be determined.

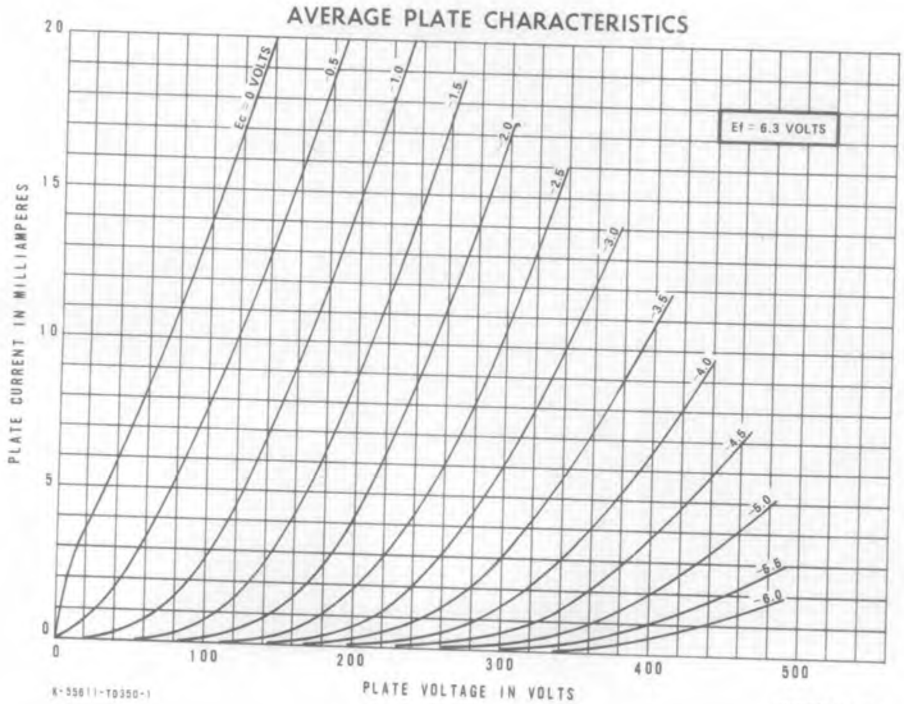
11-22-67 (B)
Supersedes 11-11-66 (B)



REF.	DIMENSIONS IN INCHES	
	MIN.	MAX.
A	- - -	0.335
B	0.271	0.279
C	0.034	0.046
D	0.094	0.104
E	0.024	0.030
F	0.156	0.174
G	0.095	0.105
H	0.022	0.028
J	0.095	0.105
K	0.268	0.292
L	0.047	0.063
M	0.430	0.460
N	0.281	0.289
P	0.055	0.081
R	0.476	0.484
S	0.086	0.094
T	0.030	- - -

NOTES:

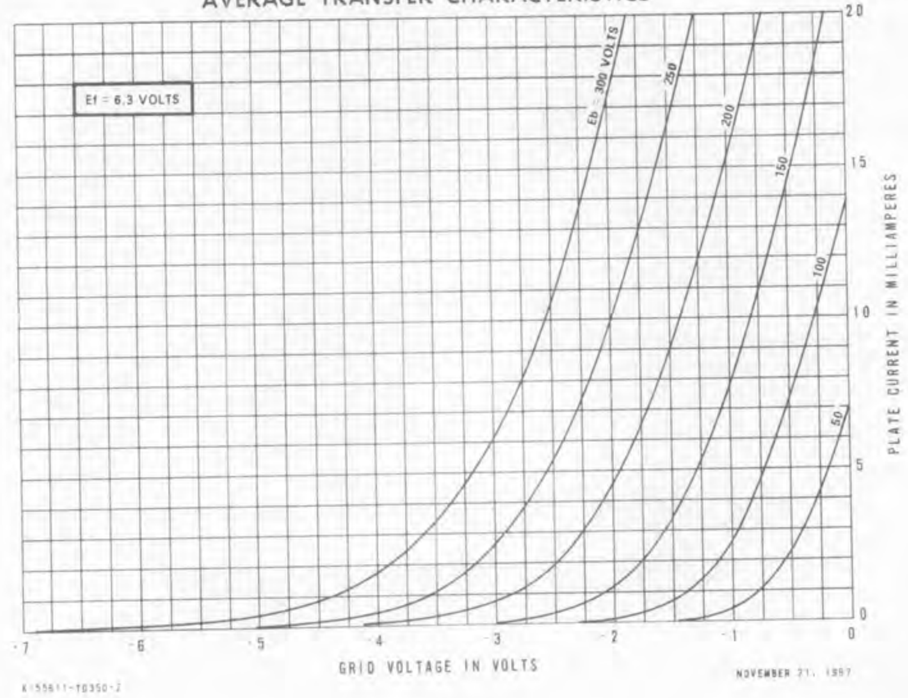
1. MAXIMUM ECCENTRICITY OF PLATE, CATHODE, AND GRID CONTACT SURFACES 0.005" FROM CENTER LINE.
2. MAXIMUM ECCENTRICITY OF INSULATORS 0.010" FROM CENTER LINE.



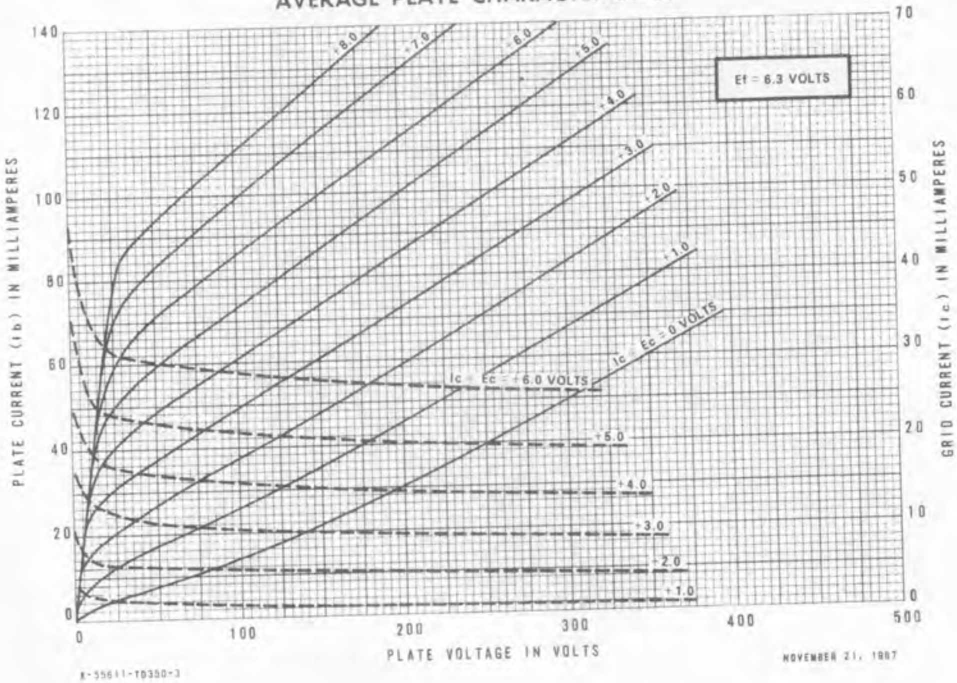
K-55611-TD350-1

NOVEMBER 21, 1967

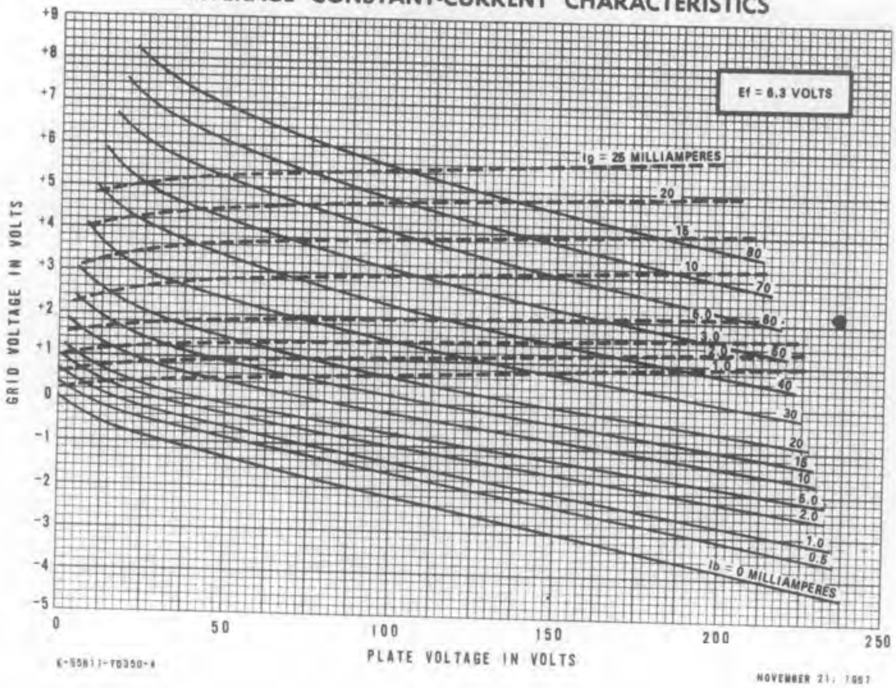
AVERAGE TRANSFER CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1730*

METAL-CERAMIC TRIODE

The Y-1730 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator or radio-frequency power amplifier.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.5	Amperes
Cathode Warm-up Time¶	5	Seconds
Direct Interelectrode Capacitances#		
Grid to Plate: (g to p)	Ø	pf
Input: g to (h + k)	Ø	pf
Output: p to (h + k)	Ø	pf
Heater to Cathode: (h to k)	Ø	pf

Mechanical

Operating Position - Any

(See Outline Drawing for dimensions and electrical connections.)

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	330	Volts
→ Plate Dissipation	6.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance		
With Fixed Bias	0.025	Megohms
With Cathode Bias	0.1	Megohms
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (CONTINUED)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	47	Ohms
Amplification Factor	100	
Plate Resistance, approximate	2500	Ohms
Transconductance	40000	Micromhos
Plate Current	25	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-4.5	Volts

UHF Oscillator Service

Frequency	400	Megacycles
Plate Voltage	300	Volts
Grid Resistor	1500	Ohms
Plate Current	25	Milliamperes
Grid Current, approximate	5	Milliamperes
Power Output, approximate	4	Watts

NOTES

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

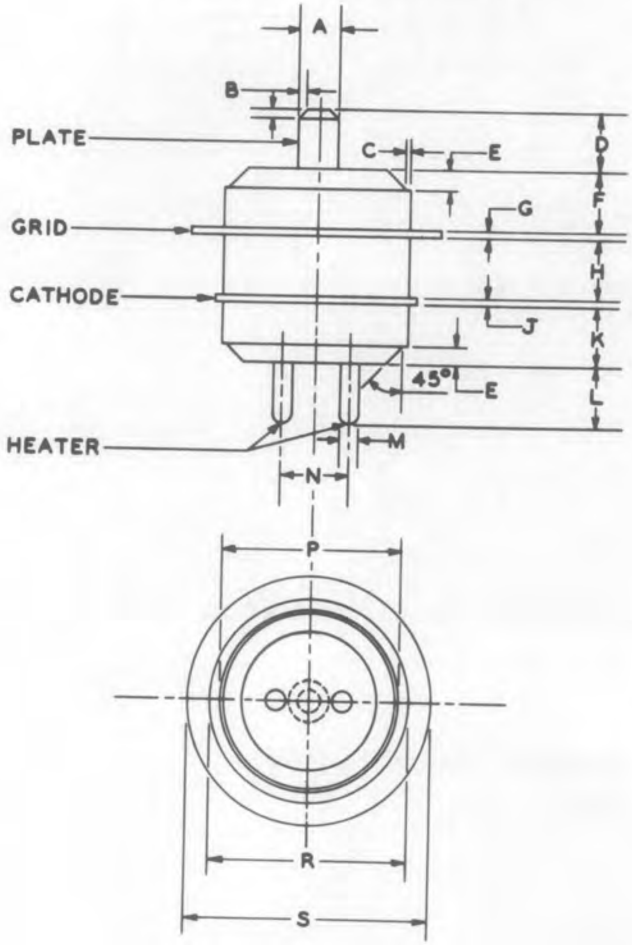
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Time required for plate current to reach 80% of its steady-state value.

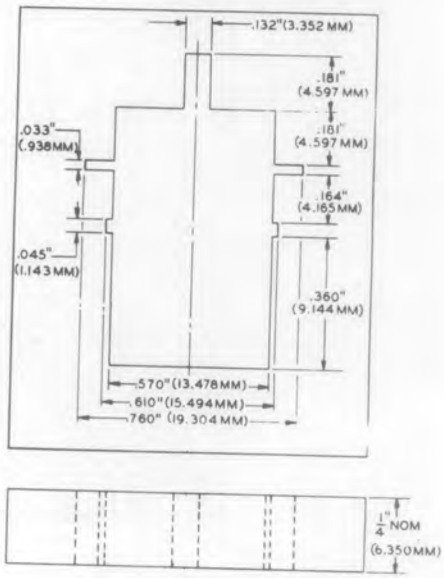
Without external shield.

∅ To be determined.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



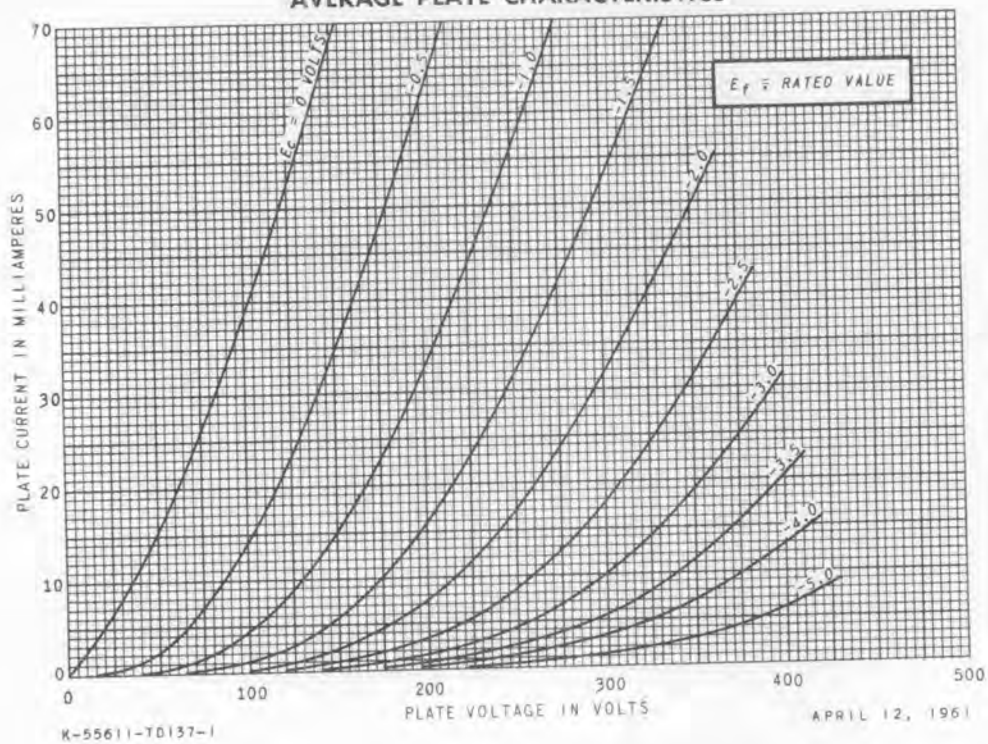
Note: Tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.170		0.180	4.32		4.57
E	0.040		0.060	1.02		1.52
F	0.165		0.175	4.19		4.45
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

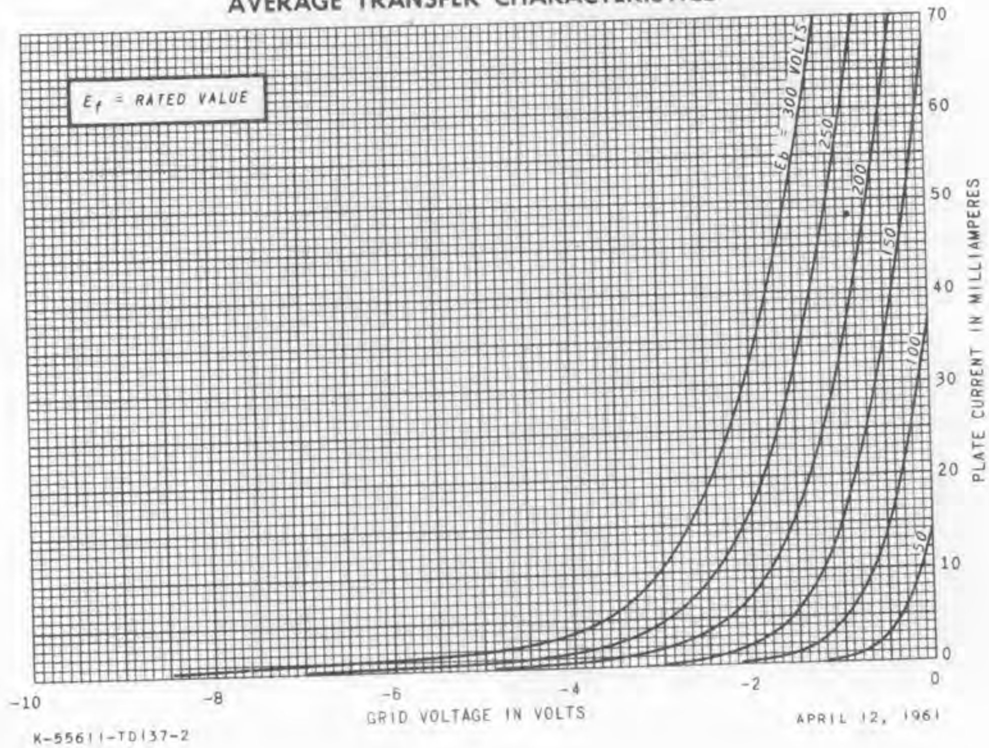
Note: The millimeter dimensions are derived from the original inch dimensions.

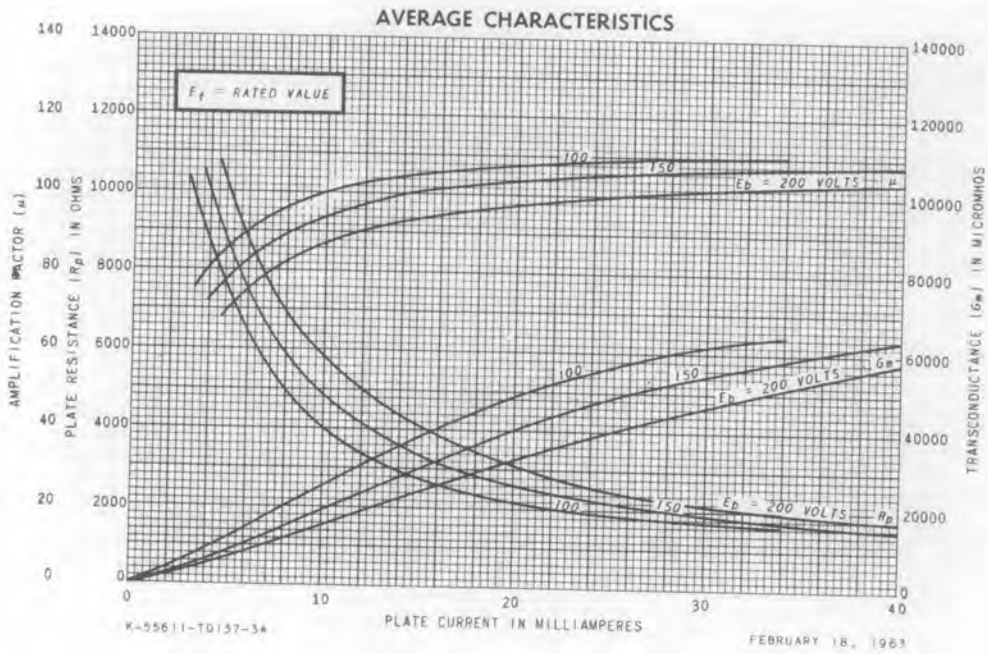
Y-1730

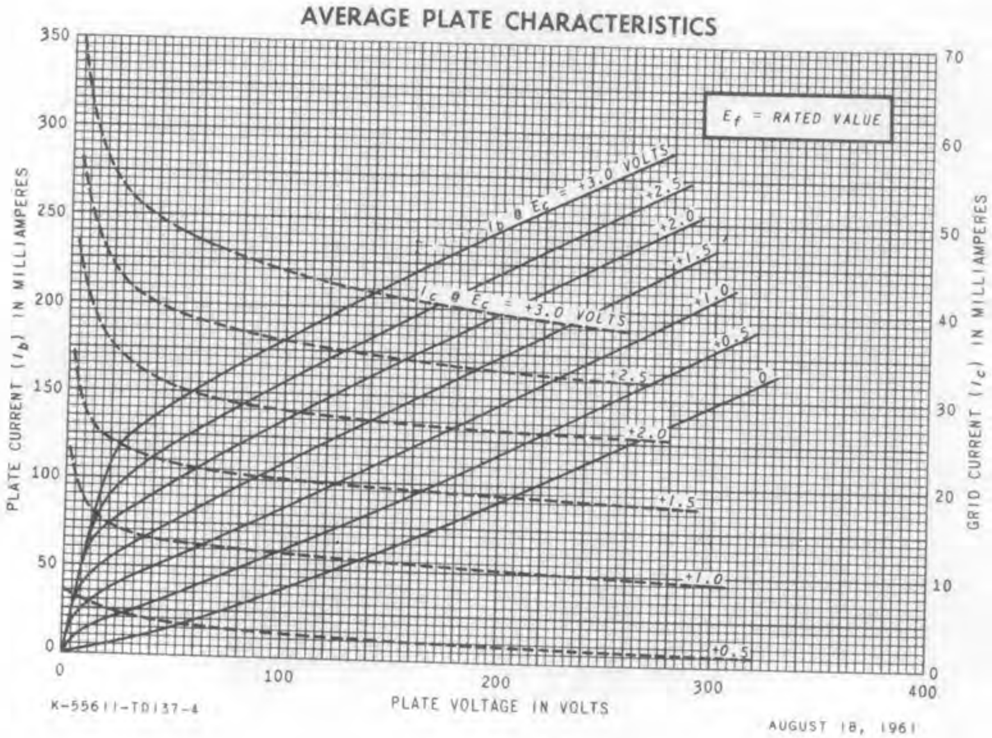
AVERAGE PLATE CHARACTERISTICS



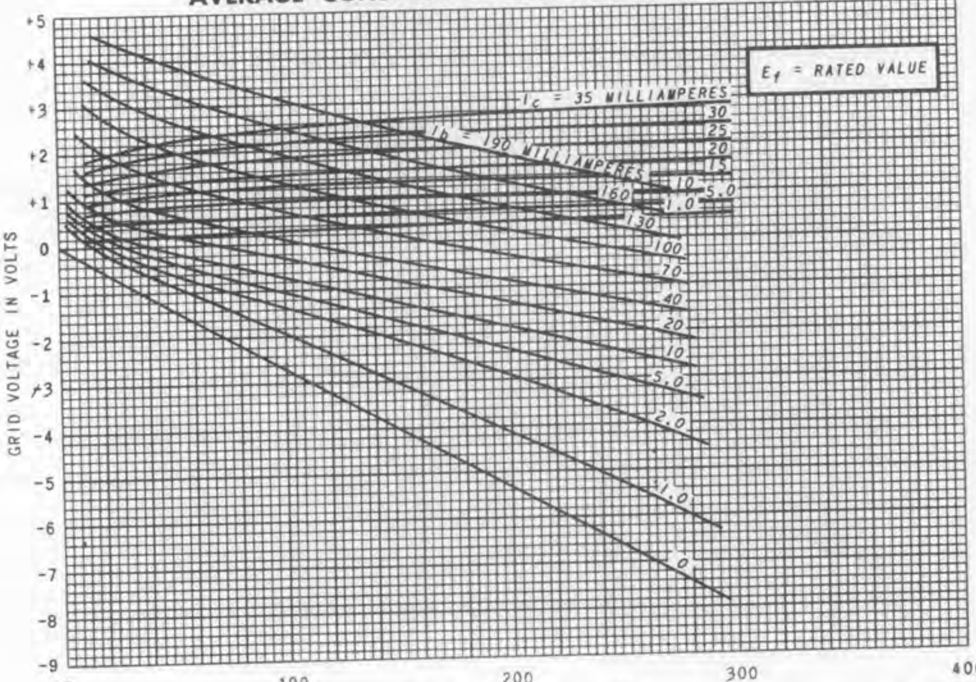
AVERAGE TRANSFER CHARACTERISTICS




AVERAGE CHARACTERISTICS
Ef = RATED VALUE
AMPLIFICATION FACTOR (µ)
PLATE RESISTANCE (Rp) IN OHMS
TRANSCONDUCTANCE (Gm) IN MICROMHOS
PLATE CURRENT IN MILLIAMPERES
Eb = 200 VOLTS
100
150
µ
Gm
Rp
K-55611-TD137-34
FEBRUARY 18, 1963


AVERAGE PLATE CHARACTERISTICS
Ef = RATED VALUE
PLATE CURRENT (Ib) IN MILLIAMPERES
GRID CURRENT (Ic) IN MILLIAMPERES
PLATE VOLTAGE IN VOLTS
Ib @ Ec = +3.0 VOLTS
Ic @ Ec = +3.0 VOLTS
K-55611-TD137-4
AUGUST 18, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD137-5

AUGUST 18, 1961

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2689*

PLANAR DIODE

The Z-2689 is a cathode-type diode of ceramic and metal planar construction intended for use as a low-current rectifier.

GENERAL

Electrical

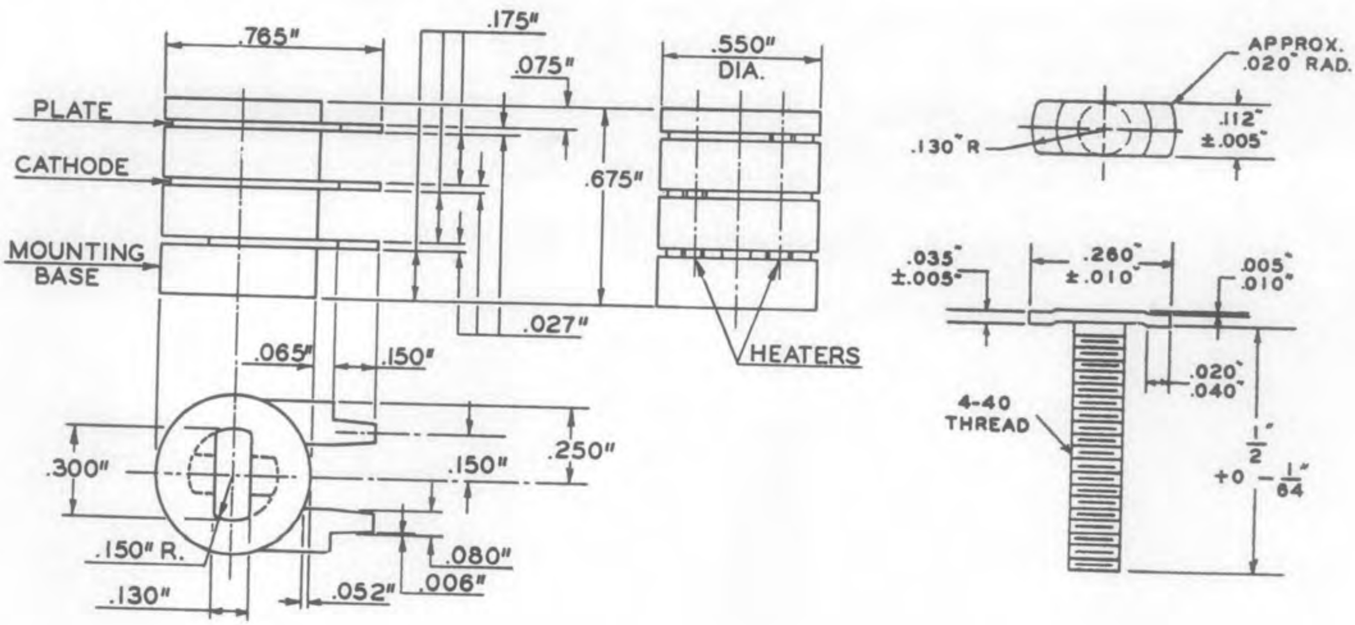
Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.6	Volts
Heater Current‡	0.4	Amperes
Direct Interelectrode Capacitances§		
Plate to Cathode	2.5	pf
Heater to Cathode	2.6	pf

Mechanical

Operating Position - Any

→ Outline Drawing



MAXIMUM RATINGS

Design-Maximum Values

Peak Inverse Plate Voltage	1000	Volts
Steady-State Peak Plate Current	150	Milliamperes
DC Output Current	25	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode		
DC Component	175	Volts
Total DC and Peak	225	Volts
Heater Negative with Respect to Cathode		
DC Component	175	Volts
Total DC and Peak	225	Volts
Envelope Temperature at Hottest Point	300	C

Design-Maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making allowance for the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration.

The equipment manufacturer should design so that initially and throughout life no design-maximum value for the intended service is exceeded with a bogey tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop Ib = 40 Milliamperes DC	15	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

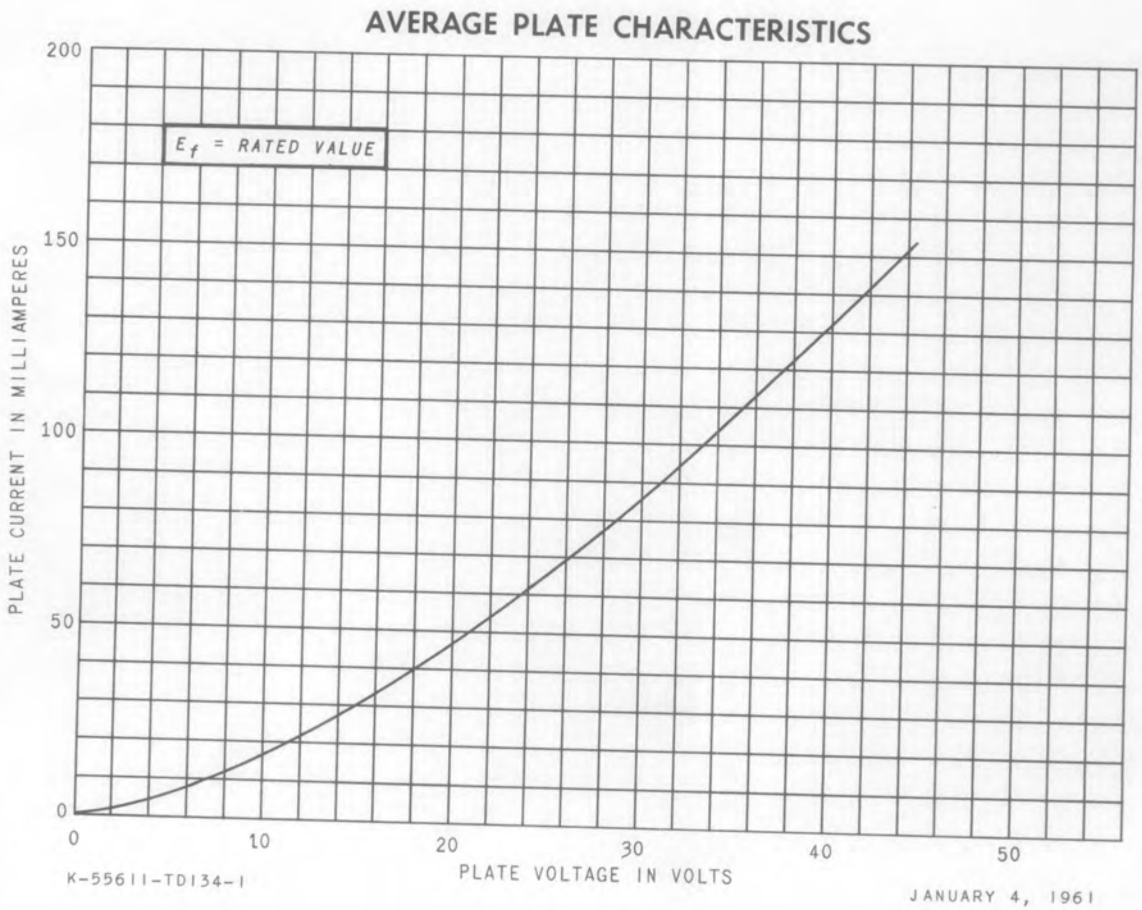
+ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

2/18/63 (B)
Supersedes 11/29/62 (B)

Z-2689


AVERAGE PLATE CHARACTERISTICS
Ef = RATED VALUE
PLATE CURRENT IN MILLIAMPERES
200
150
100
50
0
0
10
20
30
40
50
PLATE VOLTAGE IN VOLTS
K-55611-TD134-1
JANUARY 4, 1961

GENERAL TECHNICAL INFORMATION

GENERAL TECHNICAL INFORMATION

SOCKETLESS TUBE CIRCUIT TECHNIQUES

J. W. Rush, Jr.
Receiving Tube Dept.
GENERAL ELECTRIC COMPANY
Owensboro, Kentucky

In most VHF, UHF, and microwave applications non-conventional vacuum tube structures are essential. Examples of such structures are the door knob tube, the acorn tube, the rocket tube, the pencil tube, the lighthouse tube, and the more recent metal-ceramic tube structures. Designing and manufacturing efficient and reliable sockets for these tubes has been a problem. To minimize this problem many circuit designers have used "semi-socket" designs combined with soldering directly to the tube elements. In most cases separate socket-like assemblies to which connections could be soldered, were built and attached to the tube. In addition to making connection to the tube elements some means of tube support was also necessary.

It has been the circuit designer's desire to solder directly to the tube. Until recently this has not been practical because the tube envelope or seals could not tolerate soldering temperatures or the tube element was not physically strong enough to be used for tube support. This latter socket requirement was a particular problem for circuitry to be subjected to high shock and vibration.

Recent tube manufacturing techniques have permitted the introduction of a line of planar ceramic vacuum tubes* that are both tolerant to soldering temperatures and can be physically mounted by the tube elements themselves. In addition to the several coaxial cavity designs for microwave service other types** were also introduced that were designed specifically for direct soldering. The tubes feature solder lugs and "T" bolt mounting of the tube envelope to a print-board or metal chassis. (See Fig. 1 and 2 illustrating the mechanical features of the "T" bolt.) Other lead attachment procedures such as wire wrap, spot welding, brazing and mechanical clips can also be used.

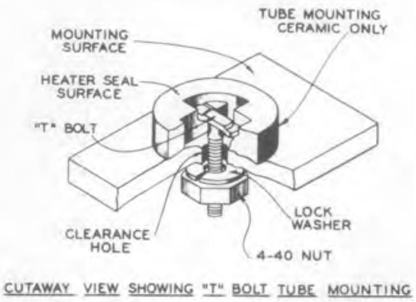


Fig. 1

Fig. 2

* EIA type number 7077, 7266, 7486, 7481
GE Development types Z-2823, Z-2835, Z-2869, Z-2866, Z-2897

** EIA numbers: 7462, 7720, 7625, 7588, 7296, 8081, 8082, 8083
GE Development types: Z-2868, Z-2354, Z-2870, Z-2731, Z-2692

For coaxial circuits it is feasible to solder cavity components directly to the tube elements (See Fig. 3). This procedure not only provides physical support in some cases but also reduces the problem of obtaining good RF contact between tube and cavity elements. With proper care the tube-circuit assembly can be replated after assembly.

Fig. 3

The application of coaxial resonant circuits soldered directly to the tube elements is illustrated by an assembled, small tube-cavity combination, and an unassembled, larger tube-cavity, tube-circuit combination. This particular combination would be useful for a half-wave grid resonator cavity for a re-entrance oscillator. The two tubes shown are designed for grounded cathode usage.

THEORETICAL ADVANTAGES

By eliminating tube sockets in their usual form, several theoretical performance advantages are obtained. In most cases, for reasons of economy or moldability, the insulator portion of a tube socket is usually a higher loss factor material. With the elimination of the socket insulator losses, higher circuit "Q's" can be realized. Higher unloaded "Q's" lead to better circuit performance through higher circuit efficiency.

In many modern electronic circuits maximum gain-bandwidth must be obtained to process the high definition and complex signal pulse. The more general relation for broadband gain in a vacuum tube is:

$$G \cong g_m R_o$$

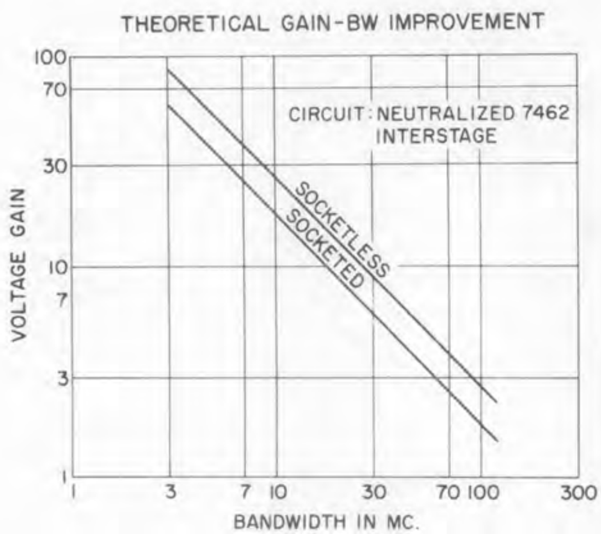


Fig. 4

The gain, G, depends most upon tube transconductance, gm, and the circuit load resistance, R_o (See Fig. 4). For a simple interstage circuit the bandwidth, BW, can be estimated to be:

$$BW = \frac{1}{2 \pi R_o C_t}$$

C_t is the total shunt interstage capacitance. If we then construct the expression for gain-bandwidth product:

$$G\text{-}BW = \frac{gm}{2 \pi C_t}$$

This relationship shows that for wide band amplification maximum available transconductance and minimum tube and circuit capacitances are essential. The available tube transconductances are high, up to 50,000 micromhos, and this is obtained with relatively small tube capacitances. To use the resulting high tube gain-bandwidth product the applied circuitry must have a low value of shunt capacitance. The use of direct soldering connections to the tube or soldering to clamps or clips supported by the tube assures maximum tube-circuit gain-bandwidth.

In addition to better gain-bandwidth products at any given center frequency, lower tube circuit capacitances permit operation at higher frequencies. By using resonant elements that clamp or solder to the tube itself, lumped constant circuitry may be used up to 1500 mc. Similar application of slab or flat parallel line elements provides efficient performance up to at least 3000 mc (See Fig. 5 and 6).

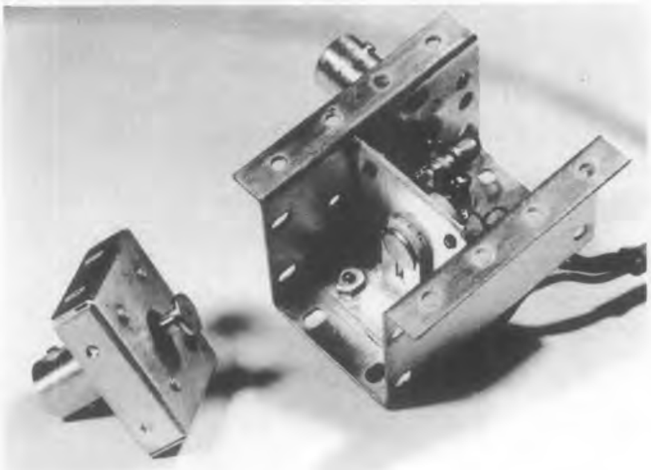


Fig. 5

A 2700-mc grounded-grid amplifier featuring the socketless techniques to obtain good performance into the kilomegacycle region. The tube anode is resonated by a short section of strip line functioning as a parallel tuned plate circuit. The base of this plate line is by-passed for RF at the bottom of the amplifier chassis. Power is coupled out by means of an adjustable series output capacitor (shown removed from the amplifier). A clip-on connector (not visible) is used to connect an input coupling capacitor to the tube cathode. Heater chokes have been soldered directly to the tube heater buttons. The grid is grounded by a flat washer held down by four 4-40 screws.

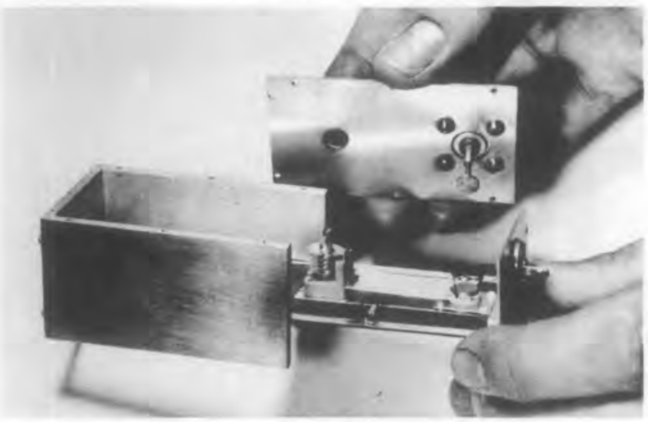


Fig. 6

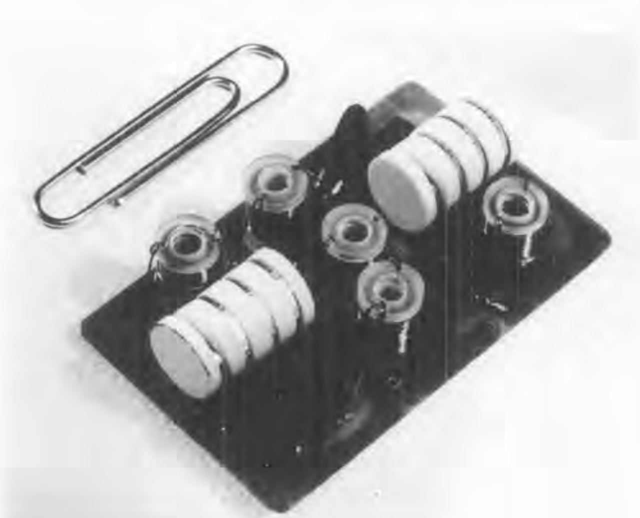
A 1200 mc oscillator featuring snap-on slab-line resonators and screwed-down grid clamps. This circuit is a modified Colpitts configuration. The grid line is an un-etched portion of the print board base. The tube fore-shortens the half wave line on one end and the tuning capacitor fore-shortens the other. A grid leak resistor is soldered at a low impedance point.

For many years the degenerative effect of cathode lead inductance has limited the high-frequency capabilities for conventional vacuum tubes as much as transit time effects. For this reason and others, the non-conventional structures of microwave tubes are used. The very low value of lead inductances in many cases was wasted by using high socket lead inductances. For the same reason tube instability was often due to poor grid grounding.

PRACTICAL ADVANTAGES

The use of socketless circuit techniques provides several practical advantages. Better system reliability is one of the more important. Since the socket can be eliminated, troubles due to contact wear, failure or corrosion are reduced. No socket insulators are present which may crack or deteriorate. Very low contact resistances can be obtained using direct soldering techniques. Better tube reliability can be obtained if known and consistent heat sinks are established for the tube. In some cases tubes have failed as a result of additional acceleration forces resulting from poor socket designs. Physical clamping of the tube directly to the chassis assures that the tube sees no more shock and vibration than the chassis itself. The increased performance gained by socketless circuitry means fewer stages for the same system gain. In some cases tubes in sockets being easy to remove, are selected to compensate for the loss of performance due to a faulty component. This repair procedure usually leads to a more catastrophic failure later on. Screwed-on or soldered connections to the tube are more easily inspected and do not depend upon assumed contact pressure.

Many of the microwave triodes are made very small to obtain low capacitance and transit time characteristics. Often the sockets for these tubes are much larger than the tubes themselves. This means that system size and weight can be lowered if alternate connection techniques are used (See Fig. 7). In some cases the tube itself also serves as a terminal strip for the connection and support of other circuit components such as resistors and capacitors. Socketless techniques also reduce the cost and design time associated with a socket design. Some of the ceramic triodes are fitted with mounting hardware requiring only a hole in a chassis or printboard. These tubes can be used with all connections being made on one side of the board or chassis. This leads to simplified circuitry or permits the use of dip-soldering techniques. (See Fig. 8 for suggested connectors for the coaxial types.)



A complete cascode circuit showing two soldered-in titanium metal ceramic triodes. This circuit features small size and weight through the elimination of sockets and the use of printed circuit techniques.

Fig. 7

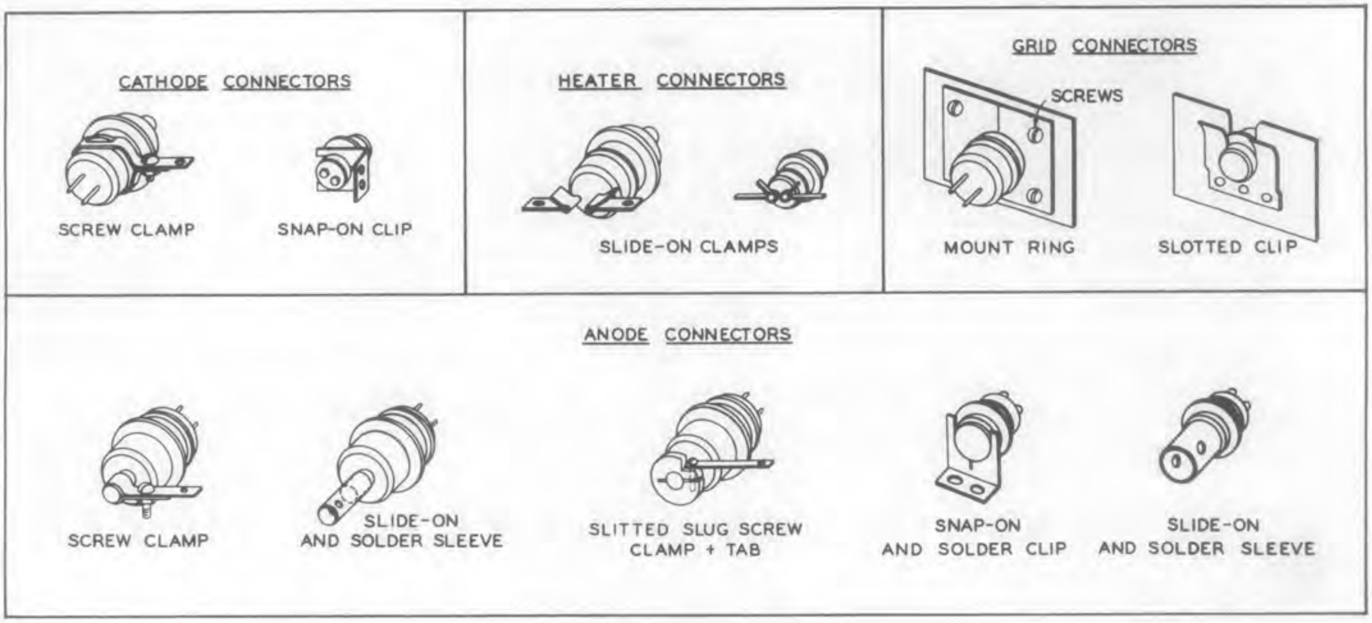


Fig. 8

SOLDERING TECHNIQUES

The use of socketless circuitry with good reliability usually requires soldering either to a tube clamp or tube element. When soldering to an auxiliary clamp or to the tube itself the usual care should be taken. If soldering directly to the tube is attempted on non-tolerant tube structures, failure can result from damaged seals. Although the use of high temperature seals and ceramic insulators greatly reduces the chance of this happening, the tubes are not indestructable. Ceramic tube structures are tolerant to soldering temperature as evidenced by tube life tests at temperatures up to 450°C. However, due to their small sizes, very large thermal gradients across the tube seals can and do cause tube failures and a resulting loss of reliability.

To reduce the possibility of tube damage a few precautions should be taken:

1. Use a solder with as low a melting point as possible for the intended tube circuit ambient operating temperature.

2. Use small wattage soldering irons to reduce the thermal inertia of the soldering heat.

3. Preheat the tube whenever possible to reduce further the thermal in-rush when heat is applied. Ovens, hot plates, I-R lamps, etc. can be used to preheat the tube prior to soldering. If these are not available, thermal shock can be reduced by operating the tube filaments for several minutes before soldering.

These precautions are most important on the smaller coaxial types since the thermal mass of these designs is small and very little thermal resistance is present between the solder surface and the tube seals. The use of solder-forms is highly recommended. The lug versions can be used with no more than the usual precaution and can be treated as any other solder-in circuit component. It should be noted that the suggested soldering procedures are conducive to cold soldering joints. This is true and care must be taken in this respect.

The basic tube structure used for these solderable tubes is made of titanium metal and ceramic. The titanium is essential for several reasons but its most important feature is the almost identical thermal coefficient of expansion when compared to good RF ceramic materials. Titanium on the other hand is very difficult to plate and no ordinary techniques have yet been devised to plate in the usual fashion. To provide solderable surfaces the titanium is first nickel plated and a thin gold layer is then applied. This gold layer is consumed by amalgamation into the solder. The nickel undercoat is the surface to which the solder connection is actually made. After many solderings, this nickel plating can be consumed. When this happens, the titanium base metal is exposed and one is confronted with the difficult task of soldering to titanium.

The thickness of the nickel plating must be carefully controlled between two limits. If the plating is too thin only a limited number of solderings can readily be made. If the plating is too thick peeling results. In development work where tubes are removed or resoldered many times increased difficulty may be expected in soldering operations.

TUBE REMOVAL

When it becomes necessary to remove the soldered-in tube the usual techniques apply. The tube can be treated as any other soldered-in component.

If the coaxial tube outline is used, it becomes expedient to use auxiliary clamps not only for soldering connections in some cases but also for the mechanical support of the tube. At microwave frequencies most circuits use the tube in a grounded grid configuration and the tube is mounted by clamping the grid element to a chassis shield or wall. In most cases DC "floating" of the grid is not essential and by-passing is not necessary. Where by-passing is required, mica or suitable spacers can be used without loss of mechanical support. Due to the physical location of the cathode of the coaxial designs, cathode clamps are usually used to provide connections and soldering surfaces at more convenient distances from the tube. Such clamps also greatly improve the ease of tube removal. Soldering or clamping is usually optional on the heater and anode terminals. Soldering is desirable for the heater connections since contact resistance at these points may seriously lower the tube heater voltage.

EXAMPLE EQUIPMENT

Figure 9 shows a 10-frequency crystal controlled "STALO" developed by the Light Military Electronics Department of General Electric Co. Socketless circuit techniques are used to reduce size and weight, to obtain mechanical and electrical stability, and to fulfill the need for maximum gain-bandwidths for the broadbanded multipliers and amplifiers. Small "T" bolt ceramic triodes are used in each of the 10 crystal channels and frequency selection is made by applying B+ to the desired channel. At the center of the 10 oscillators a "clamp-on" cathode connector is used as a common input to a grounded grid stage and connections are made around the

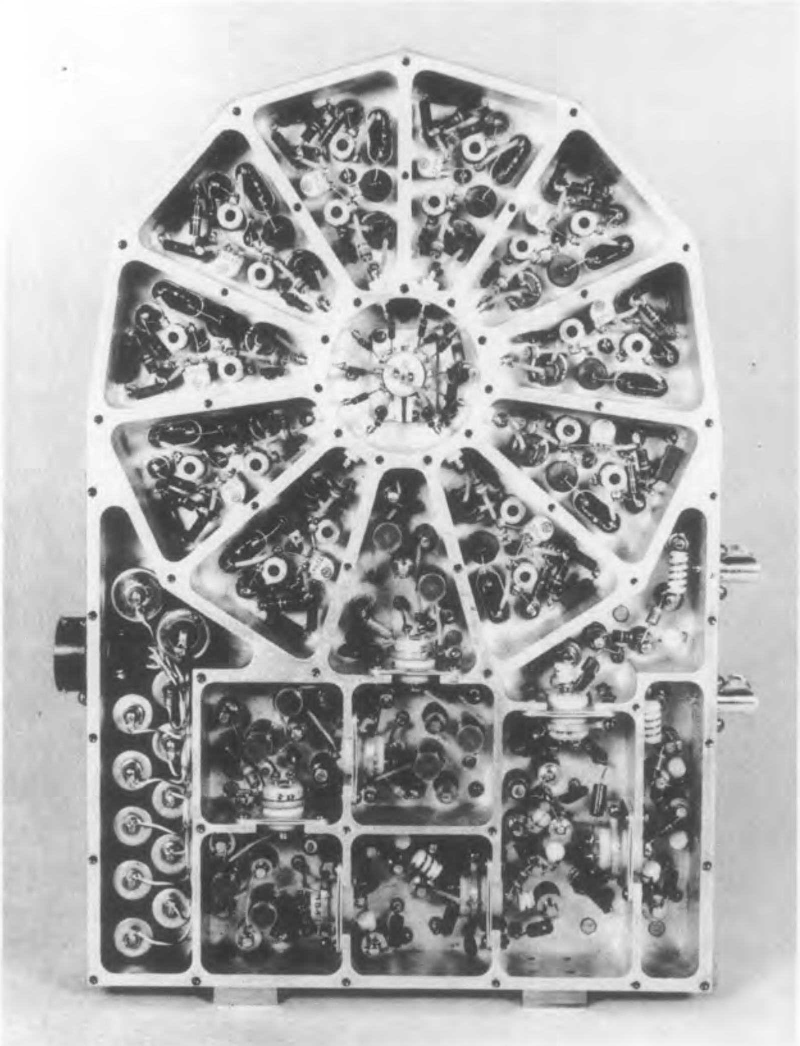


Fig. 9

circumference of the cathode clamp. The grid of this tube and the remaining larger coaxial triodes, eight in all, use flat sandwich or surface clamps. The same cathode clamp is used for all the coaxial outline tubes. The wide bandwidths were essential to provide multiplying and amplification over about a 10% bandwidth at near 500mc center frequency. The maximum gain per stage was essential to keep the total number of stages to a minimum for maximum reliability. Multiplying at wide band-widths is traditionally difficult and high transconductance triodes as well as socketless circuitry were required for acceptable performance.

CONCLUSION

With the advent of new vacuum tube manufacturing techniques it has become practical to use new socketless circuit techniques. Where sockets are not specified, circuit performance and reliability are improved. Such techniques permit the use of vacuum tubes at higher frequencies as well as providing a companion component to improve the state-of-the art for lumped constant and slab line circuitry.

NOISE FIGURE AND THE GRIDDED VACUUM TUBE

The three most important types of noise in the gridded triode vacuum tube are shot noise, flicker noise, and induced grid noise.

Shot noise is characterized by its independence from frequency effects and its dependence upon tube currents and transconductance.

Flicker noise or one-over-frequency-noise usually follows the simple rule of varying inversely with frequency at the rate of three decibels per octave. Flicker noise usually limits the sensitivity of very low frequency amplifiers and produces instability in DC amplifiers. The exact cause of flicker noise is not well defined but reduction of this effect can be best obtained by using triodes with high transconductance at low plate currents. To reduce both shot and flicker noise effects, triodes with maximum transconductance to plate current ratios should be used. The planar ceramic triode is outstanding in this respect.

Induced grid noise is caused by transit-time effects which induce shot noise into the signal grid. This source of noise is characterized by its six decibels per octave increase with frequency. Figure 1 is an approximate representation of these three noise sources as a function of frequency.

Johnson or thermal noise can also be generated by tube and circuit losses or if any unbypassed resistances are used. This noise source is usually not a serious problem if proper components and circuitry are used.

When a tube is subjected to shock or vibration, another source of noise called microphonics can occur. The frequency profile of this noise varies greatly with tube structure. Although microphonics usually produce AM signals in audio amplifiers, some AM and FM effects can occur in RF amplifiers. The planar ceramic tubes are usually less microphonic than other competing tube structures and the use of bonded-heater techniques has practically eliminated this source of noise.

Equivalent Noise Circuits

Figure 2 shows two simplified forms of a commonly used noise figure equation[1]. An equivalent noise circuit is also shown. The noise figure equation can be solved for minimum noise figure with respect to R_s or G_s. This relationship is:

$$NF_{min} = 1 + 2\sqrt{5G_t \, Req}$$

The resulting optimum source resistance equation is:

$$R_s \text{ opt.} = \sqrt{Req. \div 5\, G_t}$$

To calculate the minimum available noise figure and the source resistance required to obtain this, the absolute values of Req and G_t must be known. The above equations assume G_c to be insignificant and in most cases this condition exists. Req can be estimated by the equation:

$$Req = 2.5 \div \text{triode transconductance}$$

G_t results from transit time effects which produce out-of-phase grid currents and voltages and has a noise output five times thermal.

A second equivalent noise circuit[2] has been developed using Req and a new term G_n. See Figure 3. Req is identical to the Req used in Figure 2 and G_n is equal to 5 G_t. The equations for minimum noise figure and optimum source resistance are then simplified as shown in Figure 3. This simplified equivalent circuit technique leads directly to the measurement of Req and G_n. If an input conductance tuning curve is obtained as described, the equation of this curve is:

$$G_{tot} - G_n = W^2 \Delta C^2 \, Req$$

G_n is obtained immediately as shown and the above equation can then be solved for Req. G_{tot} and ΔC are obtained for two points A and B on the curve. The curve shown in Figure 3 can be generated from tests conducted on a circuit similar to the one shown in Figure 7. L_1 can be calibrated for an equivalent capacitance change or a tuning capacitor can be added in shunt with the input inductor. R_s is omitted.

The measured values of Req can be checked against the previous approximate equation. The factor of 2.5 appears to vary from about 2 to 3.5 depending on the tube size and geometric configuration. The approximate value of G_t can be obtained by dividing G_n by five. This value of G_t can then be used to determine input circuit bandwidths if all loading is due to transit-time effects.

Measured Results

The procedure outlined in Figure 3 was used to determine the equivalent noise parameters for several low noise planar ceramic triodes:

Type	Req (ohms)	G_n at 90 MC (mohms)
6299	170	160
7077	300	100
7462	300	100
7588	45	500
7644	170	160
7768	40	500
7784	170	160
8083	300	100

It should be noted that minimum noise figure is a function of the product of Req and G_n. For similar cathode current densities, grid wire sizes, grid wire spacing, and grid to cathode spacing, this ratio appears to be relatively constant. These geometric and electrical conditions exist on the low noise planar triodes and similar noise figures are quoted for all types. See the "Optimum Noise Condition vs Frequency" curves shown at the front of the ceramic tube reference manual. The value of optimum source resistance varies directly with the ratio of Req and G_n. The larger triodes provide more transconductance and lower values of Req. The larger tubes also have higher values of transit-time conductance and G_n. These conditions result in much lower values of optimum source resistance for the larger tubes, 7588 and 7768, at any given frequency.

Noise Parameters vs Frequency

The table shown above records measured values of G_n at 90 megacycles. The value of Req has been described to be independent of frequency and G_n to be a function of frequency squared. Using the values of Req and Gn measured at f_o equal to 90 mcs, minimum noise figures and optimum source resistance at any other frequency, f, can be calculated. See Figure 4. Reasonably good correlation between measured and calculated performance has been obtained between frequencies from 30 to 3000 megacycles.[3]

Tube Selction

One might ask, why use the larger tubes if similar noise figures can be obtained with the smaller tubes? For minimum over-all noise figures, the gain of the first stage and noise figure of the second stage are important. The noise figures previously discussed apply only to the first stage of an amplifier chain. The relationships are equated as follows:

$$NF_{1,2} = NF_1 + \frac{NF_2 - 1}{GL}$$

The noise figure subscripts apply to the first and second stages and G_1 is the available gain of the first stage. Wide bandwidths are usually required in most modern low noise amplifiers. For wideband circuits, the larger tubes are desirable to obtain both maximum gain and lower values of optimum source resistance. The smaller tubes can be used most effectively for narrow-band low noise circuits where their size, weight, low-input powers, and economy are more important. In both cases, the second stage should also be a low noise tube if lowest noise figures are desired.

Noise Performance vs Operating Conditions

The low noise triode must be properly applied if optimum noise performance is desired. Tests have shown that variations in heater voltage within rated values produce little effect on noise figure. The voltage changes normally associated with plate voltage supplies are also unimportant if the initial value is properly chosen. Generally speaking, the triode should be operated under those conditions which provide a maximum transconductance to plate current ratio, produce no grid currents, and provide suitable gain to reduce second stage noise effects. In most cases, the tube is operated with about .5 volt bias, rated heater voltage, and maximum rated plate dissipation if maximum noise performance is required.

There are three acceptable methods of biasing the triode and these are shown in Figure 5. Condition "a" is the simplest and uses a low value of cathode resistor and a fixed plate voltage. This method produces the widest variation in operating conditions from tube to tube. The type shown in Figure 5 is the 7462 and each small square represents one tube. Condition "b" uses the same value of cathode resistor but more constant plate currents are obtained through the use of a large plate dropping resistor. Higher plate voltages must be used and the power loss in R_B must be tolerated. Referring to Figure 6, it can be seen that minimum noise figures are obtained along a bias line slightly less than .5 volts. These curves were taken on the type 7588. In Figure 5, condition "b" gives the smallest variation in bias and the level is maintained near the desired value of about .5 volts. For this reason, condition "b" is the best bias method for obtaining good initial noise performance from tube to tube and maintenance of low noise with life. Condition "c" uses a fixed value of plate voltage and a large cathode resistor to maintain constant plate currents. A negative voltage at the cathode or a positive voltage at the grid is necessary to provide the proper bias between the grid and cathode. This bias method results in wide variations in bias from tube to tube with a large percentage of the tubes operating at very low bias. Three reject 7462's were purposely included in Figure 5. These three tubes required zero bias to maintain the recorded plate currents near 6.5 ma. for condition "c". These same three tubes were the three highest noise figure tubes shown for condition "c" but gave lower noise figures using condition "b" bias.

High Current Density Effects

To improve the noise performance of the triode at RF frequencies the effect of transit-time must be reduced. This can be done with closer grid to cathode spacing or by increasing the accelerating forces on the electron. In some cases closer grid to cathode spacings are practical but noise figure tests show no significant improvements. Most types are designed to make maximum use of cathode space-charge smoothing and this is not always the closest grid to cathode spacing. The second method, using greater accelerating potentials, is present when the tube is operated at higher current densities. In addition to reducing the transit times, much higher transconductance result and lower values of Req are present. The type 7077 triode is normally tested at about .15 amperes per sq cm and noise figures around 8 db are measured at 1200 mcs. Noise tests were made at .6 a/cm^2 and an over-all noise figure of 4.8 db was measured. Some of the ceramic tubes listed in the reference manual have good life at .6 a/cm^2 and lower than published noise figures can be obtained.

Circuit Considerations

The neutralized grounded cathode and grounded grid stage are most used for low noise amplifiers. The input impedances for these two circuits are radically different and require different noise considerations. In theory, both circuits have similar minimum noise figure, and optimum source resistance. The theory also predicts that power match and minimum noise figure conditions cannot exist at the same time. Therefore, the effect of mismatch between the source and tube input becomes important. The grounded cathode circuit is most useful at lower frequencies because less mismatch exists. For wide band circuits the lower optimum source resitance types should be used as previously discussed. Figure 8 shows the measured input bandwidth, measured over-all noise figures, and calculated first stage noise figure for a cascoded pair of 7462 triods at 30 mcs. The results on this grounded cathode input circuit also shows that relatively large changes in source resistance result in small changes in noise figure if values near the optimum value are initially chosen.

At higher frequencies much lower source resistances are required and the grounded grid stage provides less mismatch under optimum noise conditions. In most cases above about 800 mcs, for all practical purposes, minimum noise is obtained under minimum VSWR adjustments. It is very difficult to determine the frequency at which similar noise results are obtained for both circuit arrangements. Calculations are complicated and various assumptions are necessary. The best method of obtaining minimum noise figures uses commercially available automatic noise figure test equipment. This equipment continuously reads noise figure as a circuit is adjusted and both circuits can be easily compared. The curves shown in Figure 6 were obtained using an automatic noise figure test set. Although under power match conditions the theoretical noise figure is over 5 db, a measured figure of slightly over 3 db was obtained. The tube input was about 25 ohms and the optimum source resistance is over 200 ohms. The automatic test set permitted an optimum low noise adjustment between conjugate and optimum source resistance conditions.

Conclusions

To assist the designer of low noise circuits simplified techniques have been developed for triodes. Both theoretical and measured results confirm that lowest noise figures require the best tube choice for a given frequency and bandwidth, proper DC operation, and proper circuit arrangements and adjustments. State-of-the-art results are very seldom if ever obtained without careful and laborious procedure.

References:

1. Vacuum Tube Amplifiers Valley and Wallman, pp 634
2. "Theory of Noisy Four Poles" Rothe and Dalke Proc. of IRE, June 1956
3. "A Comparison of Domestic and Foreign RF Amplifier Tubes for UHF-TV" C. Metelman Die Telefunken Rohre, 1959.

VACUUM TUBE NOISE

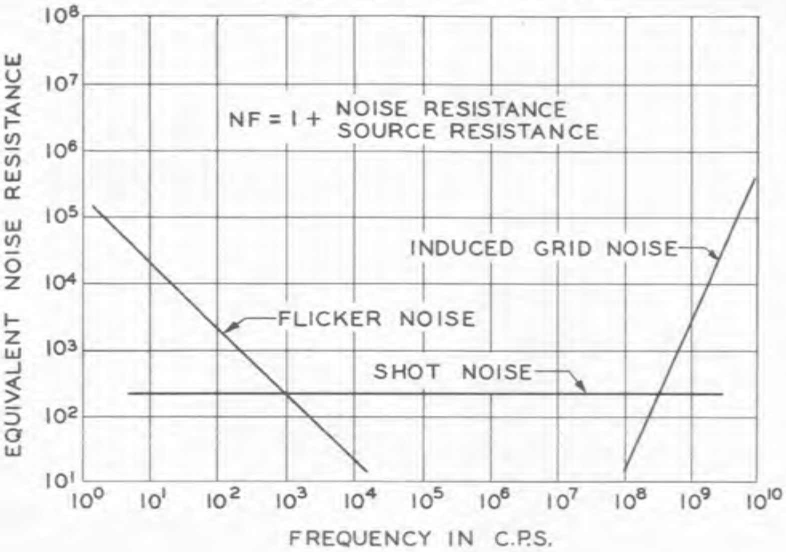


Fig. 1

NOISE FIGURE EQUATIONS

REFERRED TO TUBE INPUT:- $NF_1 = 1 + \frac{G_C}{G_S} + \frac{5G_\tau}{G_S} + \frac{R_{EQ}|G_S + G_\tau|^2}{G_S}$

OR:- $NF_1 = 1 + \frac{R_S}{R_C} + \frac{5R_S}{R_\tau} + \frac{R_{EQ}}{R_S}\left|\frac{R_S + R_\tau}{R_\tau}\right|^2$

WHERE:- NF_1 = FIRST STAGE NOISE FIGURE (POWER RATIO)

NF_1 IN DB. = 10 LOG NF_1

$R_S - G_S$ = SOURCE RESISTANCE OR CONDUCTANCE TRANSFORMED TO INPUT GRID

$R_\tau - G_\tau$ = TRANSIT TIME LOADING OR CONDUCTANCE

$R_C - G_C$ = COLD INPUT RESISTANCE OR CONDUCTANCE

R_{EQ} = EQUIVALENT SHOT NOISE RESISTANCE

EQUIVALENT NOISE CIRCUIT:-

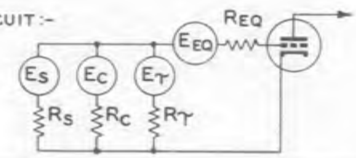
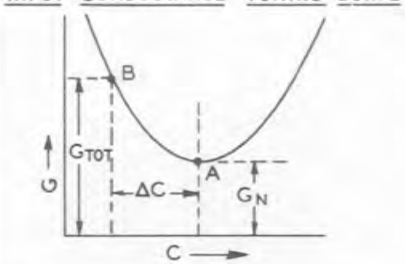


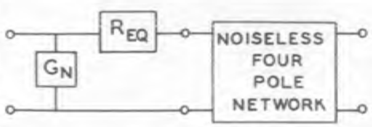
Fig. 2

EQUIVALENT INPUT NOISE PARAMETERS

INPUT CONDUCTANCE TUNING CURVE



EQUIVALENT NOISE PARAMETERS INPUT CIRCUIT



G_N = $20 I_D$ AT MINIMUM INPUT CONDUCTANCE (A)

G_{TOT} = $20 I_D$ AT DETUNED POINT (B)

ΔC = CHANGE IN TOTAL INPUT SHUNT CAPACITANCE BETWEEN A AND B

I_D = NOISE DIODE CURRENT TO DOUBLE NOISE OUTPUT OF TUBE UNDER TEST

$$G_{TOT} - G_N = \omega^2 \Delta C^2 R_{EQ}$$

$$NF_1 - 1 = 2\sqrt{G_N R_{EQ}}$$

$$R_{S(OPT)} = \sqrt{\frac{R_{EQ}}{G_N}}$$ (IF CIRCUIT LOSSES ARE NOT CONSIDERED)

Fig. 3

$$R_s \text{ (optimum)} = \frac{f_o}{f}\sqrt{\frac{R_{eq}}{G_n}}$$

Where: R_s (optimum) = Optimum source resistance in ohms

f_o = Frequency in megacycles at which G_n was measured

f = Desired frequency of operation in megacycles

Minimum attainable noise figure in decibels may be calculated with the following formula:

$$NF \min = 10 \log \left(1 + 2\frac{f}{f_o}\sqrt{R_{eq} G_n}\right)$$

Fig. 4

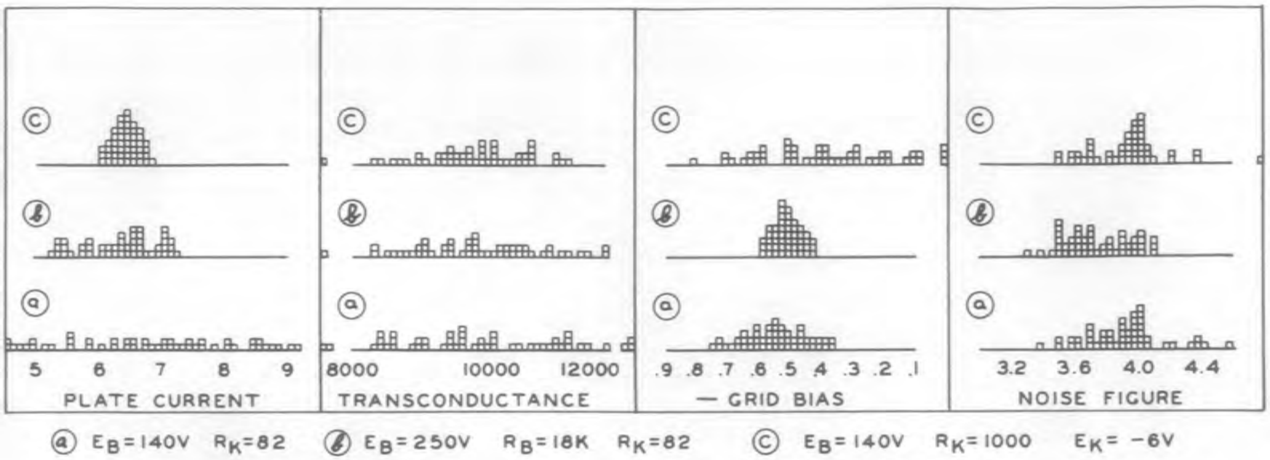


Fig. 5

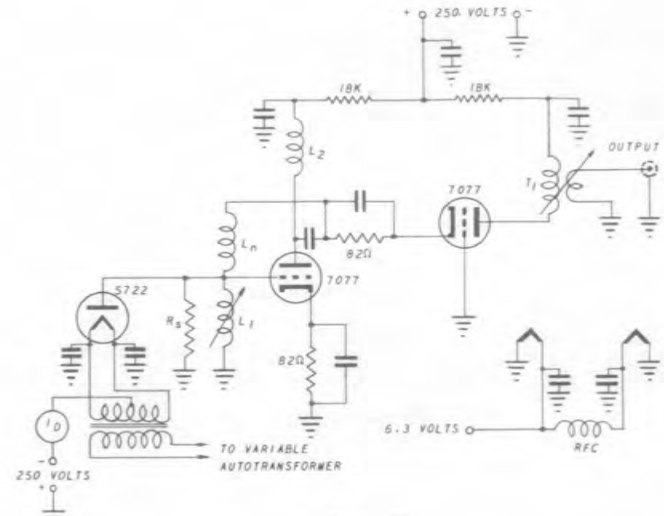


Fig. 7

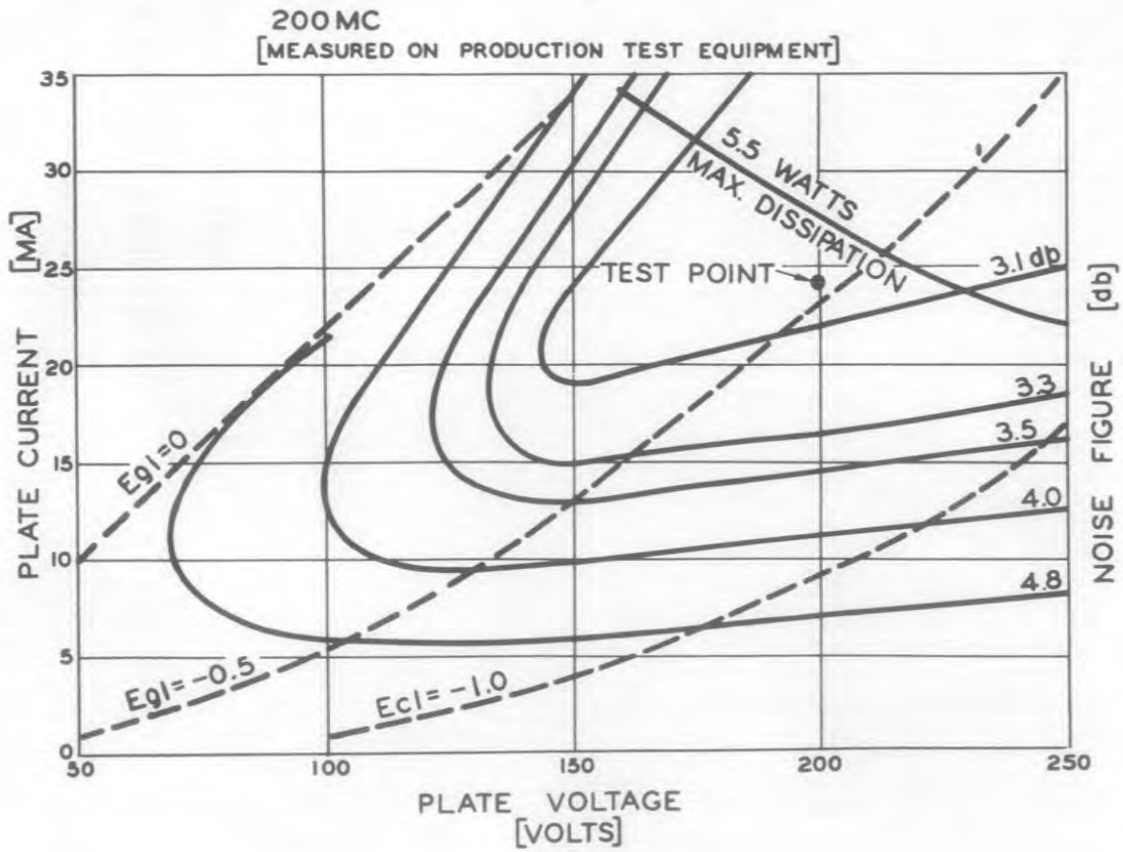


Fig. 6

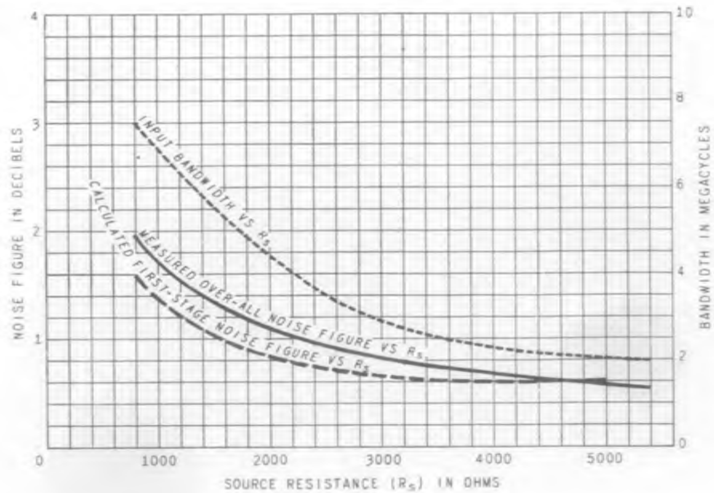


Fig. 8

THE USE OF GRIDDED CERAMIC VACUUM TUBES IN PHASED-ARRAY LONG-PULSE UHF RADARS

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Introduction

Until recently, existing radars have been able to handle the traffic of satellites, space probes, and missiles. To handle the expected traffic resulting from the stepped-up space efforts, new radars are being conceived and designed.

Many of these recent radar designs feature electronically steerable, phased arrays to obtain the high pulse powers, beam definition, and efficient low noise reception necessary for long range, three dimensional, multitarget tracking.

System studies have been made, [1] and operating frequencies in the low UHF and/or high VHF spectrum appear to be attractive. Part of this conclusion was based on the simplicyty, ease of application, cost per kilowatt of power, stability, and the wide type and size selection associated with the gridded vacuum tube. It is the purpose of this paper to display the approximate performance capabilities of the gridded tube, and only limited comparison with competing devices is attempted. This is necessary because of the lack of available data, either known or unknown.

This paper is principally concerned with the radar functions of pulsed power generation and low noise reception. The requirements of extreme phase fidelity and the desire for rapid frequency shift dictate the use of broadband amplifiers in both the transmitting and receiving functions. Broadband performance from 425 mc. to 1400 mc. is presented and amplifier bandwidths up to 15% are discussed. Power levels from thermal to kilowatts are assumed.

Transmitter

The vacuum tube appears to be one of the most useful and economical sources[2] of RF power for the frequencies being considered. Since both high

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[1] "Phased Arrays selected for New Generation Radars" Manfred Meisels July 1962 Microwaves

[2] See article "Array Radars - A Survey of their Potential and their Limitations" J. L. Allen (Note excellent bibliography) May 1962, Microwave Journal

power and long pulses are desired, the radar performance depends primarily upon the long life and performance capabilities of the vacuum tube chosen.

The most important requirements for the transmitter are:

1. High pulse power outputs.
2. Long duration pulsing.
3. Broadband amplification for phase fidelity.
4. Long life.

Long Pulse Derating:

Tube manufacturers have been reluctant to provide tube performance data and ratings for long pulses, greater than about 10 microseconds, without specific life testing. To provide a preliminary design derating curve, all available long pulse data was collected and the curves shown in Figure 1 were plotted.

Due to the lack of actual life test data over the wide range of pulse widths shown, the data plotted was taken from several sources. The data plotted up to about 6 µsec has been published by several tube companies and represents earlier and presently used pulse widths for UHF gridded tubes. In the 10 to 1000 µsec region only limited data was available. Video pulse life tests, at about 20 µsec have been made by one company active in the phased array field. One tube company[3] has been running some life tests at 100 µsecs and most of the 1000 µsec data was taken on pulse life tests run on computer tubes.[4]

The data shown in Figure 1 was purposely plotted in terms of unit cathode area and unit grid-to-plate spacing to make the curves applicable to all tubes. It is impractical to present this data on one tube or even on a family of tubes. Using the chart all tube sizes and spacings can be "tested" for their intended application. The transmitter designer must obtain the required dimensions from the tube manufacturer.

These ratings have not been proven with exhaustive life tests and should be used only as a guide in the early choice of tube sizes and configurations. The curves apply only for plate pulsing and additional derating is necessary for grid and/or cathode pulsing. This derating will apply both for input video and RF pulsing. A rule-of-thumb for plate voltage derating might be one-half to three-fifths of the permissible peak plate-pulsed value. This rule generally

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[3] Private communication from D. W. Hawkins, GE Company, Bldg. 269, Schenectady, N.Y.

[4] Subminiature Electron Tube Life Factors: Edwards, Lammers & Zoellner Reinhold Pub. Corp.

applies to oxide coated cathodes. Current deratings are unknown factors and usually do not require the degree of derating necessary for plate voltages. This is generally true because excessive and damaging arcing occurs at the steady state high stress conditions common for input pulsing. In both input and plate pulsing applications the current derating is more dependent upon the long life capabilities of the cathode. Cathode life also depends on other factors in addition to current loading and voltage stresses.

Tube Choice:

Using the design curves shown in Figure 1 the circuit designer can work backwards to obtain the appropriate tube area and spacings for a given desired power output. For maximum efficiency the tube should be used near these rated conditions. However, when this is done, power gain usually suffers and the final operating point must be selected with both efficiency and desired power gain in mind. In practice, an optimum approach to the proper tube complement would use the tube at least in one stage at its maximum rating for maximum efficiency and the same tube in previous stages for increased stage gain. This philosophy can be applied until the efficiency becomes so low that a smaller tube would be more practical from the standpoint of size, cost, and/or power consumption.

Tube Characteristics:

It is interesting to note the effect of normal tube characteristics upon power outputs and power gains for a given input power. To determine this, special engineering tubes were built with a wide variety of both mu and transconductance values. Test results on these tubes, given on Figure 2, show that although mu and transconductance are not important considerations where power output and efficiency are concerned, they are important with respect to power gain. The curve clearly shows the desirability of both high mu and high transconductance.

The curves shown on Figure 2 were developed from performance measured on about forty tubes. The various mu's and transconductances were obtained by varying such things as grid wires per inch, plate to grid spacing, grid wire sizes and grid configurations. There would be other variables such as tube capacitances but at 425 mc the different values obtained on the relatively small tubes evaluated were not important. On larger tubes the capacitances would be more important. Actually the higher mu tubes, which were also the higher transconductance tubes, had the lowest plate to grid capacitance.

Gain vs Power Output:

It is difficult to determine the theoretical gain as a function of drive level and one must usually resort to actual measurements. Figure 3 shows the test results obtained on two different ceramic triodes, Z-2869 and 7768, when driven at various levels. These data were taken using the triodes as class C amplifiers and gating the tube "on" with an RF pulse of 500 microseconds duration. The measured values of power output, efficiency, and power gain were recorded as a function of cathode loading in ma. per square centimeter of active cathode surface. The mu's are different with similar transconductances. The Z-2869 has a mu of about 100 and the 7768 has a mu of about 225. Although these results would not apply to all triodes, they would be useful in predicting at least qualitative results. The tests were made at 425 mc using single-tuned plate circuits and narrow bandwidths.

Wide Band Performance:

As stated previously, it is important that the tube performance be determined at the desired bandwidths. To do this, a lumped-constant, double-tuned plate circuit, grounded-grid amplifier was constructed and the test results are shown in Figure 4. It is difficult to accurately establish the broadband high level pulsed characteristics due to the lack of suitable sweep generators. The results shown here represent bandwidths obtained by point to point measurements and for a double tuned circuit optimized near the anticipated required bandwidths. The cathode loading was approximately 1.2 amperes per square centimeter. At lower drive levels one would expect higher gains and lower power outputs. The available power gains would increase to the values obtainable for class A conditions. The performance of the 7768 under these conditions will be discussed later.

Grid and/or Cathode Plate Pulsing:

For simplicity, the performance data shown in Figures 2, 3, and 4 were taken on RF cathode pulsed class C stages. However, as previously discussed, the tube must be operated at plate voltages lower than permissible using pulsed plate voltages. Where maximum power output is most important more pulsed power can be obtained from the plate pulsed stage. This latter method, however, requires higher voltages and more elaborate modulating equipment. Another factor in favor of plate pulsing would be the reduction in transit-time effects with the higher voltages. This may be important for the larger tubes which have wider element to element spacings. These various factors, plus others which may not be so obvious, suggest that the individual designer must make his own decision as to the type of amplifier gating he should use.

Triodes vs Multi-Grid Structures:

Available test results do not clearly define the comparative UHF performance between the tetrode (or pentode) and an equivalent triode. The performance advantages of the multigrid tube, where they exist, must be weighed against the extra cost and circuit complexity.

Using the design curves shown in Figure 1 and substituting the plate-to-screen-grid spacing for plate-to-control-grid values, the resultant ratings were spot checked on a power tetrode, the 7399, and the measured power outputs agree basically with predicted values using plate efficiencies common for this tube size and at the test frequency. The spacing between the screen and control grids must also be considered to prevent arcing between these two grids. Although this spacing is usually much less than the spacing from screen grid to anode, the voltages are also much lower. Data on the 7399 has been taken at about 400 mc using plate pulses of 100 microseconds and operating at a duty factor of .005. Good life test results have been obtained out to at least 5000 hours. Life also depends upon other factors such as cathode and envelope temperatures. This sort of information must be obtained from the individual tube manufacturer.

If the broadbanded triode and multigrid structures are compared in a simplified theoretical fashion, the advantages of the multigrid tube may be questionable. For example, the voltage gain for the tetrode or pentode can be estimated by:

$|A| = gmRo$ where Ro is the load resistance and gm is the tube transconductance. The gain-bandwidth product is:

$|A|\ \Delta f = \frac{gm}{2\pi Ct}$ where Δf is the

half-power bandwidth and Ct is the total interstage shunt capacitance. When the grounded grid triode stage is considered, the broad-band gain is approximately the same as the multigrid tube when Ro is much less than the tube's plate resistance. For the equivalent interstage circuitry, the grounded grid triode gain-bandwidth product is theoretically approximately equal to the multigrid tube. At narrow band the very high plate resistance values of the multigrid tube make this tube parameter relatively unimportant. This is not true for triodes.[5]

Available Cathode Sizes:

The curves shown in Figure 1 suggest that available power outputs are limited only by cathode areas and tube spacings. This is true except for the usual limitations applied to vacuum tubes used at low UHF. Large areas and wide spacings cannot be used and only the well-designed high-frequency structures are applicable. Cathode areas up to about 10 square centimeters have been designed into efficient ceramic tube structures and useful peak powers up to 100 kilowatts are obtainable at pulse widths of around 100 microseconds.

Life vs Performance:

Tube manufacturers have known for years that efficiency can be improved by running the tube's cathode at high current densities. The resultant high performance is short lived, and for long life applications the tube must be used more conservatively. In an effort to determine the performance versus life capabilities, life tests have and are being conducted and in some cases by the systems design people themselves. Significant life tests have been conducted

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[5] Chap. 7 Electronic Designers Handbook Landee, Davis, and Albrecht McGraw Hill

at about two to three amperes per square centimeters loading at pulse lengths of useful value. The results obtained on the 7399 have been mentioned. Figure 5 shows the early results obtained on the Z-2869 and 7768 previously mentioned. These life tests are being run at about 1.5 amps peak video per square centimeter with a duty factor of .005 and for a pulse duration of 500 microseconds. For simplicity, the tubes are being life tested as grid-pulsed oscillators.

Receiver

The most desirable performance features for the receiver are:

1. Low noise.
2. High broadband gain.
3. Long life.
4. Wide dynamic range.
5. Tolerance to overloads.

The metal ceramic planar triode can best provide all of these features. In view of the low noise figures obtainable from competing devices it is important that the best available tube be used that can operate efficiently at UHF.

Preamplifier Design and Performance:

From a theoretical standpoint, since maximum gain-bandwidth is desirable, multituned interstages should be used. For example, if equal "Q" double-tuned interstage circuits are assumed and the primary and secondary capacitances are equal, a double-tuned circuit will give $\sqrt{2}$ more gain-bandwidth than a single tuned interstage. Triple tuning and so on will give additional performance. For multistage amplifiers, alignment becomes very difficult and practical designs might limit themselves to double and triple tuned interstages. It should be noted from a theoretical standpoint that the maximum available gain-bandwidth product in multituned circuits can be obtained only if the required conditions of circuit "Q", coefficient of coupling, primary and secondary capacitances, and so on, are used.

Using two 7768's as cascaded grounded grid amplifiers, a 425 mc. amplifier has been constructed using lumped constant circuitry and double tuned interstages between the two tubes and at the amplifier output plate circuit. A typical performance of 35 db gain and a 4.0 to 4.5 db noise figure was obtained with a 3 db bandwidth of about 7.5%. This measured gain-bandwidth product of about 1600 mc. per stage agrees with the theoretical value. Similar products have been measured at 1000 and 1350 mc.

Dynamic Signal Range:

To permit simultaneous tracking of close-in targets as well as threshold return signals, it is important that the receiver have a wide dynamic signal range. Figure 6 shows the power gain of the 7768 measured for input signals from noise level to distortion due to overdrive. A useful dynamic range of about 100 db is evident.

Tolerance to Over-signals:

Two types of signal overload can be present in any radar. One of these is the ever-present transmitter power leakage due to poor or inadequate TR techniques. This leakage tends to reduce receiver life and represents a problem of operating cost. Another type of signal overload is a transitory one and results from either TR failures or intentional power jamming. In both cases the most logical solution is the use of tolerant receiver components. This results in less stringent TR requirements and better protection against unpredictable signal levels.

The exact signal overload tolerances of the various receiver components are difficult to find and in most cases to measure. To illustrate the relative tolerances of the various receiver techniques, best available results are shown in Figure 7.

If gating voltages are available, additional protection can be obtained by turning the receivers off during the transmitted pulse period. This resulting mismatch reflects energy normally received. This type of extra protection is usually more effective using vacuum tubes because of the larger obtainable mismatches without such problems as reverse bias breakdown and burnout.

Some degree of mismatch and resulting reflection of unwanted signals exists when the receiver is overdriven due to changes in device input impedances. This would only be permissible if the overdrive does not shorten the receiver life.

Long Life and Reliability:

Previously mentioned transmitting tube life test results and the results shown in Figure 8 demonstrate the high performance obtainable from the vacuum tube. If similar tube structures with proven pulse capabilities are used in the receiver the survival under high pulsed conditions due to signal overload is assured.

Conclusion

Preliminary evaluation of the usefulness of the vacuum tube in the phased-array long-pulse radar concept has been made. Test results show power outputs sufficient to provide very large radiated pulsed powers. With the simplicity and low cost of the vacuum tube approach these powers can be obtained economically. Life test results both in the transmitting and receiving function have demonstrated tube life sufficiently long to minimize the maintenance problems present in such a large and complicated radar concept.

Gridded vacuum tubes are easier to apply in the receiver function than other devices and are much more tolerant to over-signals both anticipated and unanticipated. Broadband gains of sufficient value have been demonstrated to reduce the problem of second stage noise contribution. The measured overall low UHF noise figures are sufficiently close to values obtained from competing solid-state devices to warrant the serious consideration of vacuum tubes. With the extra protection necessary for the solid-state receiver and the insertion losses and costs of the required additional circuitry, the performance differentials most often quoted between the solid state and vacuum tube approaches should be carefully evaluated.

The writer wishes to thank W. P. Kimker and C. E. Finley of the Receiving Tube Department and R. P. Watson of the Power Tube Department of the General Electric Company for their assistance in the preparation of this paper and in obtaining the test results shown therein.

JW Rush/ka

PULSE VOLTAGE AND CURRENT VS. PULSE DURATION*

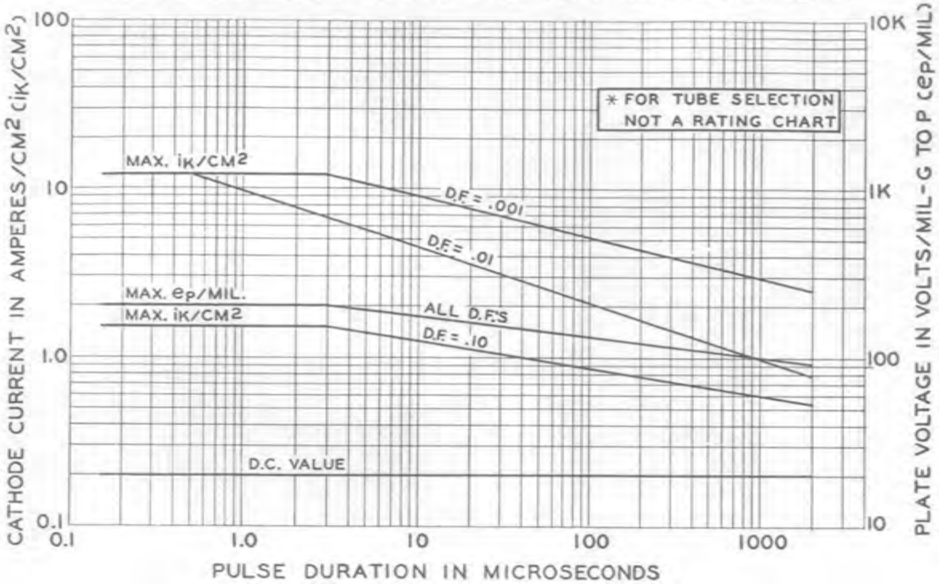


FIG. 1

PULSED PERFORMANCE AS A FUNCTION OF TRIODE CHARACTERISTICS

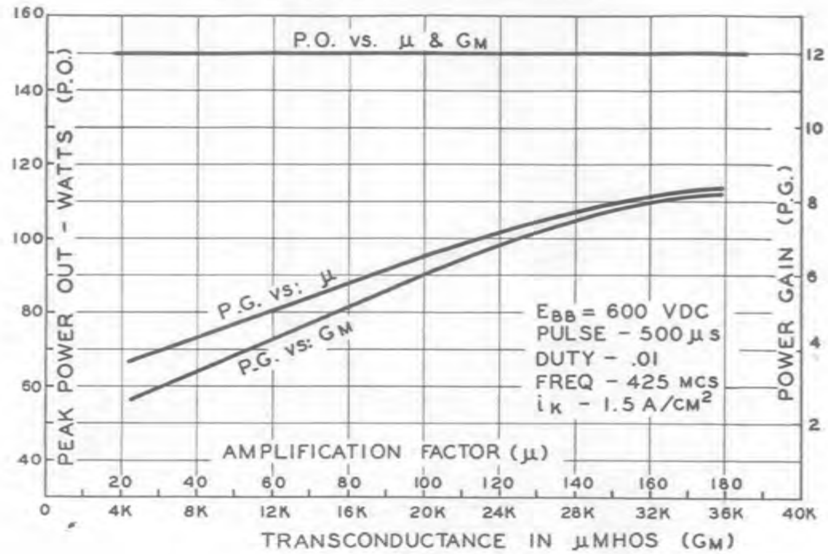


FIG. 2

PULSED PERFORMANCE AS A FUNCTION OF CATHODE LOADING

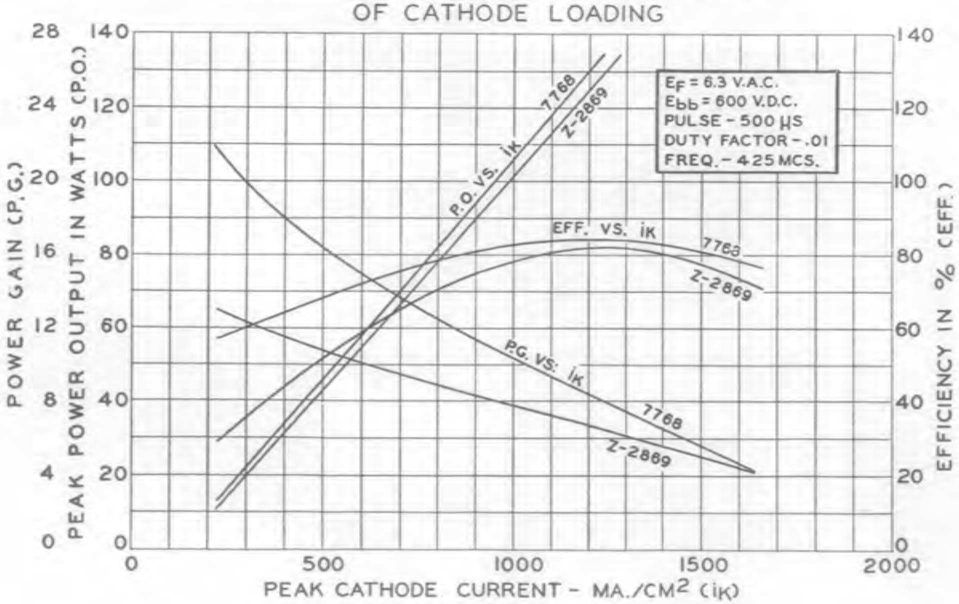


FIG. 3

PULSED CLASS C PERFORMANCE

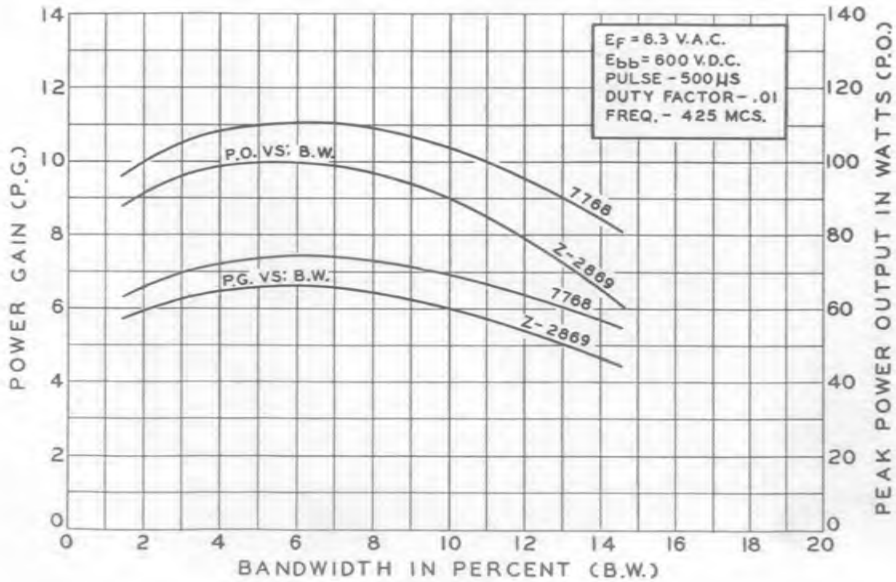


FIG. 4

GRID PULSED OSCILLATOR LIFE TEST

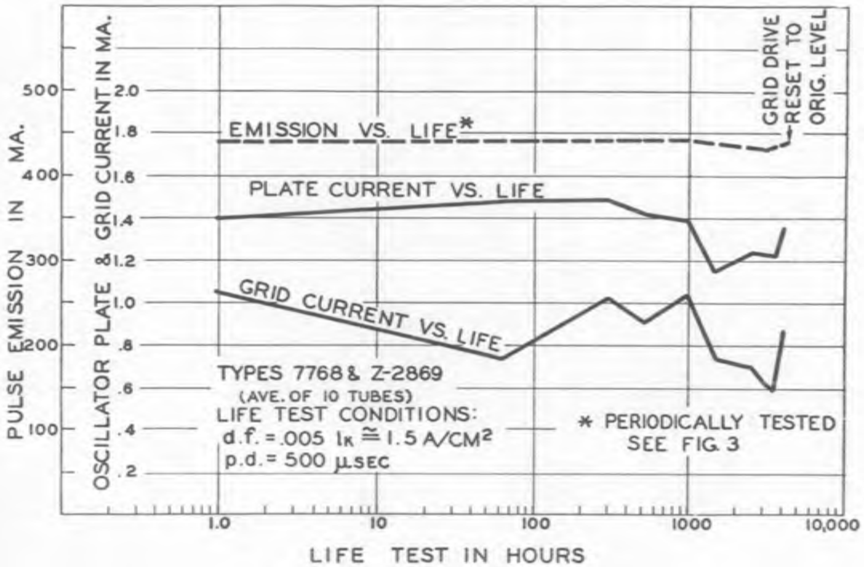


FIG. 5

USEFUL CLASS A DYNAMIC RANGE

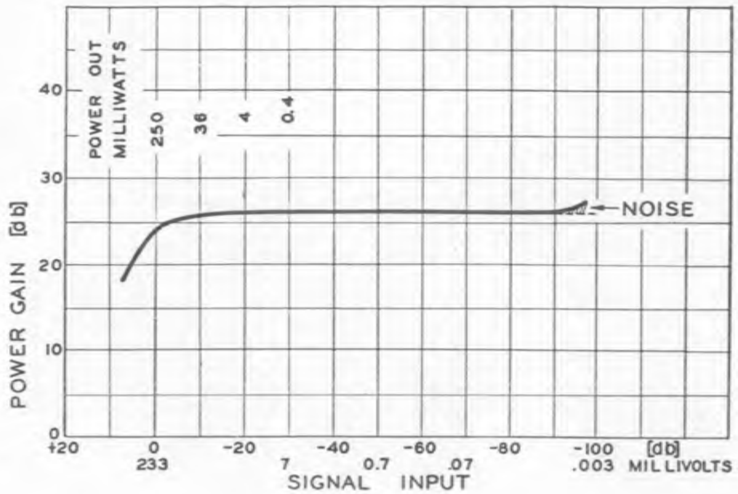


FIG. 6

TOLERANCES TO SIGNAL OVERLOADS (ESTIMATED BURN-OUT)	
CRYSTAL MIXERS AND DETECTORS	- 10 ERGS
TUNNEL DIODE	- 100 ERGS
LOW NOISE PARAMETRIC DIODES	- 1000 ERGS
EPITAXIAL PARAMETRIC DIODES	- 10^{+4} ERGS
CERAMIC VACUUM TUBE	- 10^{+8} ERGS

FIG. 7

NOISE FIGURE VS. LIFE

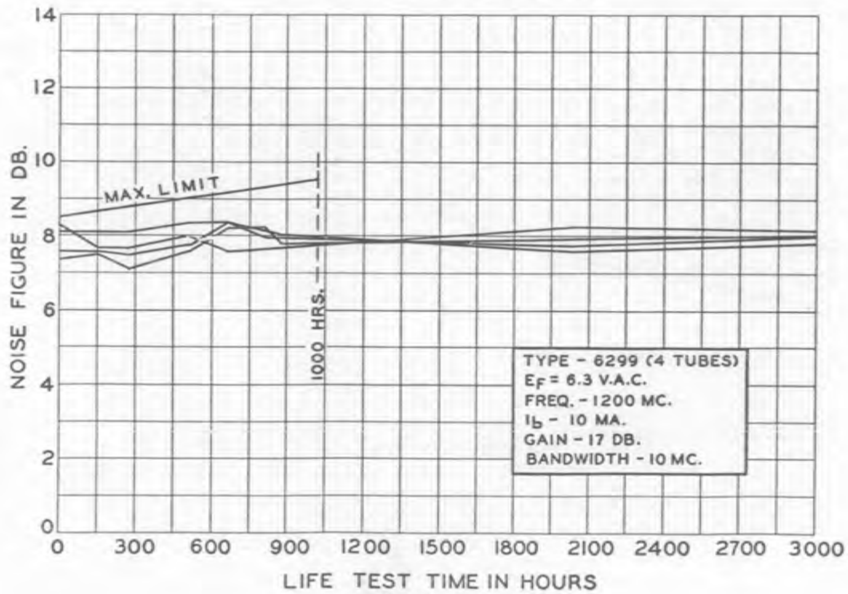


FIG. 8

LIFE TEST SUMMARY OF CERAMIC TYPES UNDER HIGH TEMPERATURE AND HIGH HUMIDITY CONDITIONS

High Temperature Life Tests

There has been a continuous interest in the high temperature capabilities of ceramic tubes at temperatures above those permitted by the published ratings. Through our regular lot acceptance life testing, considerable data have been accumulated which substantiate the published temperature ratings. However, other special life tests have been conducted to evaluate the tubes at higher-than-rated temperatures and a summary of some of these tests is presented in this report. Attached are life test data consisting of Plate Current and Transconductance medians versus time for the following tests:

Type	Lot	Amb. Temp.	Env. Temp.	Ef*	L.T. Duration	n
7296	472	400°C	450°C	5.4 V	2000 Hrs.	10
7296	305	500°C	550°C	4.3 V	4000 Hrs.	10
7296	45	240°C	300°C	6.3 V	15000 Hrs.	10
7296	46	240°C	300°C	6.3 V	15000 Hrs.	10
Z-2354	253	400°C	450°C	5.0 V	17000 Hrs.	10

* Note that lots 472 and 305 of the 7296, and lot 253 of the Z-2354, were life-tested at reduced heater voltage. This was done to obtain longer tube life by keeping the cathode temperature within bounds. However, the particular value of heater voltages used in these tests are not necessarily the optimum values. The lower plate current and transconductance values of lot 305, as compared with lot 472, are caused, at least in part, by the higher envelope temperature of lot 305. Higher envelope temperature increases the spacings between the tube elements, thus reducing the transconductance and plate current. It may be that with the particular heater voltage used, the cathode temperature was lower for lot 305, causing part of the difference in characteristics. However, this was not verified by measuring cathode temperatures.

Humidity Test

In addition to the high ambient life test operation summary, test data of a special humidity test are included. This test was performed to investigate the effect on tube properties due to absorption of moisture into the ceramic and seal areas. The test consisted of type 7768 tubes placed in a chamber and subjected to a steam vapor of approximately 100°C and 95-100 percent relative humidity for an extended period. These test conditions are in accordance with MIL-E-1, Par. 4.9.9, with the exception of a longer duration. The tubes were taken out of the chamber at various intervals, conditioned at room ambient for several hours, and read for heater current and plate current characteristics to detect any air leaks or other degradation in electrical characteristics. Of the two lots being tested, one has completed 1030 hours and the other has completed 466 hours. The results indicate no significant change in plate current or heater current throughout the test. These readings are good indicators of tube condition and it is evident that the tubes have withstood the humidity environment without deleterious effects.

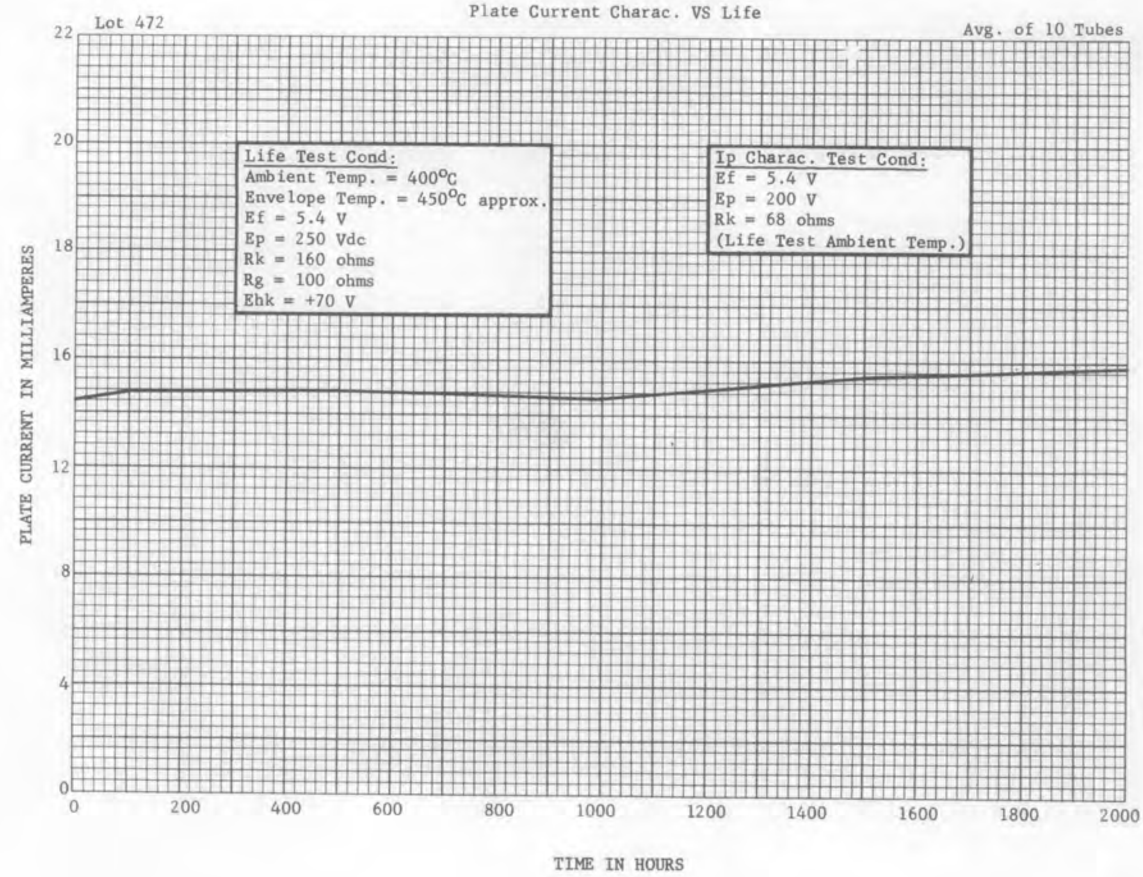
These data, of course, are insufficient to provide a great deal of statistical proof, but the long-duration life performance data do present an encouraging indication of reliable operation under high ambient and high humidity conditions.

This material was prepared by W. H. Lemaster, Specification Development, General and I&M Tubes, Receiving Tube Engineering, and distributed by Technical Data Unit, Receiving Tube Department.

TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

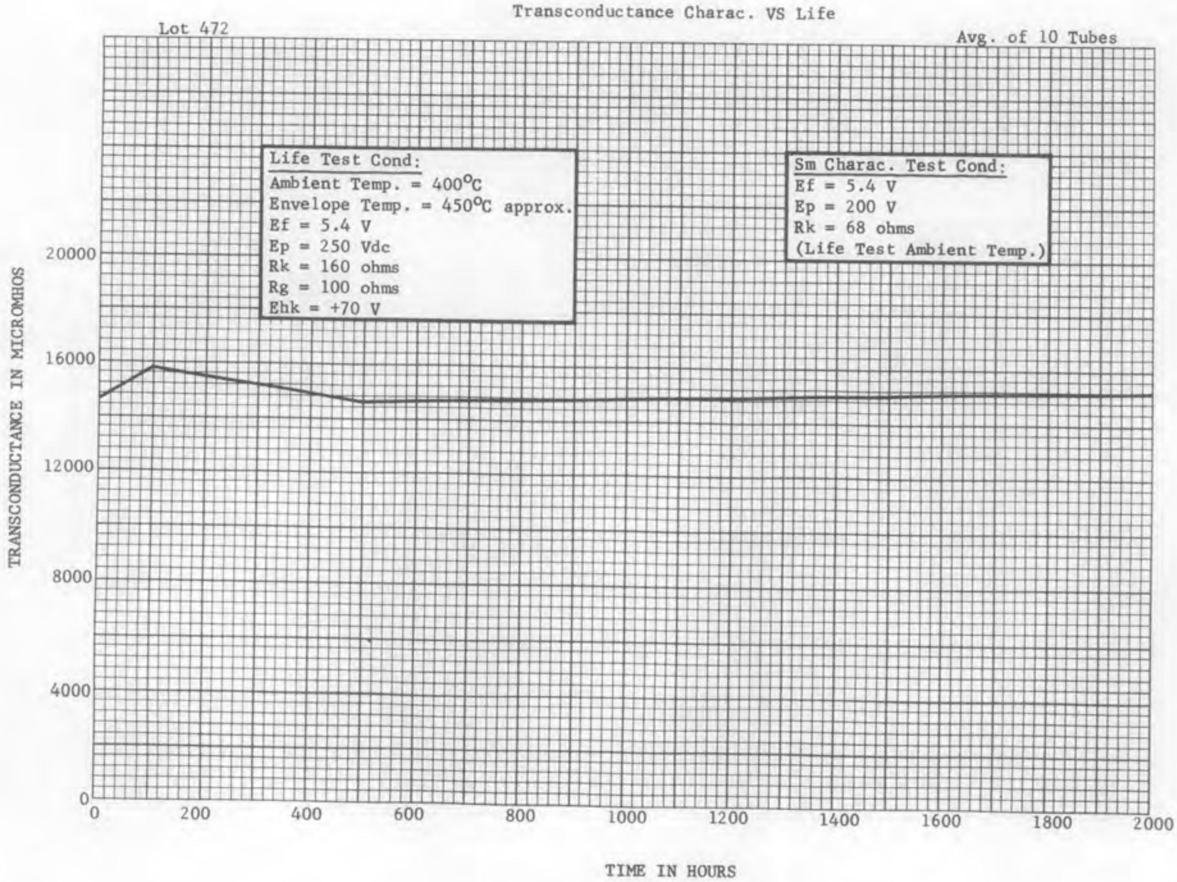
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

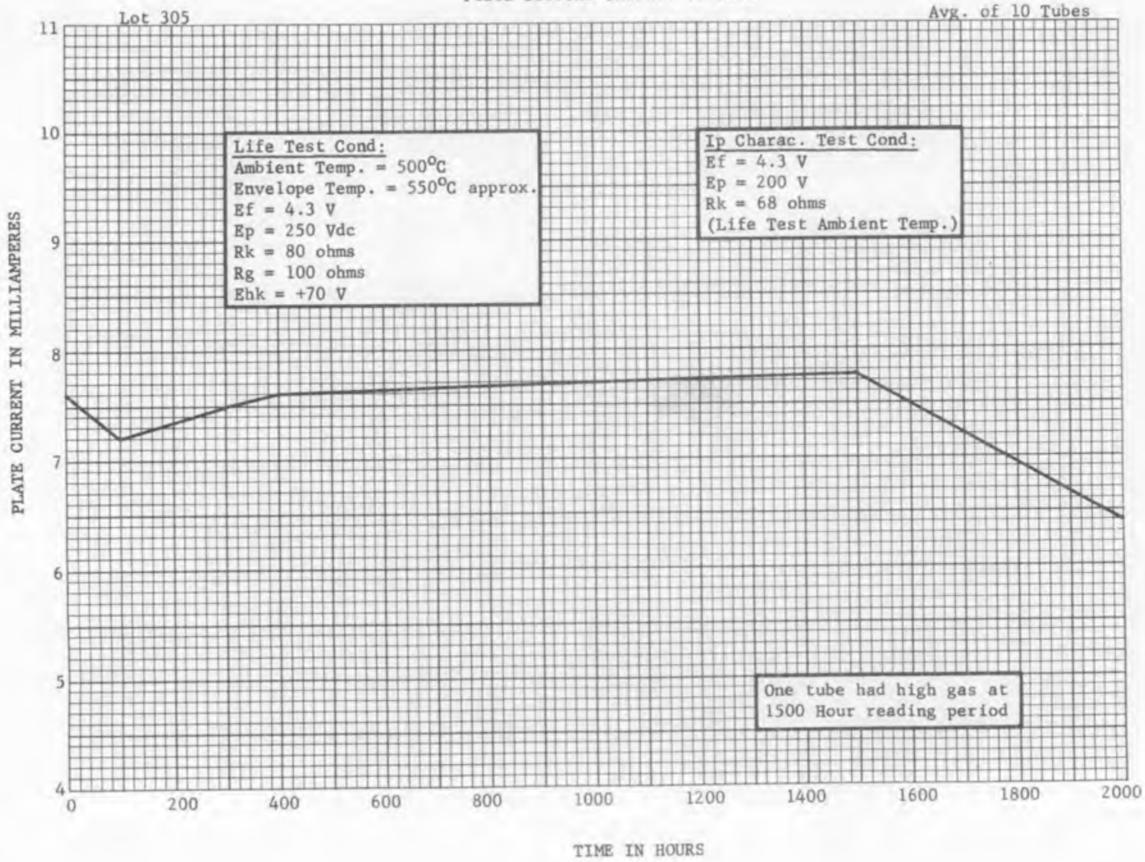
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

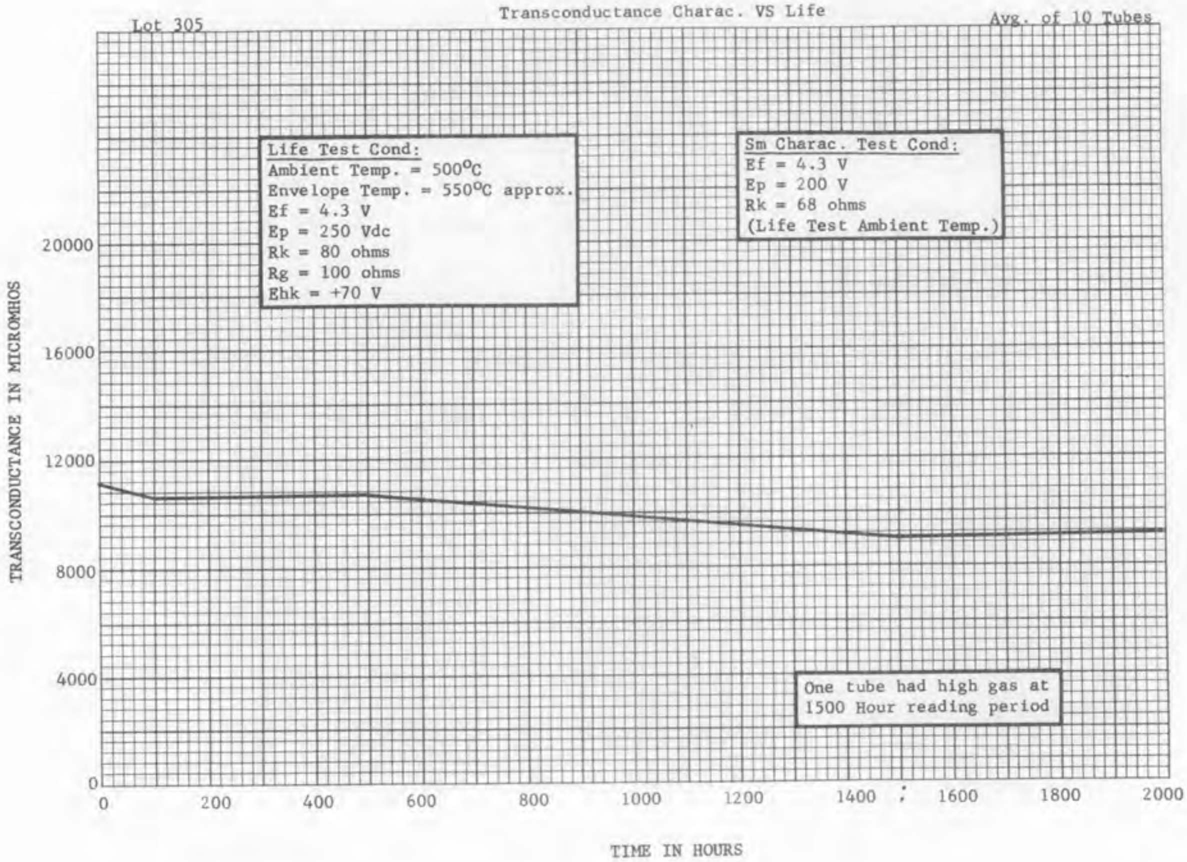
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

Transconductance Charac. VS Life



TYPE - 7296

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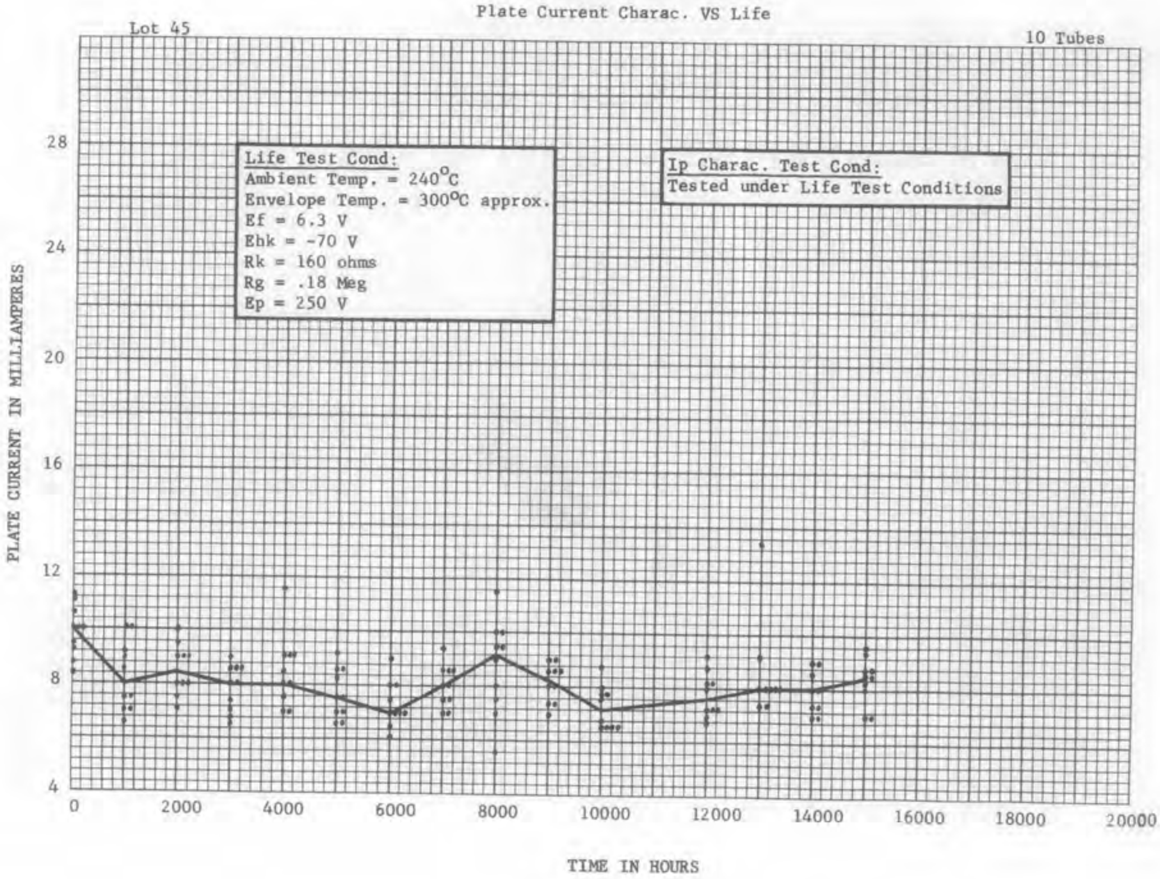
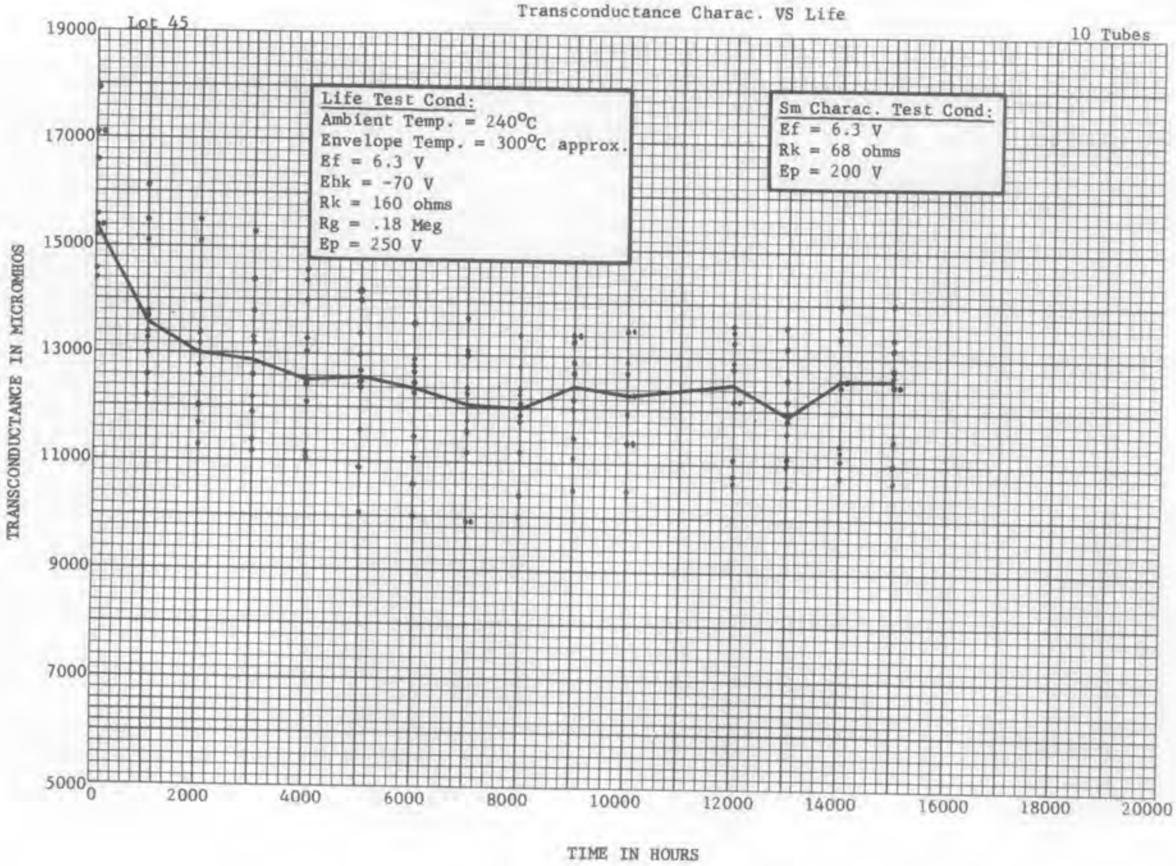
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

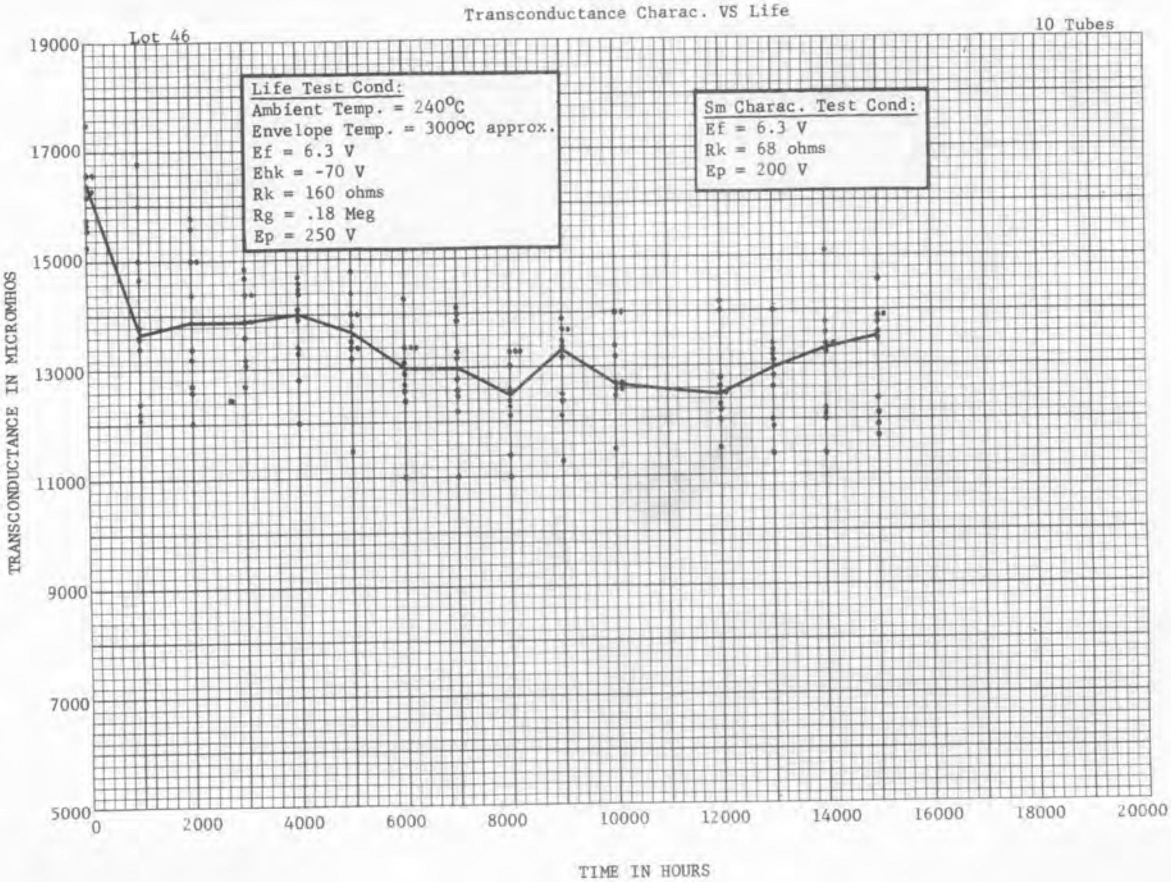
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

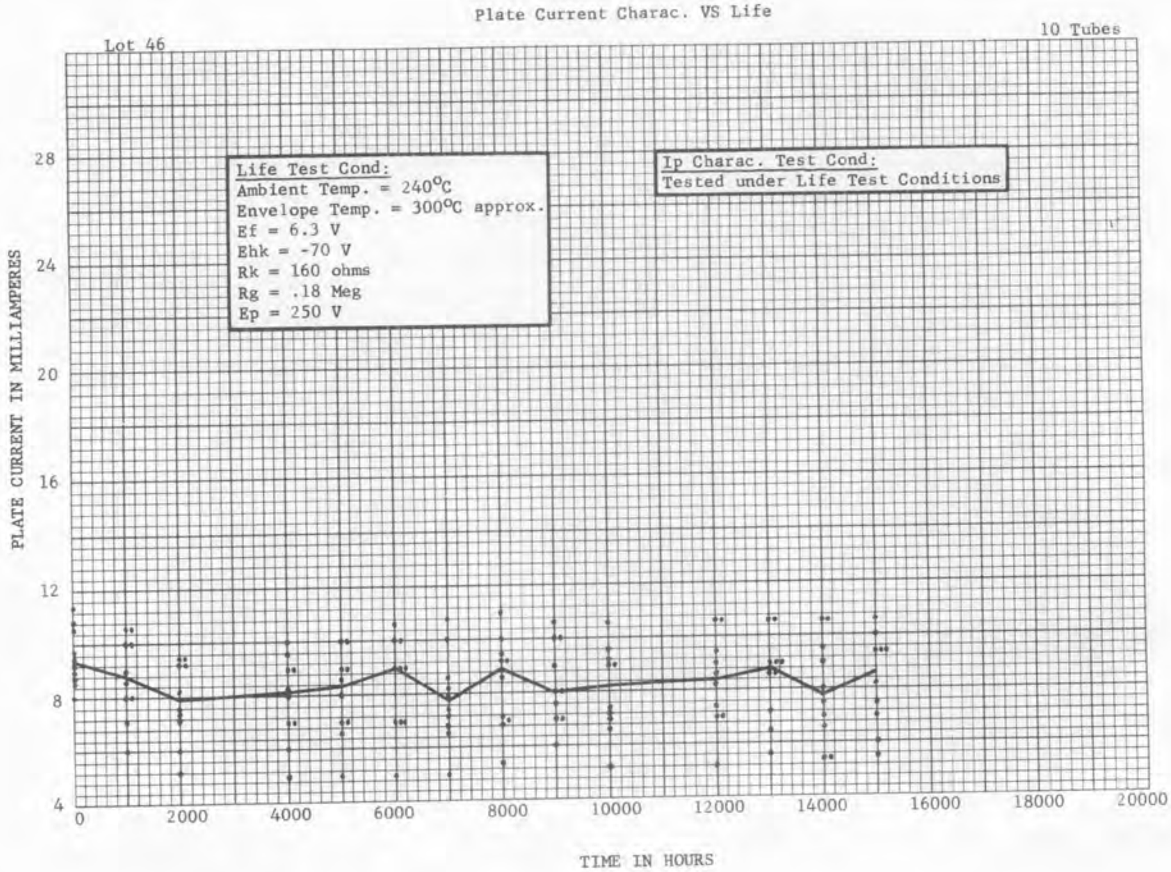
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

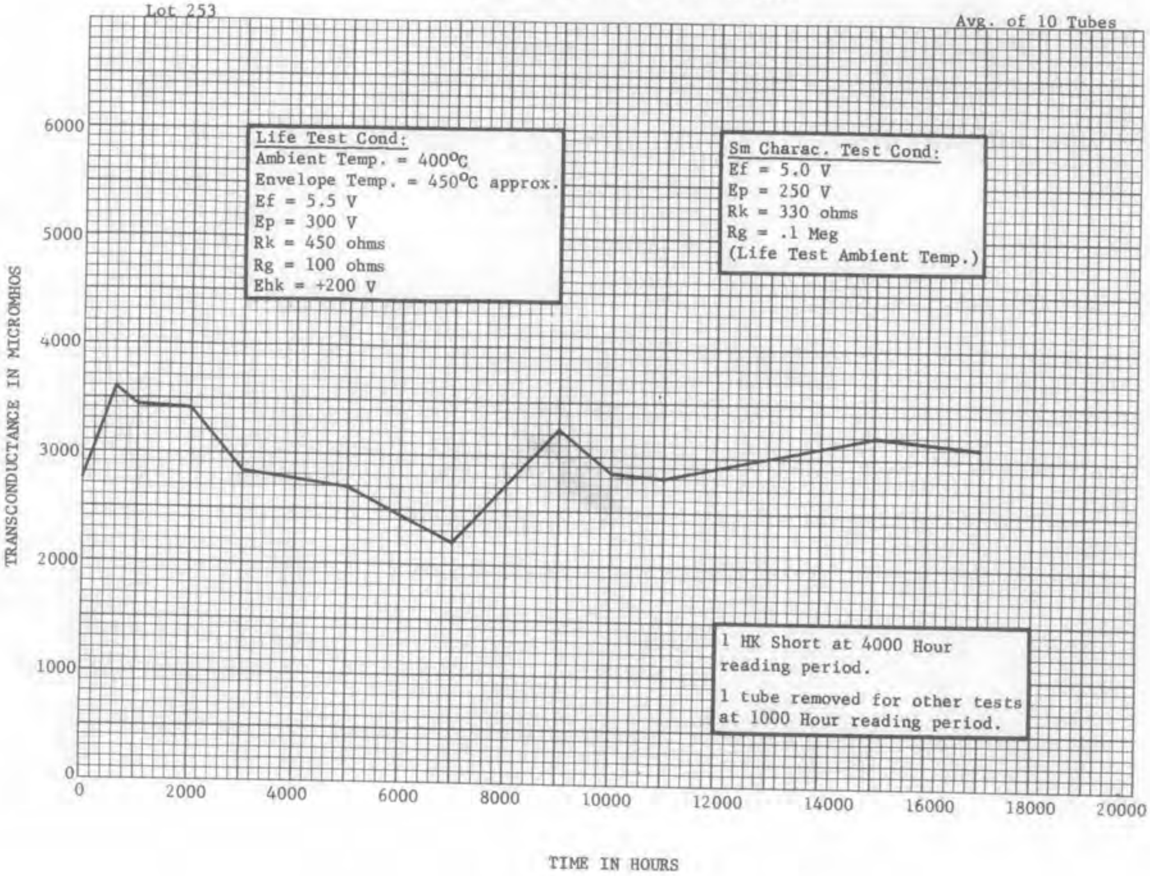
Plate Current Charac. VS Life



TYPE Z-2354

HIGH TEMPERATURE LIFE TEST DATA

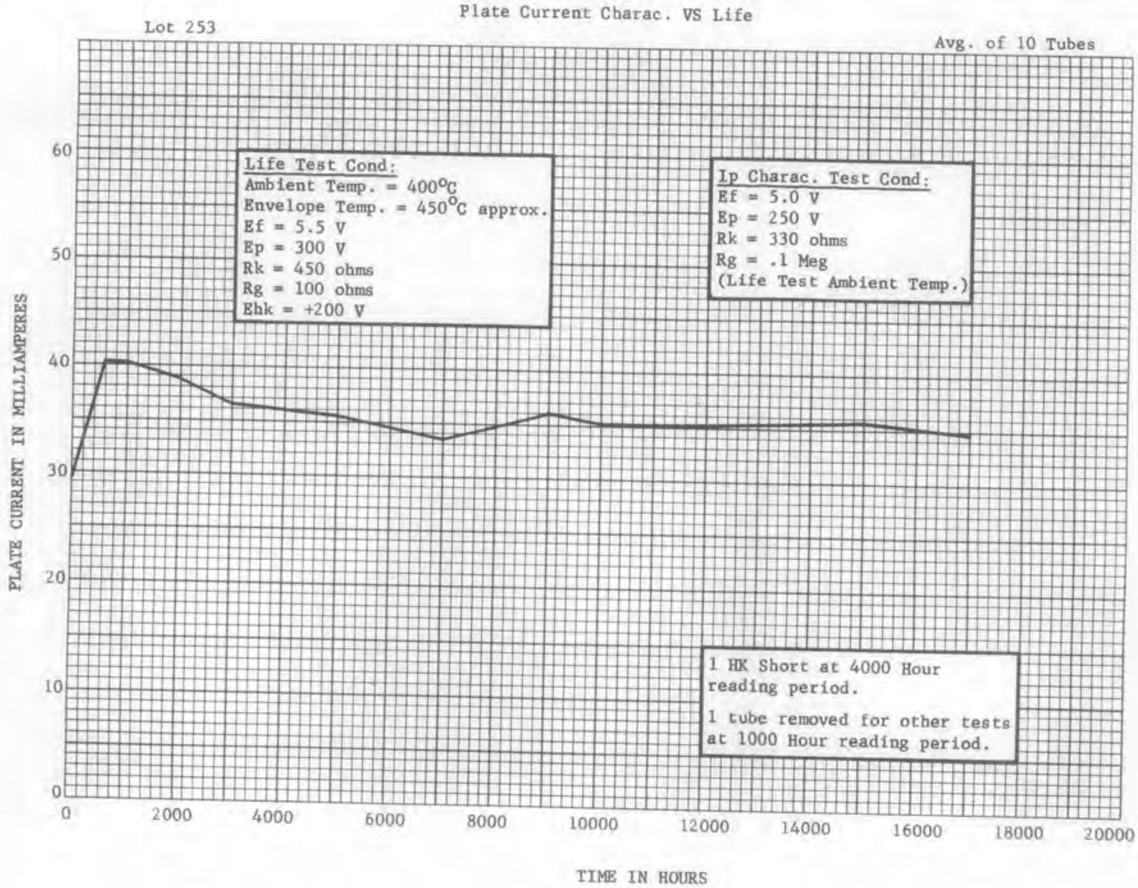
Transconductance Charac. VS Life



TYPE - Z-2354

HIGH TEMPERATURE LIFE TEST DATA

Plate Current Charac. VS Life



Humidity Test Results of Ceramic Type 7768

Test Conditions Per MIL-E-1 4.9.9

Group #1

Tube #		0 Hr.	92 Hr.	261 Hr.	404 Hr.	568 Hr.	706 1/2 Hr.	845 Hr.	1031 Hr
1P-26	If(mA)	---	400	399	400	400	400	400	400
	Ip(mA)	32.0	31.5	31.0	32.8	31.8	34.0	32.2	34.9
1P-28		---	400	400	400	400	400	400	390
		24.0	27.0	27.0	28.0	27.0	38.0	27.5	26.0
1P-41		---	400	402	401	401	402	402	402
		24.5	26.5	27.0	27.0	26.9	27.8	26.9	26.5
1P-43		---	419	420	419	420	420	420	415
		25.0	25.0	25.0	26.0	28.0	29.0	29.0	28.8
1P-49		---	399	400	395	400	400	400	398
		21.0	23.5	23.5	24.5	24.5	25.0	24.0	25.0
1P-68		---	402	400	400	405	400	402	400
		18.0	22.5	21.0	22.0	23.0	21.0	20.8	21.5
1P-72		---	398	399	395	399	399	398	398
		24.0	30.0	30.0	30.0	30.9	30.0	27.2	30.2
1P-77		---	399	399	399	399	399	399	395
		26.0	28.0	27.0	27.5	26.9	27.0	27.5	28.9
1S-10		---	405	405	405	408	405	405	405
		25.0	29.0	28.0	29.0	30.0	30.0	29.9	29.0

Group #2

Tube #		0 Hr.	138 1/2 Hr.	280 Hr.	466 Hr.
1L-1	If(mA)	400	400	400	395
	Ip(mA)	21.0	21.0	21.0	21.0
1L-13		392	395	398	395
		28.0	29.0	28.0	29.0
1L2-13		409	410	410	405
		26.0	26.5	25.9	25.8
1K4-23		400	402	405	400
		19.5	20.0	19.5	19.5
1K6-3		410	410	400	398
		21.5	20.9	20.0	19.0
1K6-7		395	405	400	400
		26.8	27.0	26.0	26.0
1P-59		402	402	405	400
		24.1	25.0	24.0	24.0
1P-65		405	405	405	405
		25.5	25.0	25.0	26.0
1P-75		398	400	400	399
		26.0	26.8	26.0	26.2
1P-78		400	400	400	400
		24.0	24.5	23.0	24.5

RESULTS OF RECENT TESTS OF CERAMIC TUBES DURING EXPOSURE TO NUCLEAR RADIATION

A number of General Electric ceramic tubes were recently operated in the field of a nuclear reactor with provisions made for periodic monitoring of the tube and circuit performance before, during, and after exposure to nuclear radiation.

Five type 6442's, 5 type 7588's, and 5 type 7077's were operated with the tubes, sockets, and connecting wires only adjacent to the reactor and all other circuitry removed from the vicinity of the reactor, while 18 type 7462's were operated in three 60-megacycle intermediate-frequency amplifiers, adjacent to the reactor. In addition, one tube of each type and one 60-megacycle amplifier were operated simultaneously away from the reactor to provide readings for comparison.

The reactor was operated for 128 hours, achieving a 3-megawatt level at 20 hours, and maintaining it to the end of the test. At intervals, measurements were made of plate current, plate current versus grid voltages, and plate current at reduced heater voltage for all tubes not in the 60-megacycle amplifiers; and plate current of each tube, gain, bandwidth, and tangential noise for the four 60-megacycle amplifiers.

During the test, there was very little change in average plate current of any of the tubes. However, two of the 60-megacycle amplifiers failed at approximately 57 hours, without plate current changes. Within two hours after shutdown of the reactor, both of the amplifiers that failed had recovered and would perform approximately as well as they did initially.

It is believed that coaxial cables carrying r-f signals to and from the amplifiers were severly affected by the heat from a hot-air line, and that this accounts for the amplifier failures, since there was no significant difference between the plate current readings for the tubes in the non-operative amplifiers and those in the amplifier that continued to function.

Detailed results of the tests are presented below in graphical form with explanatory notes.

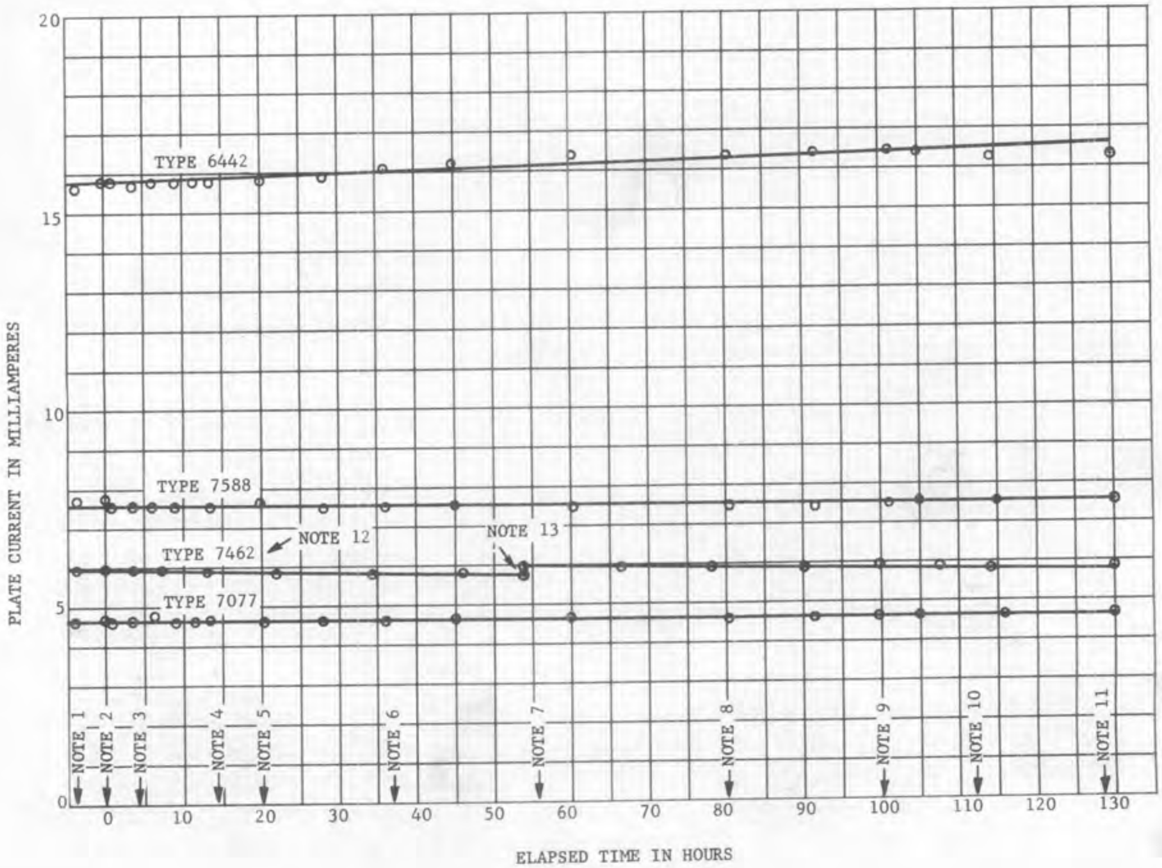


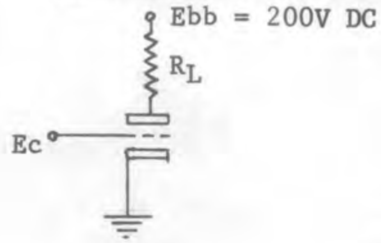
FIGURE 1

Notes:

1. Reactor output level = 0 Kilowatts
2. Reactor output level = 50 Kilowatts
3. Reactor output level = 150 Kilowatts
4. Reactor output level = 1 Megawatt
5. Reactor output level = 3 Megawatts
6. Estimated dosage = 1.5×10^{-16} NVT (E > 0.3 Mev) and 1.8×10^{10} Ergs/GM(c) All dosages are estimated on the basis of previous dosimetry of the source.

7. Estimated dosage = $3x10^{16}$ NVT (E > 0.3 Mev) and $3x10^{10}$ Ergs/GM(c)
8. Estimated dosage = $5.5x10^{16}$ NVT (E > 0.3 Mev) and $5x10^{10}$ Ergs/GM(c)
9. Estimated dosage = $7.5x10^{16}$ NVT (E > 0.3 Mev) and $7x10^{10}$ Ergs/GM(c)
10. Final estimated dosage = $1x10^{17}$ NVT (E > 0.3 Mev) and $9x10^{10}$ Ergs/GM(c)
11. Reactor shut down at 128 hours.
12. The 7462's were approximately 10 inches further away from the reactor than the other tubes. Therefore, for these tubes divide both neutron dose and gamma dose by 2.
13. The bias battery for the amplifiers was changed at this point.

Test Circuit



No. of Tubes	Type	Test Conditions	
		Ec	R_L
5	6442	-1.0V	3.3K
5	7588	-0.5V	10K
5	7077	-0.5V	20K

Plate current of the 18 type 7462's in the 60 MC amplifiers was obtained by measuring voltage drop across each cathode-bias resistor.

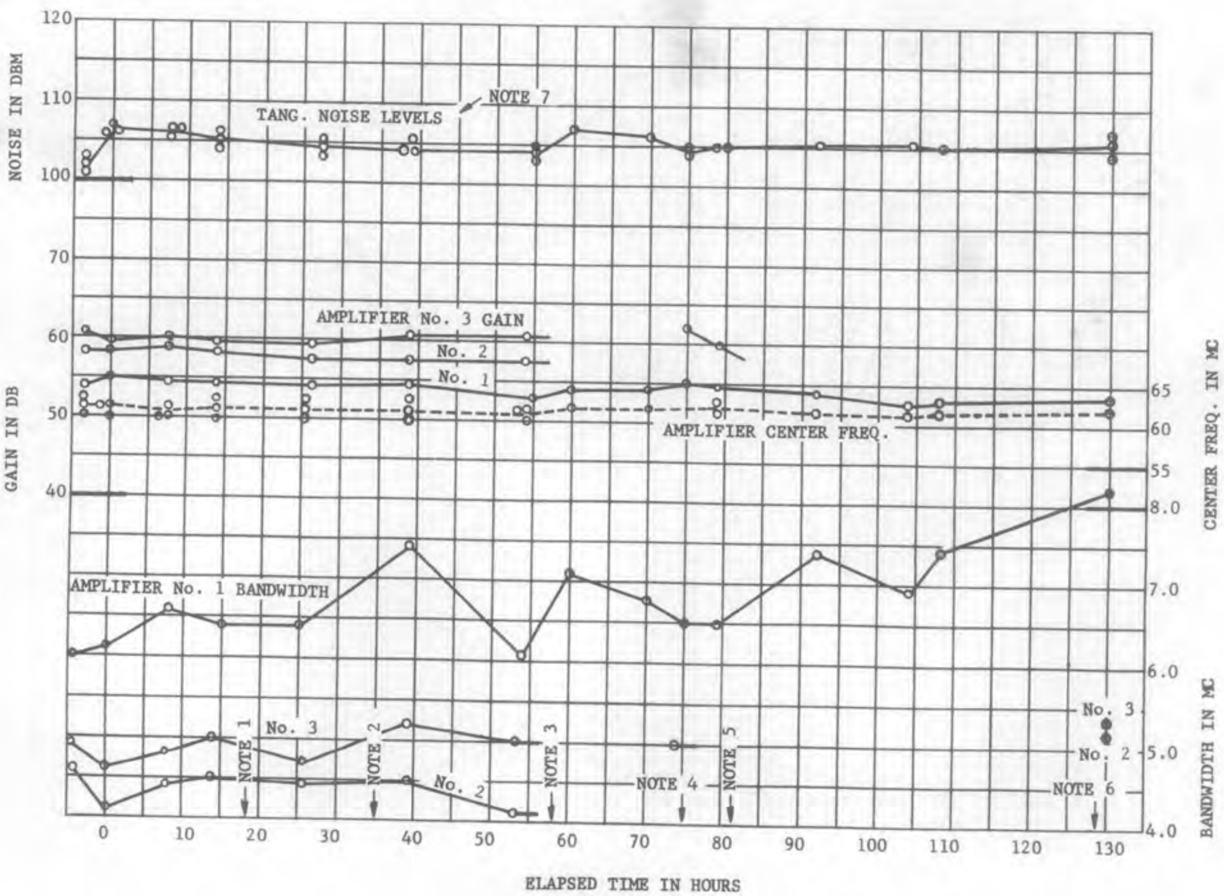


FIGURE 2

Notes:

1. Design and test gamma dosage goal - $3x10^9$ Ergs/GM(c)
2. Design and test gamma dosage goal - $1x10^{16}$ NVT (E > 0.3 Mev)
3. Amplifiers #2 and #3 failed. Estimated dosage - $2.5x10^{16}$ NVT (E > 0.3 Mev) and $3X10^{10}$ Ergs/GM(c)
4. Amplifier #3 operating again and stable
5. Amplifier #3 intermittent from here to shutdown
6. Reactor shut down at 128 hours. All three amplifiers operating within two hours after shutdown.
7. Noise levels not best obtainable. Amplifier inputs were loaded with 2.2K grid resistors and matched to a 50-ohm input cable for desired bandwidth and minimum VSWR.

Gain - Insertion gain was measured using a small-signal r-f pulse.

Noise - Tangential noise is the DBM level of small-signal r-f pulse equal in amplitude to the noise. This does not show the low noise capabilities of the 7462, because the shunt resistor used in the input of the 60-MC amplifier was chosen to obtain the desired bandwidth and low VSWR rather than minimum noise.

Center Frequency and Bandwidth - These were both measured by observing, with an oscilloscope, the swept response of the 60-megacycle amplifiers. The length of coaxial cable required (200 feet) between the amplifiers and the measuring equipment, and its exposure to the reactor environment, are believed responsible for most of the variations in bandwidth recorded.

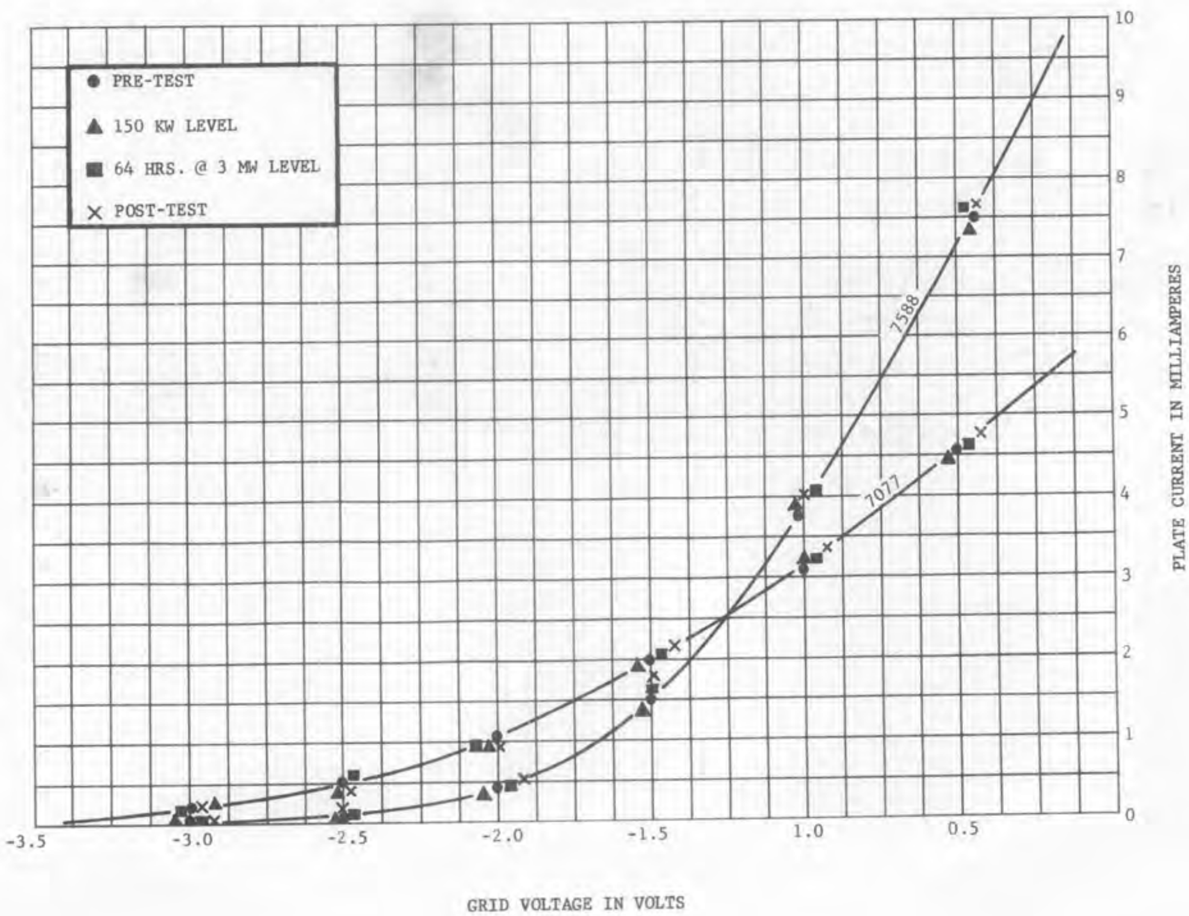


FIGURE 3

Figure 3 shows the average variation in plate current with bias for 5-tube samples of the 7077 and 7588. These measurements were made four times during the tests. Where the four readings are shown in line with the curve, they were so close together that they could not be distinguished when the curve was plotted.

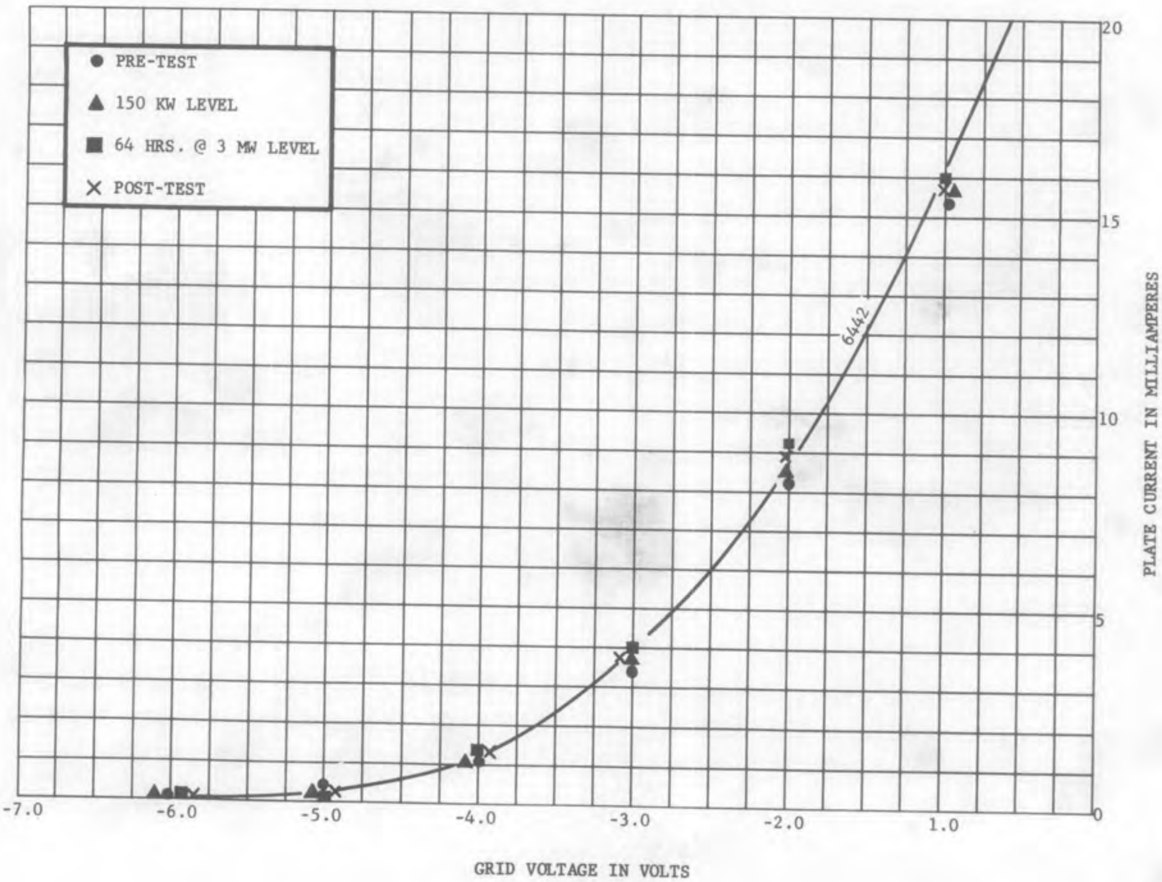


FIGURE 4

Figure 4 presents data for the 6442, similar to that presented in Figure 3 for the 7077 and 7588.

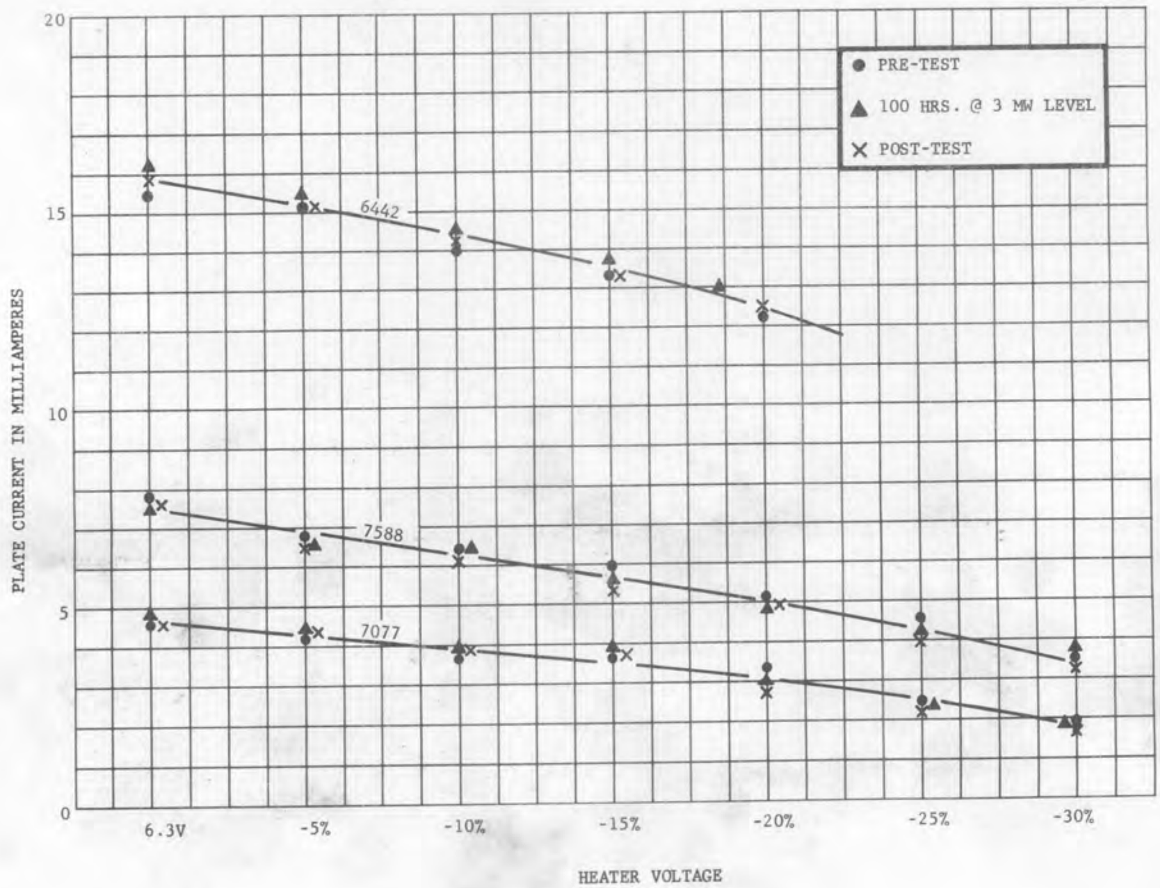


FIGURE 5

Figure 5 shows changes in plate current resulting from variation in heater voltage for the 6442, 7077, and 7588. A ten-minute period was allowed between each heater voltage change in order to stabilize the readings.

Prepared and distributed by Technical Data Unit, Receiving Tube Engineering, Owensboro, Kentucky on the basis of information obtained in tests that were made under Air Force Contract AF33(657) 8686 for which a manufacturer other than General Electric was the prime contractor.