DOE/ET/28413--T5

SAN/1330-1
Distribution Category UC-66b

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CERAMIC VACUUM TUBES FOR GEOTHERMAL WELL LOGGING

TECHNICAL REPORT, JANUARY 1977

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Date Published—January 1977

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ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
DIVISION OF GEOTHERMAL ENERGY
UNDER CONTRACT E(04-3)1330

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1.0 INTRODUCTION

This report summarizes the results of investigations carried out by Mechanics Research, Inc. (MRI) into the availability and suitability of ceramic vacuum tubes for the development of logging tools for geothermal wells. This investigation is one task being performed for the U. S. Energy Research and Development Administration (ERDA) as part of Contract E(04-3)-1330 for the design, development and test of an instrumentation amplifier capable of operating in a downhole well logging environment including ambient temperatures up to 500°C.

One objective of this contract is to demonstrate the feasibility of meeting the ERDA long term temperature capabilities of 500°C in downhole logs with present day technology. The technical approach is based on the prior successful use of ceramic vacuum tubes for a 250°C downhole instrumentation amplifier (References 1 and 2) and successful operation of ceramic vacuum tubes for 4000 hours at 500°C (Reference 3).

The information in this report is presented to aid future development of high temperature electronics with ceramic vacuum tubes. This information is in no manner intended to be an exhaustive study of the subject of ceramic vacuum tubes, but rather to present useful design data acquired in the evaluation of ceramic vacuum tubes for the development of a 500°C instrumentation amplifier. Section 2 of this report discusses the general requirements for ceramic vacuum tubes for application to the development of high temperature well logs. Commercially available tubes are described in Section 3 and future contract activities that specifically relate to ceramic vacuum tubes are detailed in Section 4. Supplemental data is presented in the appendix.

2.0 GENERAL REQUIREMENTS

Stringent and frequently conflicting requirements exist on active electronic devices for their use in downhole geothermal well logging. Even though these devices are usually packaged in rugged, pressure proof sondes, the devices must be able to function properly in very hostile temperature and shock environments. The devices should be small to permit efficient packaging. They should consume small amounts of power, have a long life and have a reasonable cost. The following paragraphs describe these requirements in more detail.

2.1 Temperature

The goal of the amplifier design is for operation at, or near, 500°C. This represents the long term temperature objective for geothermal well logging instruments as stated in Reference 4. Thus, the tube envelope must be at somewhat higher temperature to transfer heat to the external environment.

High temperature can cause a number of problems in the operation of ceramic vacuum tubes. The high ambient temperature can cause elevated filament and cathode temperature, which can result in accelerated depletion of the thermionic emission material of the cathode and/or loss of tube life by filament burn-out. The high temperature can also cause an increase in the rate of outgassing and loss of tube performance and/or life by contamination. In addition, temperature changes cause changes in the spacings between tube elements because of thermal expansion. This change in tube spacing is reflected in tube performance characteristic changes.

2.2 Shock

Well logs are subjected to severe mechanical shocks during deployment and recovery. The logs are generally deployed and recovered by a

single electro-mechanical cable. Thus, the log is unconstrained laterally, and it slams against the sides of the well as the log is lowered or raised. In addition, the logs are sometimes used as battering rams to reopen the hole if bridging occurred when the drill string was removed. This environment is unknown, but intuitively it must be a severe shock environment. The primary requirement for active electronic devices is to survive a large number of these shocks without performance degradation.

2.3 Size

In general, it is desirable to have the active electronic device as small as possible so that the complete instrument can be packaged in a small volume. Some slimhole sondes are only 1.4 inches in internal diameter. However, with ceramic vacuum tubes, the reduced size must be compromised with a loss in some performance characteristics, most notably reduced transconductance from reduced cathode area.

2.4 Power

It is desirable to keep the total power required low and the number of power supplies required low as discussed below:

Present operational techniques require transmission of the electrical power over long cables (3 to 5 miles) from the surface downhole to the log. Also, the total number of electrical conductors is usually quite limited (frequently 1 conductor plus the mechanical strength member, or 7 conductors plus the strength member).

Filament power should be as low as possible. Most of the ceramic vacuum tubes applicable to high temperature well logging are designed for nominal 6.3 volt filament power. Thus, the tube should require a minimal filament current. The filament current is normally the largest current required and over long lines this current causes a very noticeable voltage drop. For example, the round trip resistance of an 18 gage conductor, 20,000 feet long is 256 ohms

at room temperature. For a one-third ampere filament current, the line drop is about 85 volts. The filament current must not exceed the current carrying capability of the conductor at its maximum useage temperature. For these reasons, the filaments of multiple stages are often wired in series. However, there are two limits on the use of series filament connections. First, the series filament drop plus the line drop voltage must not exceed the voltage rating of the insulation material of the cable. Second, there is a finite limit on the allowable voltage difference between the filament and cathode of a given tube. This voltage must not be exceeded. It is desirable for this tube characteristic to be as large a voltage as possible.

For the B+ supply, it would simplify amplifier design if multiple B+ and B- supplies could be used. However, with the limitations on the number of conductors in the logging cable, the amplifier design is forced toward a single B+ supply. Lack of large coupling capacitors for operation at these temperatures further forces the amplifier design toward direct coupling. Therefore, the tube should be capable of linear operation over a wide range of B+ voltages, because in cascaded direct coupled amplifiers it is desirable to start with a low plate voltage at the initial stage and increase with subsequent stages.

Another requirement on the B+ power supply is that the voltage at the amplifier plus the line drop not exceed the allowable voltage rating of the cable insulation. (Thus, low B+ current requirements for the tubes are desireable.)

The amplifier design should be such that its performance is tolerant of fairly broad B+ and/or filament power variations.

2.5 Performance

Economically, it is presently desirable to minimize the number of types of tubes used in an instrument design to enhance the quantity price breaks. Yet in a typical amplifier, quite different performance requirements exist for tubes used in different stages. Input stage tubes must be able to amplify

very small voltages from transducers, intermediate stage tubes must amplify relative high level voltages and output stage tubes must be able to drive long, lossy transmission lines. The input and intermediate stage tubes should have high mu's, but with different linear operating points and the output stage tube should have a very low plate resistance. High mu and low plate resistance tend to be conflicting requirements, especially when the desire is to minimize B+ current and physical size. To minimize the temperature dependence of tube characteristics is desirable, but to some extent conflicts with good performance characteristics.

3.0 COMMERCIALLY AVAILABLE TUBES

A survey was made to determine which commercially available ceramic vacuum tubes appear to be the most applicable to the design of a 500°C instrumentation amplifier. The following suppliers of ceramic vacuum tubes were located by MRI:

- Amperex Electronic Corporation
  A North American Phillips Company
  Distributor Sales Operation
  230 Duffy Avenue
  Hicksville, L.I., New York 11802
  (516) 931-6200

- EIMAC
  Division of Varian
  1678 S. Pioneer Road
  Salt Lake City, Utah 84104
  (801) 487-7561

- General Electric Electronic Components Business Division
  Tube Products Department
  316 East Ninth Street
  Owensboro, Kentucky 42301
  (502) 683-2401

- The Machlett Laboratories, Inc.
  A Subsidiary of Raytheon Company
  1063 Hope Street
  Stamford, Conn. 06907
  (203) 348-7511

Most of the commercially available ceramic vacuum tubes are not suitable for high temperature downhole well logging for one, or more, of the following reasons:

- too large,
- excessive power requirements and/or
- development required for 500°C ambient operation.

The one exception found was in the General Electric product line. They manufacture a number of planar triodes and a few diodes that are sufficiently small, have low power requirements, and have demonstrated high temperature capabilities. Other suppliers have the capabilities to develop tubes for high temperature well logging, which is of interest to future developments, but not compatible with the schedule and budget requirements of our present contract. Table 1 summarizes the characteristics of the GE ceramic vacuum tubes that appear most useful for high temperature well logging applications. Figure 1 displays the various physical configuration of these tubes. Electrical connections can be made to these tubes by soldering, wire wrapping, welding, brazing and mechanical clips. Sockets are available for some tube types, though not recommended for other than testing purposes.

Tube types 7296 and 7588 were used by MRI in the development of a 250°C downhole well logging amplifier (see reference 1). The 7296 type of tube was tested by GE at elevated temperatures (see reference 3). One of these test conditions was a 4000 hour life test at an ambient environment of 500°C. Thus, these tubes appear to have immediate potential for application to the long range (500°C) well logging requirements.

Detailed data sheets for some of these tubes are presented in the Appendix.

Table 1

Nominal Characteristics of Selected General Electric Production Type Ceramic-Metal Vacuum Tubes (Extracted From GE Publication, "Ceramic Tubes for Original Equipment Design", EI-61A and "Reference Data for General Electric Microwave Products".

GENERAL MAXIMUM RATINGS							
TYPE	GENERAL DESCRIPTION	OUT-LINE	HEATER		MAX PLATE VOLTS AND WATTS *	MAX GRID CUR-RENT	MAX FREQ. (MHz)
			VOLTS	AMPS			
7077	METAL-CERAMIC TRIODE INTENDED FOR LOW-NOISE UHF AMPLIFIER SERVICE	H	6.3	0.24	250 1.1	-	3000
7266	METAL-CERAMIC DIODE INTENDED FOR INSTRUMENT-PROBE SERVICE	I	6.3	0.215	600 (1)	-	3000
7296	METAL-CERAMIC TRIODE INTENTED FOR VHF OSCILLATOR OR AMPLIFIER SERVICE	J	6.3	0.4	330 5.5	10 MA	500
7391	METAL-CERAMIC TRIODE INTENDED FOR UHF OSCILLATOR SERVICE	F	6.3	0.38	200 2.25	3.0 MA	6000
7462	METAL-CERAMIC TRIODE INTENDED FOR LOW-NOISE VHF AMPLIFIER SERVICE	K	6.3	0.24	250 1.1	-	500
7486	METAL-CERAMIC TRIODE INTENDED FOR UHF OSCILLATOR OR AMPLIFIER SERVICE	H	6.3	0.24	250 1.0	2.2 MA	3000
7588	METAL-CERAMIC TRIODE INTENDED FOR VHF AMPLIFIER SERVICE	J	6.3	0.4	300 5.5	-	500
7625	METAL-CERAMIC TRIODE INTENDED FOR LOW-LEVEL AUDIOFREQUENCY AMPLIFIER SERVICE	K	6.3	0.215	275 0.85	-	-
7644	METAL-CERAMIC TRIODE INTENDED FOR LOW-NOISE UHF AMPLIFIER SERVICE	F	6.3	0.3	200 2.0	-	3000

NOTES

(1) Peak inverse voltage.
(2) This is the bogey value at which average characteristics are determined. For some classes of operation, a lower value may be recommended.
(3) These are the highest values listed for any class of CW operation; lower values may be indicated for some classes of CW operation. Refer to the complete Product Information sheets for this information.
(4) Adjusted for Ib = 75 milliamperes.
(5) Peak voltage rating for pulse service.
(6) Pulse Service.
(7) Adjusted for Ib = 75 milliamperes.
(8) The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.
(9) Adjusted for Ib = 10 milliamperes.
(10) Adjusted for Ib = 10 milliamperes; range must be variable from 75 to 200 volts.
(11) Bypassed resistor (18k) in plate-supply lead.
(12) With Rk = 910 and Eg = +6.0 volts.
(13) With Rk = 270 and Eg = +6.0 volts.
(14) Bypassed resistor (17.5k) in plate-supply lead.
(15) Plate dissipation of 100 watts is permissible with forced-air cooling.

Table 1A

GENERAL MAXIMUM RATINGS							
TYPE	GENERAL DESCRIPTION	OUT-LINE	HEATER		MAX PLATE VOLTS AND WATTS *	MAX GRID CUR-RENT	MAX FREQ. (MHz)
			VOLTS	AMPS			
7720	METAL-CERAMIC TRIODE INTENDED FOR VHF OSCILLATOR SERVICE	K	6.3	0.24	250 1.0	2.2 MA	500
7768	METAL-CERAMIC TRIODE INTENDED FOR UHF AMPLIFIER SERVICE	L	6.3	0.4	330 5.5	-	3000
7784	METAL-CERAMIC TRIODE INTENDED FOR LOW-NOISE UHF AMPLIFIER SERVICE	M	6.3	0.3	200 2.0	-	3000
7841	METAL-CERAMIC DIODE INTENDED FOR DETECTOR SERVICE	I	6.3	0.215	350 (1)	-	3000
7910	METAL-CERAMIC TRIODE INTENDED FOR UHF PLATE-PULSED OSCILLATOR OR AMPLIFIER SERVICE	P	6.3	0.275	1200 (5) 1.5 (6)	200 MA (6)	750
7913	METAL-CERAMIC TRIODE INTENDED FOR OSCILLATOR OR AMPLIFIER SERVICE	L	6.3	0.4	330 3.5	10 MA	3000
8081	METAL-CERAMIC TRIODE INTENDED FOR LOW-LEVEL AUDIOFREQUENCY AMPLIFIER SERVICE	R	6.3	0.215	275 0.85	-	-
8082	METAL-CERAMIC TRIODE INTENDED FOR UHF OSCILLATOR SERVICE	R	6.3	0.24	250 1.0	2.2 MA	500
8083	METAL-CERAMIC TRIODE INTENDED FOR LOW-NOISE VHF AMPLIFIER SERVICE	R	6.3	024	250 1.1	-	500

NOTES

(1) Peak inverse voltage.
(2) This is the bogey value at which average characteristics are determined. For some classes of operation, a lower value may be recommended.
(3) These are the highest values listed for any class of CW operation; lower values may be indicated for some classes of CW operation. Refer to the complete Product Information sheets for this information.
(4) Adjusted for Ib = 75 milliamperes.
(5) Peak voltage rating for pulse service.
(6) Pulse Service.
(7) Adjusted for Ib = 75 milliamperes.
(8) The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.
(9) Adjusted for Ib = 10 milliamperes.
(10) Adjusted for Ib = 10 milliamperes; range must be variable from 75 to 200 volts.
(11) Bypassed resistor (18k) in plate-supply lead.
(12) With Rk = 910 and Eg = +6.0 volts.
(13) With Rk = 270 and Eg = +6.0 volts.
(14) Bypassed resistor (17.5k) in plate-supply lead.
(15) Plate dissipation of 100 watts is permissible with forced-air cooling.

Table 1B

CHARACTERISTICS AND TYPICAL OPERATION											
TYPE		PLATE VOLTS	NEG. GRID VOLTS	PLATE MILLI-AM-PERES	GRID MILLI-AM-PERES	μ	Rp, OHMS	Gm, μMHOS	GAIN IN DECI-BELS	R.F. POWER OUT-PUT	FREQ. (MHz)
7077	AVG. CHAR.	250 (11)	Rk = 82	6.5	-	90	9000	10000	-	-	-
	GROUNDED-GRID AMP.	250 (11)	Rk = 82	6.5	-	-	-	-	14.5	-	450
7266	INSTRUMENT DETECTOR	TUBE VOLTAGE DROP: 1.0 VOLTS AT 1B = 1.0 MA. VAX D-C CATHODE CURRENT = 2.2 MA; MAX PEAK CATHODE CURRENT = 11 MA.									
7296	AVG. CHAR.	200	Rk = 68	17	-	90	5450	16500	-	-	-
7391	AVG. CHAR.	175	1.5	10	-	62	-	11000	-	-	-
	CLASS C OSCILLATOR	150	-	12	3.0	-	-	-	-	65mW	5400
	CLASS C OSCILLATOR	150	-	12	3.0	-	-	-	-	500mW	500
7462	AVG. CHAR.	150	(12)	7.2	-	94	9000	10500	-	-	-
7486	AVG. CHAR.	150	Rk = 82	7.5	-	90	-	10500	-	-	-
	CLASS C OSCILLATOR	150	Rg = 1000	8.0	2.0	-	-	-	-	300mW	1200
	CLASS C AMPLIFIER	150	Rg = 3000	5.0	1.0	-	-	-	-	300mW	450
7588	AVG. CHAR.	200	(13)	24	-	175	3900	45000	-	-	-
7625	AVG. CHAR.	150	Rk = 1000	0.95	-	80	57000	1400	-	-	-
7644	AVG. CHAR.	175	(9)	10	-	110	7300	15000	-	-	-
	CLASS A RF AMP. - GROUNDED-GRID	300 (14) 300	0	10	-	-	-	-	11	-	3000

Table 1C

CHARACTERISTICS AND TYPICAL OPERATION											
TYPE		PLATE VOLTS	NEG. GRID VOLTS	PLATE MILLI-AM-PERES	GRID MILLI-AM-PERES	μ	Rp, OHMS	Gm, μMHOS	GAIN IN DECI-BELS	R.F. POWER OUT-PUT	FREQ. (MHz)
7720	AVG. CHAR.	150	Rk = 82	7.5	-	90	-	10500	-	-	-
	CLASS C OSCILLATOR	150	Rg = 7000	4.0	0.5	-	-	-	-	100mW	450
7768	AVG. CHAR.	200	(13)	24	-	225	4500	50000	-	-	-
7784	AVG. CHAR.	175	(9)	10	-	110	7300	15000	-	-	-
	CLASS A RF AMP. -	(10)	0	10	-	-	-	-	17.5	-	450
	GROUNDED -GRID	(10)	0	10	-	-	-	-	11	-	3000
7841	SIGNAL DETECTOR	TUBE VOLTAGE DROP: 2.6 VOLTS AT I_B = 5.0 MA. MAX D-C CATHODE CURRENT = 5.5 MA; MAX PEAK CATHODE CURRENT = 22 MA.									
7910	AVG. CHAR.	125	Rk = 82	11.5	-	75	-	16000	-	-	-
	PLATE-PULSED OSC.- D.F. = 0.001	1000 PEAK	-	600 PEAK	200 PEAK	-	-	-	-	100W PEAK	5900
7913	AVG. CHAR.	200	Rk = 47	25	-	100	2500	40000	-	-	-
	CLASS C OSCILLATOR	300	Rg = 1500	25	5.0	-	-	-	-	4.0W	400
8081	AVG. CHAR.	150	Rk = 1000	0.95	-	80	57000	1400	-	-	-
8082	AVG. CHAR.	150	Rk = 82	7.5	-	90	-	10500	-	-	-
	CLASS OSCILLATOR	150	Rg = 7000	4.0	0.5	-	-	-	-	100mW	450
8083	AVG. CHAR.	150	(12)	7.2	-	94	9000	10500	-	-	-

Table 1D

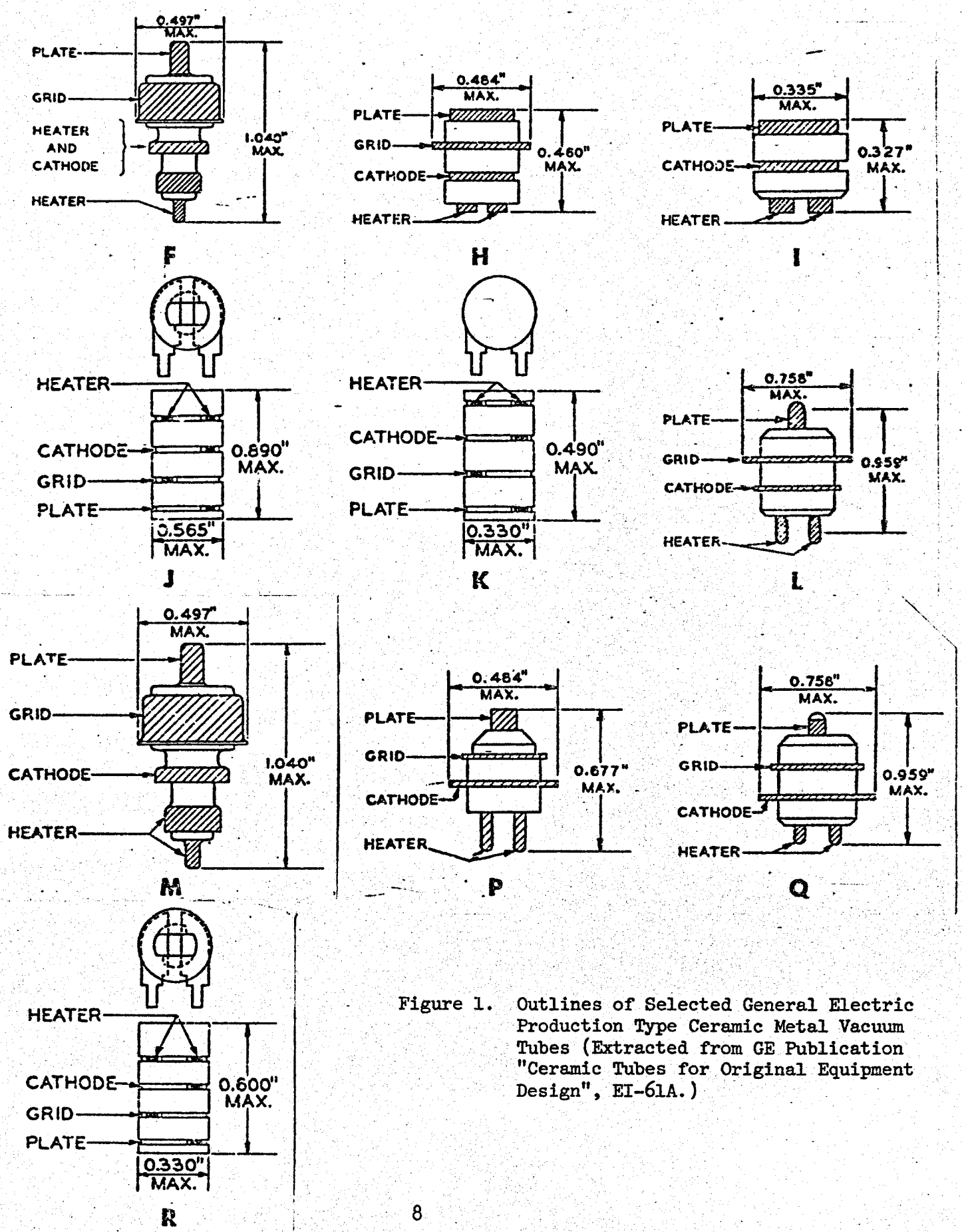


Figure 1. Outlines of Selected General Electric Production Type Ceramic Metal Vacuum Tubes (Extracted from GE Publication "Ceramic Tubes for Original Equipment Design", EI-61A.)

4.0 FUTURE ACTIVITIES

Before selecting tube types for use in the development of the Ultra High Temperature Amplifier, MRI plans to perform some supplemental temperature testing of selected tubes. Small quantities of tube types 7296, 7588, 7625 and 7462 have been ordered. These particular tubes have been selected to permit trade-offs of characteristics such as voltage amplifier performance, line driver performance, temperature performance, physical size, plate power requirements, filament power requirements and cost. Table 2 summarizes pertinent nominal characteristics of the selected tube types.

Table 2. Nominal Tube Characteristics

Characteristic	Tube Type			
	7296	7588	7462	7625
mu	90	175	94	80
G_m (Micromhos)	16,500	45,000	10,500	1,400
I_p (ma.)	17	24	7	1
I_f (ma.)	400	300	240	215
Diameter (in.)	1/2	1/2	1/3	1/3
Unit Cost ($)	94	180	63	84

The primary emphasis of the planned testing will be the determination of tube characteristic variations with temperature, since no data is available on this characteristic. It is important that tube characteristics do not change in a major way with temperature because the well log must operate over a broad spectrum of temperatures, not just a single temperature.

In addition to the above four commercially available tube types, one special tube is being developed by GE for a nominal cost. The objective

of this tube is to provide both a high amplification factor and high transconductance in a single tube. If successful, this approach will permit a single tube type to perform both the voltage amplification and line driving functions. The design goals for this tube are:

- Size: 1/3 inch diameter (8081 configuration)
- Filament Current: 215 ma @ 6.3V
- Amplification Factor: 300 ±75 @ $I_p = 5$ ma
- Transconductance: 21,000 ±1000 Mmhos @ $I_p = 10$ ma

Use of a single tube type is advantageous from the standpoints of volume price discount and spares requirement. This tube type will be tested in the same manner as the standard product line tubes.

REFERENCES

1. W. Cannon, "Development of a Prototype High Temperature Amplifier for Geothermal Well Logging", Mechanics Research, Inc., report MRI - 2870, May 1976.

2. R. D. Kelly, "Brief Report on Downhole Tests", letter to Larry Ball, ERDA Division of Geothermal Energy, May 27, 1976.

3. Unknown, "Life Test Summary of Ceramic Types Under High Temperature And High Humidity Conditions", General Electric Engineering Information - EI-43A

4. L. E. Baker, R. P. Baker, and R. L. Hughen, "Report of the Geophysical Measurements in Geothermal Wells Workshop", Sandia Laboratories report SAND75-0608, December 1975.

APPENDIX

Detailed Data Sheets for

Selected Ceramic Vacuum Tubes

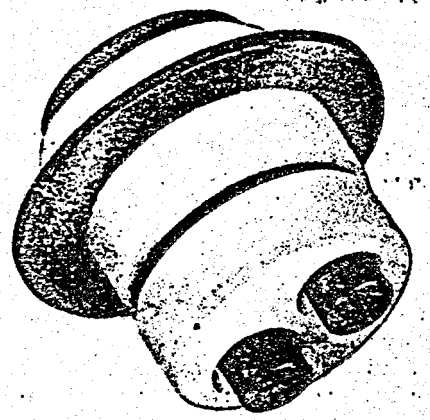
ELECTRONIC INNOVATIONS IN ACTION

TUBES

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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

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.

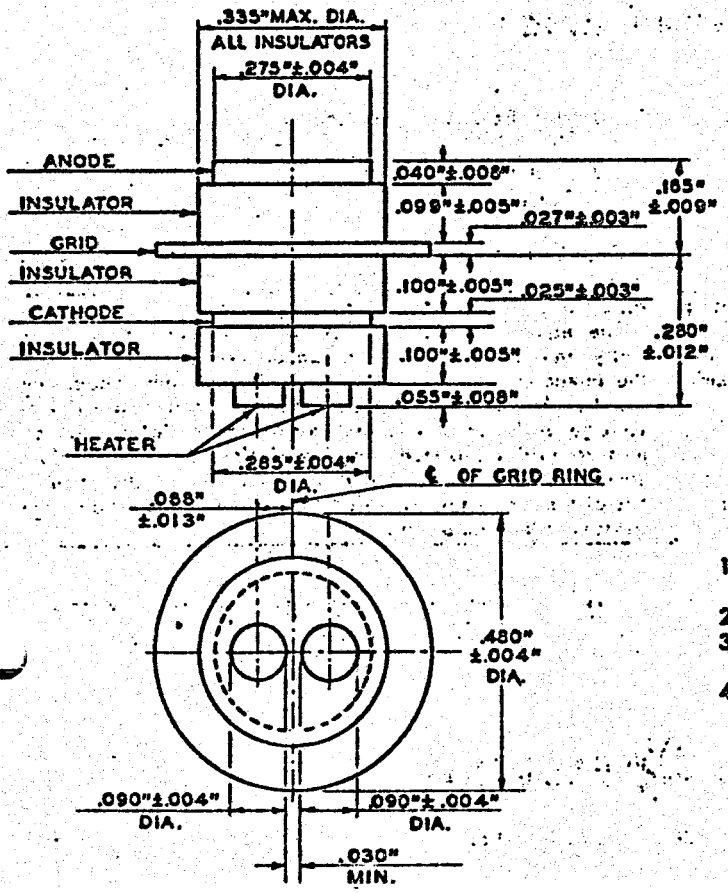
† Heater current of a bogey tube at Ef = 6.3 volts.

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

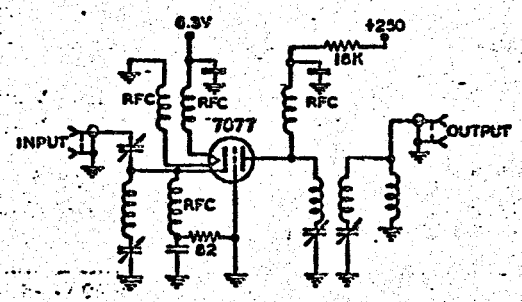
§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7077 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation,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

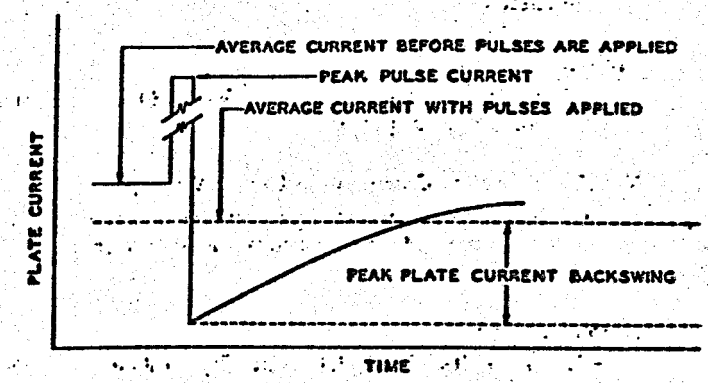
Grid Recovery

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

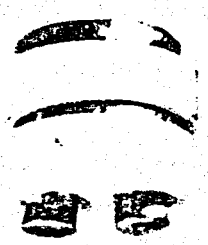
Fatigue

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

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

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

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 All 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

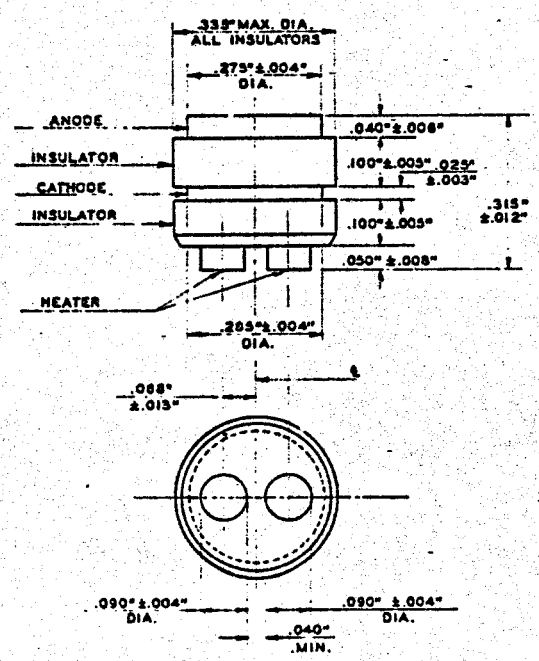
Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour) no other voltages applied. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, tube voltage drop, heater-cathode leakage,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

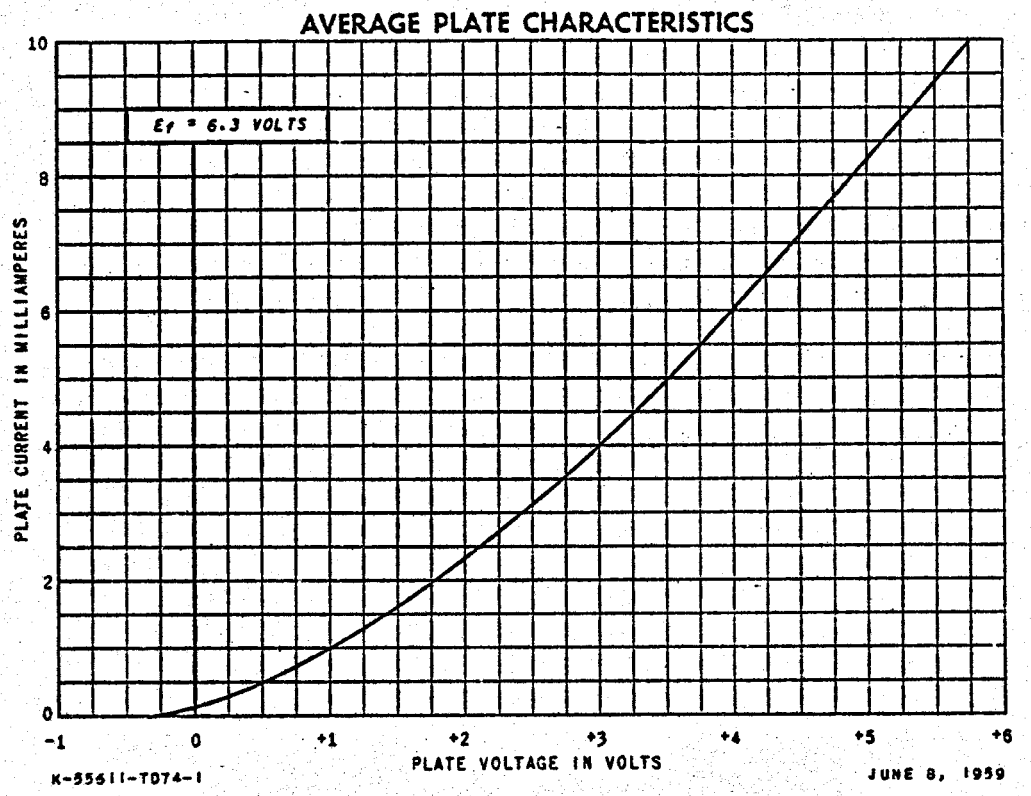
Heater-Cycling Life Test

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





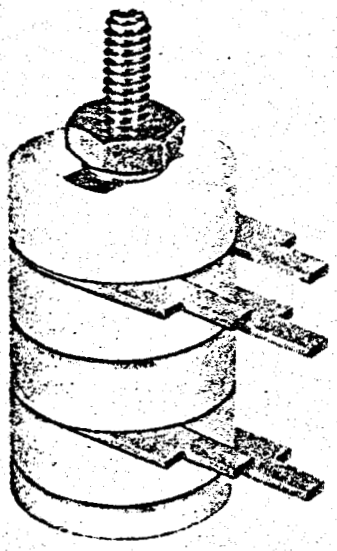
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS

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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

Supersedes ET-T1538A dated 2-60

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.

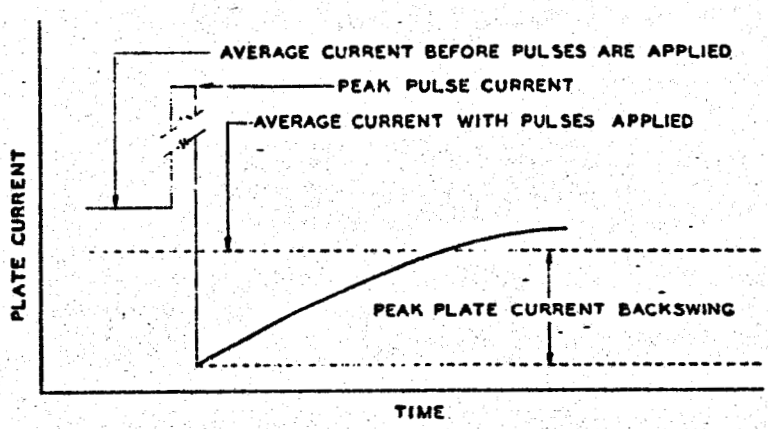
Pulse Emission	320	.....	.....	Milliamperes

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.

Grid Recovery — Change in Average Plate Current	.....	.....	1.0	Milliamperes
Grid Recovery — 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:



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.

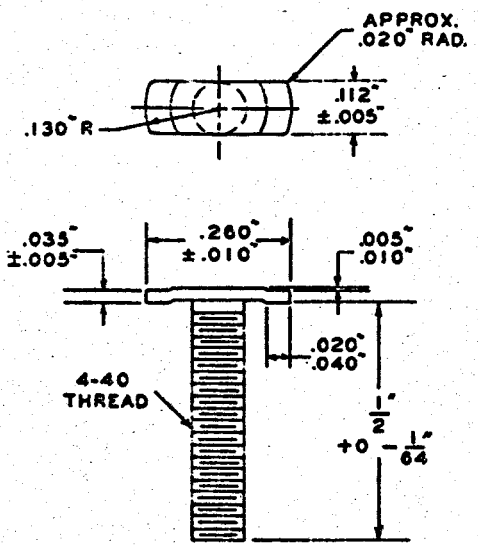
Interface Life Test

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.

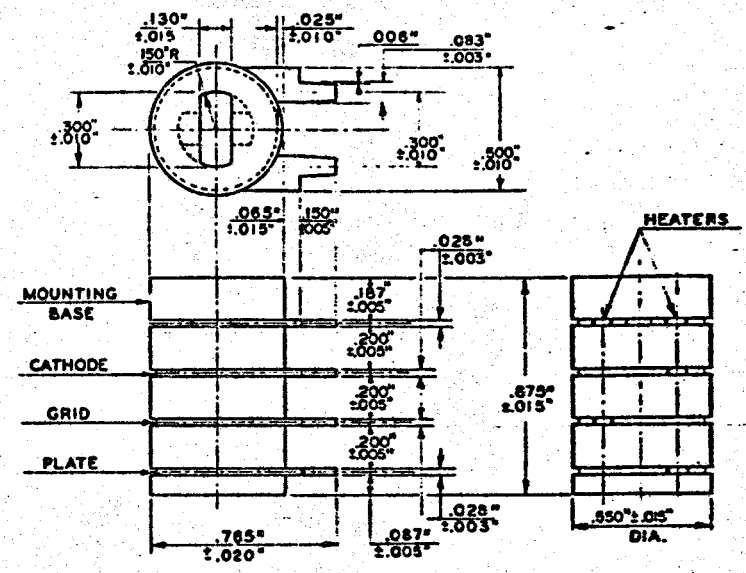
Heater-Cycling Life Test

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

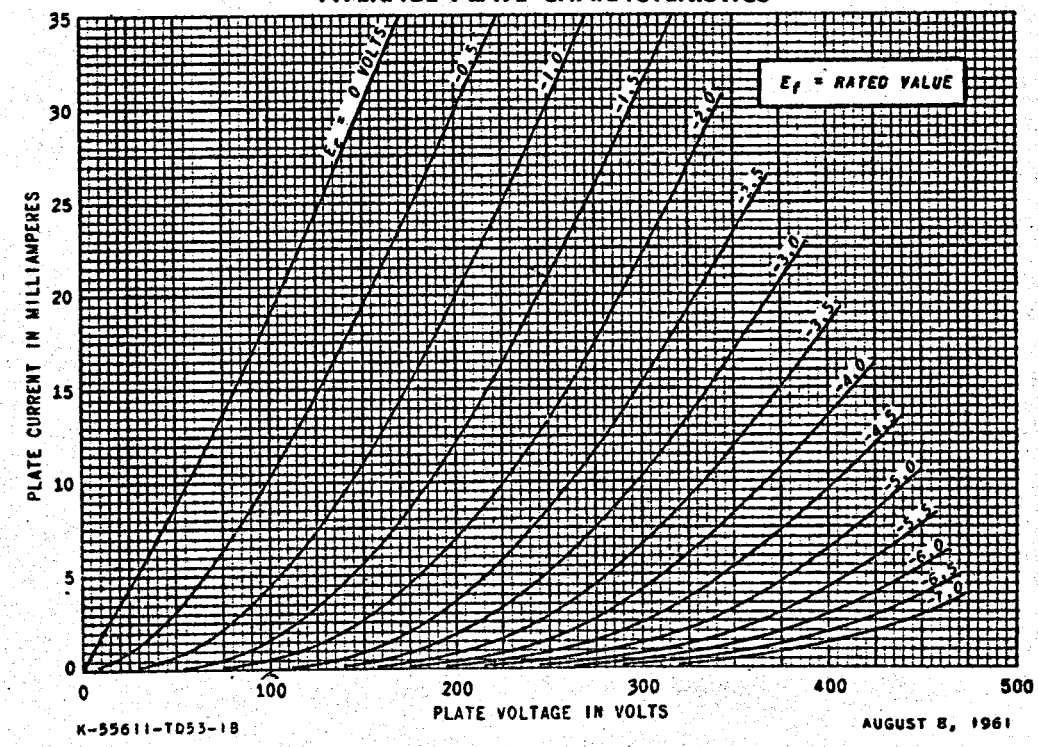


PHYSICAL DIMENSIONS



Maximum eccentricity of insulators 0.015 in. from center line.

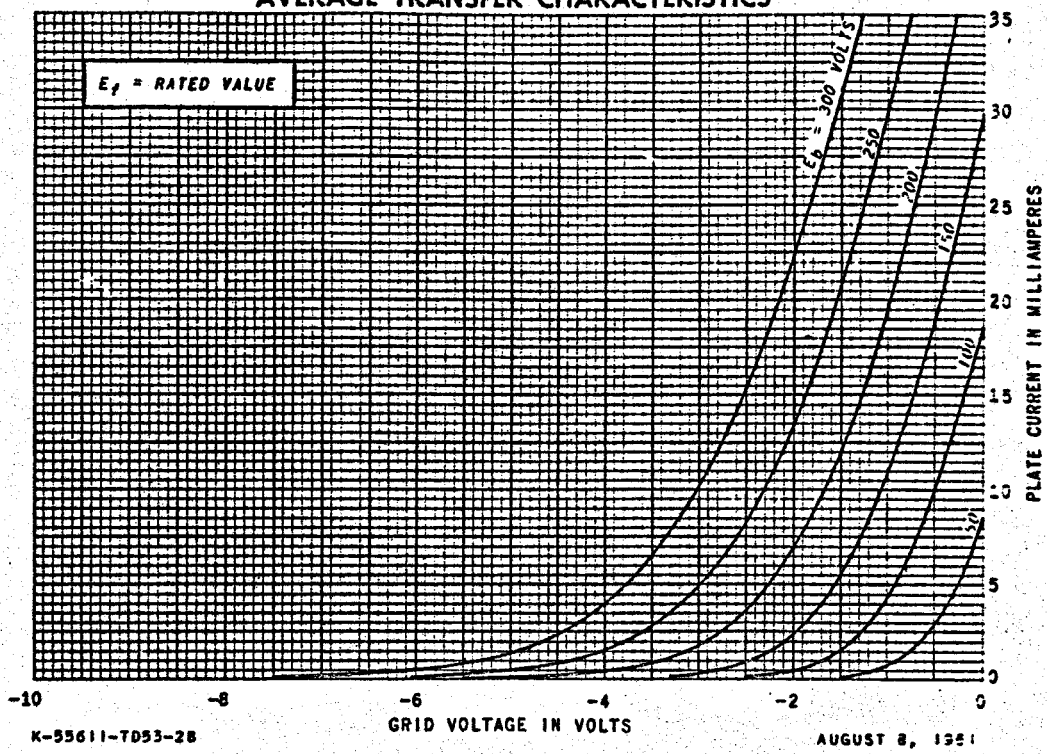
AVERAGE PLATE CHARACTERISTICS



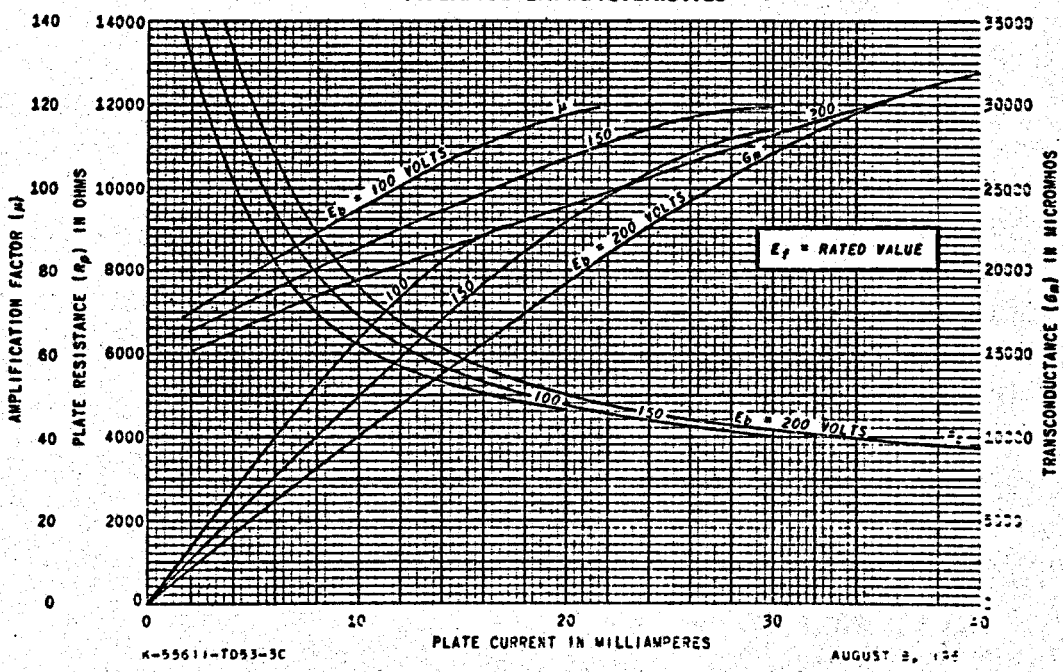
K-55611-TD53-1B

AUGUST 8, 1961

AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

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

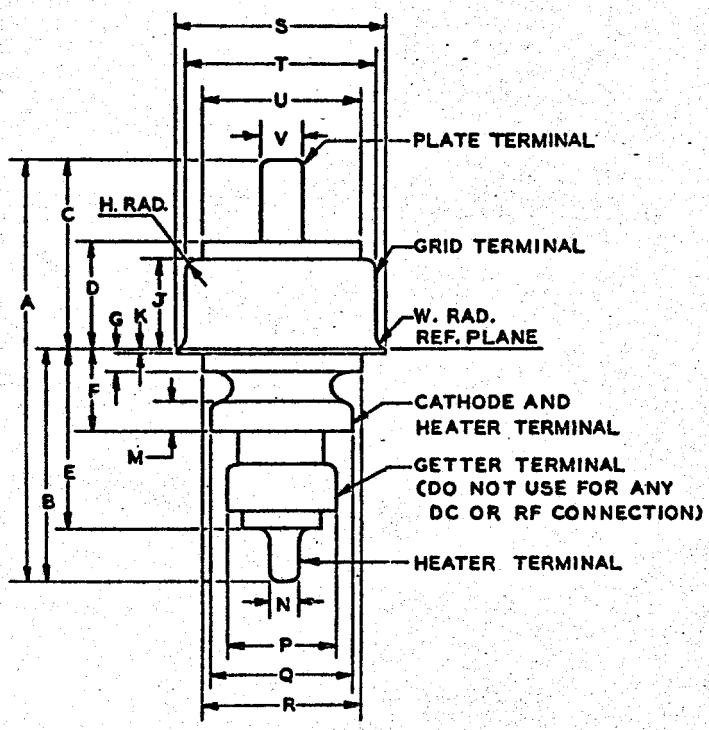
5400 Megacycle Oscillator Power Output				
Ef = 6.3 volts, Eb = 150 volts, Rg = 2000 ohms, Ib = 15±0.5 ma, F = 5400 MC, min.	30	65	---	Milliwatts

DEGRADATION RATE TESTS

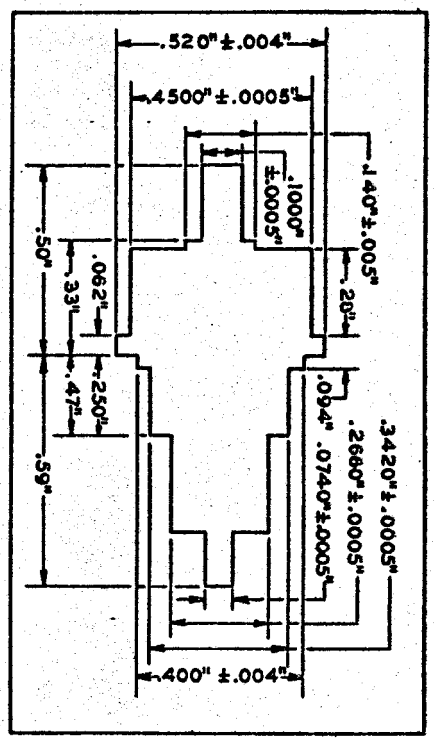
500-Hour Life

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

PHYSICAL DIMENSIONS

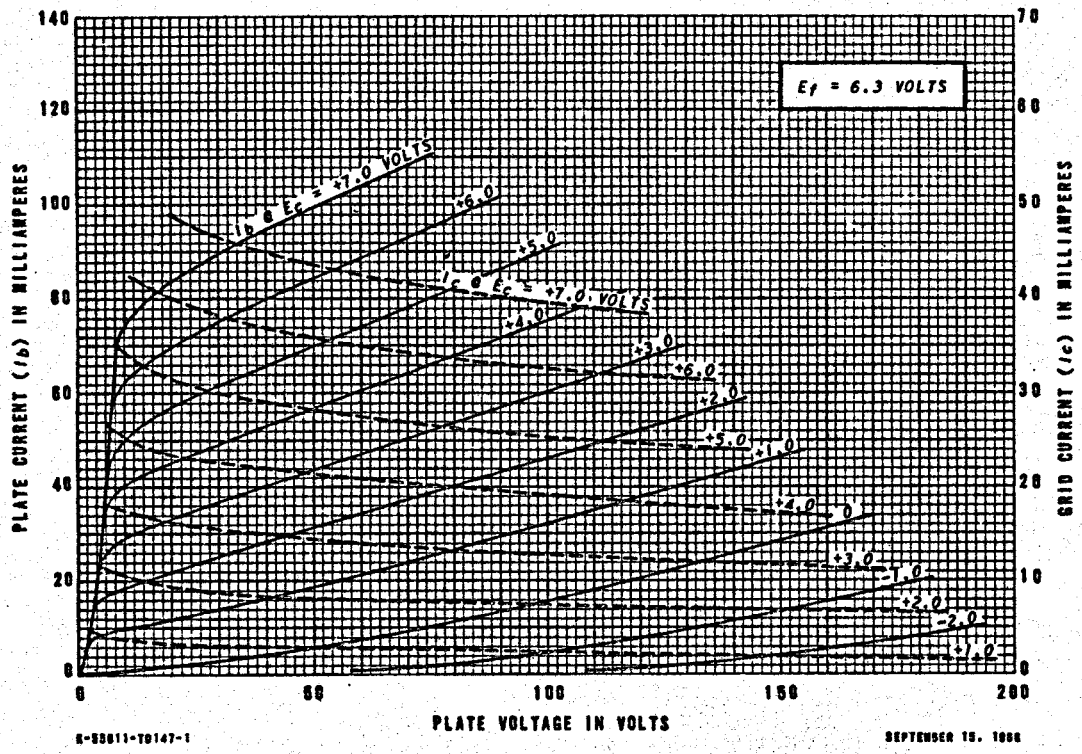


ALIGNMENT GAUGE



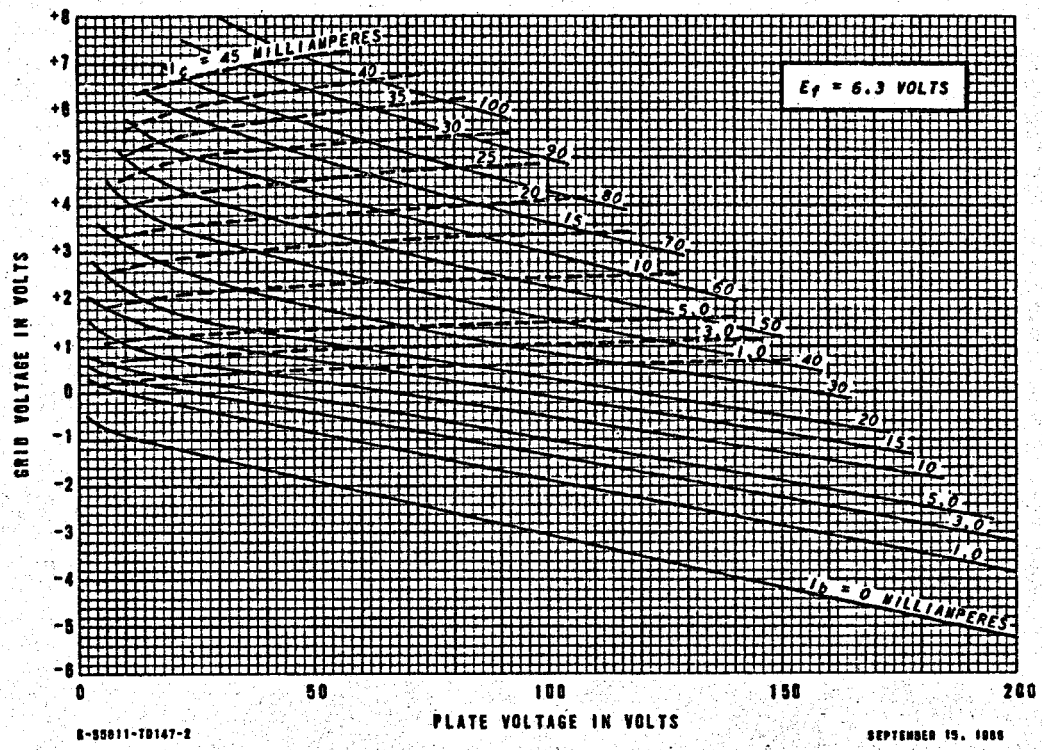
Ref.	INCHES		MILLIMETERS	
	Minimum	Maximum	Minimum	Maximum
A	0.960	1.040	24.38	26.42
B	0.530	0.590	13.46	14.99
C	0.410	0.470	10.41	11.94
D	---	0.272	---	6.91
E	---	0.475	---	12.07
F	0.163	0.193	4.14	4.90
G	---	0.060	---	1.52
H	---	0.030	---	0.76
J	0.190	0.210	4.83	5.33
K	0.009	0.015	0.23	0.38
M	0.040	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



G-55811-T0147-1 SEPTEMBER 15, 1966

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



G-55811-T0147-2 SEPTEMBER 15, 1966

TUBE DEPARTMENT

GENERAL ELECTRIC

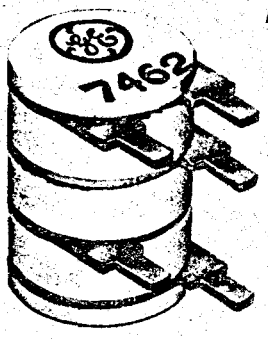
Owensboro, Kentucky

ELECTRONIC INNOVATIONS IN ACTION

TUBES

7462

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

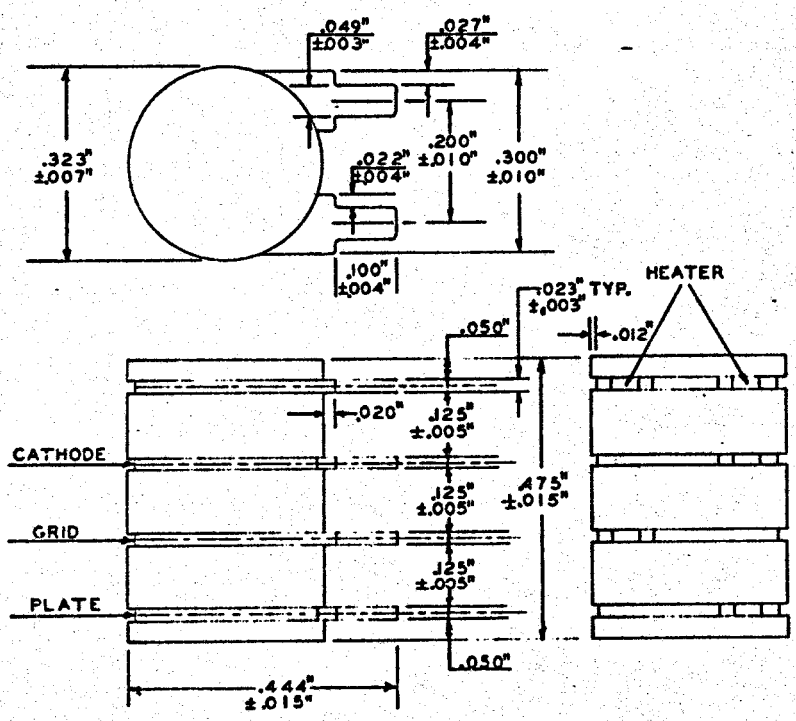
AVERAGE CHARACTERISTICS

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.

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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.

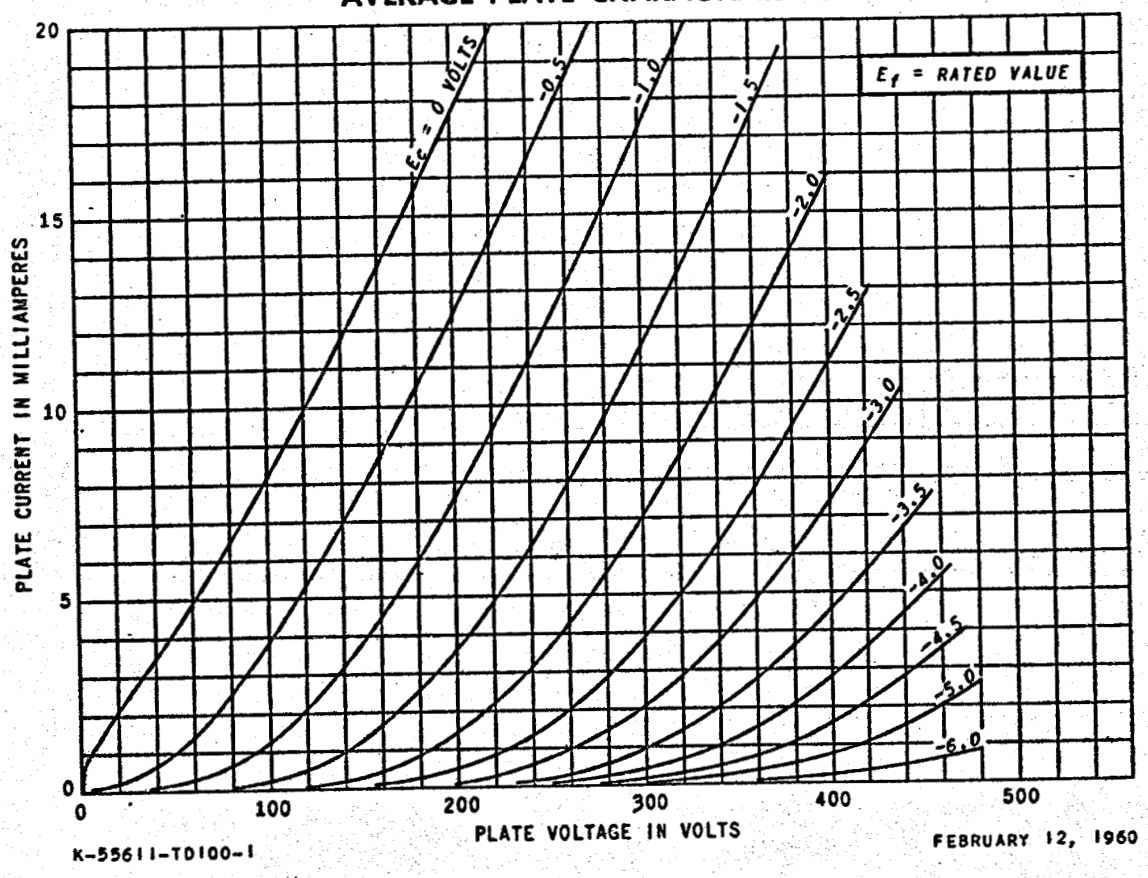
Interface Life Test

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.

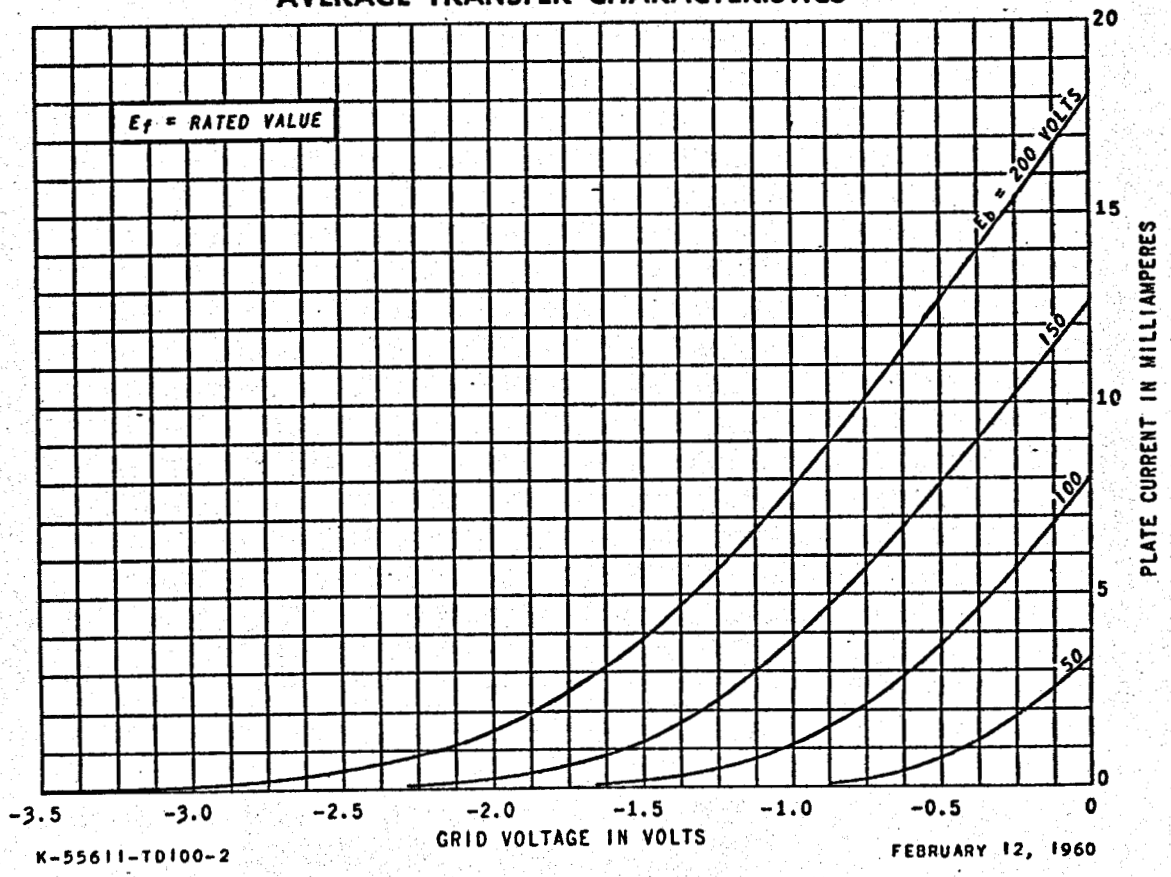
Heater-Cycling Life Test

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.

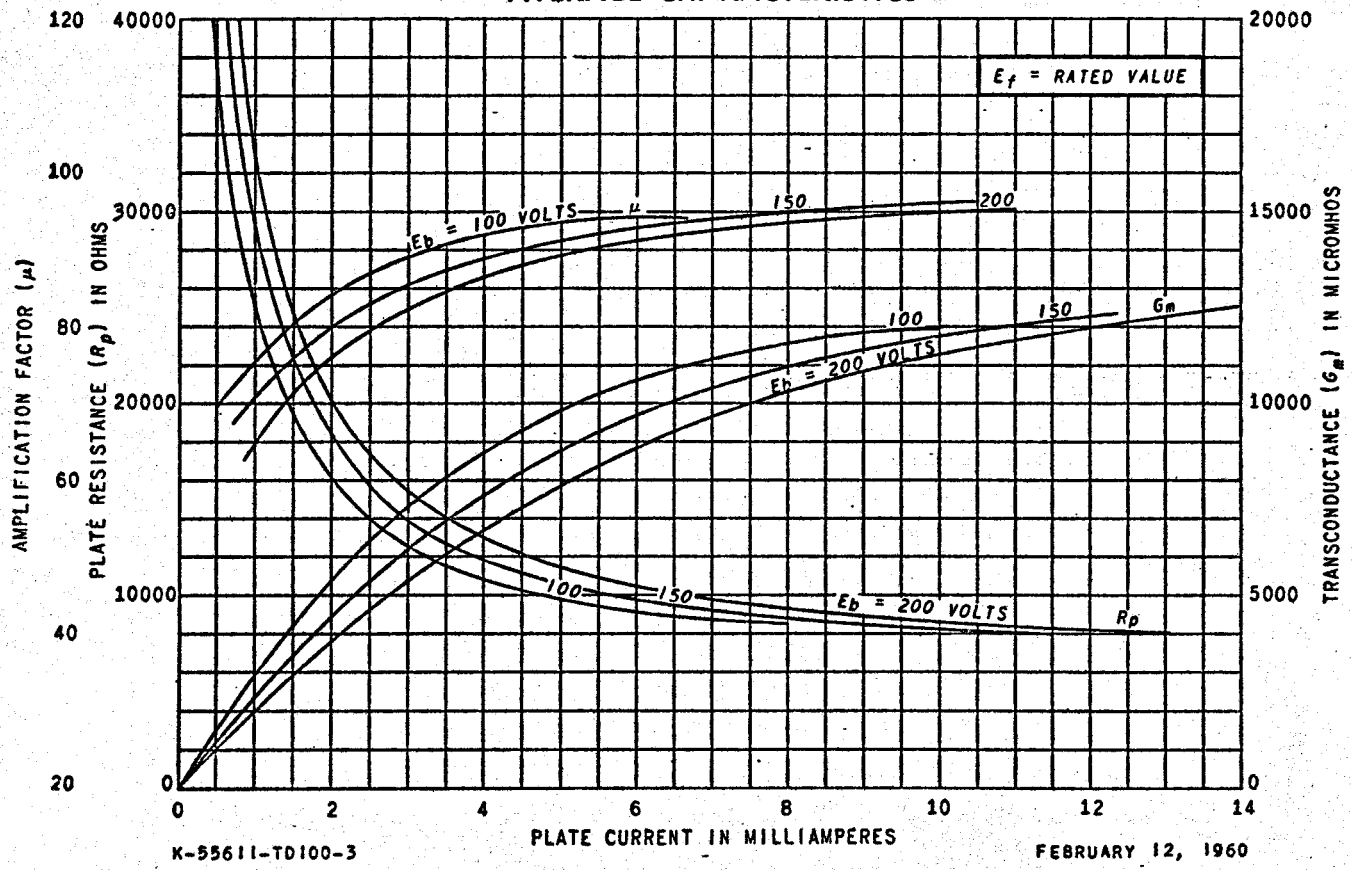
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



K-55611-TD100-3

FEBRUARY 12, 1960

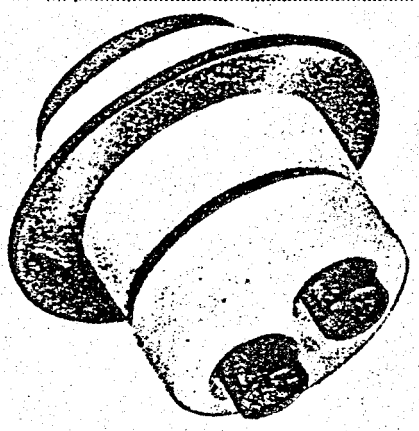
ELECTRONIC INNOVATIONS IN ACTION

TUBES

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.

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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

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

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

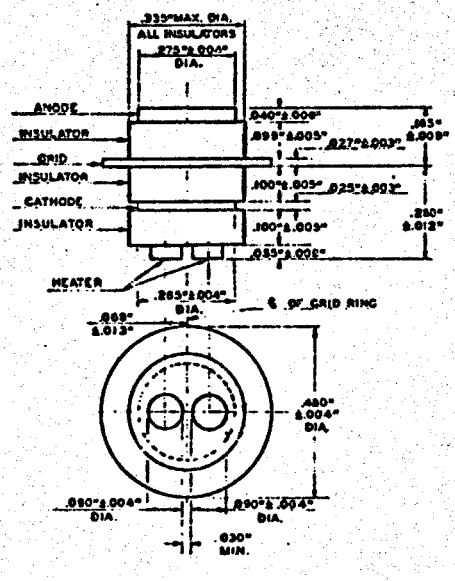
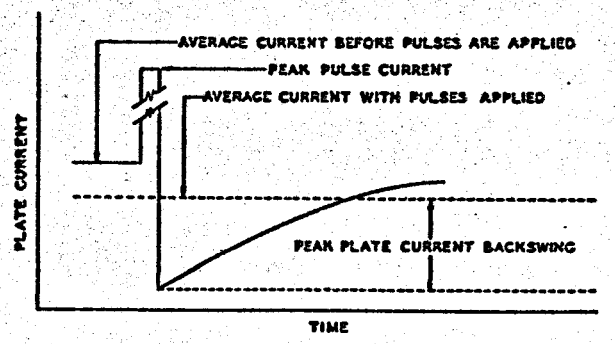


PLATE CURRENT VS TIME— GRID RECOVERY TEST



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

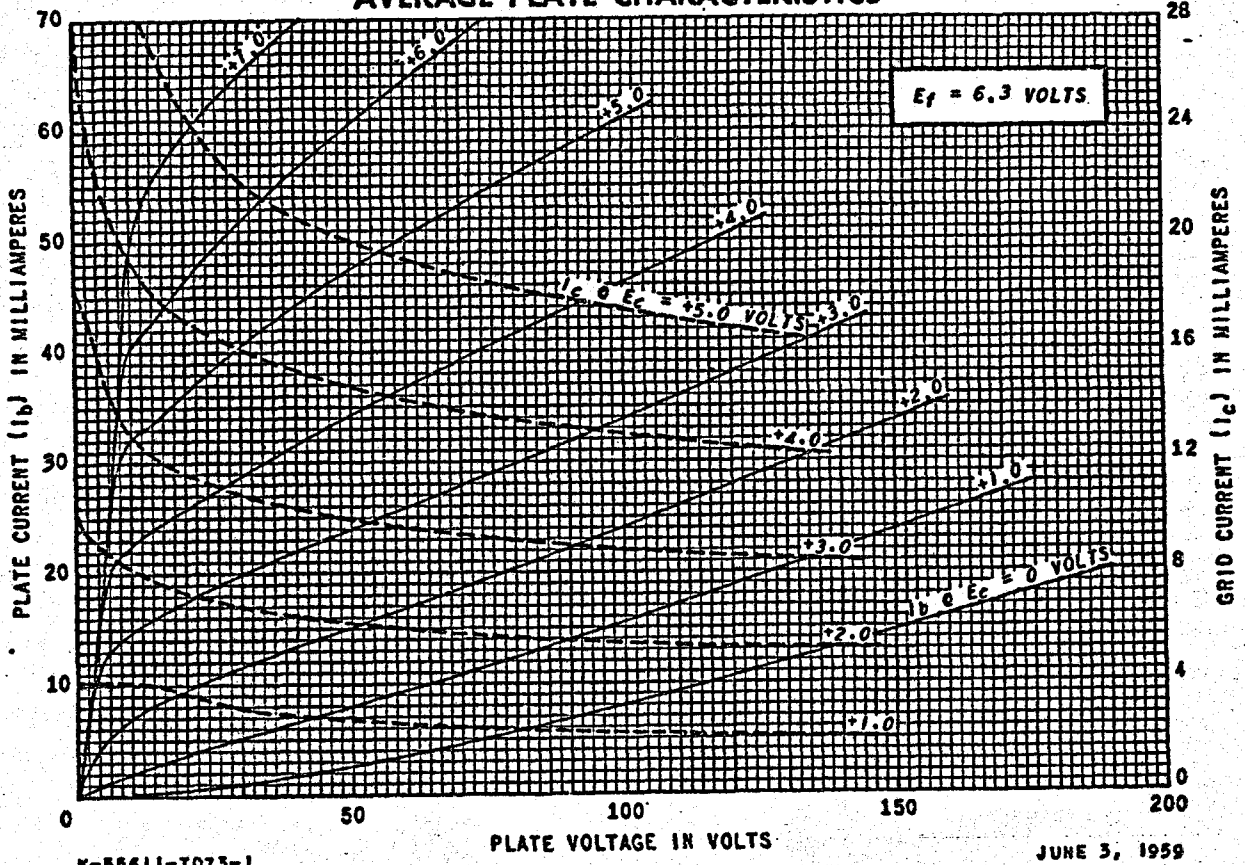
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

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.

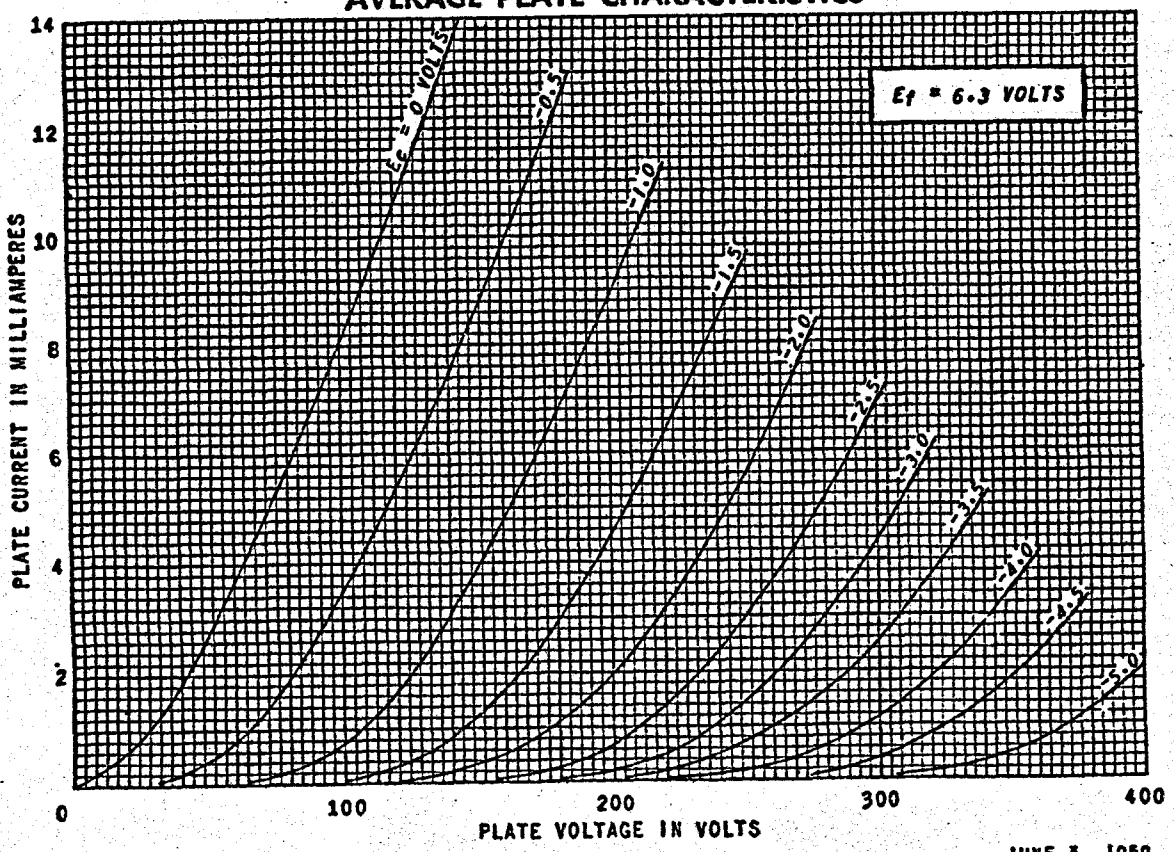
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

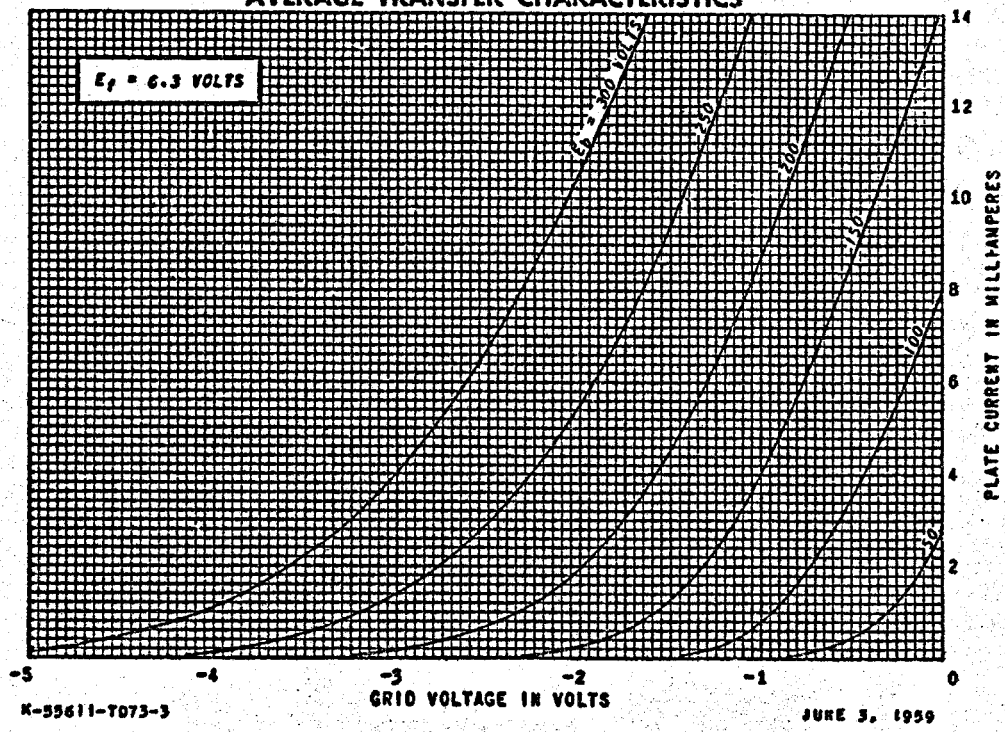
AVERAGE PLATE CHARACTERISTICS



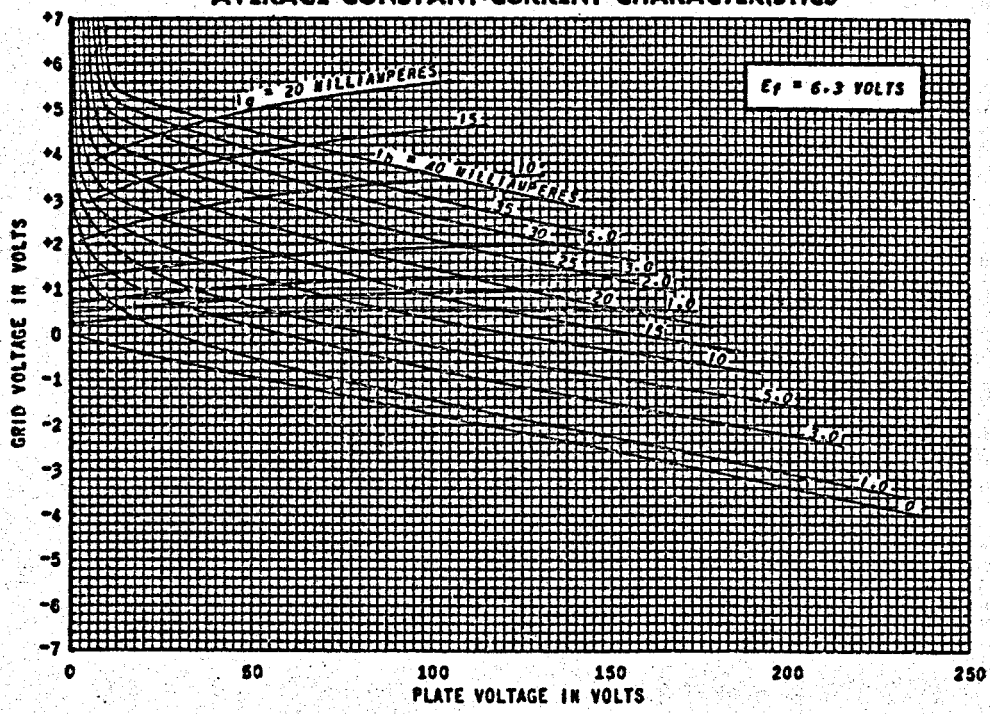
K-55611-TD73-2

JUNE 3, 1959

AVERAGE TRANSFER CHARACTERISTICS

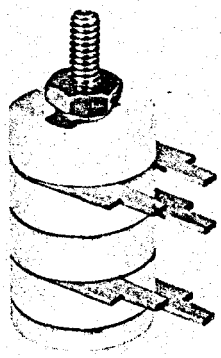


AVERAGE CONSTANT-CURRENT CHARACTERISTICS



CONSTANT-CURRENT CURVES

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

GENERAL ELECTRIC

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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

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

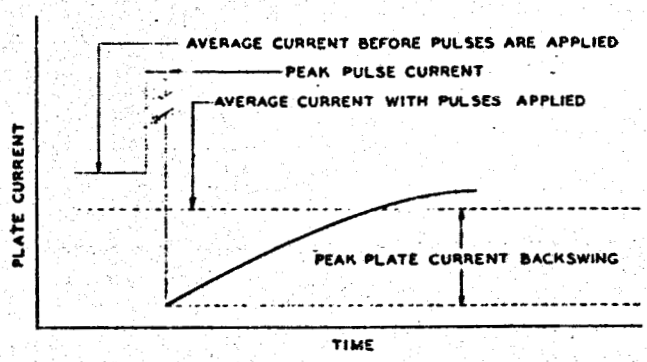
SPECIAL PERFORMANCE TESTS

	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.

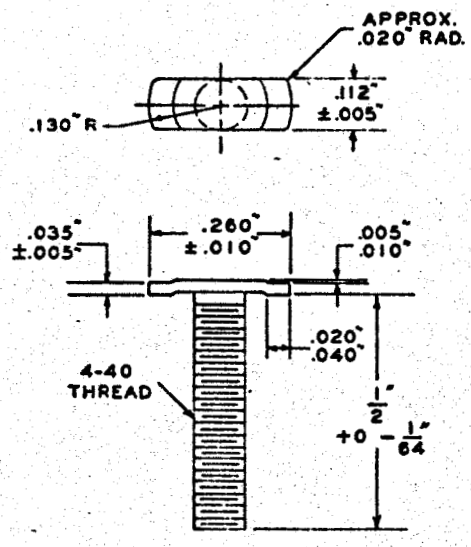
Interface Life Test

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.

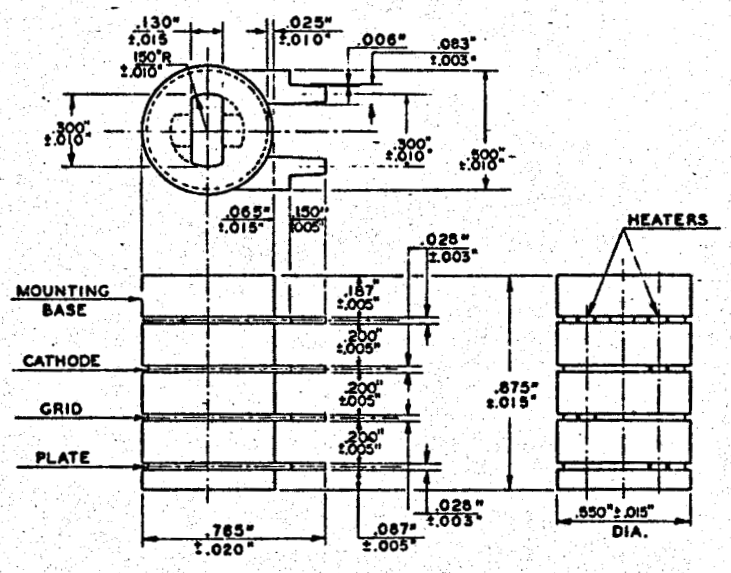
Heater-Cycling Life Test

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

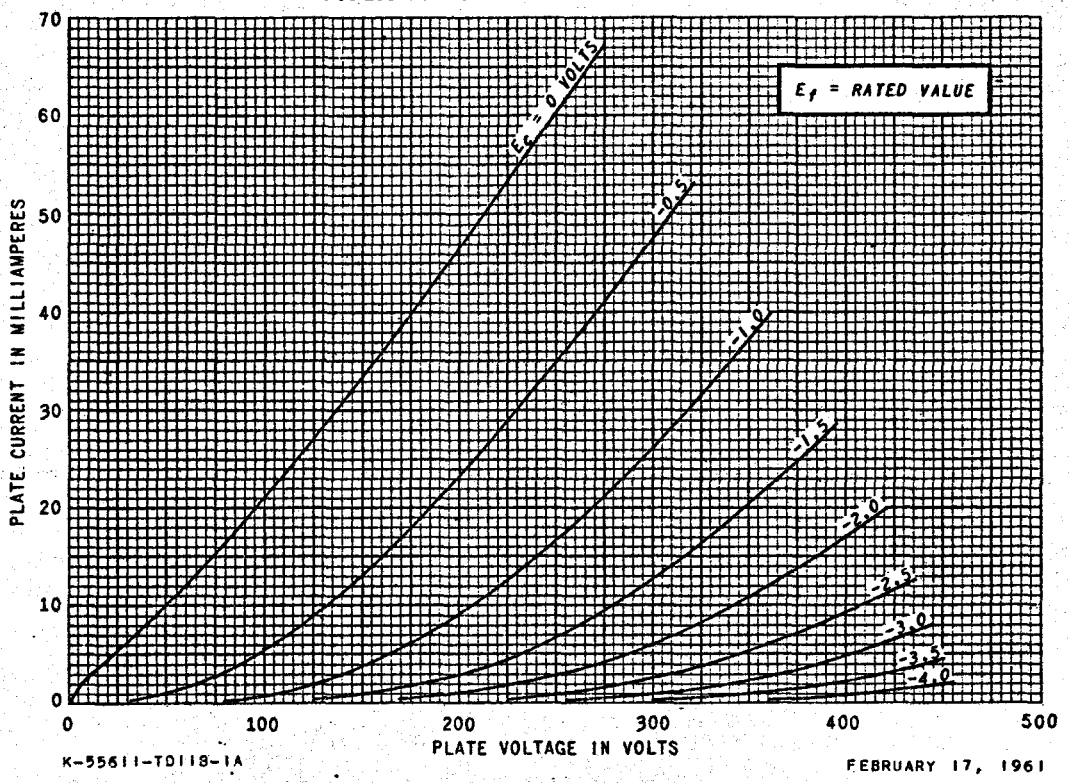


PHYSICAL DIMENSIONS

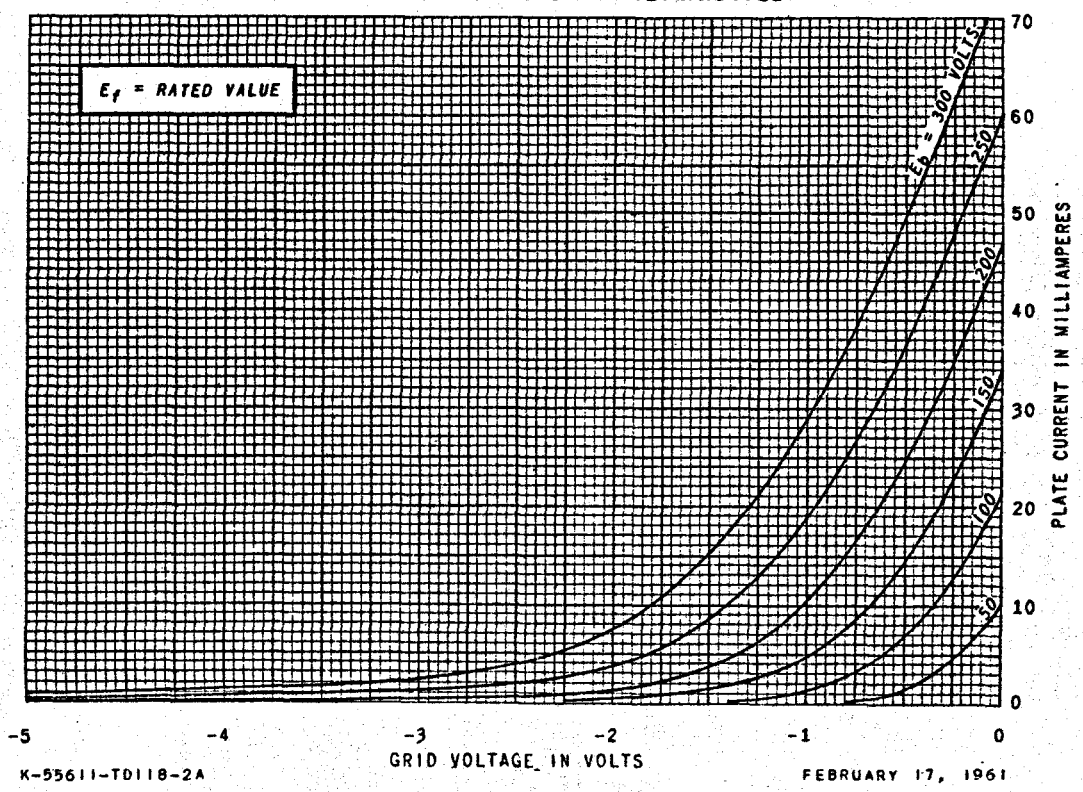


Maximum eccentricity of insulators 0.015 in. from center line.

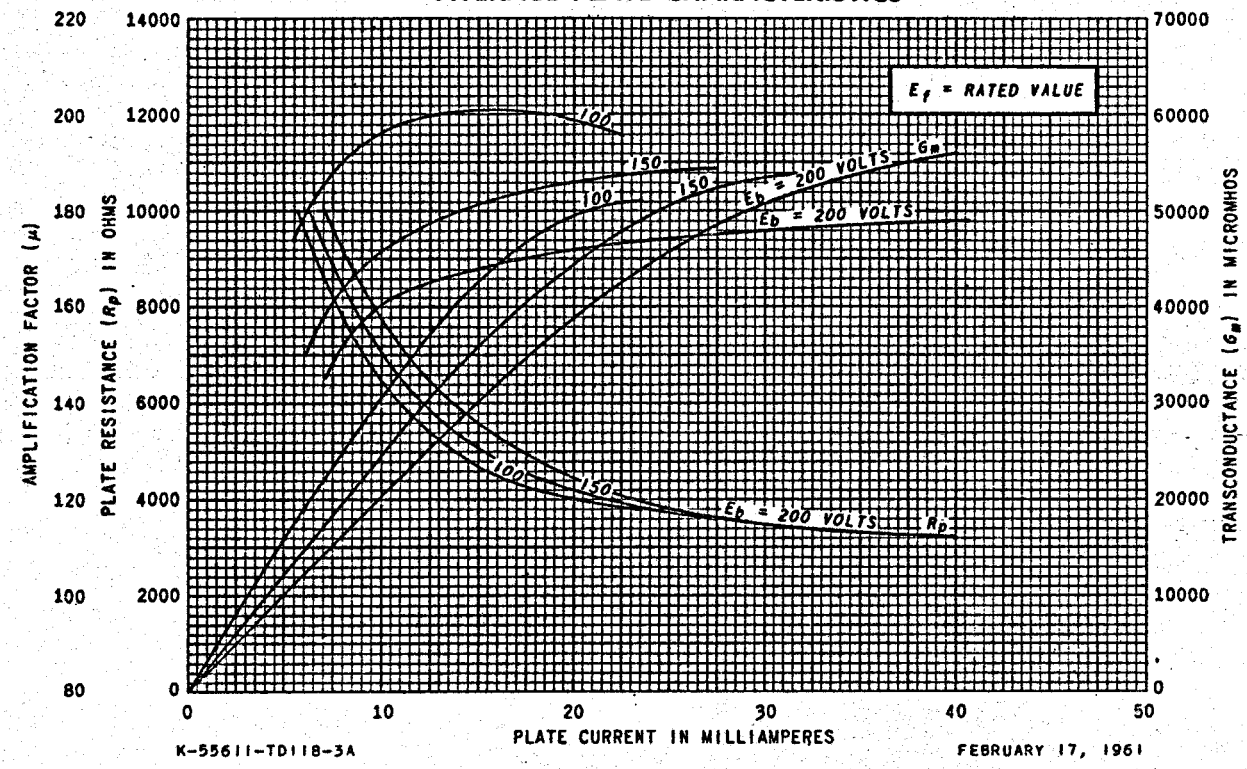
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



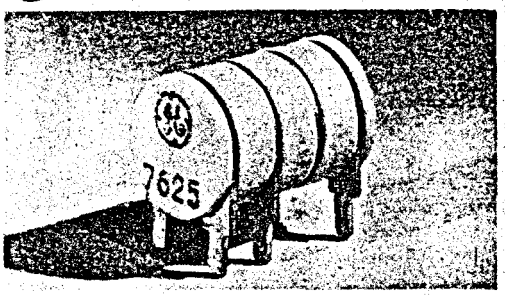
AVERAGE PLATE CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky



METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7625 is a high-mu triode of ceramic-and-metal planar construction primarily intended for low-level audio-frequency amplification.

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‡		
Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.5	pf
Output: p to (h+k)	0.03	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

DC Plate Voltage	275	Volts
Peak Plate Voltage	400	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	0.85	Watts
DC Cathode Current	3.8	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§	0.2	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	150	Volts
Cathode-Bias Resistor	1000	Ohms
Amplification Factor	80	
Plate Resistance, approximate	57000	Ohms
Transconductance	1400	Micromhos
Plate Current	0.95	Milliamperes
Grid Voltage, approximate Ib=10 Microamperes, Eb=250 Volts	−4.6	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.

§ If resistance is used in the cathode or plate circuits, the grid-circuit resistance may be high as (200,000+500 RK+10 RL) ohms, where RK is the cathode-bias resistance in ohms, and RL is the DC plate load resistance in ohms.

¶ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7625 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.

SPECIAL PERFORMANCE TESTS

	Maximum	
Variable-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (bypassed), R_L = 10000 ohms; Note 1	15	Millivolts peak to peak
Low-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (bypassed), R_L = 10000 ohms, G = 15, F = 40 cps; Note 2	0.75	Millivolts RMS

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.

Note 1: The variable-frequency vibration test shall be performed as follows:

a. 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.
b. 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.
c. The peak acceleration shall be maintained at 10 ± 1 G throughout the test.
d. The vibrational output produced across R_L as a result of the vibration shall be coupled to a low-pass filter that has the following characteristics:
   (1) A response within ± 1 db of the response at 1000 cps over the frequency range of 100 to 17000 cps.
   (2) The response shall be down at least 1.5 db at 20000 cps and have a cut-off rate of at least 18 db per octave above 20000 cps.

Note 2: The tube shall be vibrated with harmonic motion in each of two planes, (1) parallel to the cylindrical axis and (2) perpendicular to the cyclindrical axis and perpendicular to a line through the major axis of a terminal lug.

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, transconductance, and negative grid current.

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, transconductance, and negative grid current.

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 readings to readings following 2 hours and 20 hours of the life test.

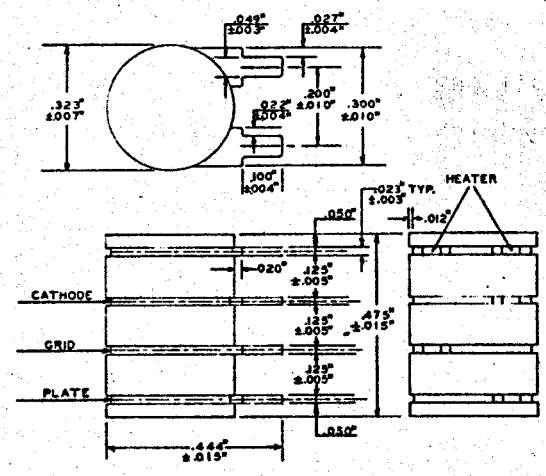
Survival Rate Life Test

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), 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, grid current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

DEGRADATION RATE TESTS (Continued)



Maximum eccentricity of insulators 0.010 in. from center line.

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.

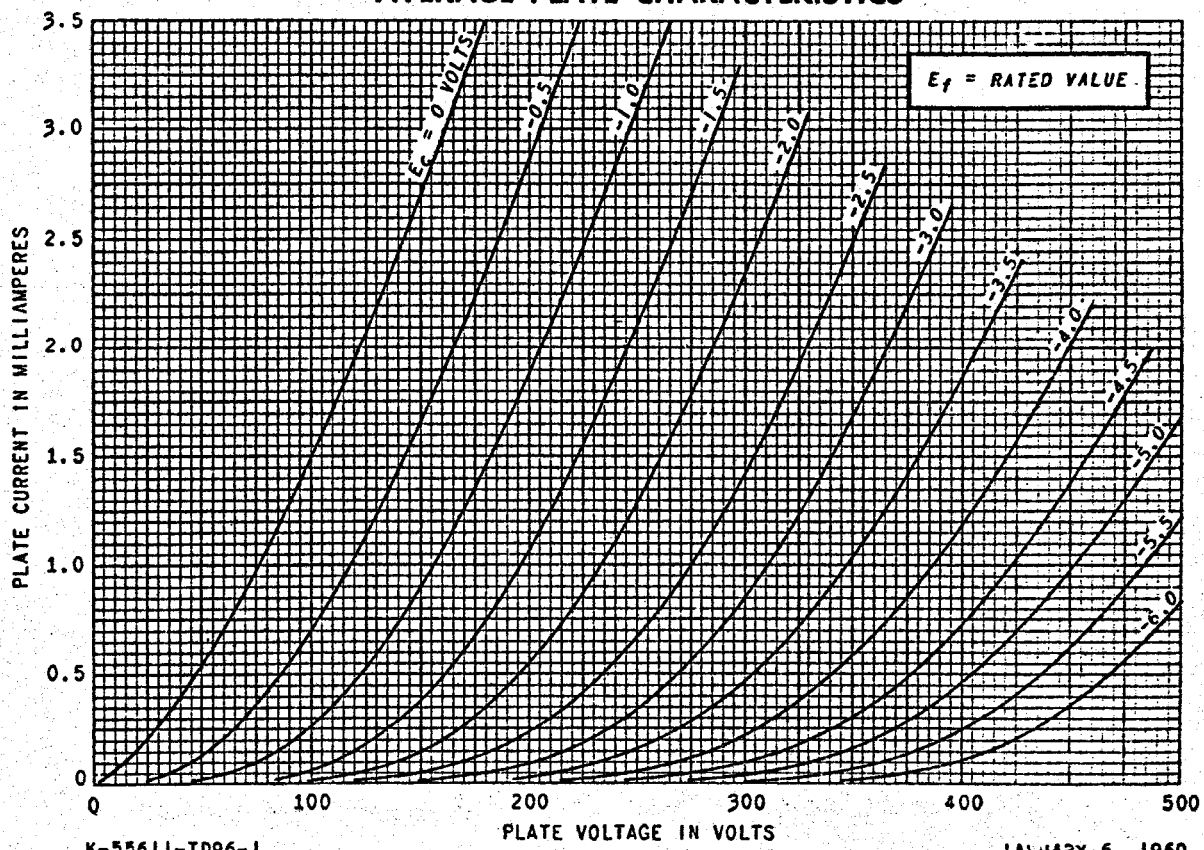
Heater-Cycling Life Test

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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

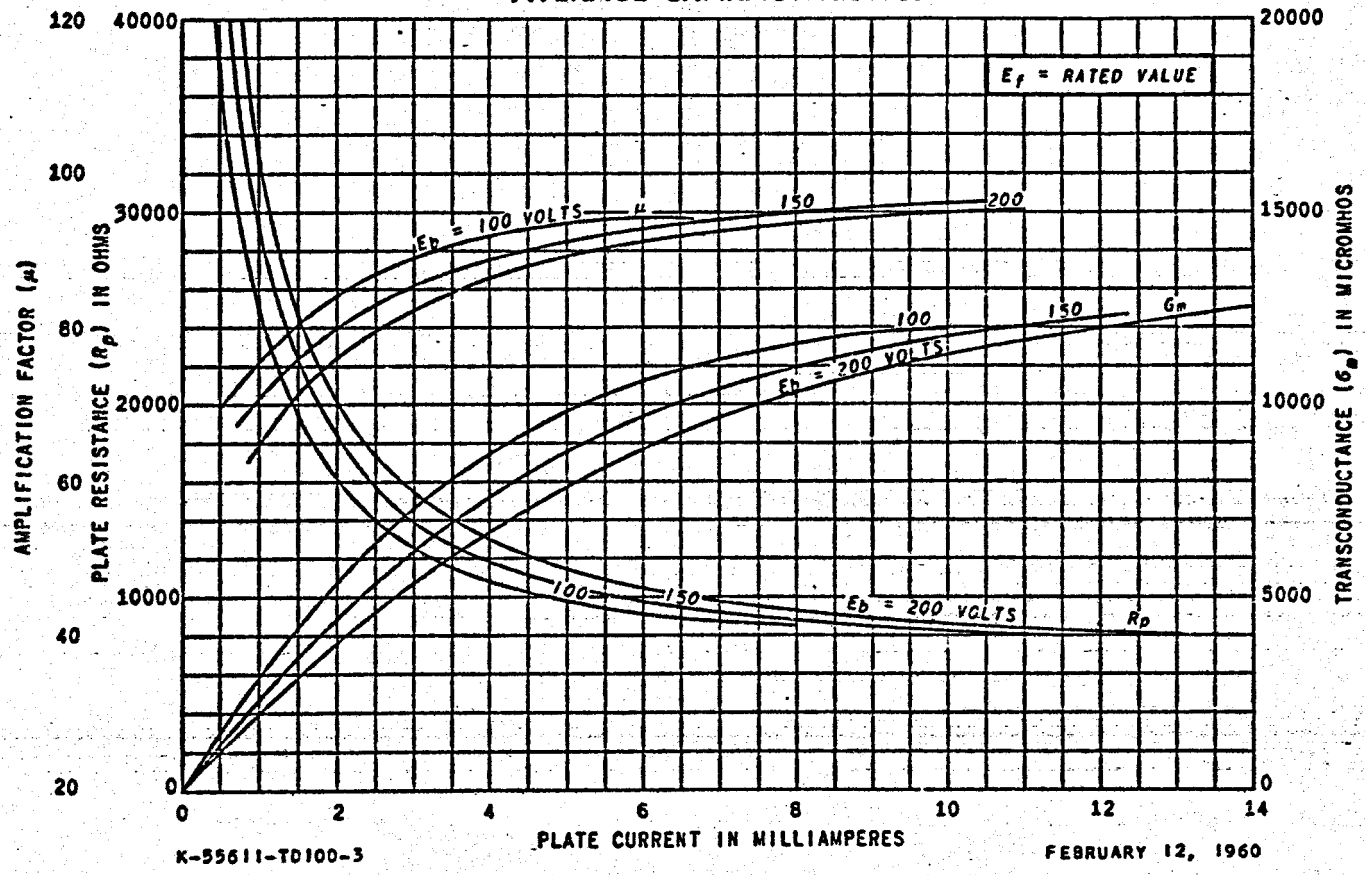
AVERAGE PLATE CHARACTERISTICS



K-55611-TD96-1

JANUARY 6, 1960

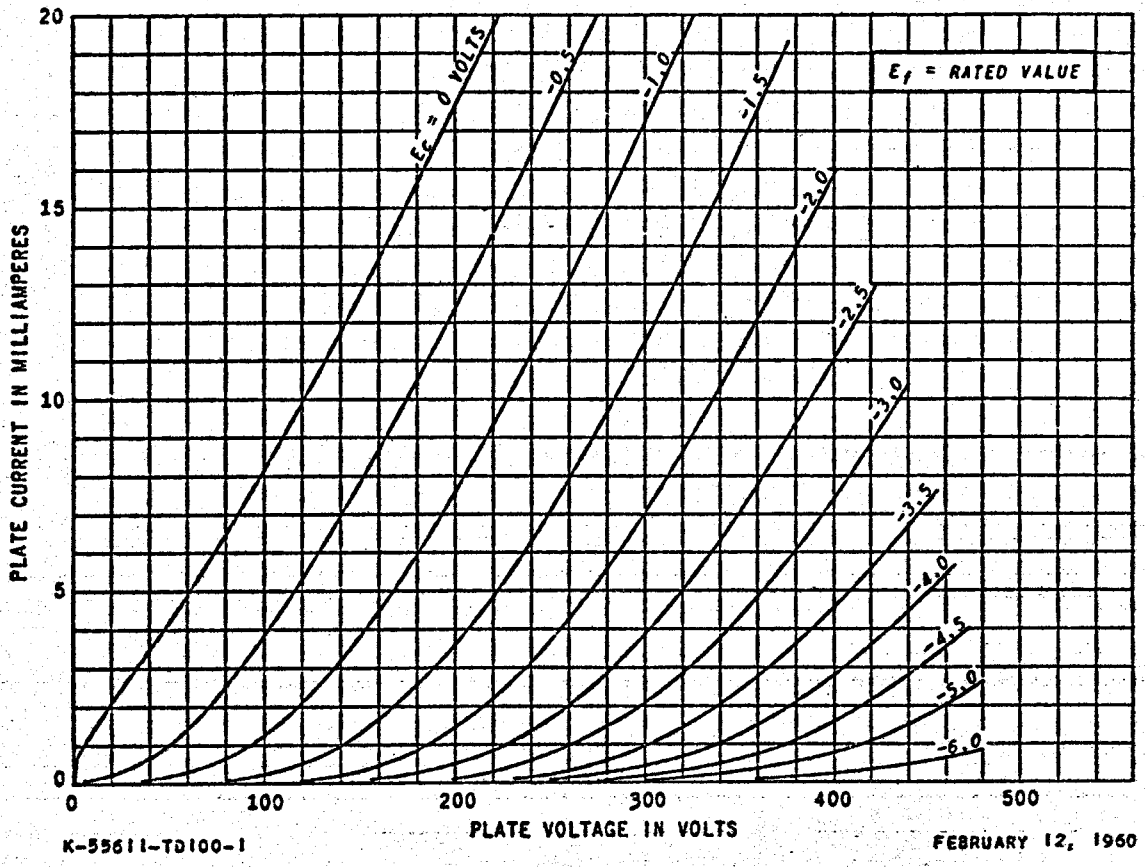
AVERAGE CHARACTERISTICS



K-55611-TD100-3

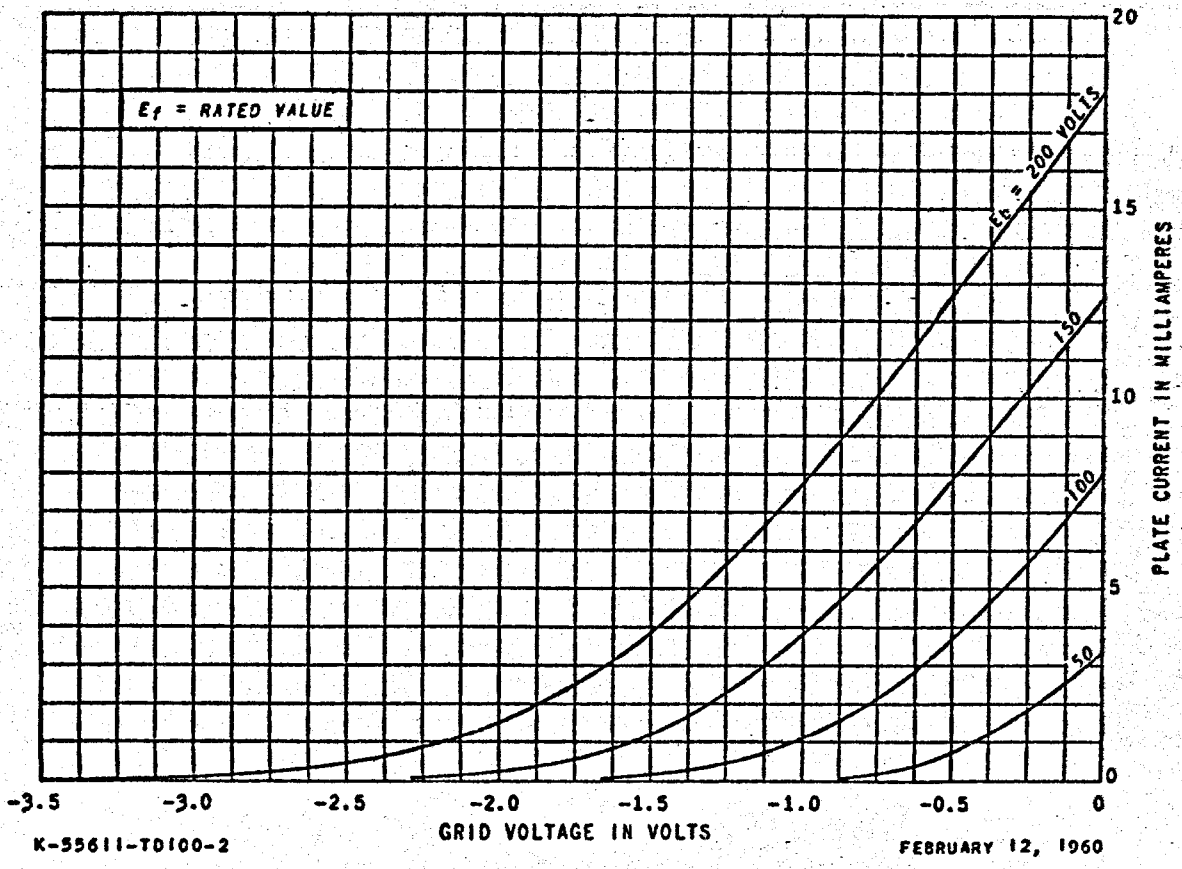
FEBRUARY 12, 1960

AVERAGE PLATE CHARACTERISTICS



K-55611-TD100-1 FEBRUARY 12, 1960

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD100-2 FEBRUARY 12, 1960

SPECIAL PERFORMANCE TESTS (Continued)

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulated 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, 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 mounted by T-bolt with 3 inch-pounds torque, and 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 for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Eb = 150 volts, Ecc = +6.0 volts, Ehk = −70 volts d-c, Rk = 910 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted and 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 circuit operating conditions.

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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	−2.2	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.

¶ One method of mounting the 8083 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 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

△ If resistance is used in the cathode or plate circuits, the grid-circuit resistance may be as high as (10000 + 100 RK + 10RL) ohms, where RK is the cathode-bias resistance in ohms, and RL is the DC plate load resistance in ohms.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 8083 is also capable of operation at envelope temperatures much higher than the rated maximum value. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

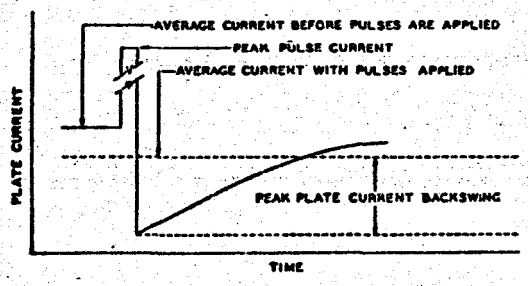
SPECIAL PERFORMANCE TESTS

	Maximum	
Noise Figure		
Ef = 6.3 volts, Ebb = 250 volts, Rk = 82 ohms, R_L = 18000 ohms, F = 200 mc	5.5	Decibels
Grid Recovery		
Change in Average Plate Current	0.6	Milliamperes
Peak Plate Current Backswing	1.0	Milliamperes

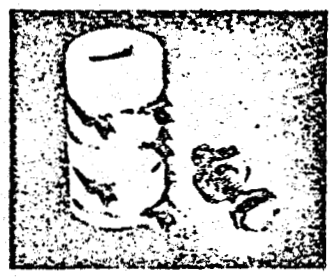
Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 8083 tubes 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 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.

PLATE CURRENT VS. TIME —GRID RECOVERY TEST



METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

The 8083 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.

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)	1.2	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

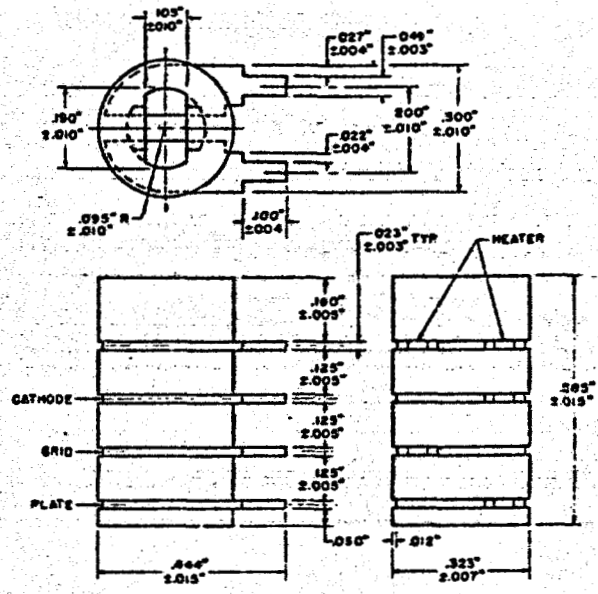
MECHANICAL

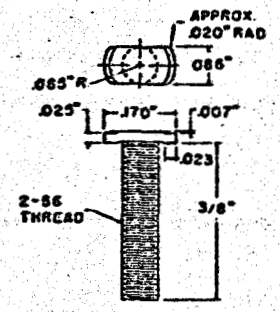
Mounting Position—Any¶

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Peak Plate Voltage	400	Volts
Positive Peak and DC Grid-to-Cathode Voltage	0	Volts
Negative Peak and DC Grid-to-Cathode 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 Δ	0.01	Megohms
Envelope Temperature at Hottest Point#	250	C



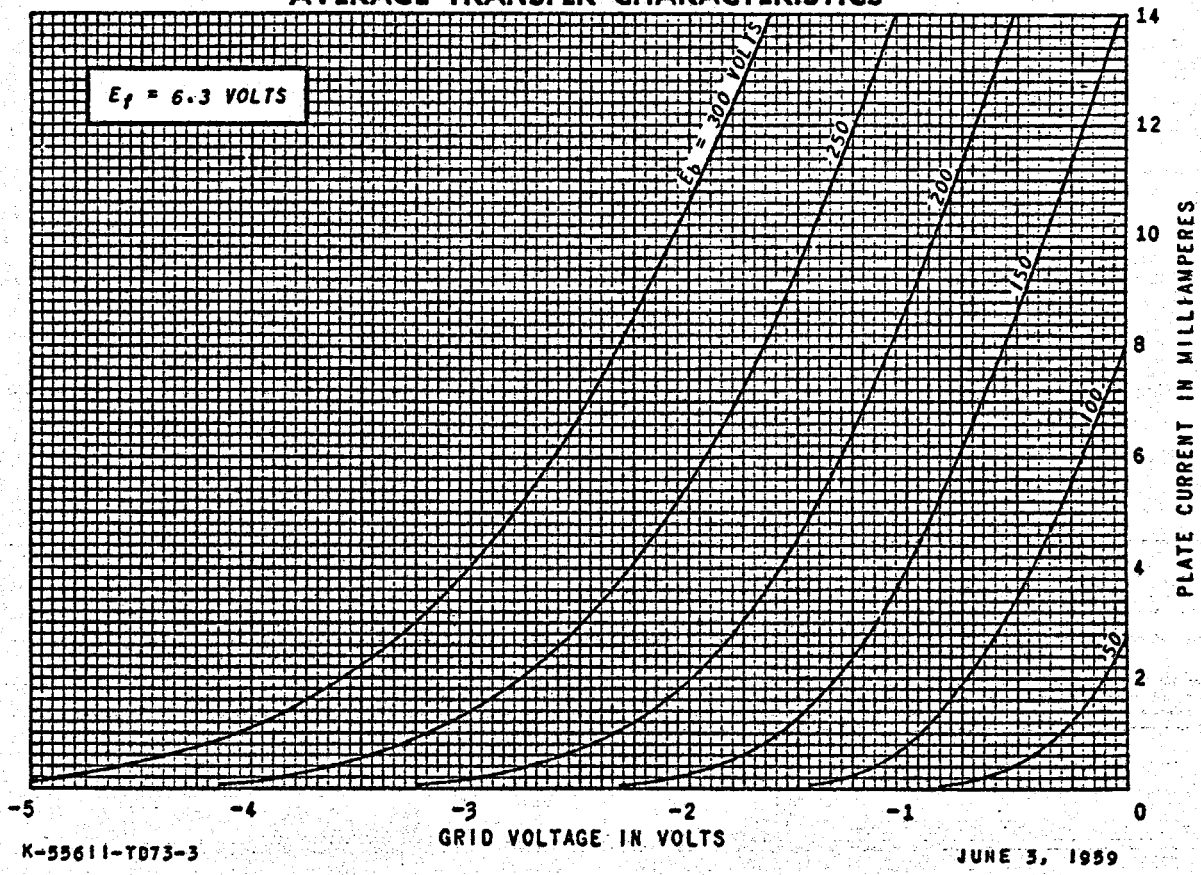


Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

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.

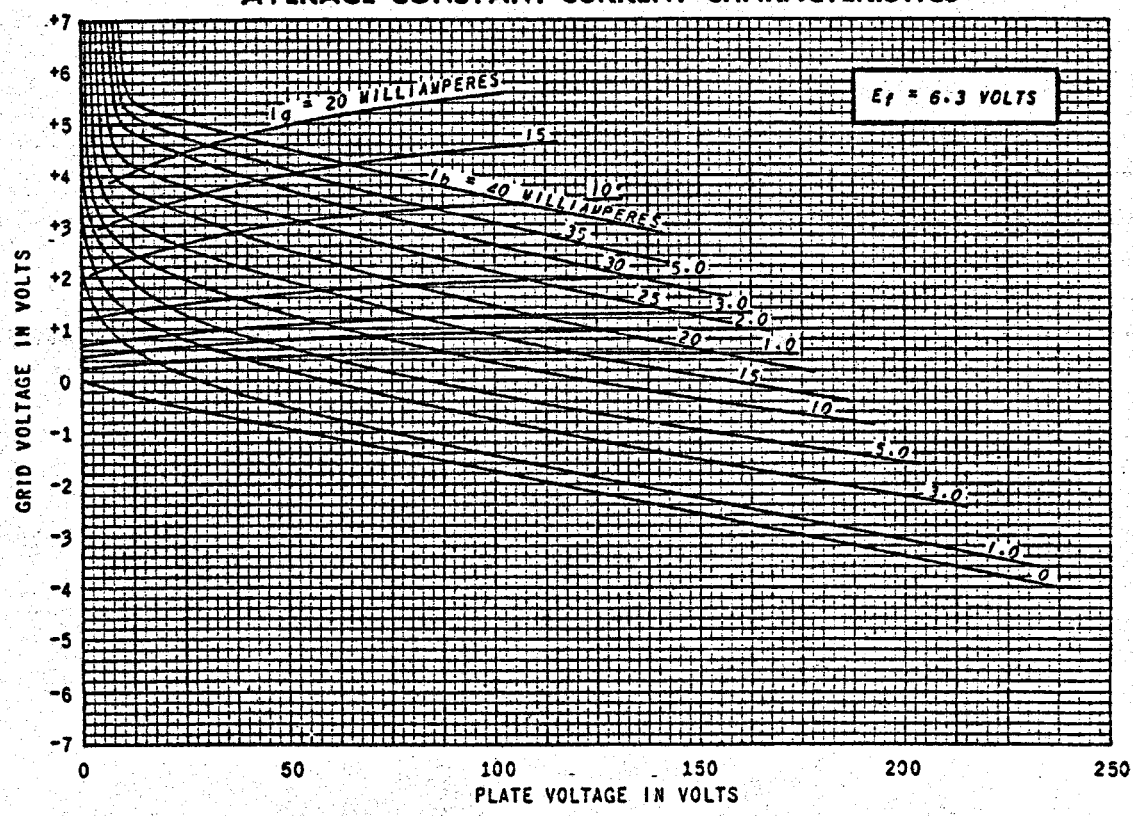
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD73-3

JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

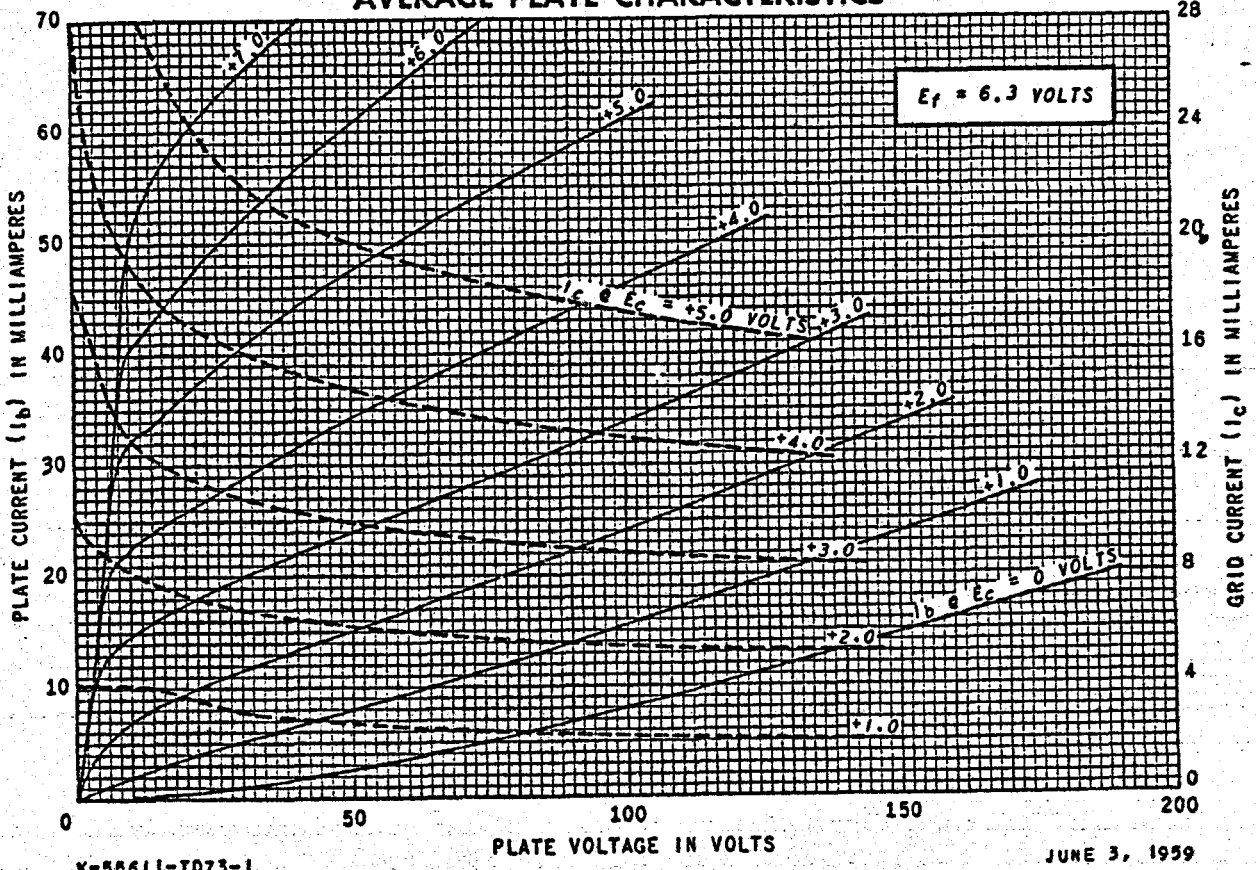


CONSTANT-CURRENT CURVES

K-55611-TD73-4

JUNE 3, 1959

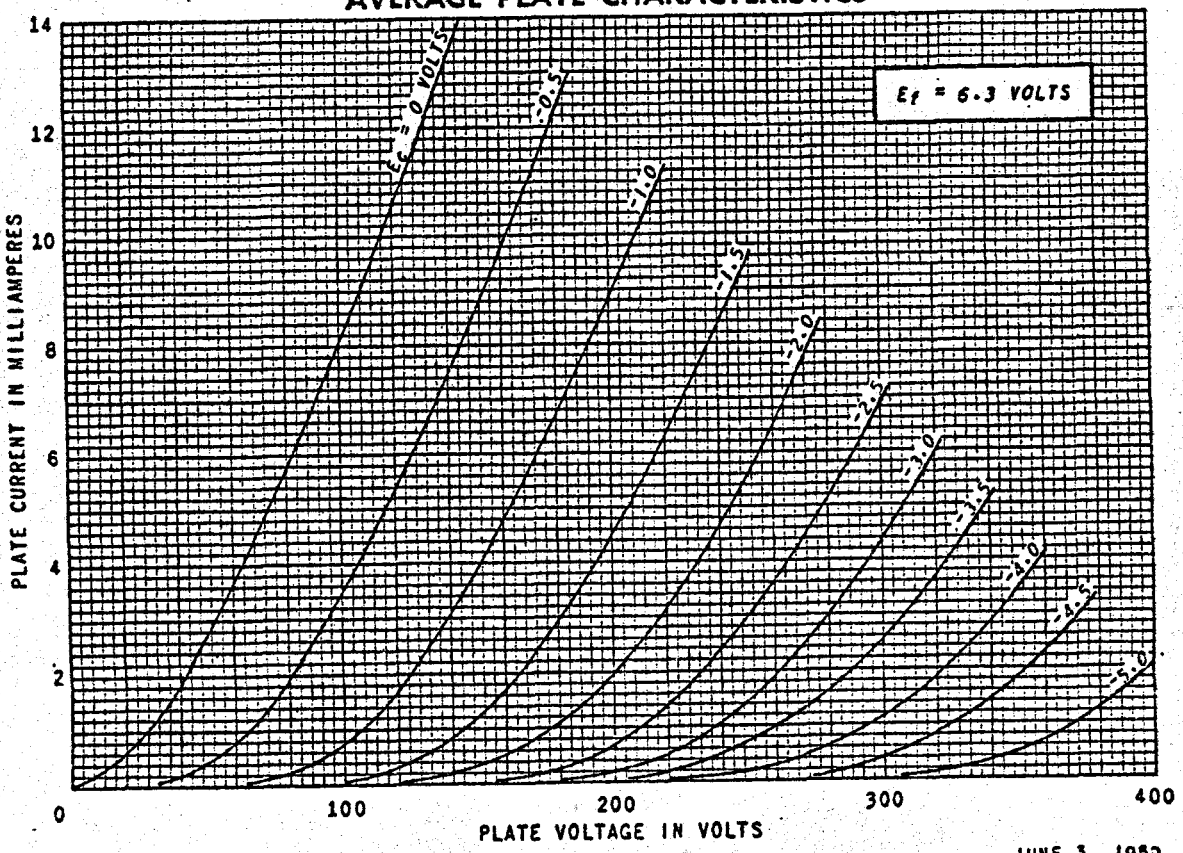
AVERAGE PLATE CHARACTERISTICS



K-55611-T073-1

JUNE 3, 1959

AVERAGE PLATE CHARACTERISTICS



K-55611-T073-2

JUNE 3, 1959

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 mounted by T-bolt with 3 inch-pounds torque, and 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, 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 emission, 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.

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	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.

¶ One method of mounting the 8082 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 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 8082 is also capable of operation at envelope temperatures much higher than the rated maximum value. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

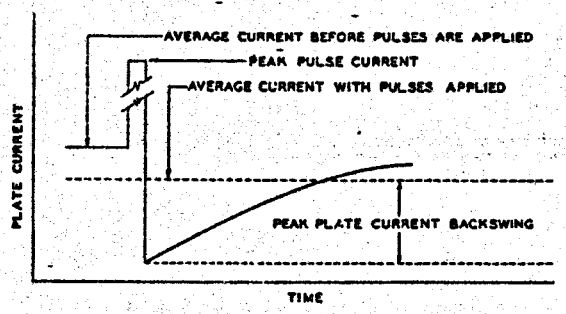
SPECIAL PERFORMANCE TESTS

	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 8082 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 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.

PLATE CURRENT VS. TIME
—GRID-RECOVERY TEST



	Min.	Bogey	Max.	
Pulse Cathode Current Ef = 6.3 volts, Eb = 150 volts, Ec = −10 volts. Grid is driven 7 volts positive with a pulse having a prr of 1000 pps and a duty factor of 0.01	90	....	....	Milliamperes

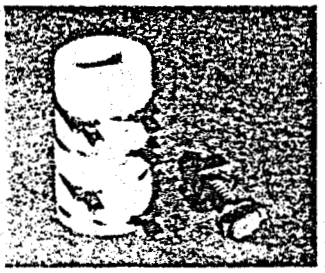
Low Pressure Voltage Breakdown Test

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.

ELECTRONICS

8082

METAL–CERAMIC TRIODE



DESCRIPTION AND RATING

The 8082 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator in the uitra-high-frequency range.

GENERAL

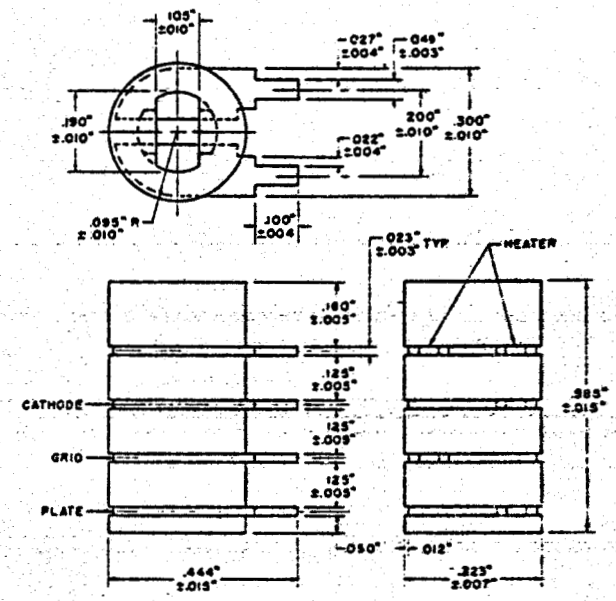
ELECTRICAL

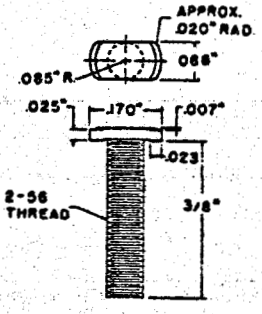
Cathode—Coated Unipotential
Heater Characteristics and Ratings

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¶





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	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.

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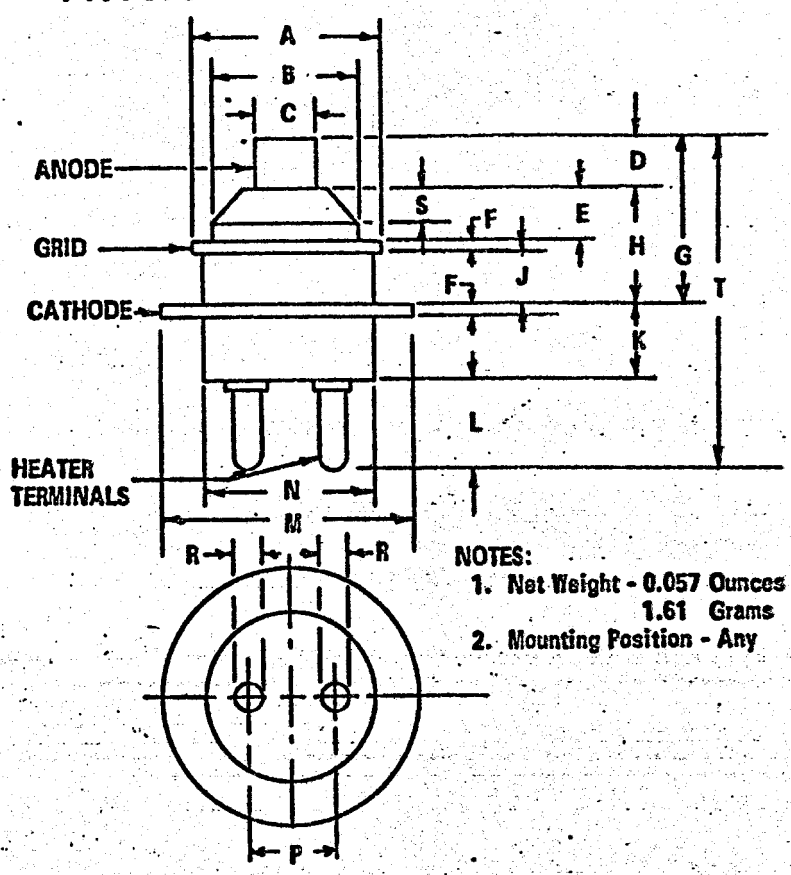
PHYSICAL DIMENSIONS



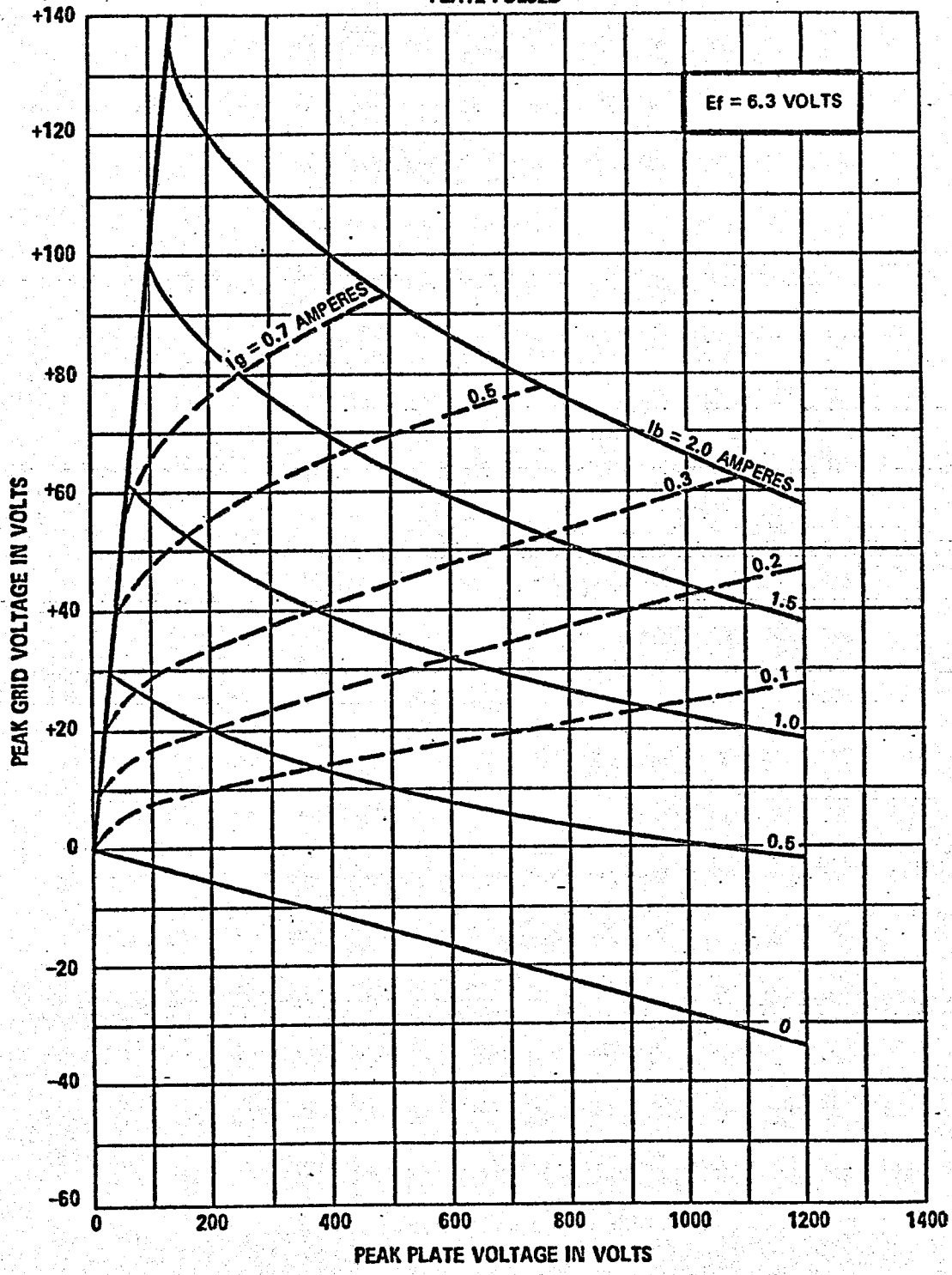
NOTES:
1. Net Weight - 0.057 Ounces
1.61 Grams
2. Mounting Position - Any

Ref.	INCHES			MILLIMETERS		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.357	0.360	0.363	9.068	9.144	9.220
B	---	---	0.285	---	---	7.239
C	0.108	0.110	0.112	2.743	2.794	2.845
D	0.095	0.100	0.105	2.413	2.540	2.667
E	0.095	0.100	0.105	2.413	2.540	2.667
F	0.025	0.028	0.031	0.635	0.711	0.787
G	0.315	0.325	0.335	8.001	8.225	8.509
H	0.216	0.224	0.232	5.486	5.690	5.893
J	0.094	0.098	0.102	2.388	2.489	2.591
K	0.143	0.150	0.157	3.632	3.810	3.988
L	0.165	0.175	0.185	4.191	4.445	4.699
M	0.476	0.480	0.484	12.09	12.19	12.29
N	---	---	0.330	---	---	8.458
P	0.130	0.136	0.142	3.302	3.454	3.607
R	0.048	0.051	0.054	1.219	1.295	1.372
S	---	0.060	---	---	1.524	---
T	0.623	0.650	0.677	15.82	16.51	17.20

TUBE PRODUCTS DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky 42301

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

PLATE PULSED



ABSOLUTE-MAXIMUM RATINGS

PLATE-PULSED OSCILLATOR SERVICE

Peak Positive-Pulse Plate Supply Voltage		
1 Microsecond Pulse Duration	1200	Volts
4 Microsecond Pulse Duration	800	Volts
Duty Factor of Plate Pulse	0.001	
Plate Current: Average During Pulse#	0.6	Amperes
Negative Grid Voltage: Average During Pulse	50	Volts
Grid Current: Average During 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
Temperature Differential Between Two Adjacent Electrodes♦	75	°C
Mechanical Vibration (20-2000 Hz Sinusoidal)	10	G Peak

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

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

NOTES

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 10 times the maximum plate current rating.

▲ For specific recommendations concerning higher temperature operation, contact your General Electric sales representative.

♦ This assumes no thermal heat sinking to any insulator.

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ELECTRONIC INNOVATIONS IN ACTION

MICROWAVE DEVICES

7910

Planar Triode

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 megahertz.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

	Minimum	Bogey	Maximum	Units	Test Conditions Ef V	Eb V	Ib Ma	Eg V	Rk Ohms
Heater Voltage, AC or DC*	6.0	6.3	6.6	Volts					
Heater Current	268	290	312	Milliamperes	6.3	---	---	---	---
Plate Current	7	12	18	Milliamperes	6.3	125	---	---	82
Amplification Factor	50	75	100		6.3	125	---	---	82
Transconductance	12000	16000	20000	Micromhos	6.3	125	---	---	82
Grid Voltage, Cutoff	---	-3.5	-6	Volts	6.3	125	0.1	---	---
Direct Interelectrode Capacitances•									
Grid to Plate: (g to p)	0.85	1.05	1.25	pf					
Input: g to (h+k)	1.5	2.1	2.7	pf					
Output: p to (h+k)	---	0.018	0.026	pf					
Cathode Heating Time	60	---	---	Seconds					

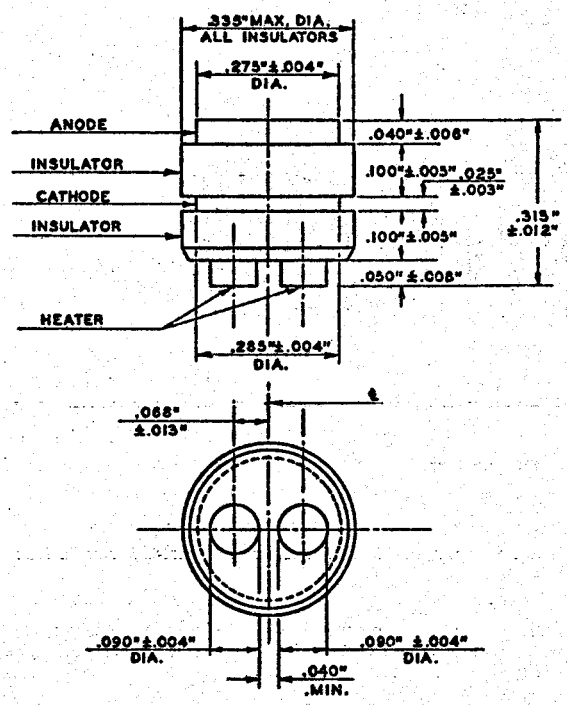
PLATE-PULSED OSCILLATOR SERVICE

Frequency	5900	Megahertz
Duty Factor	0.001	
Pulse Duration	1	Microseconds
Pulse Repetition Rate	1000	Pulses Per Second
Peak Positive - Pulse Supply Voltage	1000	Volts
Plate Current: Average During Pulse	0.6	Amperes
Grid Current: Average During Pulse	0.2	Amperes
Power Output: Average During Pulse	100	Watts

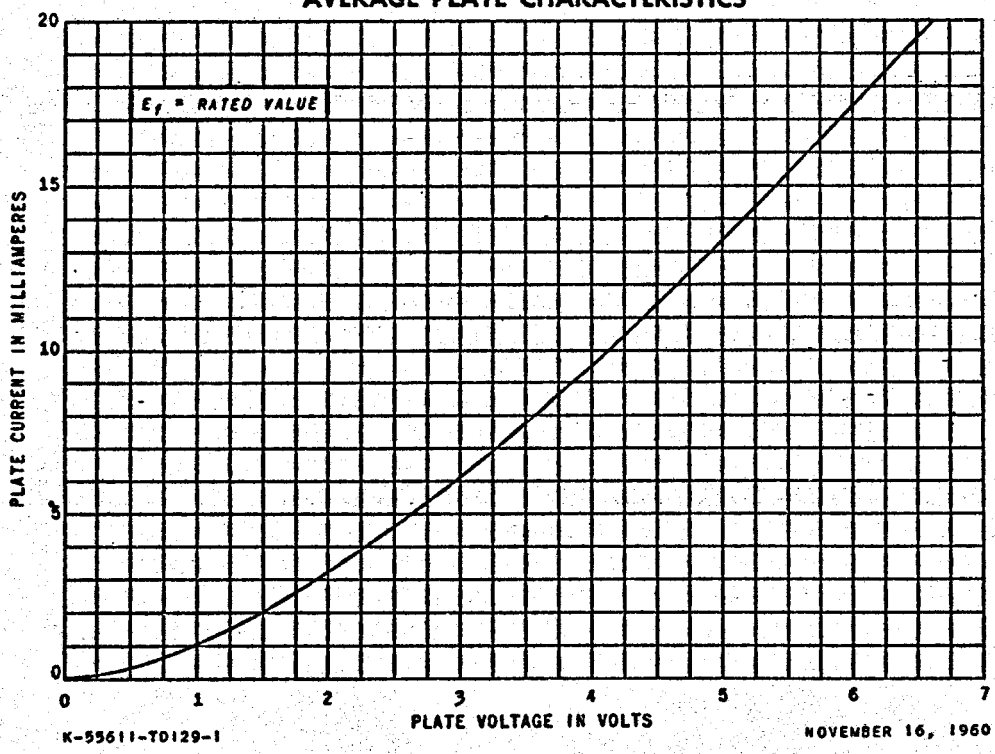
NOTES

* 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. In some applications, longer tube life may be obtained at reduced heater voltage. For specific recommendations, contact your General Electric sales representative.

• Measured at 450 KHz using a grounded adapter that provides shielding between external terminals of tube.



AVERAGE PLATE CHARACTERISTICS



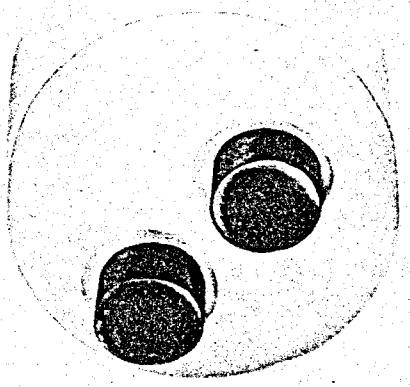
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

METAL-CERAMIC DIODE

DESCRIPTION AND RATING



The 7841 is a cathode-type diode of ceramic-and-metal planar construction intended for detector and low-current rectifier applications.

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).....1.1 pf
Heater to Cathode: (h to k).....1.2 pf

MECHANICAL

Mounting Position—Any
See outline drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES

Peak Inverse Plate Voltage.....350 Volts
Steady-State Peak Plate Current..... 22 Milliamperes
DC Output Current..... 55 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=5.0 Milliamperes DC.....2.6 Volts

FOOTNOTES

* 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.
§ Measured using a grounded adapter that provides shielding between external terminals of tube.
**For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.

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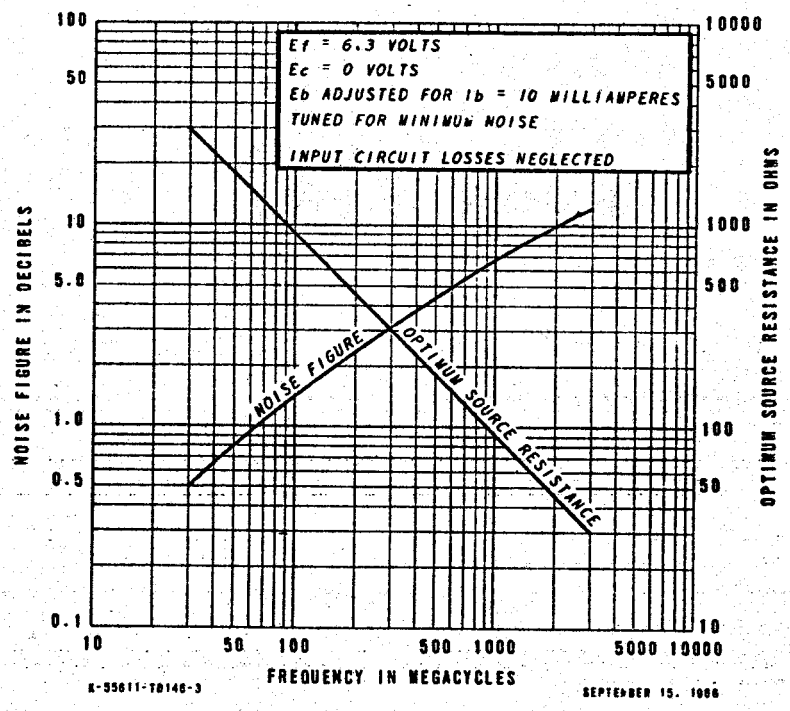
PREDICATED NOISE PERFORMANCE

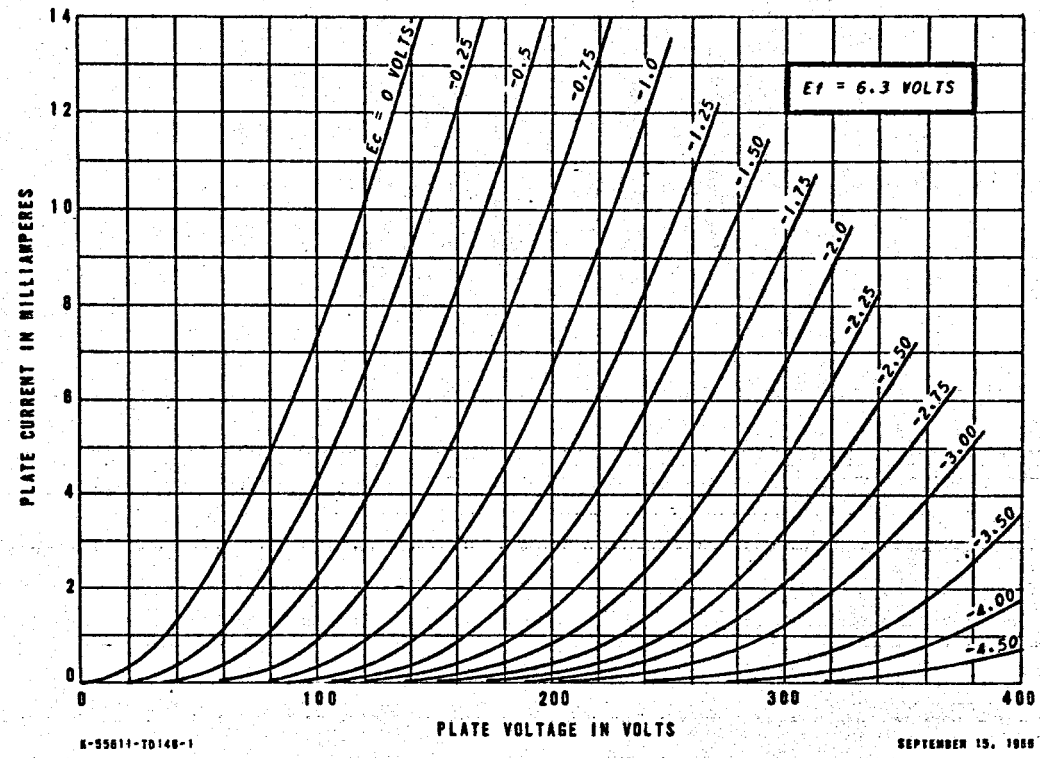


TUBE DEPARTMENT

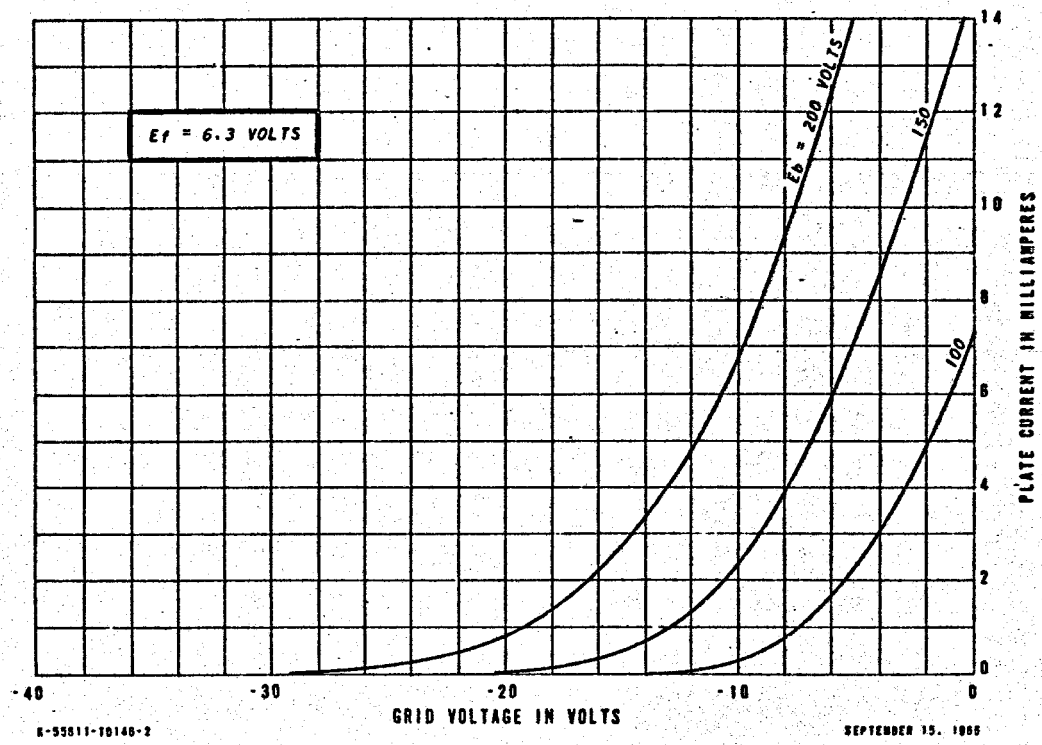
GENERAL ELECTRIC

Owensboro, Kentucky

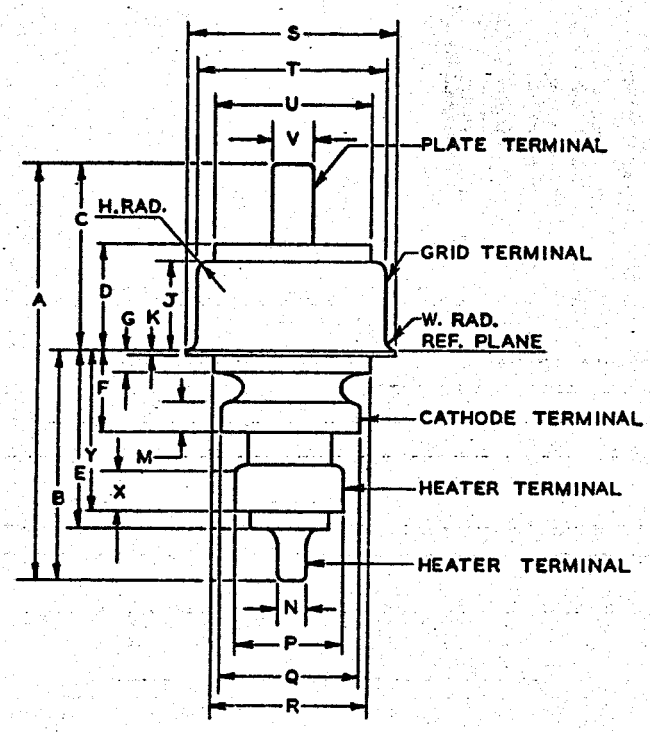
AVERAGE PLATE CHARACTERISTICS



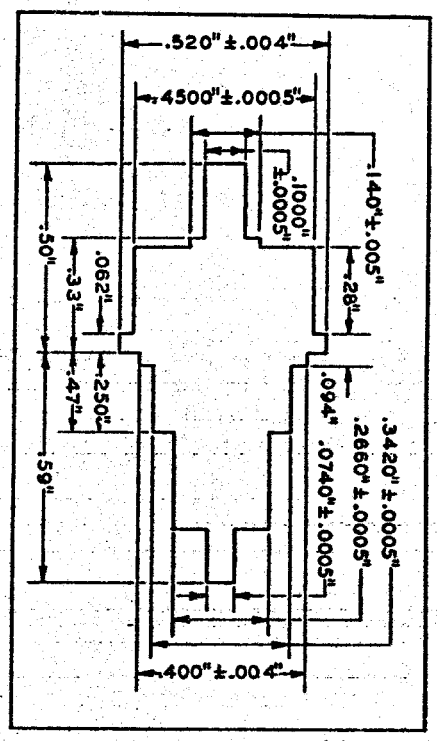
AVERAGE TRANSFER CHARACTERISTICS



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	0.247	0.257	6.27	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
X	0.070	0.100	1.78	2.54
Y	0.355	0.395	9.02	10.05

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	
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 50 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 Cathode 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
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

DEGRADATION RATE TESTS

1000-Hour Life

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

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.

¶ 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.

The 7784 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.

7784

Planar Triode

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

The 7784 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 7784 is used in a grounded-grid coaxial circuit.

The 7784 differs from the 6299 only in having an isolated heater.

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	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
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
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.

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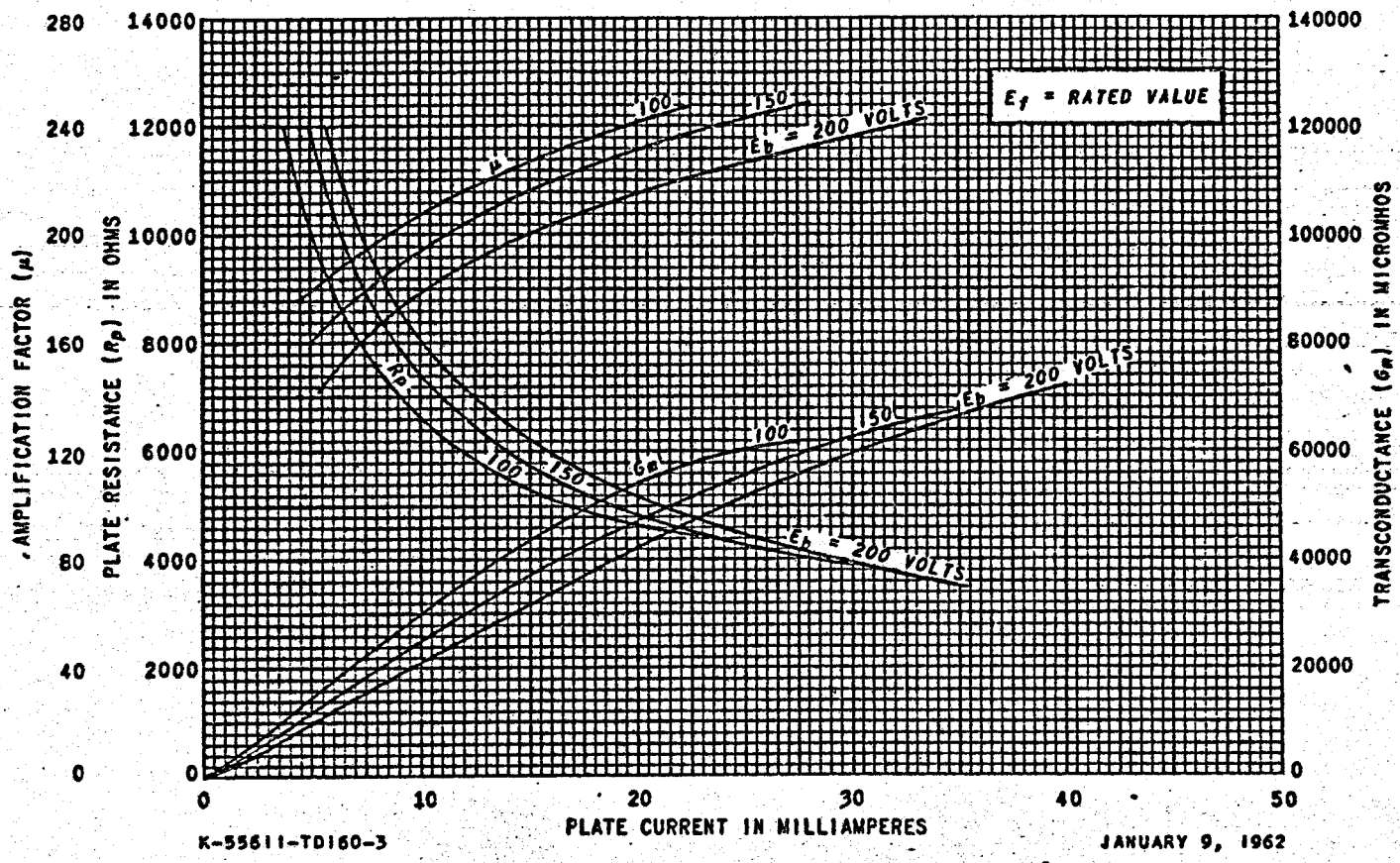
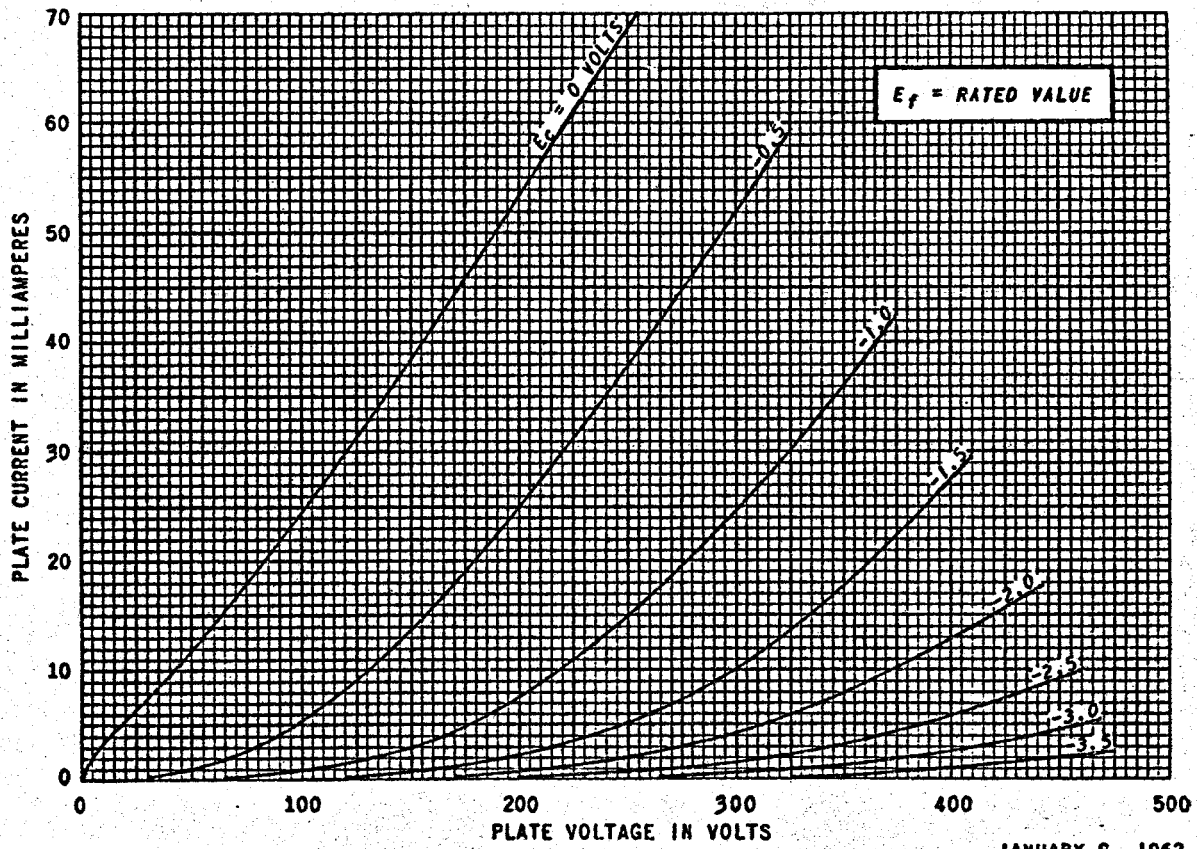
AVERAGE CHARACTERISTICS



K-55611-TD160-3

JANUARY 9, 1962

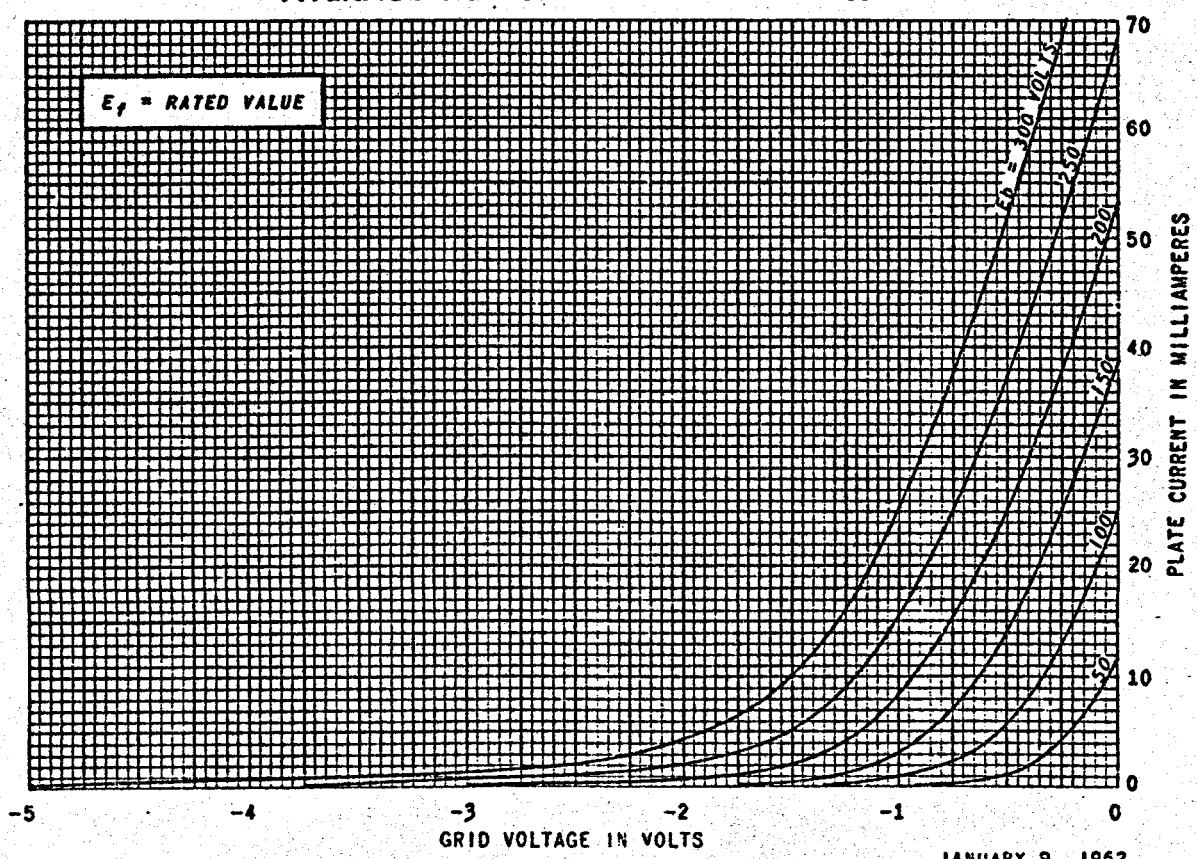
AVERAGE PLATE CHARACTERISTICS



K-55611-TD160-1

JANUARY 9, 1962

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD160-2

JANUARY 9, 1962

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.

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.

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

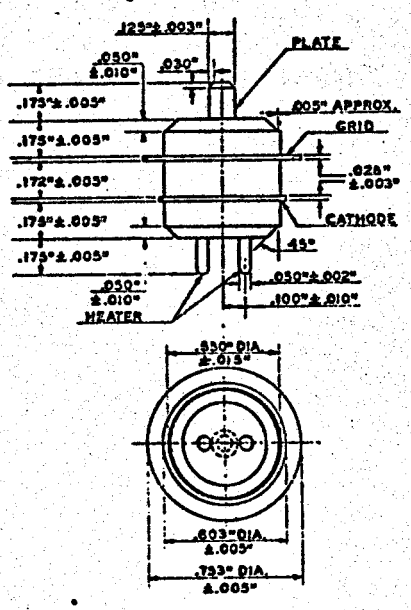
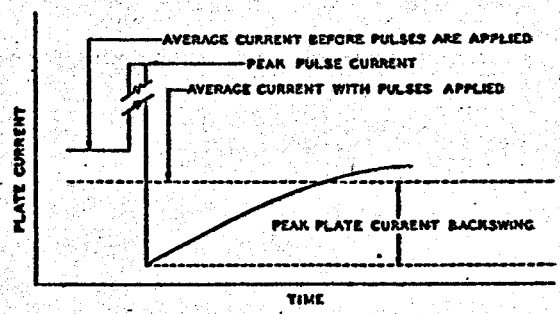


PLATE CURRENT VS. TIME —GRID RECOVERY TEST



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

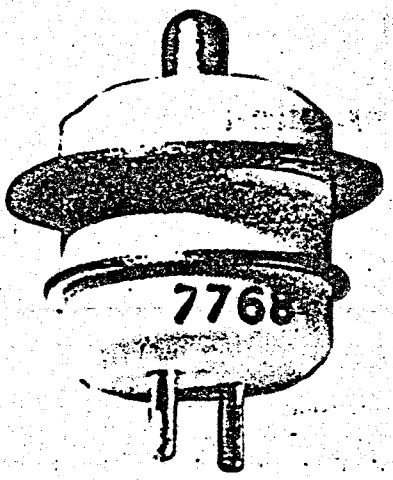
	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	14	22	30	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	40000	50000	60000	Micromhos
Amplification Factor				
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 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

ELECTRONIC INNOVATIONS IN ACTION

TUBES

7768

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

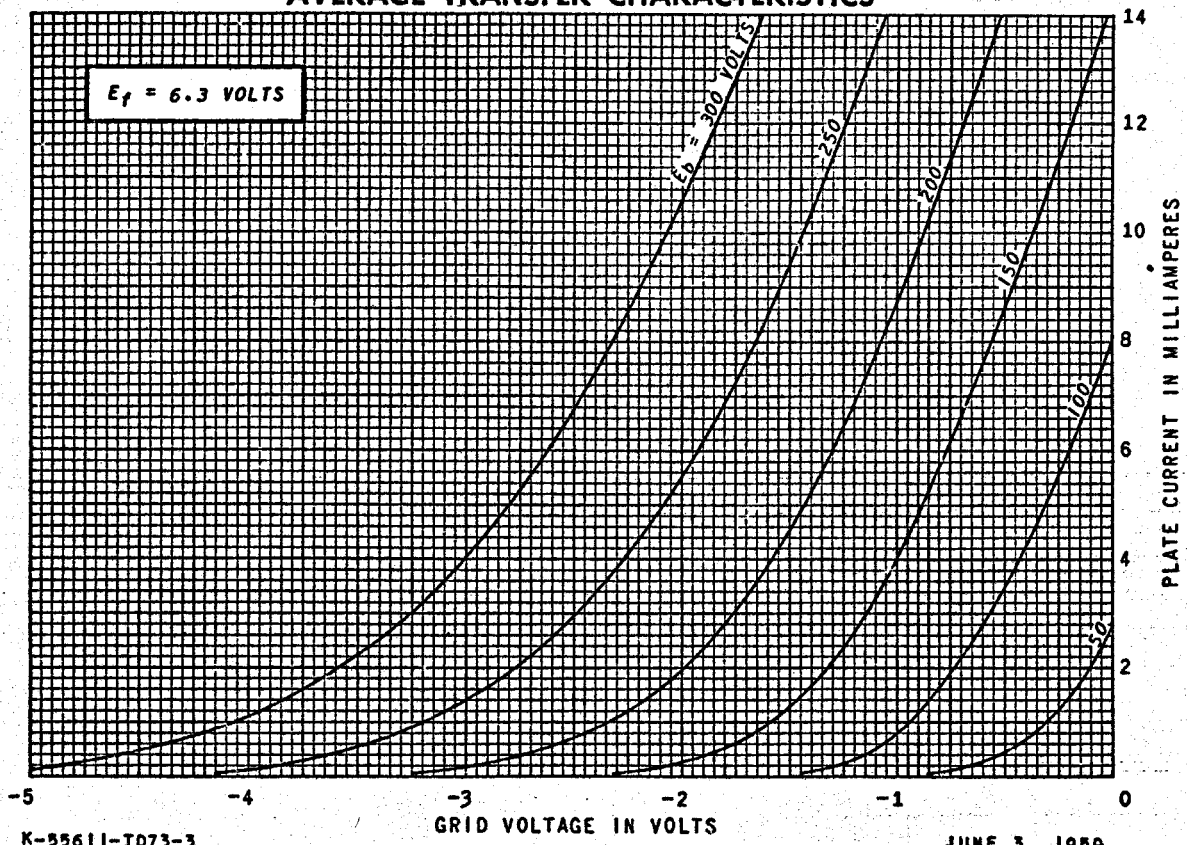
Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

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.

The tubes and arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein nor the sale of tubes by General Electric Company conveys any license under patent claims covering combinations of tubes with other devices or elements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement arising out of any use of the tubes with other devices or elements by any purchaser of tubes or others.

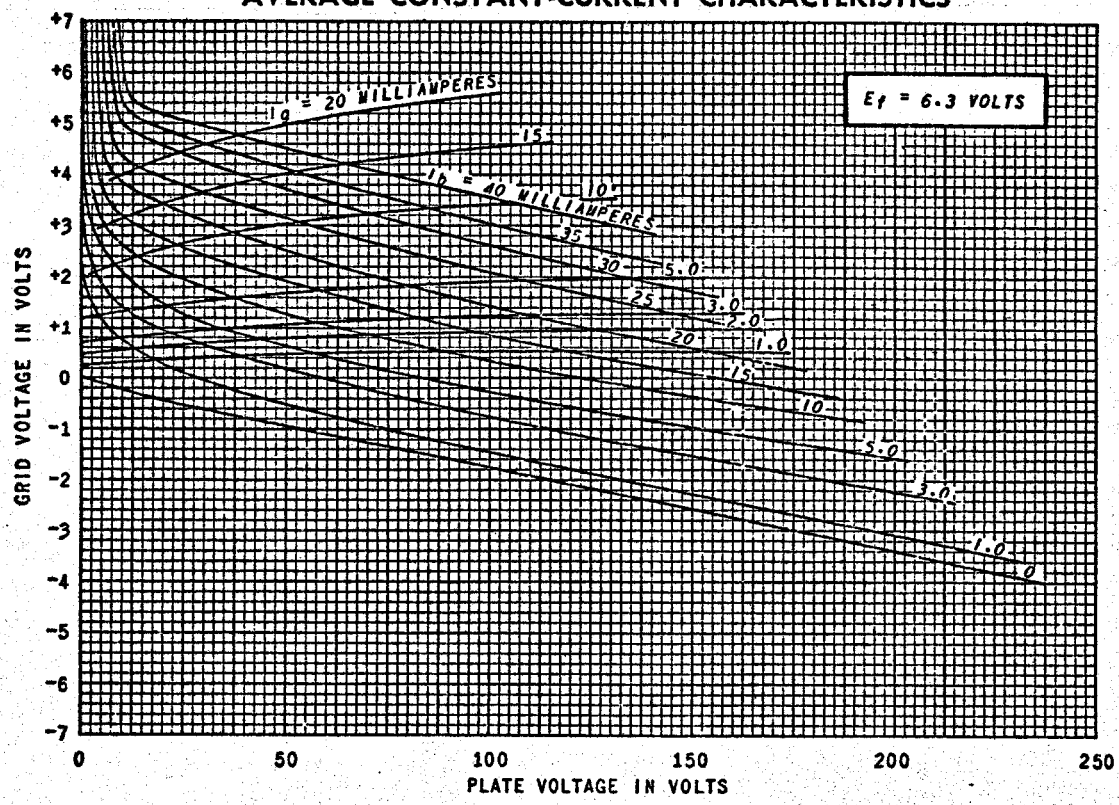
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD73-3

JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD73-4

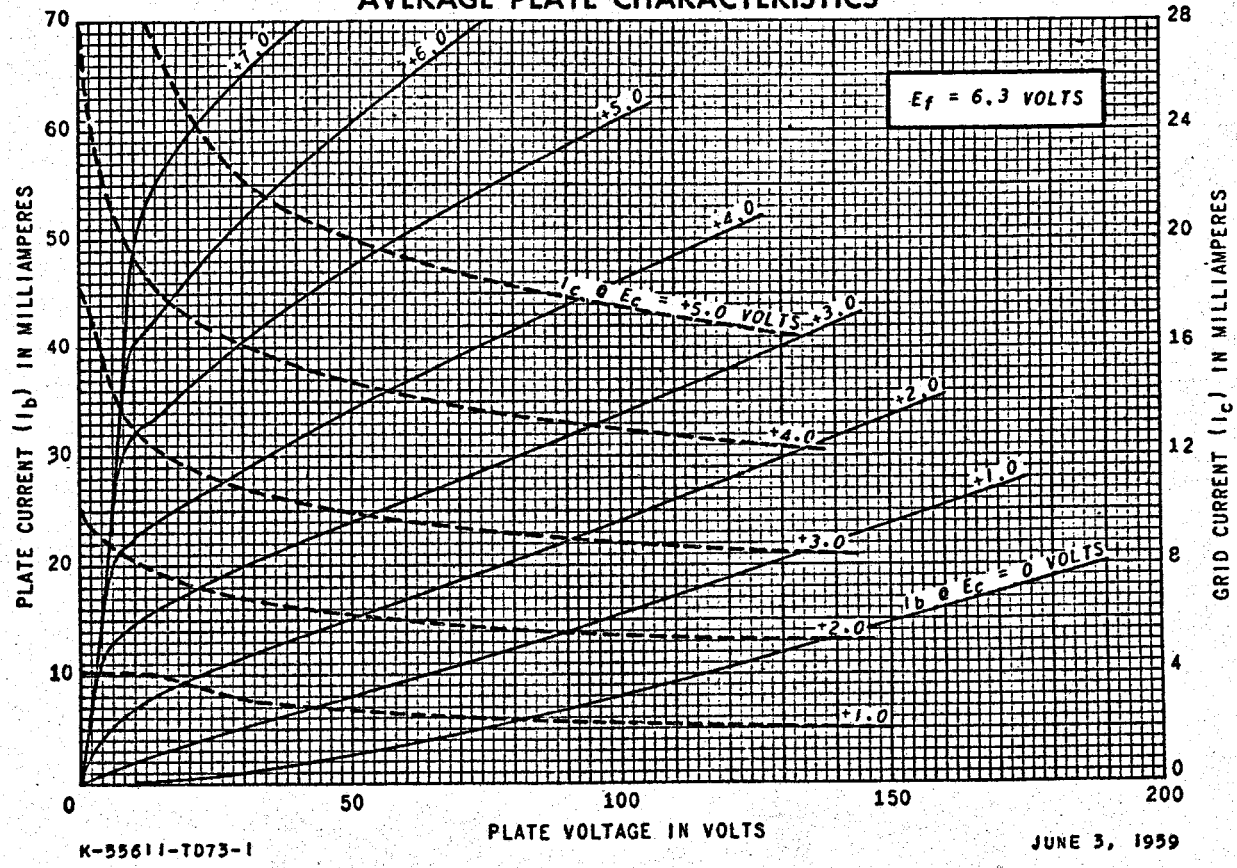
JUNE 3, 1959

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

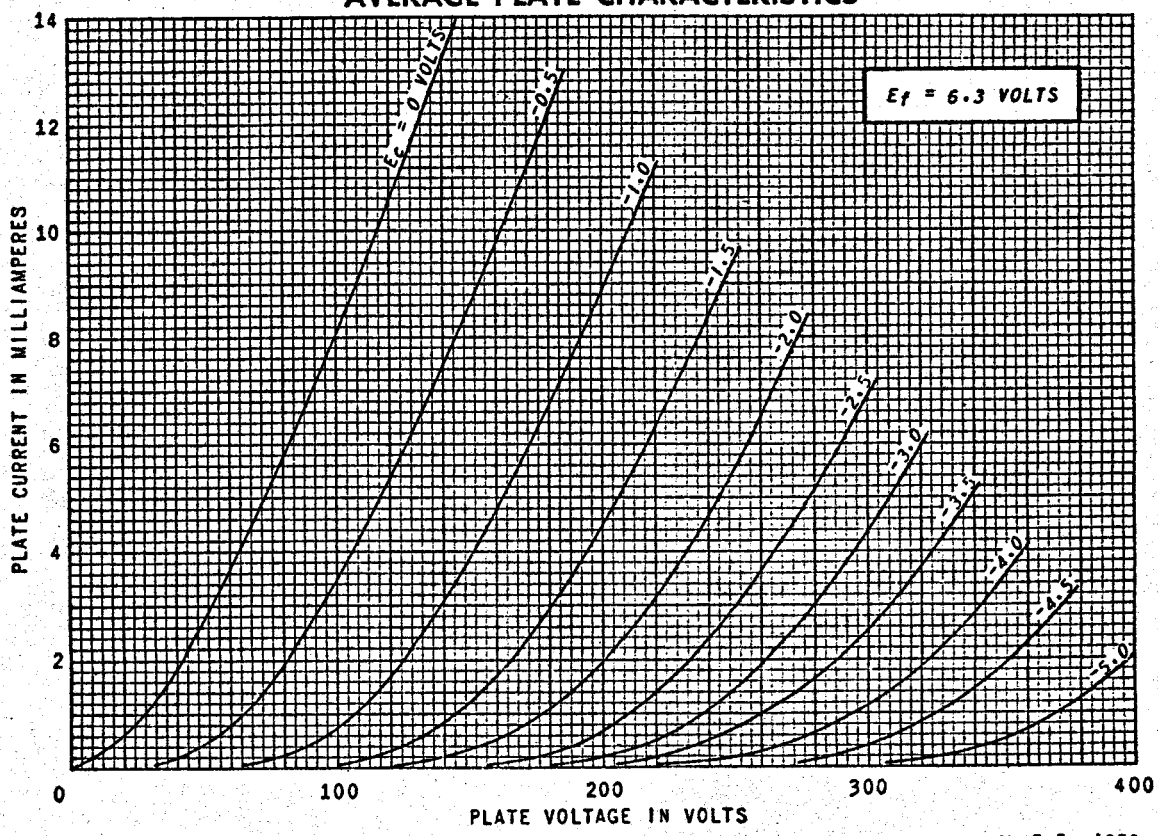
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-2

JUNE 3, 1959

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

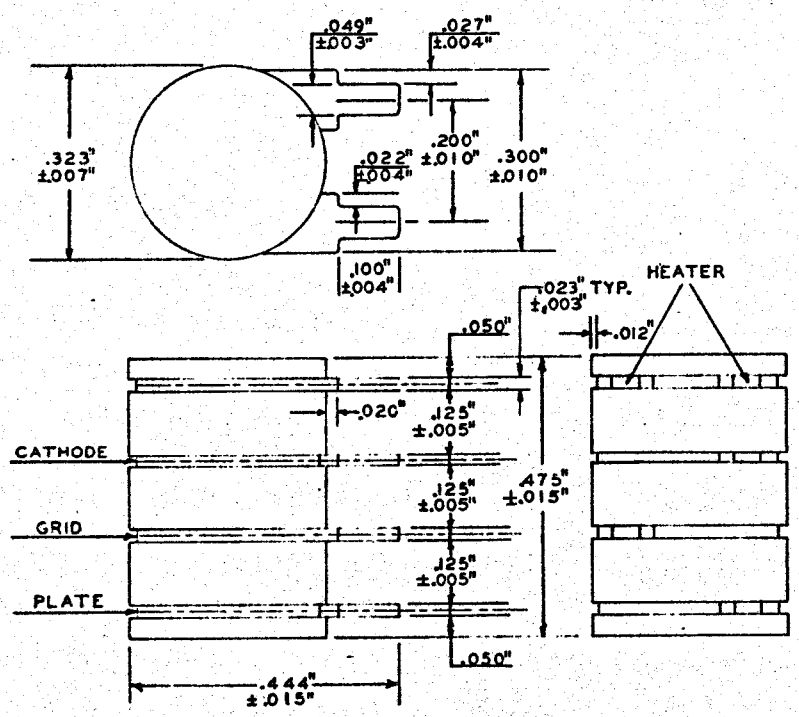
* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

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

‡ Without external shield.

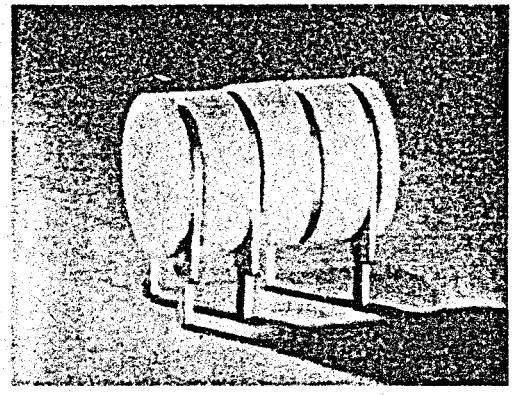
**For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.

OUTLINE DRAWING



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

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.

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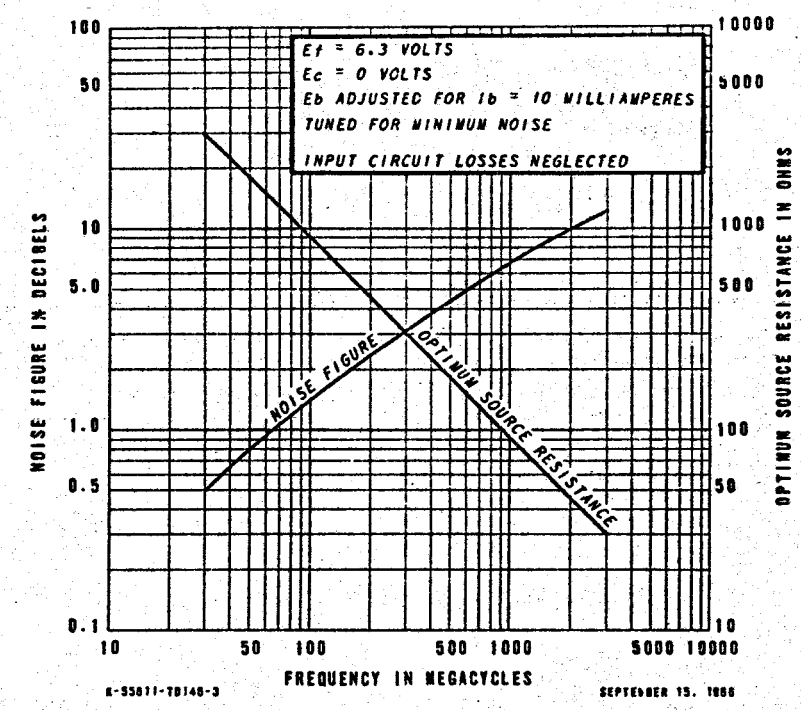
PREDICATED NOISE PERFORMANCE

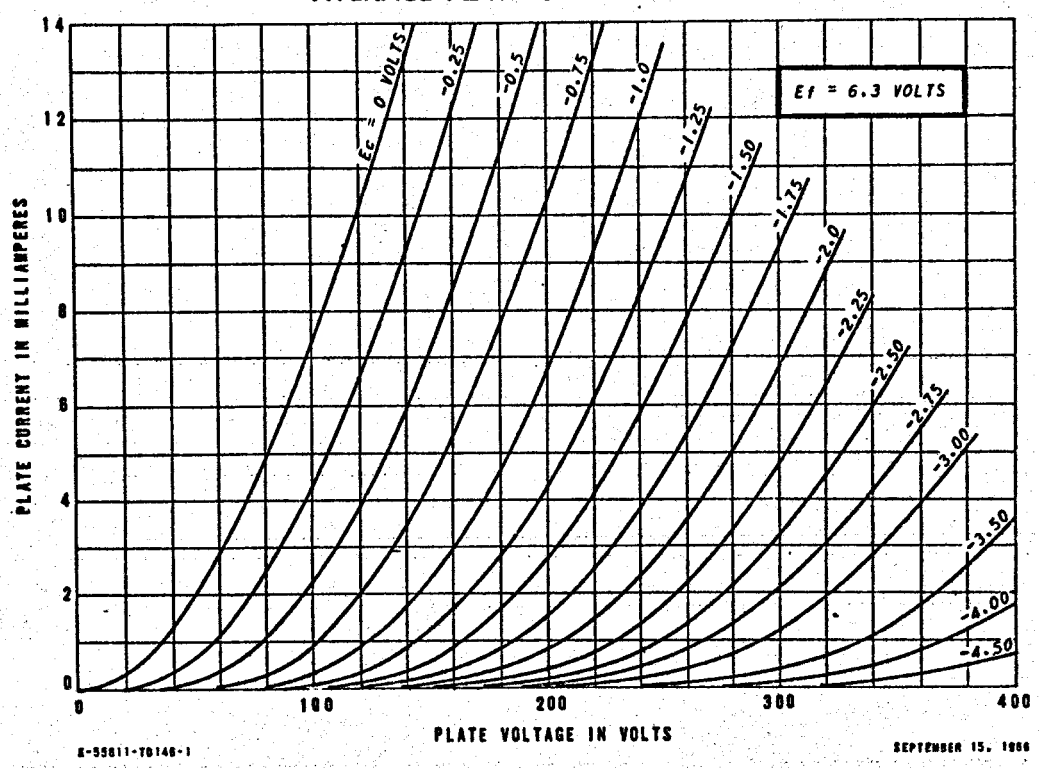


TUBE DEPARTMENT

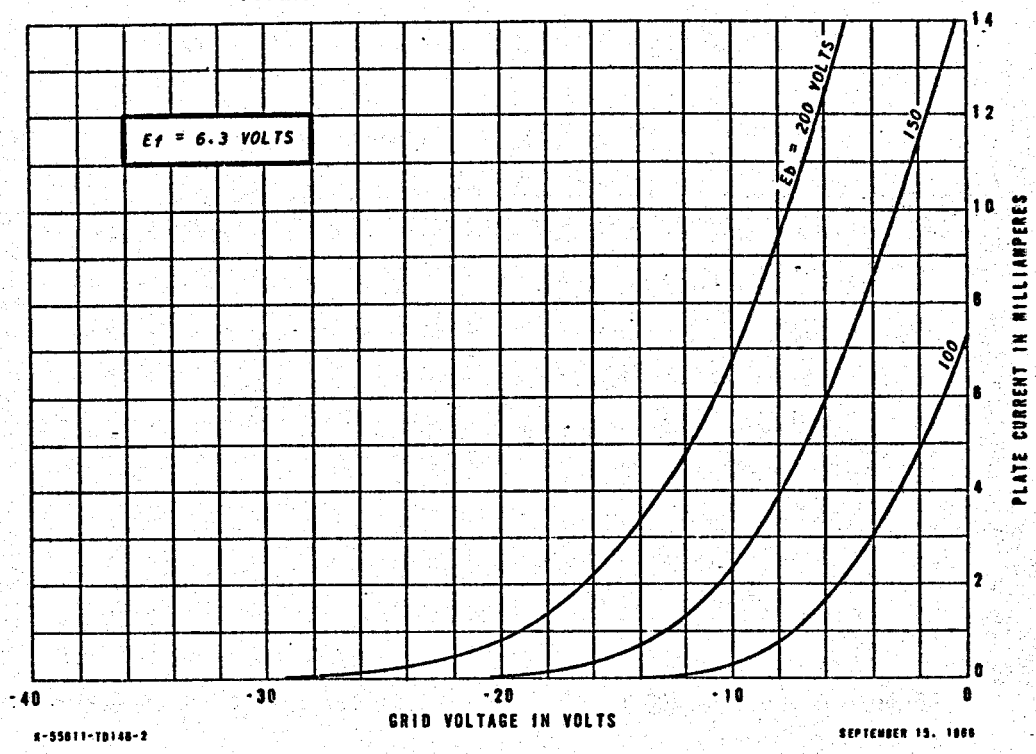
GENERAL ELECTRIC

Owensboro, Kentucky

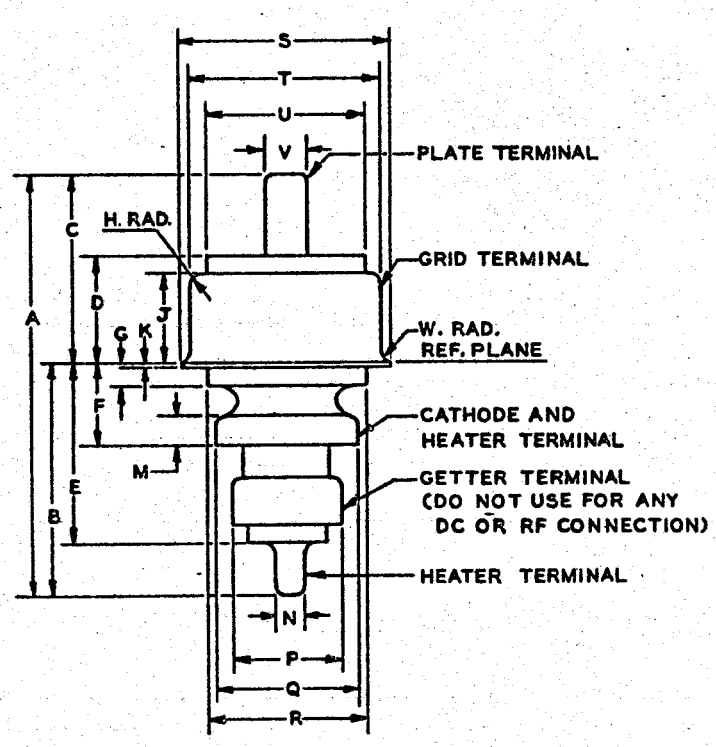
AVERAGE PLATE CHARACTERISTICS



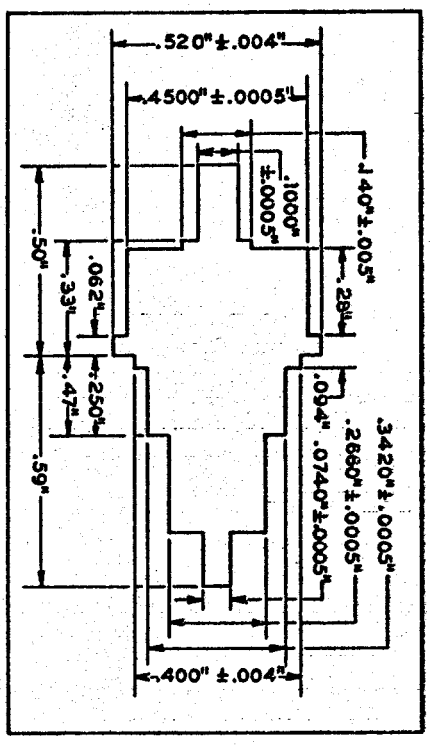
AVERAGE TRANSFER CHARACTERISTICS



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

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	20000	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	2.5	---	---	Megohms
Grid to Plate at 500 volts d-c	25	---	---	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
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

DEGRADATION RATE TESTS

1000-Hour Life

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

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	3000	Megacycles
Plate Supply Voltage¢	300	300	300	Volts
Resistor in Plate Circuit (bypassed)	17500	17500	17500	Ohms
Grid Voltage**	0	0	0	Volts
Plate Current	10	10	10	Milliamperes
Bandwidth, min	10	10	10	Megacycles
Gain	17.5	17	11	Decibels
Noise Figure, Power-Matched	4.5	8.2	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 at a minimum.

The 7644 is rated only for Class A amplifier service.

∆ Adjusted for Ib = 10 milliamperes.

¢ 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.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

7644

Planar Triode

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

The 7644 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.

Within the limitations of its ratings, the 7644 may be used in radar receivers, or similar applications, where the grid of the tube may be driven positive by leakage pulses. The physical appearance and dimensions of the 7644 are identical to those of the 6299, and the electrical characteristics are nearly identical.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.13	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
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.0	Watts
DC Plate Current	12	Milliamperes
Leakage Pulse		
Duty Cycle	0.0011	
Pulse Width	15	Microseconds
Peak RF Grid Voltage#	7.0	Volts
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.

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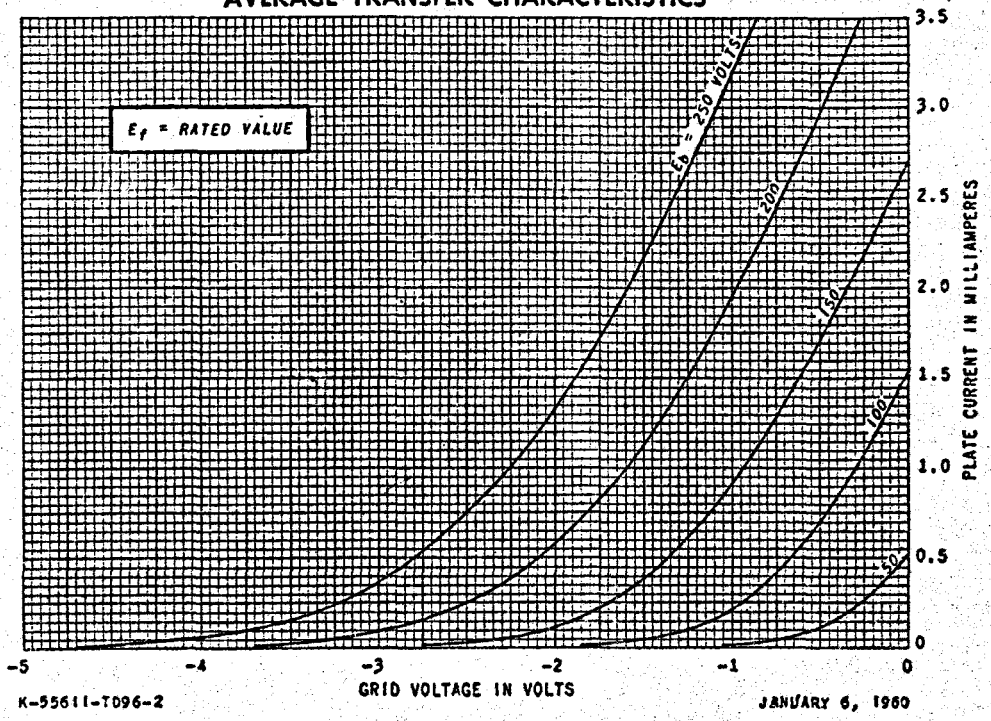
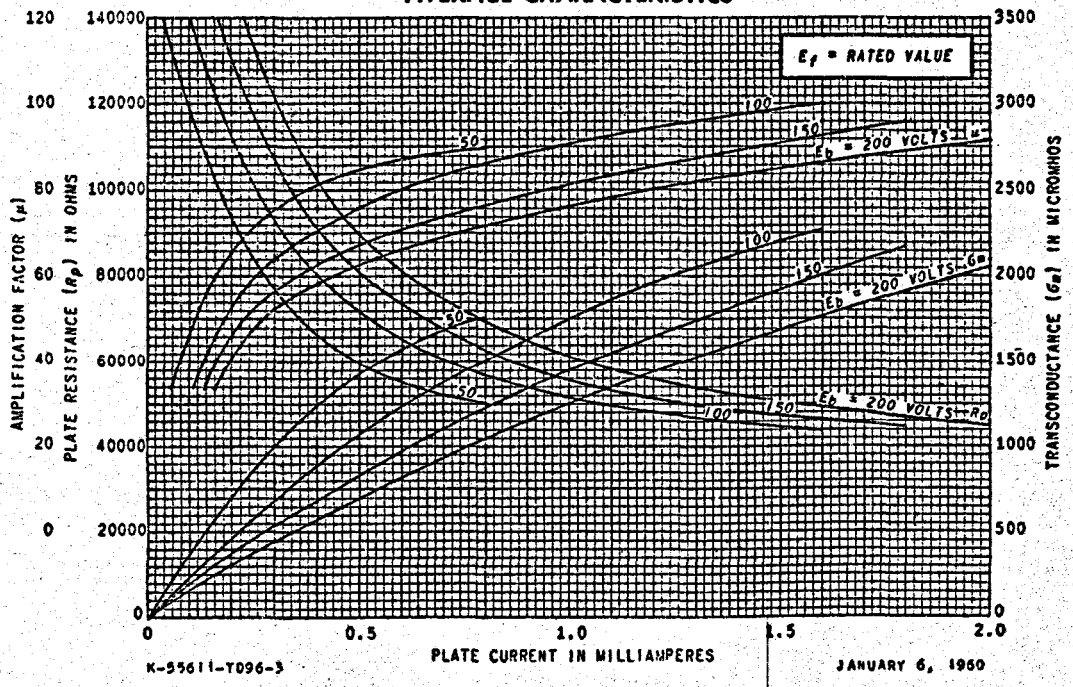
GENERAL ELECTRIC

Supersedes ET-T1593A dated 12-61

AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky