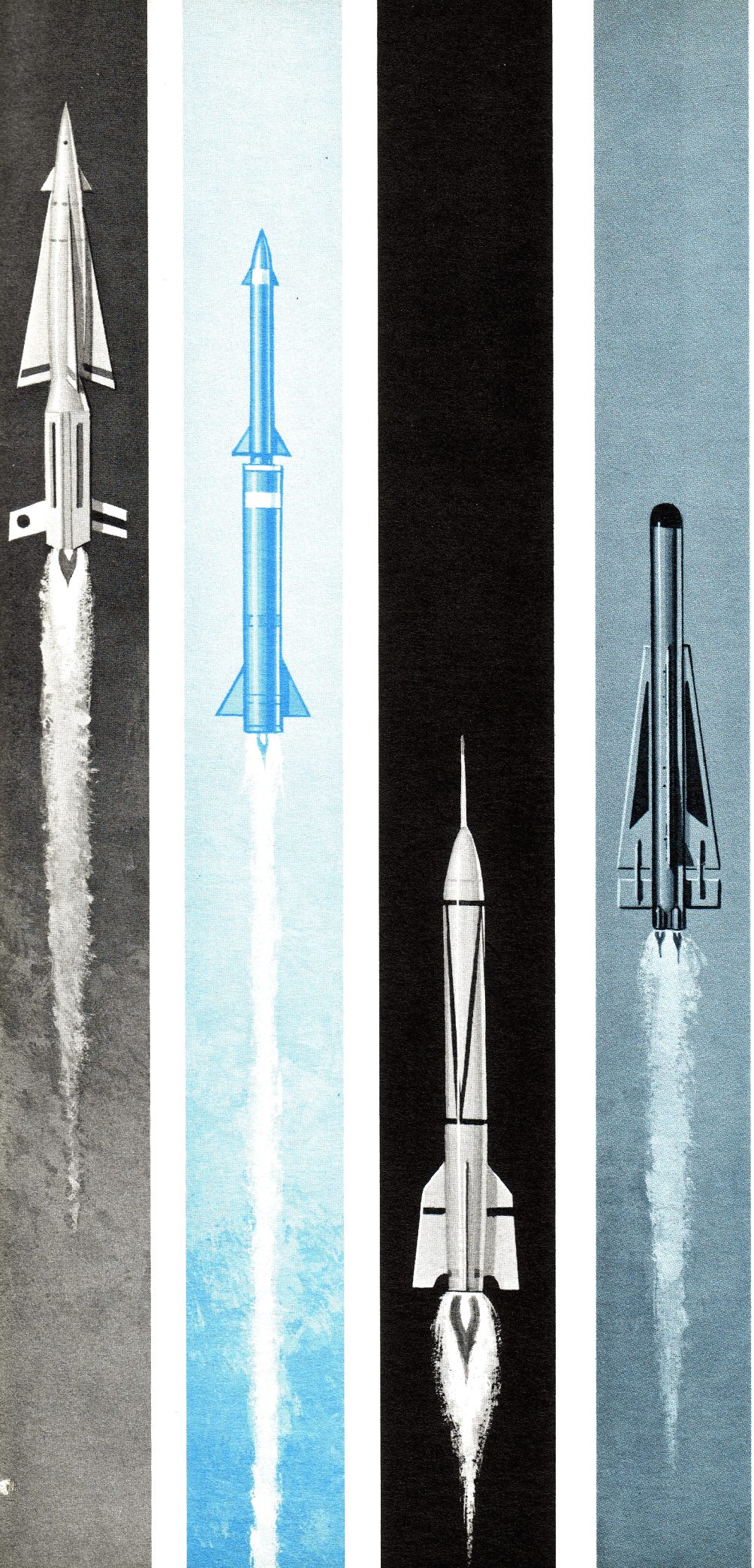
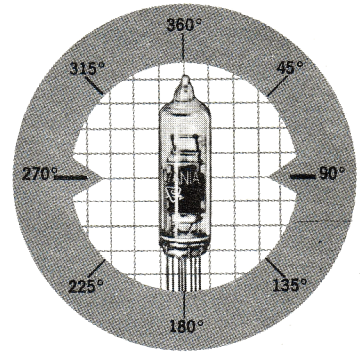


SYLVANIA



GUIDED MISSILE TUBES

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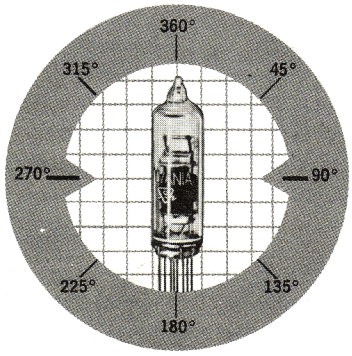
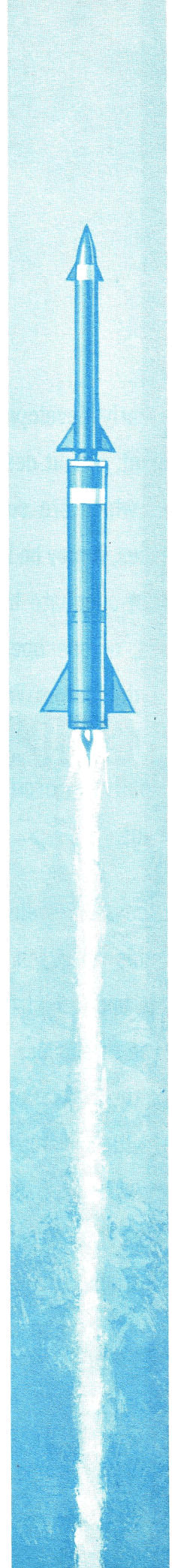


GUIDED MISSILE TUBES

In the early development stages of most electronic equipment, circuit designers customarily employ components which are currently available. As the design progresses, it may be that stock components are sometimes not adequate because of unusual performance demands, unique operating conditions or severe environmental factors. Where a high assurance of success is vital, it becomes desirable to develop components specifically tailored to satisfy the needs of such equipment.

The successful development of Guided Missiles exemplifies this approach. Guided Missiles posed unique demands upon electron tubes. The urgency of a high assurance of success was indisputable. In recognition of this, the Navy Department, Bureau of Ships contracted with Sylvania Electric Products to first survey the special needs peculiar to guided missiles and then develop a series of subminiature electron tubes to satisfy these needs. This endeavor culminated in Sylvania's Guided Missile tube line.

FEATURES OF NEW GUIDED MISSILE TUBE LINE



A review of the most salient and desirable features of the line specifically demonstrates the progress that has been achieved in the evolution of tubes designed for missile service.

SEVERE FLICKER SHORTS TEST

The first step in checking the guided missile tubes is a 100% test for continuity. They are then subjected to a very stringent dc "shorts" check. In this test, the exciter delivers blows of 75 G peak acceleration level to the tube. Each tube is tapped a total of six times, three times in each of two planes, 90 degrees apart. The shorts detection equipment is a dc device of extreme sensitivity as indicated by the following table:

Interelement Resistance	Time Duration
4.5 megohms or less	80 microseconds or greater
2.2 megohms or less	27 microseconds or greater
1.0 megohm or less	14 microseconds or greater
0.1 megohm or less	4.5 microseconds or greater
10,000 ohms or less	2.5 microseconds or greater

SEVERE FATIGUE TEST

To better assure the mechanical durability of the guided missile tubes under vibrational conditions, sweep frequency techniques have been adapted to fatigue testing. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep frequency vibration has a constant acceleration level of 10 G's. The sweep frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours. Following the fatigue test, the tubes are submitted to a series of

electrical tests, including the white noise vibration measurements test, to measure the extent of degradation. It would be well to emphasize that the white noise vibration test is a measurement test whereas the fatigue test is a test of tube durability.

VIBRATION NOISE MEASUREMENT TEST

The mechanical environment of electronic packages within guided missiles varies among different missiles and also between components and packages within a missile. In order to best simulate actual environmental conditions and to provide complete quality control assurance throughout this mechanical spectrum, a new vibration testing technique has been developed. This test provides a mechanical excitation of tubes on a random-frequency, random G-level basis. The excitation frequency range ranges from 100 to 5,000 cycles per second on an equal energy per octave basis. The G value is random, achieving peaks of 15 G, and having an rms value of 5.4 G. The noise output is measured both for peak and rms values over a frequency range from 100 to 10,000 cycles per second. Sylvania's ENGINEERING INFORMATION SERVICE, Volume 3, Number 3, titled "White Noise Vibration Test for Electronic Tubes" should be consulted for detailed information about vibrational noise testing.

SEVERE LIFE TESTING

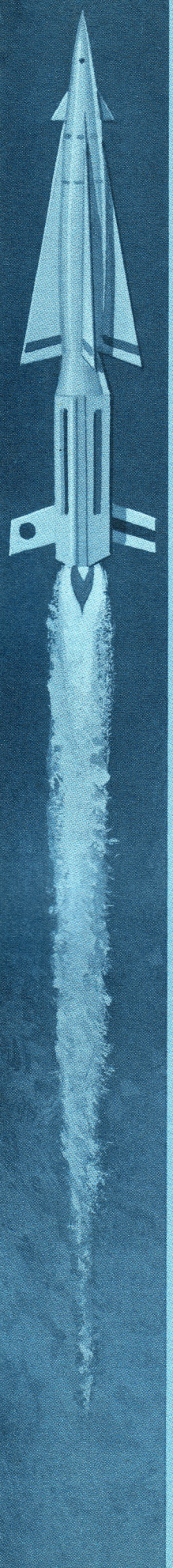
The requirements for guided missile components indicated the need for high reliability over a short life span. The life test on this line of tubes is therefore specified for a duration of 200 hours and is conducted at combinations of the maximum rated conditions wherever possible. In all cases, maximum bulb temperature and rated plate voltage are realized. Likewise, maximum dissipation and maximum grid resistance are utilized during the life test. It is impossible to get all combinations of maximum rated conditions simultaneously. Other operating conditions are also at maximum rated values, whenever practical.

FAILURE RATE ASSURANCE

Included in the Mil-Type, statistical format specifications is a new control pioneered by Sylvania to assure the consumer a failure rate below some maximum specified limit. In order to accomplish this, statistically sound sampling plans have been developed for life tests that will assure that the lots of tubes will not exceed this maximum value. In order to make this information most useable to the equipment designer, information is specified as three (3) separate failure rates. The first failure rate is the maximum allowable for inoperative tubes. The second failure rate is the maximum allowable when the tubes are measured for all life test end point characteristics specified in MIL-E-1 at the termination of life test. The third failure rate presented differs from the second failure rate only in that the end points used for the end of life criteria are modified. This information permits the equipment designer greater flexibility in determining his expected reliability and it can be readily seen that greater reliability can be achieved if the equipment will tolerate only very minor increases in the life test end point tolerances. The detailed operation of the failure rate life tests is included with each tube specification. The general principal involved is to couple a moving average control on five lots together with the acceptance criteria for each individual lot. In this manner with the controls providing a statistical assurance of homogeneity among these lots, greater statistical assurance may be provided to the consumer on predicted life reliability.

RADIATION RATINGS

This atomic age requires our vital systems and equipments to function satisfactorily when subjected to nuclear radiation environments. Although component specifications have neglected this most serious environment, ratings and tests have been established to assure reliable tube performance when subjected to nuclear radiation. Two ratings are specified: 10^{16} NVT for total integrated dosage and 10^{12}



NV for the dosage rate. These terms are expressed in units of fast neutrons per cm^2. Total dosage represents the flux rate integrated with the time of irradiation.

250 VOLT RATINGS

Maximum plate voltage ratings of 250 volts are permissible during normal operation.

PLUS OR MINUS 10% HEATER VOLTAGE RATINGS

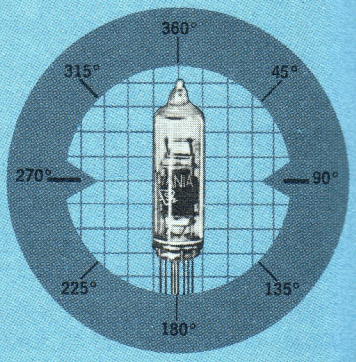
An inherent design feature of this line of tubes is the stability of electrical characteristics when operated over a wide range of heater voltage. This feature permits rating the tubes with a plus or minus 10% of rated heater voltage, more accurately reflecting actual in-service conditions. Satisfactory operation at the minimum rated heater voltage is insured by a performance check at a heater voltage 13% below the center rated value.

HIGH BULB TEMPERATURE

The guided missile tubes have maximum bulb temperature ratings comparable to the highest available on currently popular Subminiature tube types.

OPERATION TIME

The tactical usage of guided missiles in some cases dictate control over the time required for tube stabilization. Operation-time controls, with 6.3 volts applied to the heater, provide reasonable uniformity among the various types as well as from lot-to-lot of a particular type. For those cases where rapid warm-up and fast operation are necessary, Accelerated Warm-Up Ratings have been incorporated. These Maximum Ratings permit the heater voltage to be boosted to Ef = 10 V for a maximum of 10 seconds. To insure reliability of operation, life test controls at these maximum ratings have been incorporated into the specification. Technical information describing the warm-up characteristics with boosted heater voltage will be published with the data for each tube type.



SYLVANIA GUIDED MISSILE TUBES

By-Classification Chart

TYPE	DESCRIPTION	EF (Volts)	If (ma)	Eb (Volts)	Ec2 (Volts)	gm (umhos)	mu	Pp (Watts)
Pentodes								
6788	Sharp Cutoff High Gain Audio Pentode	6.3	175	100	100	1100		0.5
6943	Sharp Cutoff HF Pentode	6.3	175	100	100	3600		1.0
6944	Semi-Remote Cutoff HF Pentode	6.3	175	100	100	3200		1.0
6945	Audio Beam Power Pentode	6.3	350	250	150	3500		3.0
Triodes								
6946	Medium Mu VHF Triode	6.3	175	100		3800	16.5	1.5
6947	Medium Mu Double Triode	6.3	350	250		4000	35	0.75 (Each Section)
6948	High Mu Double Triode	6.3	350	250		1650	70	0.5 (Each Section)

MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DL
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250 °C	
Altitude[2]	80,000 Ft.	
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16} nvt	
Dose Rate (neutrons/sq. cm/sec.)	10^{12} nv	

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V
Heater Current	175 mA

DIRECT INTERELECTRODE CAPACITANCES (Unshielded)

Grid No. 1 to Plate	0.032 μμf	Max.
Input	2.4 μμf	
Output	3.3 μμf	

RATINGS[1] (Absolute Maximum)

Heater Voltage [3]	6.3 (−12, + 10%) V
Plate Voltage	250 Vdc
Peak Plate Forward Voltage[4]	360 v
Grid No. 2 Voltage	150 Vdc
Plate Dissipation	0.5 W
Grid No. 2 Dissipation	0.15 W
Average Cathode Current	5.5 mAdc
Grid No. 1 Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid No. 1 Circuit Resistance	4.0 Meg

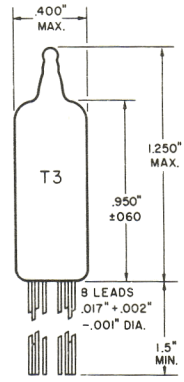
CHARACTERISTICS

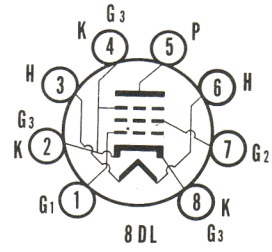
Plate Voltage	100 Vdc
Grid No. 2 Voltage	100 Vdc
Cathode Resistor	1500 Ohms
Plate Current	0.7 mAdc
Grid No. 2 Current	0.10 mAdc
Transconductance	1100 μmhos
Plate Resistance	1.2 Meg
Grid No. 1 Voltage for Ib = 50 μAdc Max.	−3.0 Vdc

QUICK REFERENCE DATA

The Premium Subminiature Type 6788 is a sharp-cutoff pentode designed for guided missile service. It is intended for use as a high gain audio amplifier or regulator amplifier where high plate loads are desired at low plate currents. The 6788 is characterized by extraordinary freedom from interelement shorts of short duration, by high resistance to interelement leakage.

The 6788 is designed to provide dependable service under conditions of severe mechanical shock, vibration, high temperature and high altitude, and is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
Sylvania Electric Products Inc.

NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltages (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center-rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *MIL-E-1D, Par. 6.5.1.1 does not apply. Peak voltage shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage . . . . . 6.3 V
Plate Voltage . . . . . 100 Vdc
Grid No. 1 Voltage . . . . . 0 V
Grid No. 2 Voltage . . . . . 100 Vdc
Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1 . 0 V
Cathode Resistor . . . . . 1500 Ohms

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	165	—	175	—	185	mA
4.10.15	Heater-Cathode Leakage	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	5.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	5.0	μAdc
4.10.6.1	Grid Current: Ic1 Eb = Ec2 = 125 Vdc; Ec1 = −1.8 Vdc; Rk = 0; Rg1 = 1.0 Meg	0.65	0	—	—	—	−0.1	μAdc
4.10.4.1	Plate Current (1): Ib ALD = 0.17	—	—	0.62	0.7	0.78	—	mAdc
4.10.4.1	Plate Current (1):	0.65	0.5	—	—	—	0.9	mAdc
4.10.4.1	Plate Current (2): E1 = −3.0 Vdc; Rk = 0 Ohms	0.65	—	—	10	—	50	μAdc
4.10.4.3	Screen Grid Current: Ic2	0.65	—	—	0.10	—	0.20	mAdc
4.10.9	Transconductance (1): ALD = 175 Sm	0.65	—	1025	1100	1175	—	μmhos
4.10.9	Transconductance (1): Sm	—	900	—	—	—	1300	μmhos
4.7.5	Continuity and Shorts (Inoperatives):	0.4	—	—	—	—	—	
4.9.1.1	Mechanical: Envelope JEDEC 3-11	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes	2.5	—	—	—	—	—	
	Eg1-all = −100 V	—	500	—	—	—	—	Meg
	Ep-all = −300 V	—	500	—	—	—	—	Meg
	Eg2-all = −200 V	—	500	—	—	—	—	Meg
4.10.9.1	Transconductance (2): △ Sm Ef = 5.5 V	2.5	—	—	—	—	15	%
4.10.4.1	Plate Current (3): Ec1 = −2.5; Rk = 0	2.5	5.0	—	50	—	—	μAdc
4.10.6.2	Grid Emission: Notes 3 and 4; Ic1 Ef = 7.5 V; Rg1 = 4.0 Meg; Rk = 0 Ohms Ec1 = −3.0 Vdc	2.5	0	—	—	—	−0.5	μAdc
4.10.3.2	AF Noise: Note 5 Esig. (Cal.) = 70 mVac; Ec2 = 19 Vdc; Rg1 = 0.1 Meg; Rg2 = 1000 Ohms; Rp = 0.2 Meg; Ck = 1000 μf	2.5	—	—	—	—	—	
----	Hum: Note 6 Ef = 6.3 Vac @ 400 cps; Eb = Ec1 = Ec2 = 0; Rk = 10,000 Ohms	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Note 7	6.5	—	—	—	—	20	secs
4.10.10	Plate Resistance:	6.5	0.8	—	1.2	—	—	Meg
4.10.14	Capacitance: Shield No. 318	6.5	—	—	—	—	—	
	Cg1p	—	—	—	—	—	0.032	μμf
	Cin	—	1.8	—	2.4	—	3.0	μμf
	Cout	—	2.5	—	3.3	—	4.1	μμf
4.9.12.1	Low Pressure Voltage Breakdown: Note 8 Pressure = 21 ± 2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1): RP = 10,000 Ohms; Ck = 1000 μf; F = 40 cps; G = 10	1.0	—	—	—	—	5	mVac
----	White Noise Vibration: Notes 9 and 10 Rp = 10,000 Ohms; Ck = 1000 μf	2.5	—	—	—	20	50	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	3	5	mVac

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
	Degradation Rate Acceptance Tests, Note 4							
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 11 Hammer Angle = 30°;	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 8 and 12 G = 10; Variable Frequency	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points:							
	Vibration (1) :	—	—	—	—	—	15	mVac
	Heater-Cathode Leakage							
	Ehk = +100 Vdc	—	—	—	—	—	15.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	15.0	μAdc
	Change in Transconductance (1) of Individual Tubes △ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain	4.0	—	—	—	—	—	
	Acceptance Life Tests, Note 4							
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 13 Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec1 = Ec2 = Eb = 0 V	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 13 Ef = 10 V; Ehk = +200 Vdc; 10 secs. on, 4 min. off; Eb = Ec1 = Ec2 = 0	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 14 Eb = 250 Vdc; Ec2 = 150 Vdc; Rk = 680 Ohms; Ehk = +200 Vdc; Rg1 = 4.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points: Change in Transconductance (1) of Individual Tubes △ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 15 Ebb = 250 Vdc; Tie Grid No. 2 to Plate; Rk = 110 ohms; Rp = .03 Meg; Rg1 = 4.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Transconductance (1) Sm	1.0	800	—	—	—	—	μmhos
	Grid Current	2.5	0	—	—	—	−0.1	μAdc
	Heater-Cathode Current: Ihk	0.65	—	—	—	—	10	μAdc
	Electrode Insulation:	6.5	—	—	—	—	—	
	Rg1-all	—	200	—	—	—	—	Meg
	Rg2-all	—	200	—	—	—	—	Meg
	Rp-all	—	200	—	—	—	—	Meg

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	MAX.	Units
4.11.5	Intermittent Life Test: Notes 16 and 17; Survival Rate life conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points: (200 Hours)					
	Inoperatives: Note 18	—	—	—	—	
	Grid Current	0	−0.5	0	−1.0	μAdc
	Heater Current	165	190	160	195	mA
	Change in Transconductance (1) of Individual Tubes; △ Sm/t	—	20	0	25	%
	Transconductance (2): △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage Ehk = ±100 Vdc	—	10	—	15	μAdc
	Insulation of Electrodes					
	g1-all	200	—	25	—	Meg
	p-all	200	—	25	—	Meg
	g2-all	200	—	25	—	Meg
	Transconductance (1) Average change Avg. △ Sm/t	—	15	—	—	%

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
Acceptance Life Tests, Note 4 (Cont'd.)		
----	Individual Lot Acceptance:	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 17	
	Failure Rate Class 1	
	Inoperatives:	5
	Failure Rate Class 2	
	Combined defectives to Limits (1)	
	Including Inoperatives:	16
	Failure Rate Class 3	
	Combined defectives to Limits (3)	
	Including Inoperatives:	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Ec2	Ec3	Rk/k	Rg1
V	Vdc	Vdc	Vdc	Vdc	ohms	Meg
7.5	250	0	150	—	680	4.0

4: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

5: The rejection level shall be set at the VU meter reading obtained during calibration.

6: Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

7: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

8: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

9: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db to 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

10: For variables sampling procedure, use MIL-E-1, Appendix C, par. 20.2.4.2.2.

11: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

12: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2 and Y1. Filament voltage only shall be applied to the tube under test.

13: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

14: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

15: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

16: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025 inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

17: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

ACCEPTANCE CRITERIA NOTES (Continued)

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 The Failure Rate Control:

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2, and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate and the defectives shall not be added into the cumulative number of defectives as plotted on the failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2, and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

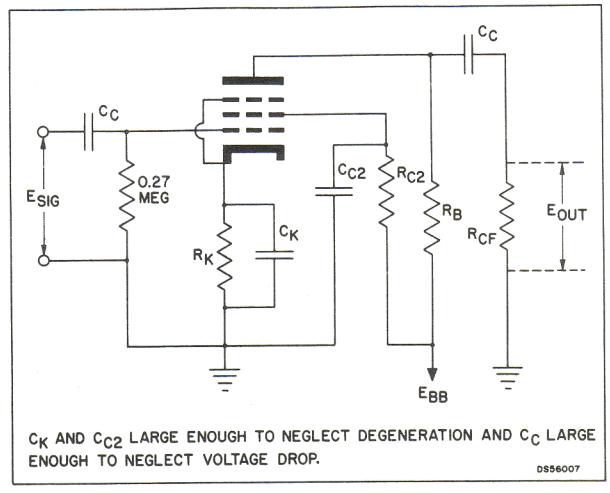
18: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Type 6788 is a Premium Subminiature sharp cut-off pentode designed for audio amplifier service. It has particular advantage as a high gain audio amplifier or regulator amplifier where high plate loads are desired at low plate current.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. In addition, vibrational output when the tube is subjected to wide band (White Noise) vibration is held to a very low value. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level used on most reliable receiving tube types. The sweep frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.



Resistance Coupled Amplifier Data

described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental

APPLICATION DATA (Continued)

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibrational test is included in the frontal section of this manual.

The 6788 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

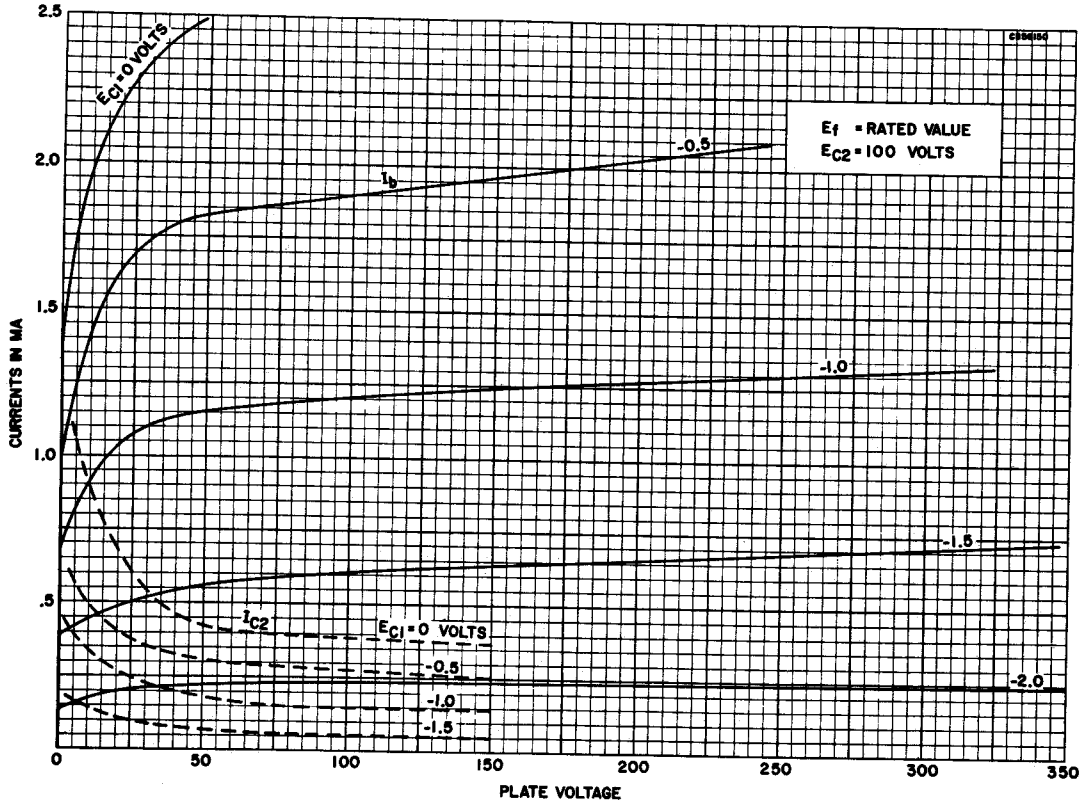
When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

RESISTANCE COUPLED AMPLIFIER DATA

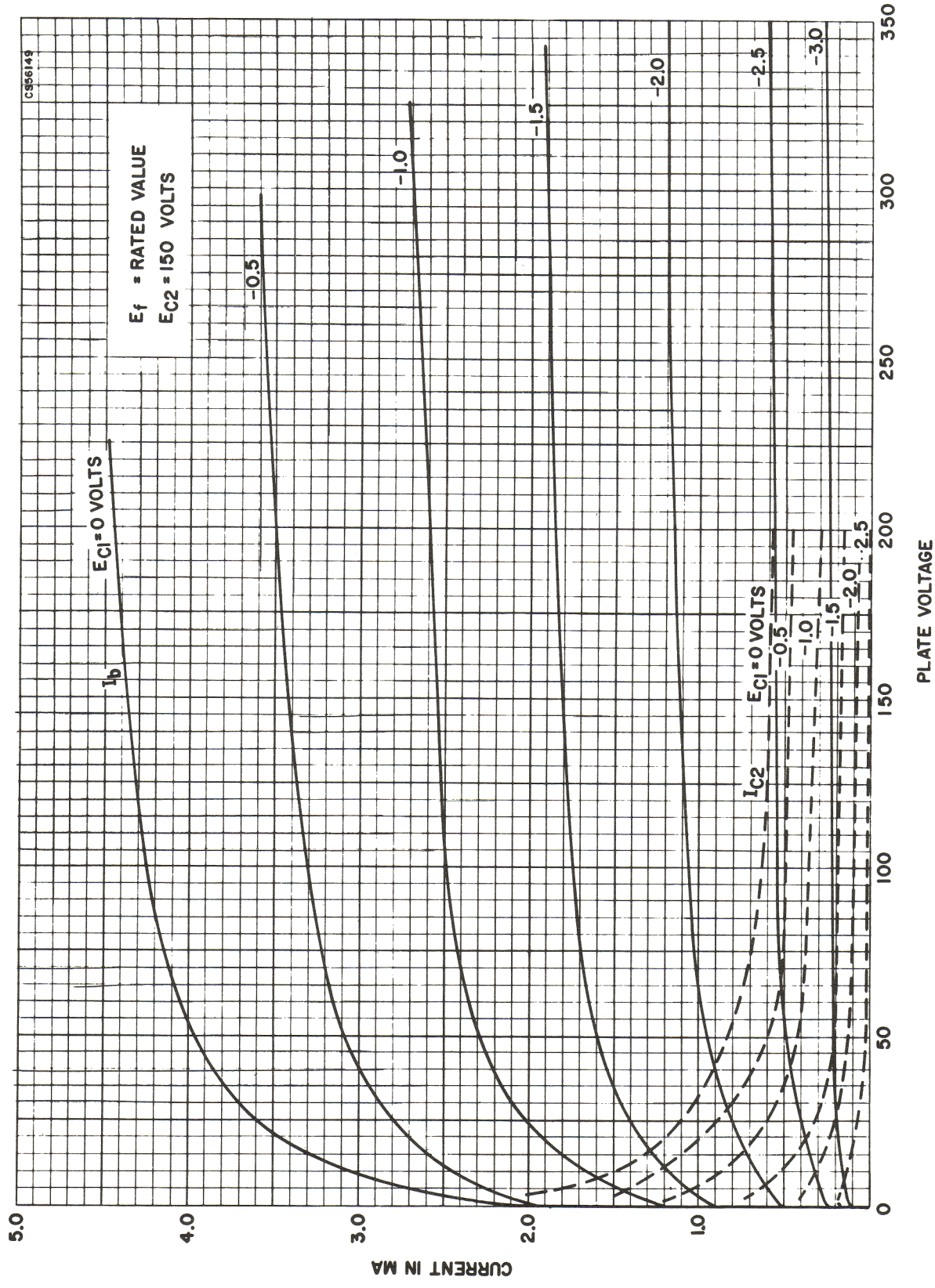
	Ebb = 100 Volts						Ebb = 250 Volts					
Rb (megohms)	0.1		0.27		0.47		0.1		0.27		0.47	
Rc2 (megohms)	.82		2.2		3.9		0.82		2.2		3.9	
Rcf (megohms)	0.27	0.47	0.47	1.0	0.47	1.0	0.27	0.47	0.47	1.0	0.47	1.0
Rk (ohms)	1800	1800	4700	3900	6800	6800	560	1000	1500	1200	2200	2200
Ib (ma)	.400	.400	.177	.187	.118	.116	1.36	1.16	.575	.61	.365	.367
Ic2 (ma)	.055	.054	.024	.026	.016	.016	.19	.17	.082	.083	.050	.050
Ec1 (volts)	−.82	−.82	−.95	−.83	−.91	−.89	−.87	−1.36	−1.02	−.83	−.92	−.92
Ec2 (volts)	54.1	55.0	46.2	46.4	38.7	38.7	96.	113	72.	66.	56	56
Eb (volts)	59.2	59.2	51.2	49.1	44.6	44.6	113.	129	87.	85.	76	76
Esig (volts, rms)	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.10	0.10
Eout (volts, rms)	3.3	3.65	4.5	5.9	4.7	6.2	9.3	10.1	16.2	19.8	18.2	23.6
Gain	66.	73.	90.	118.	94.	124.	93.	101	162.	198.	182.	236.
% Distortion	2.0	2.0	3.9	3.75	4.6	4.25	0.9	1.0	1.8	1.17	3.7	3.2
Esig* (volts, rms)	0.09	0.10	0.07	0.07	0.06	0.06	0.18	0.47	0.25	0.13	0.14	0.17
Eout (volts, rms)	5.9	7.28	6.3	8.2	5.6	7.35	16.6	45.	39.	25.7	25.3	38.
Gain	65.5	72.8	90.	117.	93.	122.	92.	96.	156.	198.	181.	224.
% Distortion	3.4	3.8	5.0	5.0	5.0	5.0	1.4	5.0	4.8	1.70	5.0	5.0

*Maximum signal for 5% distortion or 1/8 microampere grid current.

AVERAGE PLATE CHARACTERISTICS

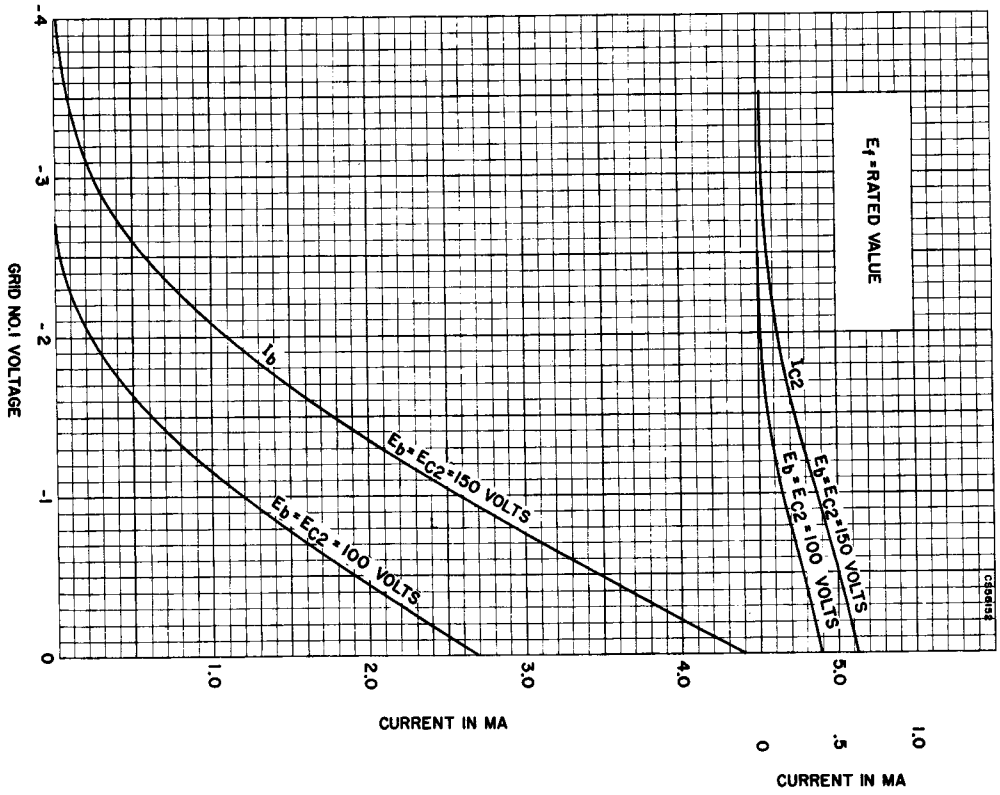


AVERAGE PLATE CHARACTERISTICS

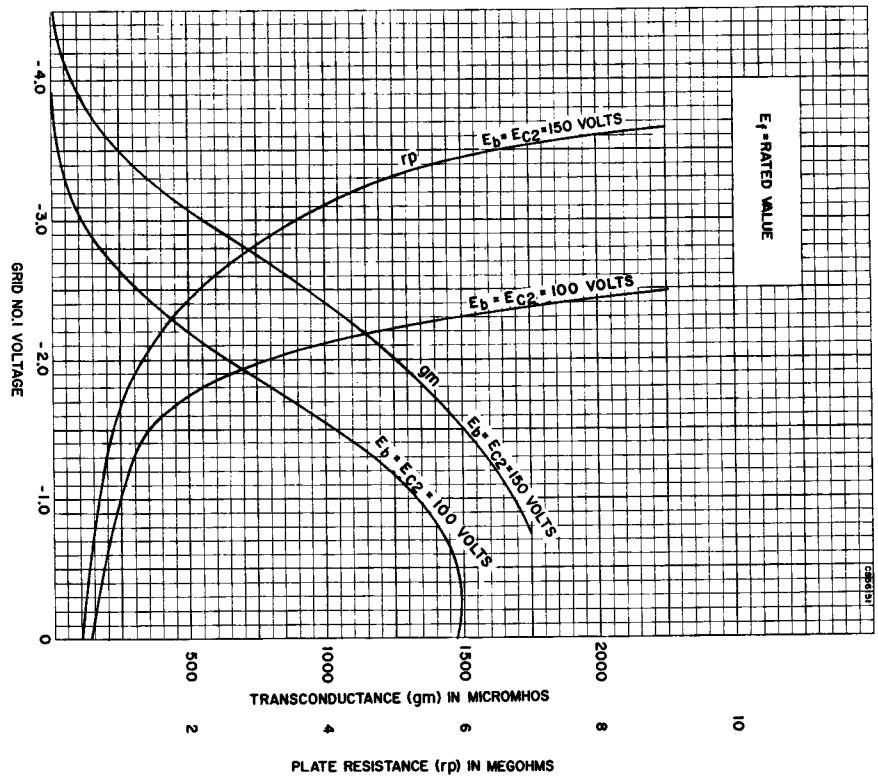


6788

AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



SYLVANIA GUIDED MISSILE TUBES

6943

MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DC
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250 °C	
Altitude[2]	80,000 Ft.	
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16} nvt	
Dose Rate (neutrons/sq. cm/sec.)	10^{12} nv	

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All End Points	5.4%/200 Hours
Class (3) — All End Points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V
Heater Current	175 mA

DIRECT INTERELECTRODE CAPACITANCES (Shielded)[4]

Grid No. 1 to Plate	0.015 μμf	Max.
Input	3.0 μμf	
Output	3.0 μμf	

RATINGS[1] (Absolute Maximum)

Heater Voltage[3]	6.3 (−12, + 10%) V
Plate Voltage	250 Vdc
Peak-Plate Forward Voltage[5]	360 v
Grid No. 3 Voltage	
Positive Value	0 Vdc
Negative Value	20 Vdc
Grid No. 2 Voltage	150 Vdc
Plate Dissipation	1.0 W
Grid No. 2 Dissipation	0.33 W
Cathode Current	15 mAdc
Grid No. 1 Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid No. 1 Circuit Resistance	1.0 Meg

CHARACTERISTICS

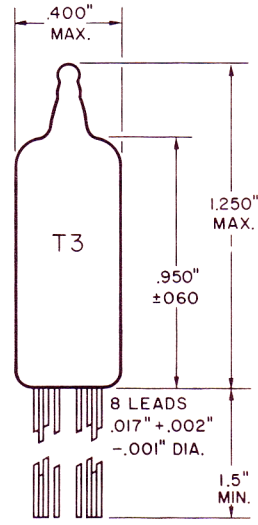
Plate Voltage	100 Vdc
Grid No. 3 Voltage	0 Vdc
Grid No. 2 Voltage	100 Vdc
Cathode Resistor	150 Ohms
Plate Current	8.0 mAdc
Grid No. 2 Current	2.3 mAdc
Transconductance	3600 μmhos
Plate Resistance	300,000 Ohms
Grid No. 1 Voltage for Ib = 100 μAdc Max.	−7.5 Vdc

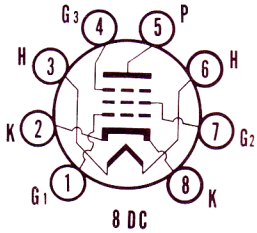
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6943 is a sharp-cutoff RF pentode designed specifically for guided missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6943 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

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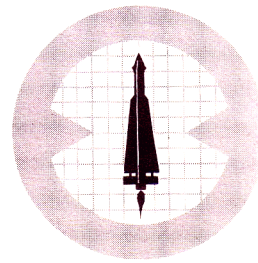


6943

NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltage (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center-rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *External shield No. 318 connected to cathode.*
5. *MIL-E-1D Par. 6.5.1.1 does not apply. Peak voltages shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage	6.3 V	Grid No. 2 Voltage	100 Vdc
Plate Voltage	100 Vdc	Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1	0 V
Grid No. 1 Voltage	0 V	Cathode Resistor	150 Ohms
Grid No. 3 Voltage, MIL-E-1 Par. 3.2.26.1	0 V		

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	165	—	175	—	185	mA
4.10.15	Heater-Cathode Leakage	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	5.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	5.0	μAdc
4.10.6.1	Grid Current: Ic1 Eb = Ec2 = 125 Vdc; Ec1 = −2.5 Vdc; Rk = 0; Rg1 = 1.0 Meg	0.65	0	—	—	—	−0.1	μAdc
4.10.4.1	Plate Current (1): ALD = 1.7	—	—	7.2	8.0	8.8	—	mAdc
4.10.4.1	Plate Current (1):	0.65	6.0	—	—	—	10.0	mAdc
4.10.4.1	Plate Current (2): Ec1 = −7.5 Vdc; Rk = 0 Ohms	0.65	—	—	—	—	100	μAdc
4.10.4.3	Screen Grid Current: Ic2	0.65	—	—	2.3	—	3.6	mAdc
4.10.9	Transconductance (1): ALD = 700 Sm	—	—	3300	3600	3900	—	μmhos
4.10.9	Transconductance (1): Sm	0.65	2800	—	—	—	4400	μmhos
4.7.5	Continuity and Shorts (Inoperatives):	0.4	—	—	—	—	—	
----	Suppressor: Tie Grid No. 2 to Plate	0.4	—	—	—	—	—	
4.9.1.1	Mechanical: Envelope JEDEC 3-11	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes	2.5	—	—	—	—	—	
	Eg1-all = −100 V	—	500	—	—	—	—	Meg
	Ep-all = −300 V	—	500	—	—	—	—	Meg
	Eg2-all = −200 V	—	500	—	—	—	—	Meg
4.10.9	Transconductance (2): Δ Sm Ef = 5.5 V	2.5	—	—	—	—	15	%
4.10.4.1	Plate Current (3): Ec1 = −5.5 Vdc; Rk = 0 Ohms	2.5	5	—	—	—	—	μAdc
4.10.6.2	Grid Emission: Notes 3 and 4 Ic1 Ef = 7.5 V; Ec1 = −7.5 Vdc; Rg1 = 1.0 Meg; Rk = 0 Ohms	2.5	0	—	—	—	−0.5	μAdc
4.10.3.2	AF Noise: Note 5 Esig (Cal.) = 70 mVac; Ec2 = 19 Vdc; Rg1 = 0.1 Meg; Rg2 = 1000 Ohms; Rp = 0.2 Meg; Ck = 1000 μf	2.5	—	—	—	—	—	
----	Hum: Note 6 Ef = 6.3 Vac @ 400 cps; Eb = Ec1 = Ec2 = Ec3 = 0; Rk = 10,000 Ohms	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Note 7	6.5	—	—	—	—	20	Secs
4.10.10	Plate Resistance	6.5	0.20	—	0.30	—	—	Meg
4.10.14	Capacitances: Shield No. 318	6.5	—	—	—	—	—	
	Cg1p	—	—	—	—	—	0.015	μμf
	Cin	—	2.2	—	3.0	—	3.8	μμf
	Cout	—	2.2	—	3.0	—	3.8	μμf
4.9.12.1	Low Pressure Voltage Breakdown: Note 8 Pressure = 21 ± 2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1): RP = 10,000 Ohms; Ck = 1000 μf; F = 40 cps; G = 10	1.0	—	—	—	—	40	mVac
----	White Noise Vibration: Notes 9 & 10 Rp = 10,000 Ohms; Ck = 100 μf	2.5	—	—	—	150	300	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	20	40	mVac

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
	Degradation Rate Acceptance Tests, Note 4							
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 11							
	Hammer Angle = 30°	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 8 and 12							
	G = 10; Variable Frequency	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points:							
	Vibration (1):	—	—	—	—	—	120	mVac
	Heater-Cathode Leakage							
	Ehk = ±100 Vdc	—	—	—	—	—	15	μAdc
	Change in Transconductance (1) of							
	Individual Tubes △ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain	4.0	—	—	—	—	—	
	Acceptance Life Tests, Note 4							
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 13 Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec1 = Ec3 = Ec2 = Eb = 0 V	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 13 Ef = 10 V; Ehk = +200 Vdc; Rhk = 0; 10 secs on, 4 min. off; Eb = Ec1 = Ec2 = 0	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 14 Eb = 250 Vdc; Ec2 = 150 Vdc; Rk = 1000 Ohms; Ehk = +200 Vdc; Rg1 = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points:							
	Change in Transconductance (1) of							
	Individual Tubes △ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 15 Ebb = 250 Vdc; Tie Grid No. 2 to Plate; Rk = 470 Ohms; Rp = 15,000 Ohms; Rg = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Transconductance (1)	1.0	2400	—	—	—	—	μmhos
	Grid Current	2.5	0	—	—	—	−0.1	μAdc
	Heater-Cathode Current: Ihk	0.65	—	—	—	—	10	μAdc
	Electrode Insulation:	6.5	—	—	—	—	—	
	Rg1-all	—	200	—	—	—	—	Meg
	Rg2-all	—	200	—	—	—	—	Meg
	Rp-all	—	200	—	—	—	—	Meg

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	MAX.	Units
4.11.5	Intermittent Life Test: Notes 16 and 17 Survival Rate life conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points: (200 Hours)					
	Inoperatives: Note 18	—	—	—	—	
	Grid Current	0	−0.5	0	−1.0	μAdc
	Heater Current	165	190	160	195	mA
	Change in Transconductance (1) of					
	Individual Tubes; △ Sm/t	—	20	0	25	%
	Transconductance (2): △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage Ehk = ±100 Vdc	—	10	—	15	μAdc
	Insulation of Electrodes					
	g1-all	200	—	25	—	Megohms
	p-all	200	—	25	—	Megohms
	g2-all	200	—	25	—	Megohms
	Transconductance (1) Average change					
	Avg. △ Sm/t	—	15	—	—	%

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
	Acceptance Life Tests, Note 4 (Cont'd.)	
----	Individual Lot Acceptance	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 17	
	Failure Rate Class 1 Inoperatives:	5
	Failure Rate Class 2	
	Combined defectives to Limits (1) Including Inoperatives:	16
	Failure Rate Class 3	
	Combined defectives to F.R. 3 Limits Including Inoperatives	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Ec2	Ec3	Rk/k	Rg1
V	Vdc	Vdc	Vdc	Vdc	ohms	Meg
7.5	250	0	150	0	1000	1.0

4: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

5: The rejection level shall be set at the VU meter reading obtained during calibration.

6: Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

7: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

8: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

9: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

10: For variables sampling procedure use MIL-E-1, Appendix C, par. 20.2.4.2.2.

11: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

12: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

13: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

14: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

15: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

16: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

17: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan

ACCEPTANCE CRITERIA NOTES (Continued)

to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 **The Failure Rate Control:**

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

18: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Sylvania Premium Subminiature Type 6943 is a sharp-cutoff pentode designed specifically for guided missile service. The 6943 is intended for use as an rf amplifier at frequencies up to approximately 100 mc. It is also well suited to a variety of low-frequency applications.

As the frequency of operation is increased, consideration should be given to the resultant decrease in input resistance, Figure 1. In some applications it may be advantageous to place an unbypassed resistance in the cathode circuit to compensate for the change in input capacitance with bias. This unbypassed resistance reduces the effective gm of the tube by the factor

$$\frac{1}{1 + gm\ Rk\left(\frac{Ib + Ic2}{Ib}\right)}$$

However, it also has the effect of raising the input resistance of the tube under certain operating conditions so that both a net increase in gain and a net decrease in input capacitance change may result. The curves of Figures 2 and 3 illustrate the effect of unbypassed cathode resistance on input resistance and capacitance. The 6943 is particularly well suited to such applications since the suppressor grid may be grounded directly, thus providing greater stability. It should be noted that the suppressor grid is not intended as a control electrode. The external suppressor grid connection also facilitates the possible employment of suppressor grid neutralization techniques*.

Two cathode leads are provided to minimize lead inductance and permit isolation of the input and output circuits.

Resistance-coupled amplifier data is presented in the accompanying table.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue-testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in

APPLICATION DATA (Continued)

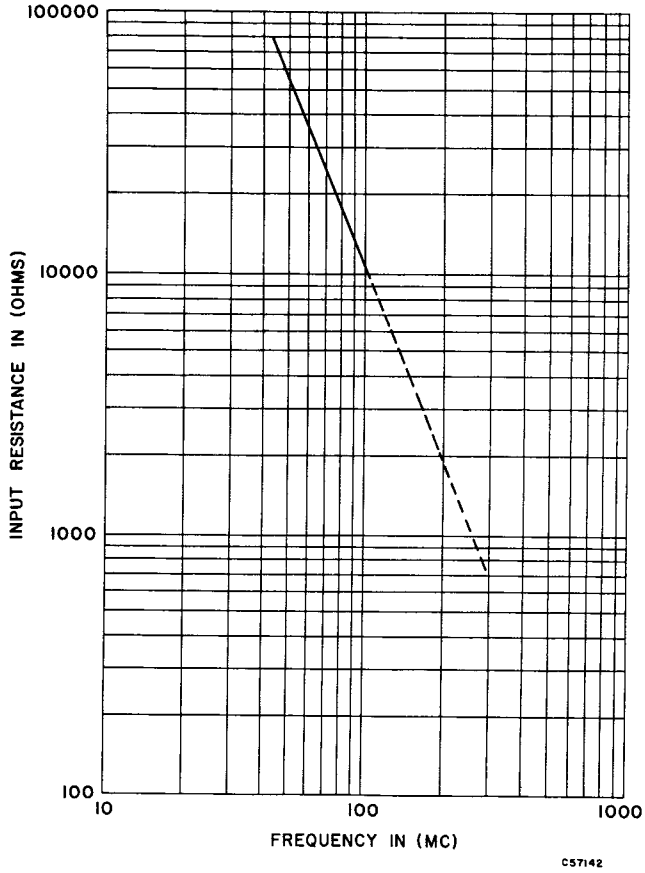


Figure 1—Input resistance vs frequency.

each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibration test is included in the frontal section of this manual.

The 6943 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

*"A Method of Neutralizing IF Amplifier Tubes at 44 Mc by Means of Suppressor Grid Reaction," Sylvania Engineering Information Service, Vol. 3, No. 1, April 1956.

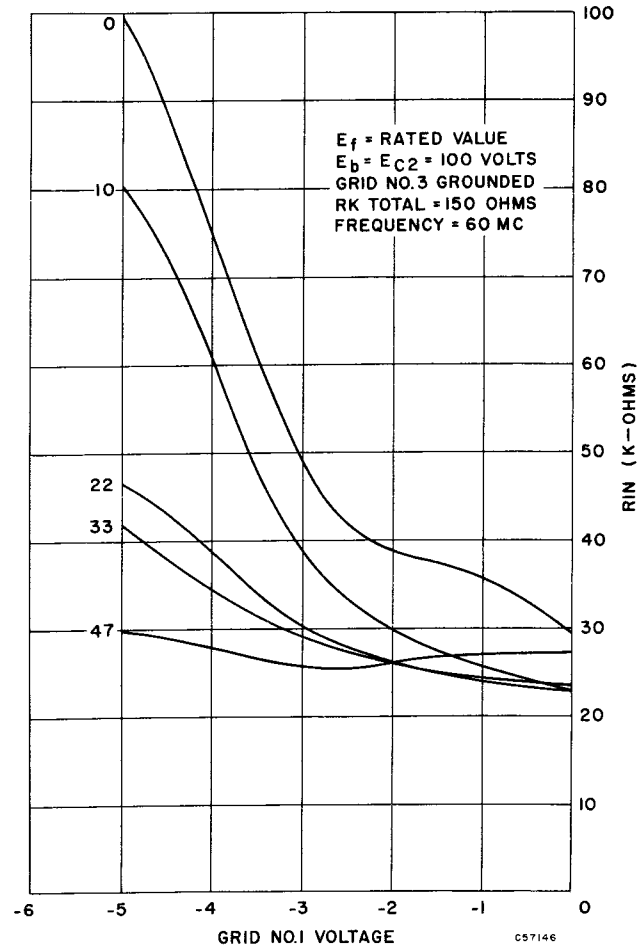


Figure 2—Effect of unbypassing portions of 150-Ohm cathode resistor on input-resistance at 60 mc.

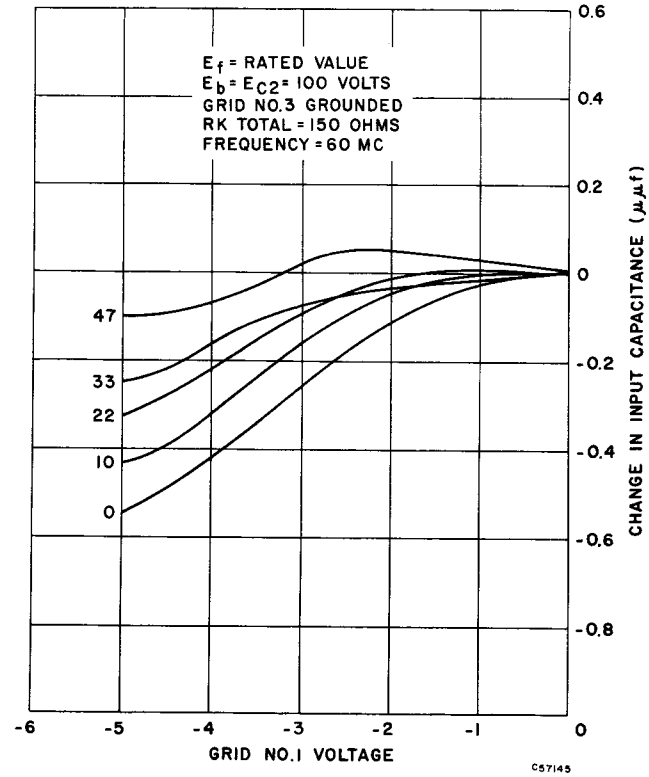
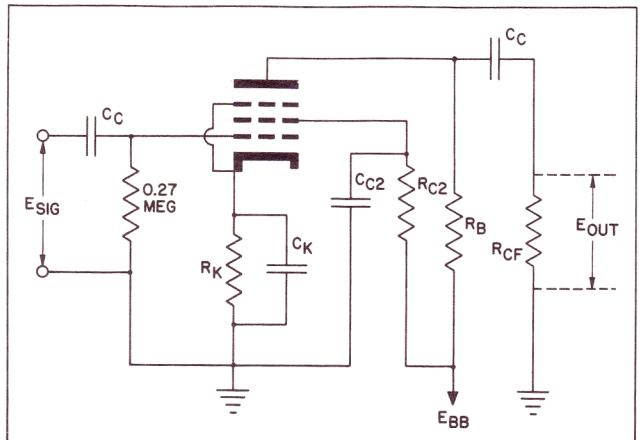


Figure 3—Effect of unbypassing portions of 150-Ohm cathode resistor on input capacitance at 60 mc.

RESISTANCE COUPLED AMPLIFIER DATA

	Ebb = 150 Volts						Ebb = 250 Volts					
Rb (megohms)	.150		.270		0.47		.100		0.150		0.68	
Rc2 (megohms)	.47	.47	.82	.82	1.5	1.5	.33	.33	.56	.56	2.20	2.20
Rcf (megohms)	.27	.47	.47	1.0	.47	1.0	.27	.47	.27	.47	.47	1.0
Rk (ohms)	1500	2200	3300	3900	4700	4700	1300	1300	1500	1500	3600	4700
Ib (ma)	.70	.66	.37	.37	.24	.22	1.68	1.68	1.06	1.06	.28	.28
Ic2 (ma)	.24	.22	.14	.13	.08	.08	.52	.52	.34	.34	.10	.10
Ec1 (volts)	−1.41	−1.81	−1.67	−1.95	−1.49	−1.42	−2.86	−2.86	−2.10	−2.10	−1.39	−1.76
Ec2 (volts)	35	23	36	42	25	26	76	76	55	55	27	33
Eb (volts)	44	63	48	48	38	46	79	79	89	90	56	60
Esig (V rms)	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
Eout (V rms)	9.8	10.5	11	12.4	10.8	13.0	10.8	12	11.2	13	14	17.5
Gain	98	105	110	124	108	130	108	120	112	130	140	175
% Distortion	2.0	0.9	1.7	2.1	1.6	4.1	0.8	1.0	1.0	1.6	3.2	4.3
Esig (volts rms)*	.34	.40	.33	.35	.24	.28	.68	.73	.48	.53	.27	.31
Eout (volts rms)	25.3	29	27	30	21.6	26.9	51	56.5	39.0	45	31	40
Gain	74.5	72.5	82	75	90	96	75	77.4	81	85	115	129
% Distortion	2.1	5.0	5.2	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.2	5.1

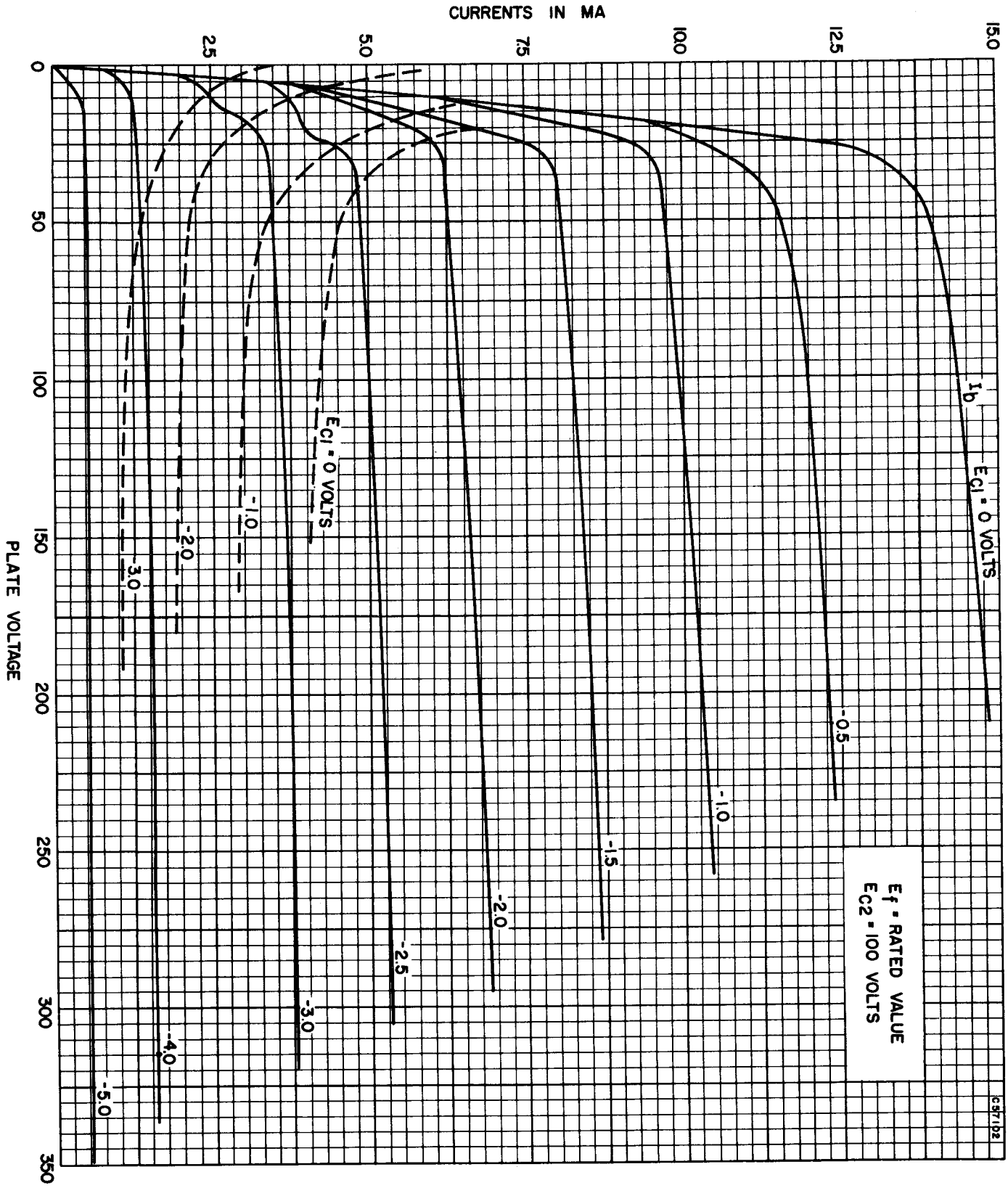
*Maximum signal for 5% distortion or ⅛ microampere grid current.



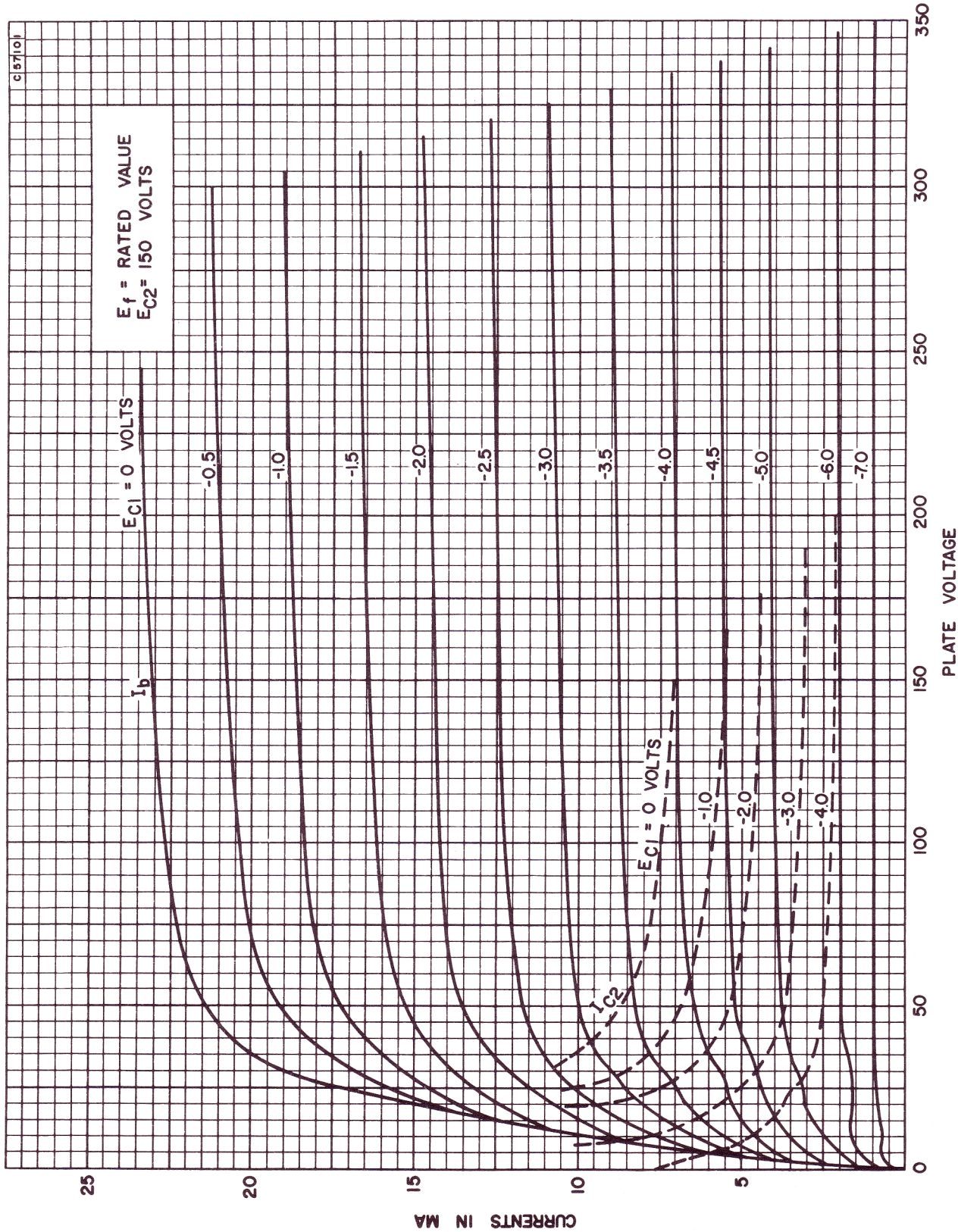
Resistance-coupled amplifier circuit
(Grid No. 3 externally connected to cathode)

6943

AVERAGE PLATE CHARACTERISTICS

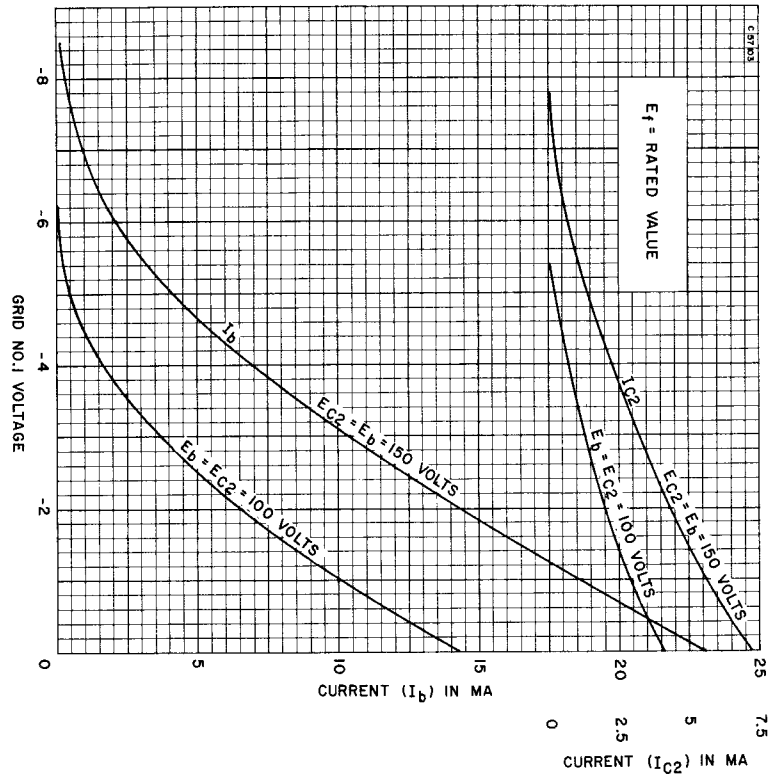


AVERAGE PLATE CHARACTERISTICS

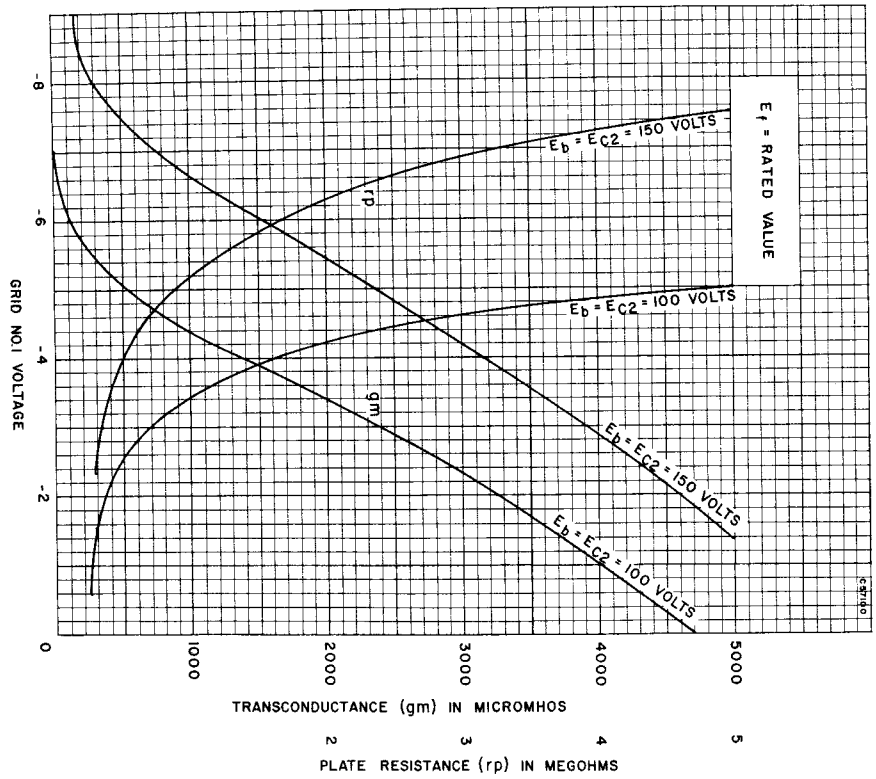


6943

AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DC
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250 °C	
Altitude[2]	80,000 Ft.	
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16} nvt	
Dose Rate (neutrons/sq. cm/sec.)	10^{12} nv	

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V
Heater Current	175 mA

DIRECT INTERELECTRODE CAPACITANCES (Shielded)[4]

Grid No. 1 to Plate	0.015 μμf	Max.
Input	2.9 μμf	
Output	3.1 μμf	

RATINGS[1] (Absolute Maximum)

Heater Voltage[3]	6.3 (−12, + 10%) V
Plate Voltage	250 Vdc
Peak-Plate Forward Voltage[5]	360 v
Grid No. 3 Voltage	
Positive Value	0 Vdc
Negative Value	20 Vdc
Grid No. 2 Voltage	150 Vdc
Plate Dissipation	1.0 W
Grid No. 2 Dissipation	0.36 W
Cathode Current	15.0 mAdc
Grid No. 1 Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid No. 1 Circuit Resistance	1.0 Meg

CHARACTERISTICS

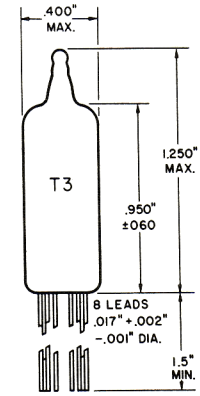
Plate Voltage	100 Vdc
Grid No. 3 Voltage	0 Vdc
Grid No. 2 Voltage	100 Vdc
Cathode Resistor	150 Ohms
Plate Current	7.0 mAdc
Grid No. 2 Current	2.0 mAdc
Transconductance	3200 μmhos
Plate Resistance	280,000 Ohms
Grid No. 1 Voltage for Transconductance = Approx. 25 μmhos (75 μmhos Max.)	−12 Vdc

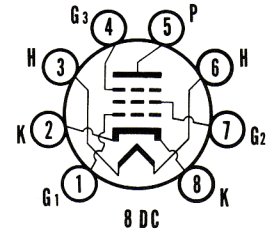
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6944 is a semi-remote cutoff RF pentode designed specifically for guided missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6944 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
Sylvania Electric Products Inc.

NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltages (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center-rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *External shield No. 318 connected to cathode.*
5. *MIL-E-1D Par. 6.5.1.1 does not apply. Peak voltage shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage	6.3 V	Grid No. 2 Voltage	100 Vdc
Plate Voltage	100 Vdc	Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1	0 V
Grid No. 1 Voltage	0 V	Cathode Resistor	150 Ohms
Grid No. 3 Voltage, MIL-E-1 Par. 3.2.26.1	0 V		

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	165	—	175	—	185	mA
4.10.15	Heater-Cathode Leakage:	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	5.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	5.0	μAdc
4.10.6.1	Grid Current: Ic1 Eb = Ec2 = 125 Vdc; Ec1 = −2.5 Vdc; Rk = 0; Rg1 = 1.0 Meg	0.65	0	—	—	—	−0.1	μAdc
4.10.4.1	Plate Current (1): ALD 1.7	—	—	6.2	7.0	7.8	—	mAdc
4.10.4.1	Plate Current (1):	0.65	5.0	—	—	—	9.0	mAdc
4.10.4.3	Screen Grid Current: Ic2	0.65	—	—	2.0	—	3.0	mAdc
4.10.9	Transconductance (1): ALD = 500 Sm	—	—	2950	3200	3450	—	μmhos
4.10.9	Transconductance (1): Sm	0.65	2600	—	—	—	3800	μmhos
4.7.5	Continuity and Shorts (Inoperatives)	0.4	—	—	—	—	—	
----	Suppressor: Tie Grid No. 2 to Plate	0.4	—	—	—	—	—	
4.9.1.1	Mechanical: Envelope JEDEC 3-11	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes	2.5	—	—	—	—	—	
	Eg1-all = −100 V	—	500	—	—	—	—	Meg
	Ep-all = −300 V	—	500	—	—	—	—	Meg
	Eg2-all = −200 V	—	500	—	—	—	—	Meg
4.10.9	Transconductance (2): Ef = 5.5 V △ Sm	2.5	—	—	—	—	15	%
4.10.9	Transconductance (3): Sm Ec1 = −12 Vdc; Rk = 0 Ohms	2.5	0.1	—	25	—	75	μmhos
4.10.6.2	Grid Emission: Notes 3 and 4 Ic1 Ef = 7.5 V; Ec1 = −12 Vdc; Rg1 = 1.0 Meg; Rk = 0 Ohms	2.5	0	—	—	—	−0.5	μAdc
4.10.3.2	AF Noise: Note 5 Esig. (Cal.) = 70 mVac; Ec2 = 19 Vdc; Rg1 = 0.1 Meg; Rg2 = 1000 Ohms; Rp = 0.2 Meg; Ck = 1000 μf	2.5	—	—	—	—	—	
----	Hum: Note 6 Ef = 6.3 Vac @ 400 cps; Eb = Ec1 = Ec2 = 0; Rk = 10,000 Ohms	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Note 7	6.5	—	—	—	—	20	secs
4.10.10	Plate Resistance	6.5	0.160	—	0.280	—	—	Meg
4.10.14	Capacitance: Shield No. 318	6.5	—	—	—	—	—	
	Cg1p	—	—	—	—	—	0.02	μμf
	Cin	—	2.2	—	2.9	—	3.6	μμf
	Cout	—	2.2	—	2.9	—	3.6	μμf
4.9.12.1	Low Pressure Voltage Breakdown: No. 8 Pressure = 21 ± 2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1): RP = 10,000 Ohms; Ck = 1000 μf; F = 40 cps; G = 10	1.0	—	—	—	—	40	mVac
----	White Noise Vibration: Notes 9 & 10 Rp = 10,000 Ohms; Ck = 1000 μf	2.5	—	—	—	150	300	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	20	40	mVac

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Degradation Rate Acceptance Tests, Note 4								
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 11 Hammer Angle = 30°;	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 8 and 12 G = 10; Variable Frequency	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points:							
	Vibration (1):	—	—	—	—	—	120	mVac
	Heater-Cathode Leakage							
	Ehk = +100 Vdc	—	—	—	—	—	15	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	15	μAdc
	Change in Transconductance (1) of Individual Tubes △ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain:	4.0	—	—	—	—	—	
Acceptance Life Tests, Note 4								
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 13 Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec1 = Ec2 = Ec3 = Eb = 0 V	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 13 Ef = 10 V; Ehk = +200 Vdc; Rhk = 0; 10 secs. on, 4 min. off	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 14 Eb = 250 Vdc; Ec2 = 150 Vdc; Rk = 910 Ohms; Ehk = +200 Vdc; Rg1 = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points: Change in Transconductance (1) of Individual Tubes △ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 15 Ebb = 250 Vdc; Tie Grid No. 2 to Plate; Rk = 390 Ohms; Rp = 15,000 Ohms; Rg1 = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Transconductance (1) Sm	1.0	2200	—	—	—	—	μmhos
	Grid Current	2.5	0	—	—	—	0.1	μAdc
	Heater-Cathode Current: Ihk	0.65	—	—	—	—	10	μAdc
	Electrode Insulation:	6.5	—	—	—	—	—	
	Rg1-all	—	200	—	—	—	—	Meg
	Rg2-all	—	200	—	—	—	—	Meg
	Rp-all	—	200	—	—	—	—	Meg

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	MAX.	Units
4.11.5	Intermittent Life Test: Notes 16 & 17: Survival Rate Life conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points: (200 Hours)					
	Inoperatives: Note 18	—	—	—	—	
	Grid Current	0	−0.5	0	−1.0	μAdc
	Heater Current	165	190	160	195	mA
	Change in Transconductance (1) of Individual Tubes △ Sm	—	20	0	25	%
	Transconductance (2) △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage					
	Ehk = ±100 Vdc	—	10	—	15	μAdc
	Insulation of Electrodes					
	g-all	200	—	25	—	Megohms
	p-all	200	—	25	—	Megohms
	g2-all	200	—	25	—	Megohms
	Transconductance (1) Average Change					
	Avg. △ Sm/t	—	15	—	—	%

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
Acceptance Life Tests, Note 4, (Cont'd.)		
----	Individual Lot Acceptance	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 17	
	Failure Rate Class 1	
	Inoperatives:	5
	Failure Rate Class 2	
	Combined defectives to Limits (1)	
	Including Inoperatives:	16
	Failure Rate Class 3	
	Combined defectives to F.R. 3 Limits	
	Including Inoperatives:	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef V	Eb Vdc	Ec1 Vdc	Ec2 Vdc	Ec3 Vdc	Rk/k ohms	Rg1 Meg
7.5	250	0	150	0	910	1.0

4: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

5: The rejection level shall be set at the VU meter reading obtained during calibration.

6: Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

7: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

8: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

9: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak acceleration shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

10: For variables sampling procedure use MIL-E-1, Appendix C, par. 20.2.4.2.2.

11: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

12: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

13: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

14: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

15: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

16: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

17: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

ACCEPTANCE CRITERIA NOTES (Continued)

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 **The Failure Rate Control:**

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The Failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

18: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Sylvania Premium Subminiature Type 6944 is a semi-remote cutoff pentode designed specifically for guided missile service. This type is intended for use as an agc-controlled rf and/or if amplifier at frequencies up to approximately 100 mc. The 6944 is also well suited to a variety of low frequency applications.

As the frequency of operation is increased, consideration should be given to the resultant decrease in input resistance, Figure 1. In some applications it may be advantageous to place an unbypassed resistance in the cathode circuit to compensate for the change in input capacitance with bias. This unbypassed resistance reduces the effective gm of the tube by the factor

$$\frac{1}{1 + gm\ Rk \left(\frac{Ib + Ic2}{Ib}\right)}$$

However, it also has the effect of raising the input resistance of the tube under certain operating conditions so that both a net increase in gain and a net decrease in input capacitance change may result. The curves of Figures 2 and 3 illustrate the effect of unbypassed cathode resistance on input resistance and capacitance. The 6944 is particularly well suited to such applications since the suppressor grid may be grounded directly, thus providing greater stability. It should be noted that the suppressor grid is not intended as a control electrode. The external suppressor grid connection also facilitates the possible employment of suppressor grid neutralization techniques*.

Two cathode leads are provided to minimize lead inductance and permit isolation of the input and output circuits.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise

APPLICATION DATA (Continued)

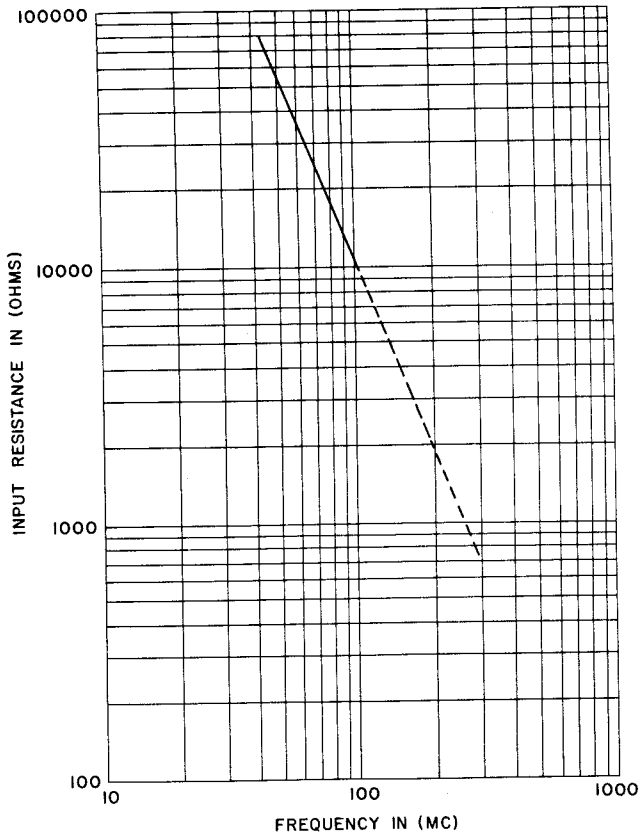


Figure 1—Input resistance vs frequency.

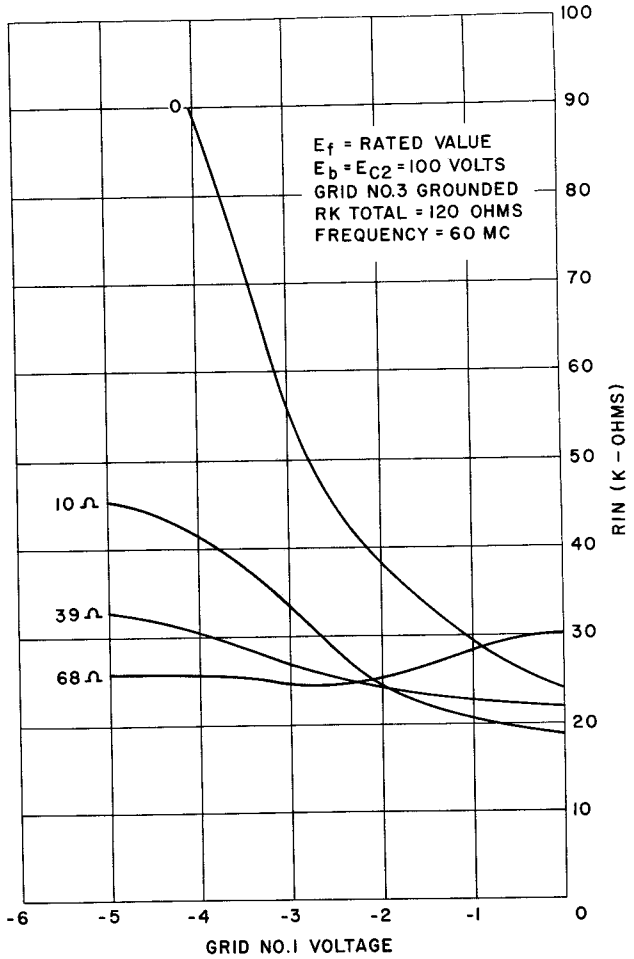


Figure 2—Effect of unbypassing portions of 150-Ohm cathode resistor on input resistance at 60 mc.

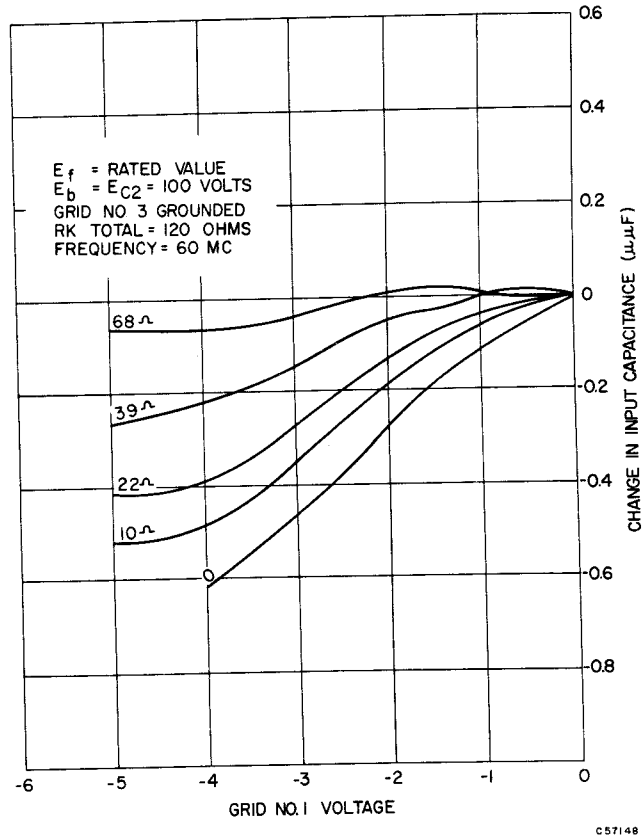


Figure 3—Effect of unbypassing portions of 150-Ohm cathode resistor on input capacitance at 60 mc.

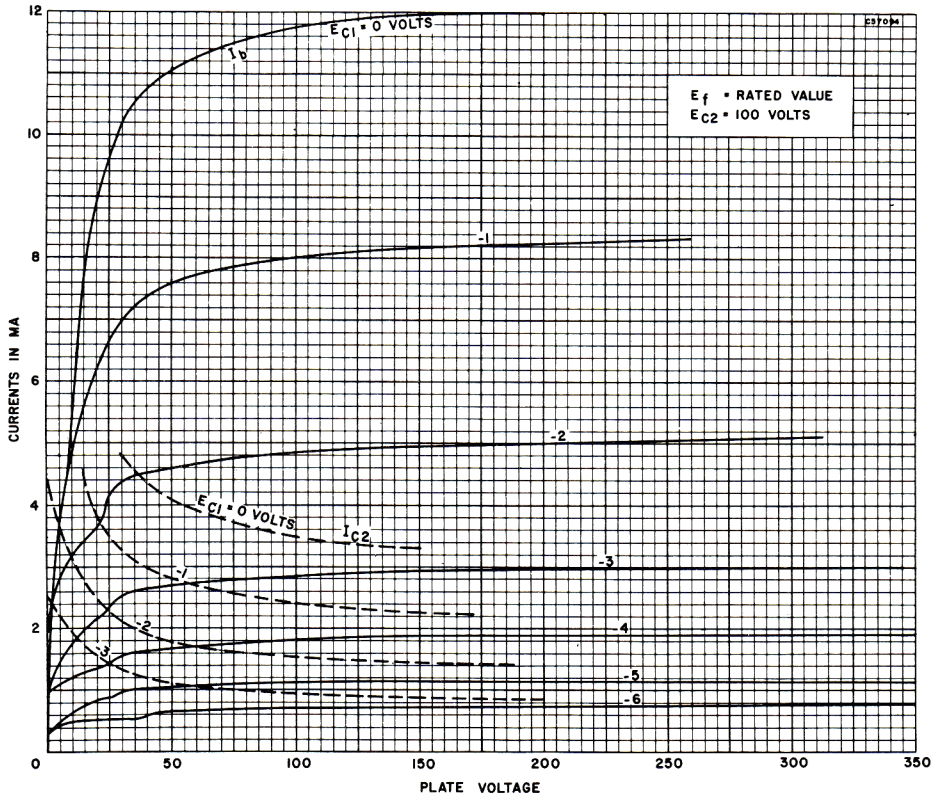
output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibration test is included in the frontal section of this manual.

The 6944 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

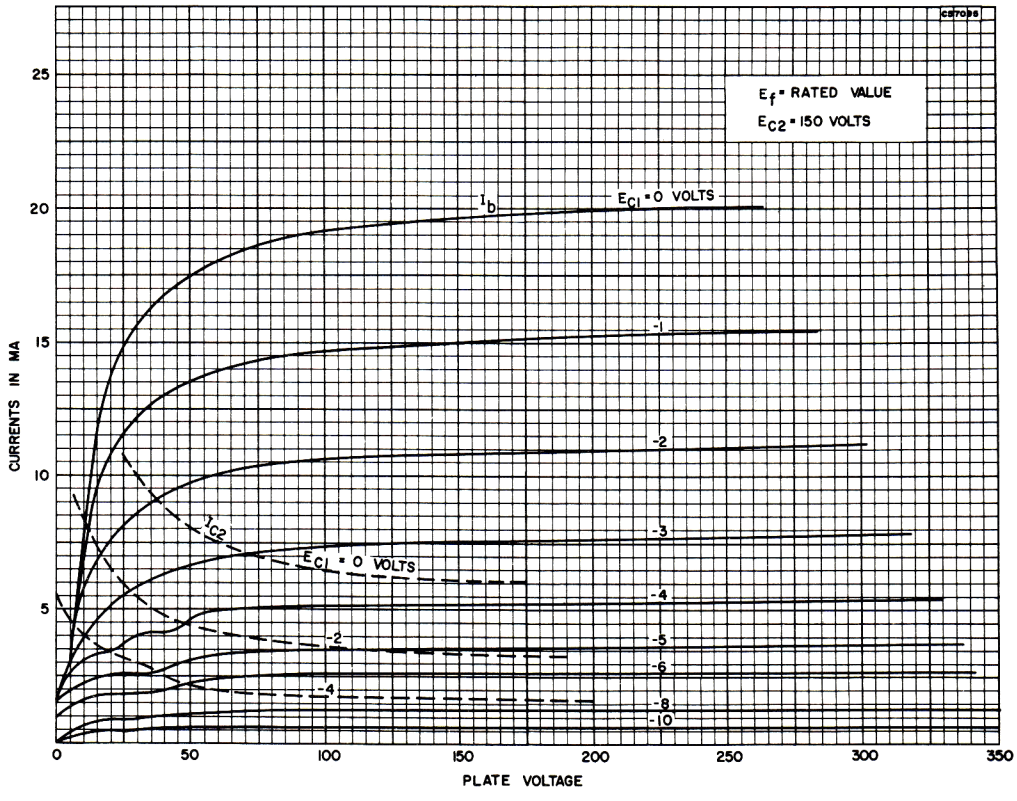
When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

*"A Method of Neutralizing IF Amplifier Tubes at 44 Mc by Means of Suppressor Grid Reaction," Sylvania Engineering Information Service, Vol. 3, No. 1, April 1956.

AVERAGE PLATE CHARACTERISTICS

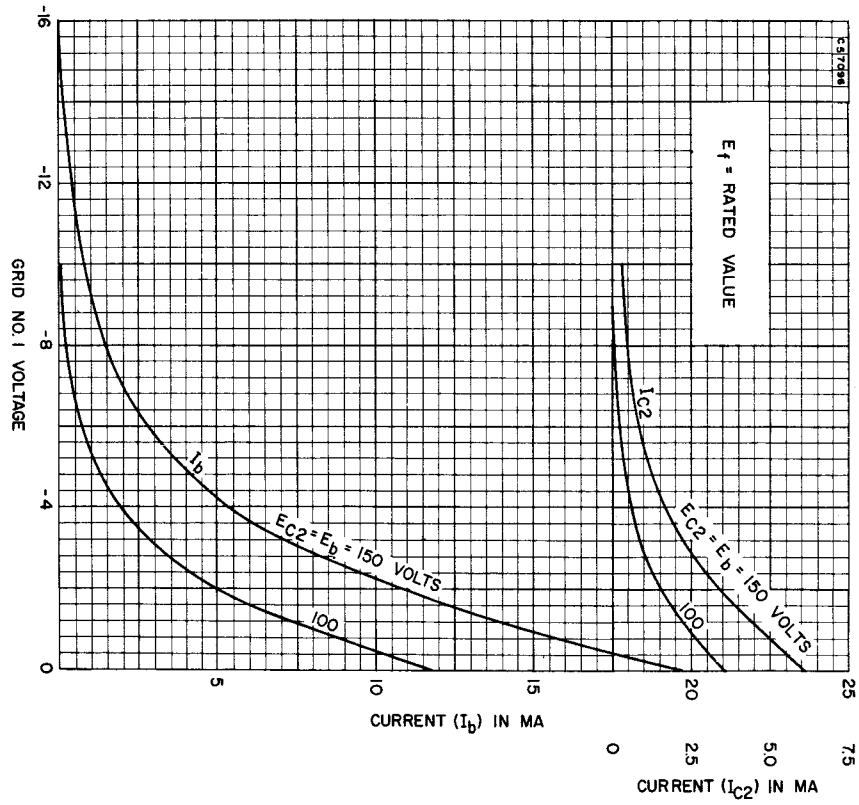


AVERAGE PLATE CHARACTERISTICS

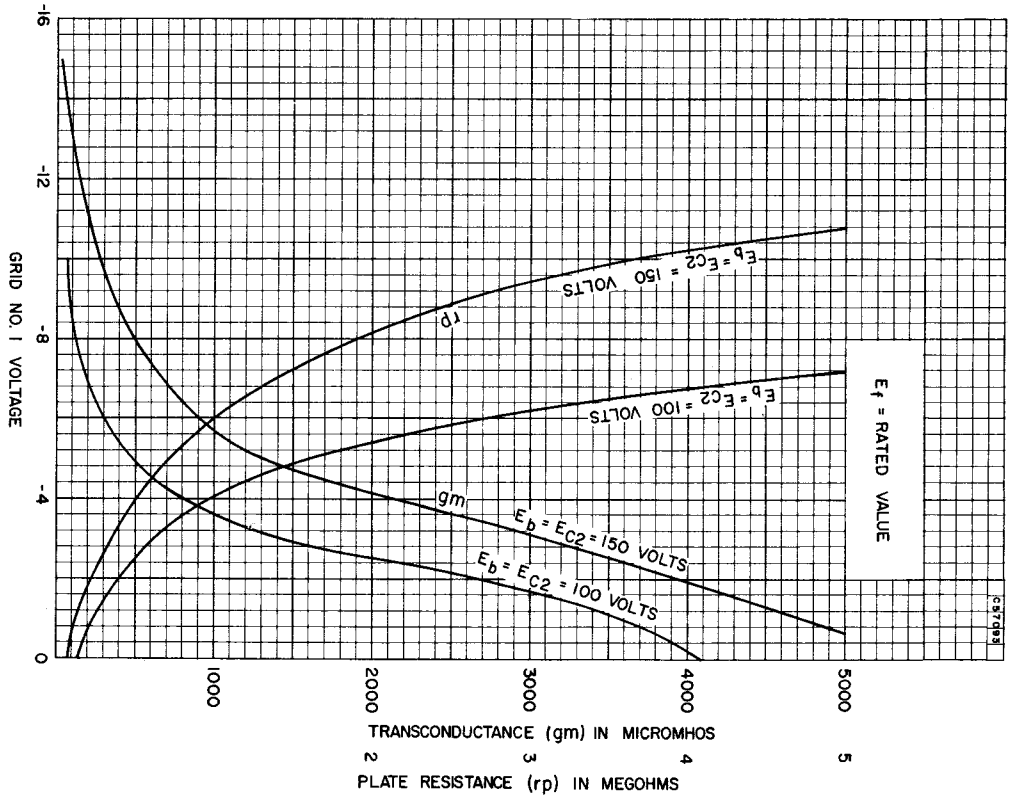


6944

AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



AVERAGE TRANSFER CHARACTERISTICS
(Pentode Connected)



MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-3
Basing	8DL
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250	C°
Altitude[2]	80,000	Ft.
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16}	nvt
Dose Rate (neutrons/sq. cm/sec.)	10^{12}	nv

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3	V
Heater Current	350	mA

DIRECT INTERELECTRODE CAPACITANCES (Shielded)[4]

Grid No. 1 to Plate	0.13 μμf	Max.
Input	5.0 μμf	
Output	5.5 μμf	

RATINGS[1] (Absolute Maximum)

Heater Voltage[3]	6.3 (−12, + 10%)	V
Plate Voltage	250	Vdc
Peak-Plate Forward Voltage[5]	360	v
Grid No. 2 Voltage	150	Vdc
Plate Dissipation	3.0	W
Grid No. 2 Dissipation	0.33	W
Cathode Current	40	mAdc
DC Grid No. 1 Voltage		
Positive Value	0	Vdc
Negative Value	55	Vdc
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	200	v
Heater Negative with Respect to Cathode	200	v
Grid No. 1 Circuit Resistance	0.5	Meg

AVERAGE CHARACTERISTICS

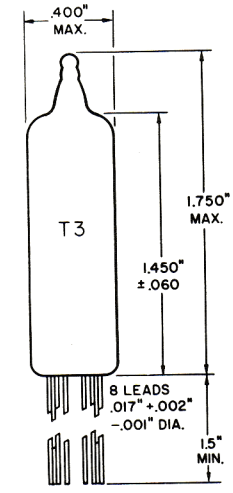
	Triode Connected	Pentode Connected	
Plate Voltage	100	100	Vdc
Grid No. 2 Voltage	100	100	Vdc
Cathode Bias Resistor	270	270	Ohms
Plate Current	26	25	mAdc
Grid No. 2 Current	—	1.5	mAdc
Transconductance	3700	3500	μmhos
Amplification Factor	5.0	—	
Plate Resistance (Approx.)	1500	20,000	Ohms
Ec1 for Ib = 35 μa Max.		−40	Vdc

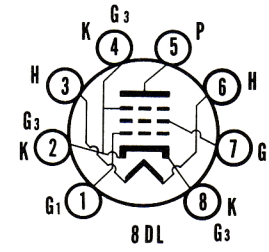
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6945 is a beam power pentode designed specifically for guided missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6945 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
Sylvania Electric Products Inc.

6945

CHARACTERISTICS AND TYPICAL OPERATION

	Triode Connected		Pentode Connected	
Class A1 Amplifier (Single Tube)				
Plate Voltage	150	250	150	Volts
Grid No. 2 Voltage	—	—	110	Volts
Cathode Resistor	680	2700	470	Ohms
Peak AF Grid No. 1 Voltage	16.3	38.2	10.6	Volts
Zero-Signal Plate Current	23.8	14.2	21.5	Ma
Max.-Signal Plate Current	25.3	15.5	20.5	Ma
Zero-Signal Grid No. 2 Current	—	—	0.8	Ma
Max.-Signal Grid No. 2 Current	—	—	3.23	Ma
Load Resistance	2200	6000	7000	Ohms
Max.-Signal Power Output	0.43	0.94	1.22	Watts
Total Harmonic Distortion (Approx.)	11.0	16.7	11.0	Percent

TWO TUBES IN PUSH-PULL

	Class A1		Class AB2	
Plate Voltage	150	200	185	Volts
Grid No. 2 Voltage	110	125	110	Volts
Grid No. 1 Voltage	—	—	−15	Volts
Cathode Resistor	270	560	—	Ohms
Peak AF Grid to Grid Voltage	21.2	39.6	31.2	Volts
Zero-Signal Plate Current	37.5	27.0	26.7	Ma
Max.-Signal Plate Current	38.0	31.6	46.0	Ma
Zero-Signal Grid No. 2 Current	1.35	0.8	0.67	Ma
Max.-Signal Grid No. 2 Current	4.67	4.30	5.90	Ma
Load Resistance (Plate to Plate)	12,000	13,000	10,000	Ohms
Max.-Signal Power Output	2.42	3.41	4.76	Watts
Total Harmonic Distortion (Approx.)	4.1	4.9	1.02	Percent

NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltages (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulations of the heater voltage to its center rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *External shield No. 318 connected to cathode.*
5. *MIL-E-1D Par. 6.5.1.1 does not apply. Peak voltage shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage	6.3 V	Grid No. 2 Voltage	100 Vdc
Plate Voltage	100 Vdc	Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1	0 V
Grid No. 1 Voltage	0 V	Cathode Resistor MIL-E-1 Par. 3.2.26.1	270 Ohms

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	330	—	350	—	370	mA
4.10.15	Heater-Cathode Leakage	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	10	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	10	μAdc
4.10.6.1	Grid Current:							
	Rg1 = 0.5 Meg	0.65	0	—	—	—	−1.0	μAdc
4.10.4.1	Plate Current (1): ALD = 5.2	—	—	22.8	25	27.2	—	mAdc
4.10.4.1	Plate Current (1):	0.65	19	—	—	—	31	mAdc
4.10.4.1	Plate Current (2):							
	Ec1 = −40 Vdc; Rk = 0 Ohms	0.65	—	—	—	—	35	μAdc
4.10.16.1	Power Output (1): Po							
	Esig = 6.4 Vac; Rp = 3000 Ohms; Ck = 1000 μf	0.65	0.50	—	0.80	—	—	W
4.7.5	Continuity and Shorts (Inoperatives):	0.4	—	—	—	—	—	
4.9.1.1	Mechanical:							
	Envelope JEDEC 3-3	—	—	—	—	—	—	

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes:	2.5	—	—	—	—	—	
	Eg1-all = −100 V	—	100	—	—	—	—	Meg
	Ep-all = −300 V	—	100	—	—	—	—	Meg
	Eg2-all = −200 V	—	100	—	—	—	—	Meg
4.10.9	Transconductance (1): ADL = 600 Sm	—	—	3240	3500	3760	—	μmhos
4.10.9	Transconductance (1):	2.5	2900	—	—	—	4100	μmhos
4.10.9	Transconductance (2):							
	Ef = 5.5 V	2.5	—	—	—	—	15	%
4.10.4.3	Screen Grid Current:	2.5	—	—	1.5	—	3.0	mAdc
4.10.6.2	Grid Emission (Ic1): Notes 3 and 4							
	Ef = 7.5 V; Ec1 = −40 Vdc; Rg1 = 0.5 Meg; RK = 0	2.5	0	—	—	—	−2.0	μAdc
4.10.3.2	AF Noise: Note 5							
	Esig. (Cal.) = 150 mVac; Ec1 = −7.2 Vdc; Rg1 = 0.5 Meg; Rg2 = 0.1 Meg; Rp = 2000 Ohms; Rk = 0;							
	Cg2 = 4 μf	2.5	—	—	—	—	—	
4.10.11.1	Amplification Factor: Note 6	6.5	4.0	—	5.0	—	6.0	
4.10.9	Transconductance (3): Note 6	6.5	3200	—	3700	—	4100	μmhos
4.10.4.1	Plate Current (3): Note 6	6.5	20	—	26	—	32	mAdc
----	Hum: Note 7							
	Ef =6.3 Vac @ 400 cps;							
	Eb = Ec1 = Ec2 = 0; Rk = 1000 Ohms	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Note 8	6.5	—	—	—	—	25	Secs.
4.10.10	Plate Resistance	6.5	.013	—	.020	—	—	Meg
4.10.14	Capacitance: Shield No. 318	6.5	—	—	—	—	—	
	Cg1p	—	—	—	—	—	0.13	μμf
	Cin	—	3.8	—	5.0	—	6.2	μμf
	Cout	—	4.5	—	6.0	—	7.5	μμf
4.9.12.1	Low Pressure Voltage Breakdown: Note 9							
	Presure = 21 ±2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1):							
	Rp = 2,000 Ohms; Ck = 1000 μf;							
	F = 40 cps; G = 10	1.0	—	—	—	—	60	mVac
----	White Noise Vibration: Notes 10 and 11							
	Rp = 2,000 Ohms; Ck = 1000 μf	2.5	—	—	—	300	550	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	40	60	mVac
Degradation Rate Acceptance Tests, Note 4								
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 12							
	Hammer Angle = 30°;	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 9 and 13							
	G = 10; Variable Frequency;	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points:							
	Vibration (1):	—	—	—	—	—	180	mVac
	Heater-Cathode Leakage							
	Ehk = +100 Vdc	—	—	—	—	—	15	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	15	μAdc
	Change in Transconductance (1) of Individual Tubes Δ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain	4.0	—	—	—	—	—	
Acceptance Life Tests, Note 4								
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 14							
	Ef = 7.0 v; 1 min. on, 4 min. off;							
	Ehk = 140 Vac; Ec1 = Ec2 = Eb = 0	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 14							
	Ef = 10 V; Ehk = +200 Vdc; Rhk = 0;							
	10 secs. on, 4 min. off;	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 15							
	Eb = 250 Vdc; Ec2 = 150 Vdc; Ehk = +200 Vdc;							
	Rg1 = 0.5 Meg; TA = Room; Rk = 1700 Ohms	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points:							
	Change in Transconductance (1) of Individual Tubes Δ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 16							
	Ebb = 250 Vdc; Tie Grid No. 2 to Plate; Rk = 820 Ohms; Rp = 5100 Ohms; Rg1 = 0.5 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Transconductance (1)	1.0	2600	—	—	—	—	μmhos
	Grid Current	2.5	0	—	—	—	−1.0	μAdc
	Heater-Cathode Current: Ihk	0.65	—	—	—	—	40	μAdc
	Electrode Insulation:	6.5		—	—	—	—	
	Rg1-all	—	200	—	—	—	—	Meg
	Rg2-all	—	200	—	—	—	—	Meg
	Rp-all	—	200	—	—	—	—	Meg

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	LOT ACCEPTANCE LIMITS (1) MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	FAILURE RATE CLASS (3) LIMITS MAX.	Units
	Acceptance Life Tests, Note 4 (Cont'd.)					
4.11.5	Intermittent Life Test: Notes 17 and 18					
	Survival Rate Life conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points: (200 Hours)					
	Inoperatives: Note 19	—	—	—	—	
	Grid Current:	0	−1.0	0	−1.5	μAdc
	Heater Current	330	380	320	390	mA
	Change in Transconductance (1) of Individual Tubes; △ Sm/t	—	20	—	25	%
	Transconductance (2): △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage Ehk = ±100 Vdc	—	40	—	60	μAdc
	Insulation of Electrodes					
	g1-all	200	—	25	—	Megohms
	p-all	200	—	25	—	Megohms
	g2-all	200	—	25	—	Megohms
	Transconductance (1) Average Change Avg. △ Sm/t					

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
----	Individual Lot Acceptance	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 18	
	Failure Rates Class 1 Inoperatives:	5
	Failure Rate Class 2 Combined defectives to Limits (1) Including Inoperatives:	16
	Failure Rate Class 3 Combined defectives to F.R. 3 Limits Including Inoperatives:	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Ec2	Rk/k	Rg1
V	Vdc	Vdc	Vdc	ohms	Meg
7.5	250	0	150	1700	0.5

4. Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

5: The rejection level shall be set at the VU meter reading obtained during calibration.

6: Triode connection — Tie grid #2 to plate.

7. Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

8: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

9: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

10: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall

ACCEPTANCE CRITERIA NOTES (Continued)

be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

11: For variables sampling procedure, use MIL-E-1, Appendix C, par. 20.2.4.2.2.

12: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

13: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

14: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

15: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

16: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

17: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

18: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with $n = 40$. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 The Failure Rate Control:

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The Failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

19: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Premium Subminiature Type 6945 is a subminiature beam power audio pentode having a relatively high power sensitivity. It is capable of efficient operation at low supply voltages. It is useful as an audio output, servo-driver or series passing tube in voltage regulator circuits.

The 6945 is also useful in many pulse applications including Class C service at low radio frequencies.

Triode connected the 6945 displays the low mu, high perseverance qualities desirable in servo control circuits. In this application, when utilizing an ac plate supply, precautions should be taken to insure against poor tube and circuit reliability.

Since conduction occurs for only one-half cycle high plate supply voltage is often deemed necessary in order to realize sufficient output. Excessive positive plate voltage, however, causes an appreciable increase in secondary emission. In addition, presence of the negative half-cycle of plate encourages primary emission by the plate and grids.

The effects of back emission can be minimized by (1) employing a low value grid resistor, (2) inserting series diodes, such as the Sylvania 5641, in the plate circuits, (3) operate the tubes conservatively with respect to supply voltage, peak currents, element dissipation and bulb temperature. Back emission approximates an exponential curve with increasing plate voltage swing and plate disc dissipation. For further discussion the reader is referred to the frontal section of this manual or "Effects of AC Plate Voltages on Tube Performance," Sylvania Engineering Information Service, Vol. 1, No. 10, May 1954.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. In addition, vibrational output when the tube is subjected to wide band (White Noise) vibration is held to a very low value. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

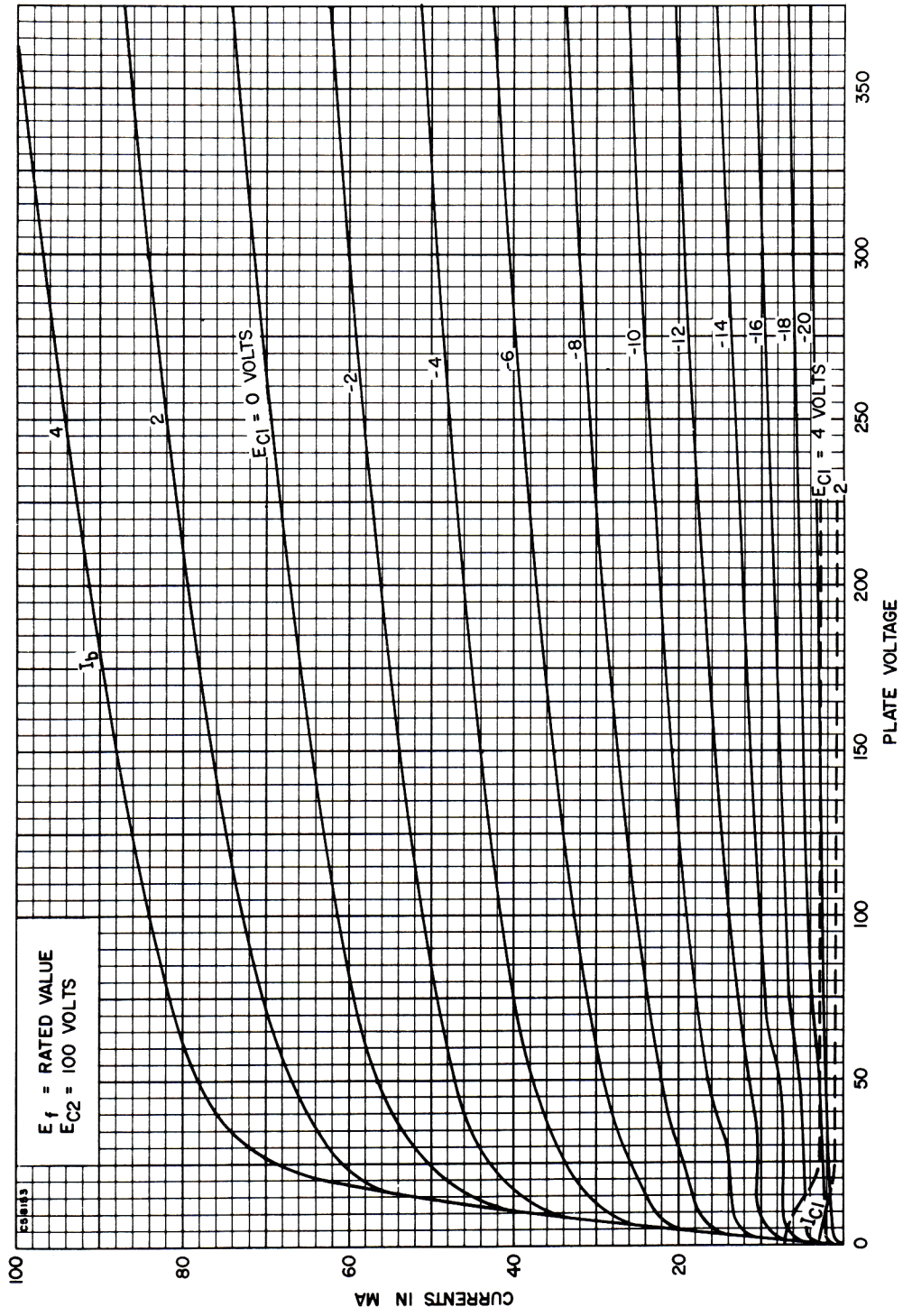
Tube durability under extreme vibration for extended periods is assured by more stringent fatigue testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibrational test is included in the frontal section of this manual.

The 6945 is manufactured and inspected to meet the applicable specification for reliability. Life expectance is described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

AVERAGE PLATE CHARACTERISTICS



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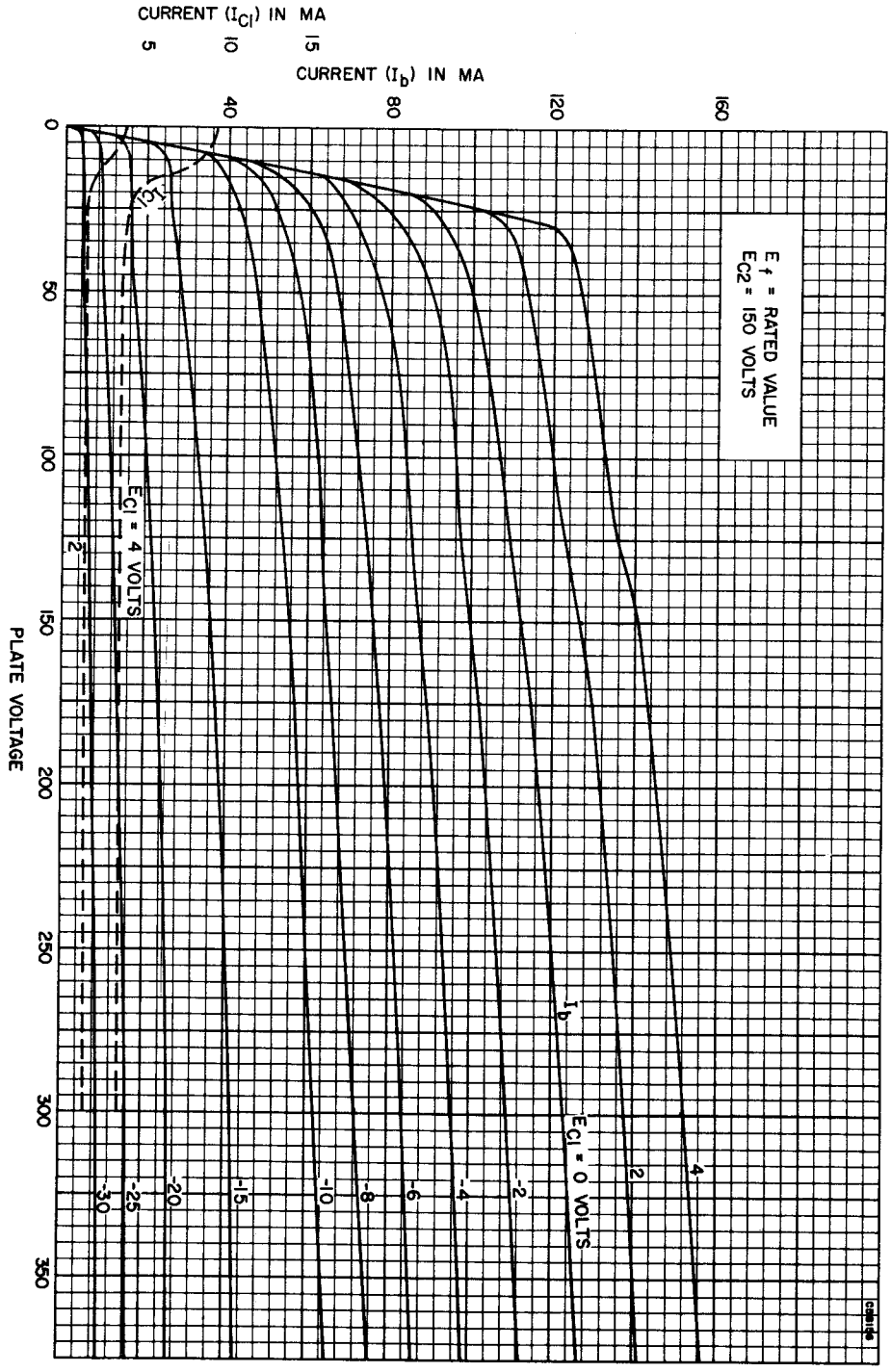
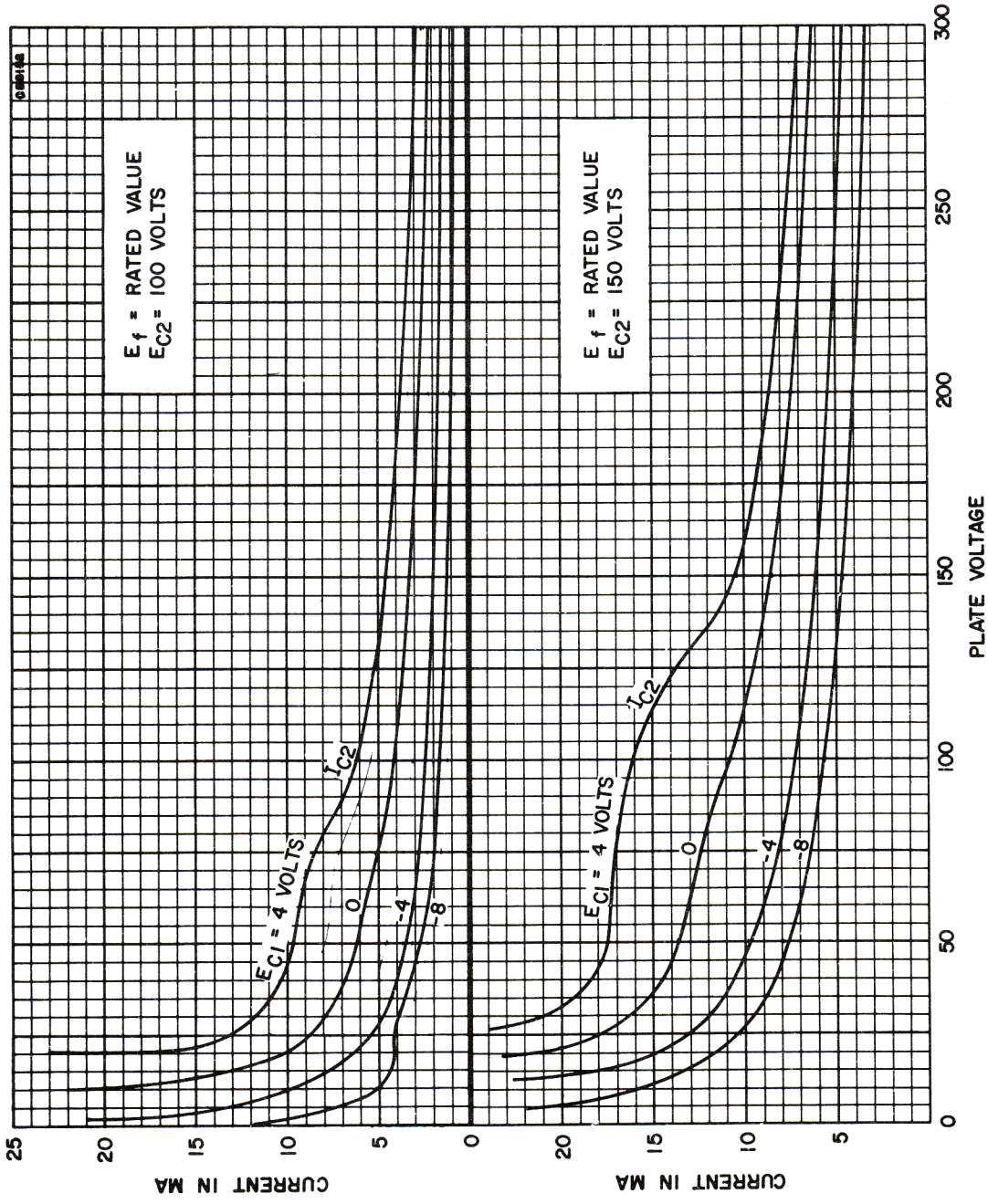
AVERAGE PLATE CHARACTERISTICS



AVERAGE SCREEN CHARACTERISTICS



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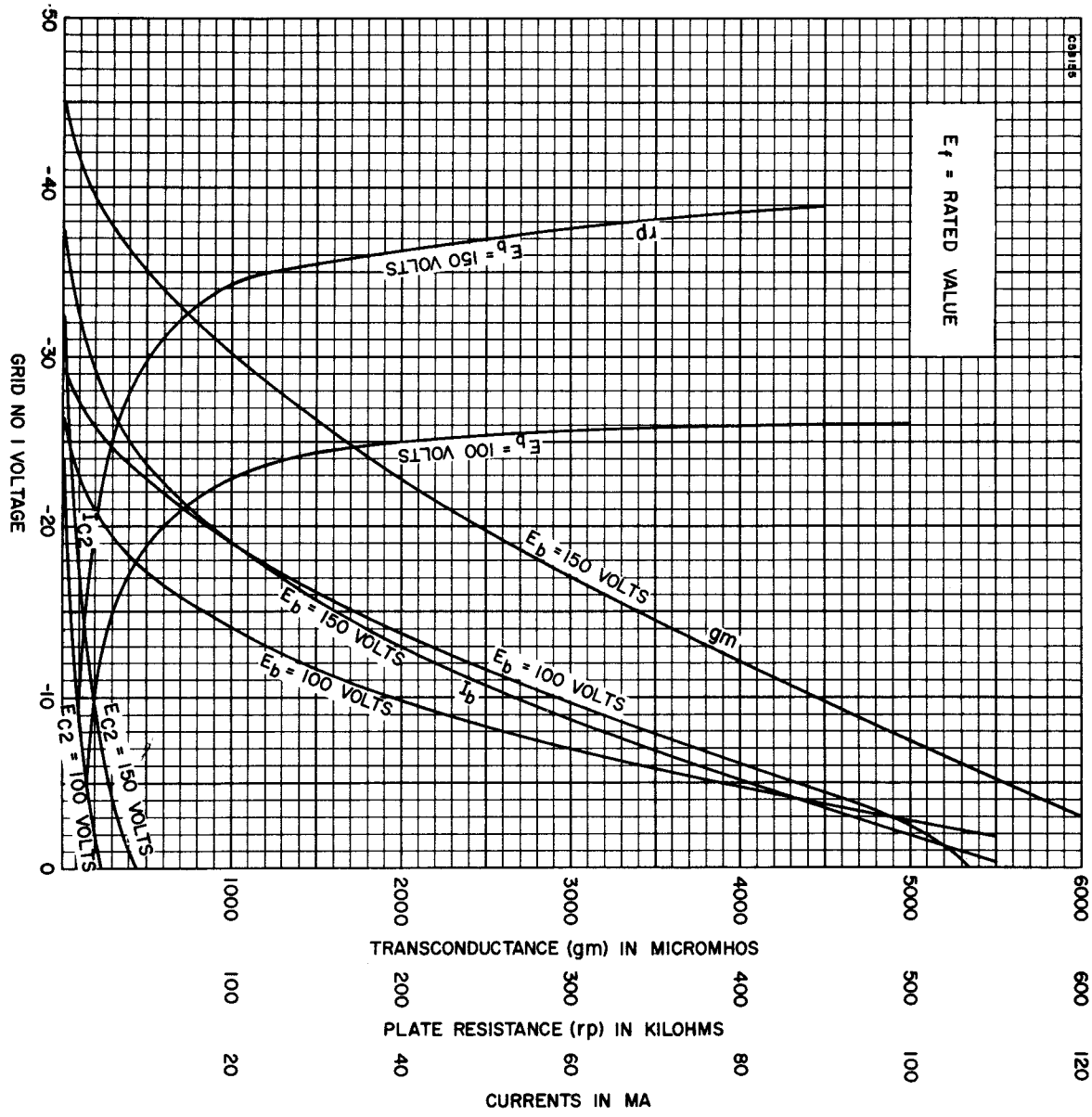
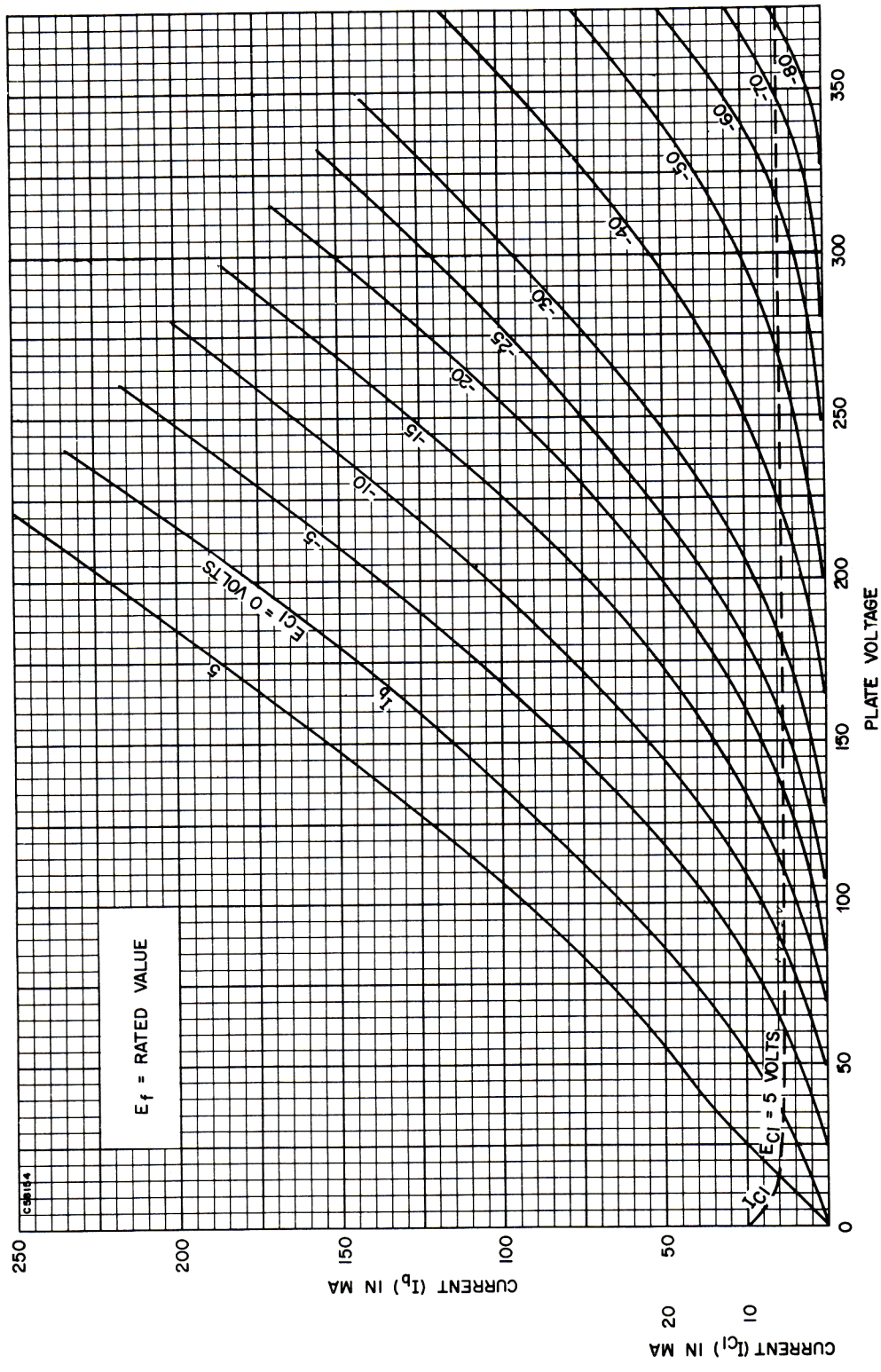
AVERAGE TRANSFER CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS
(TRIODE CONNECTED)



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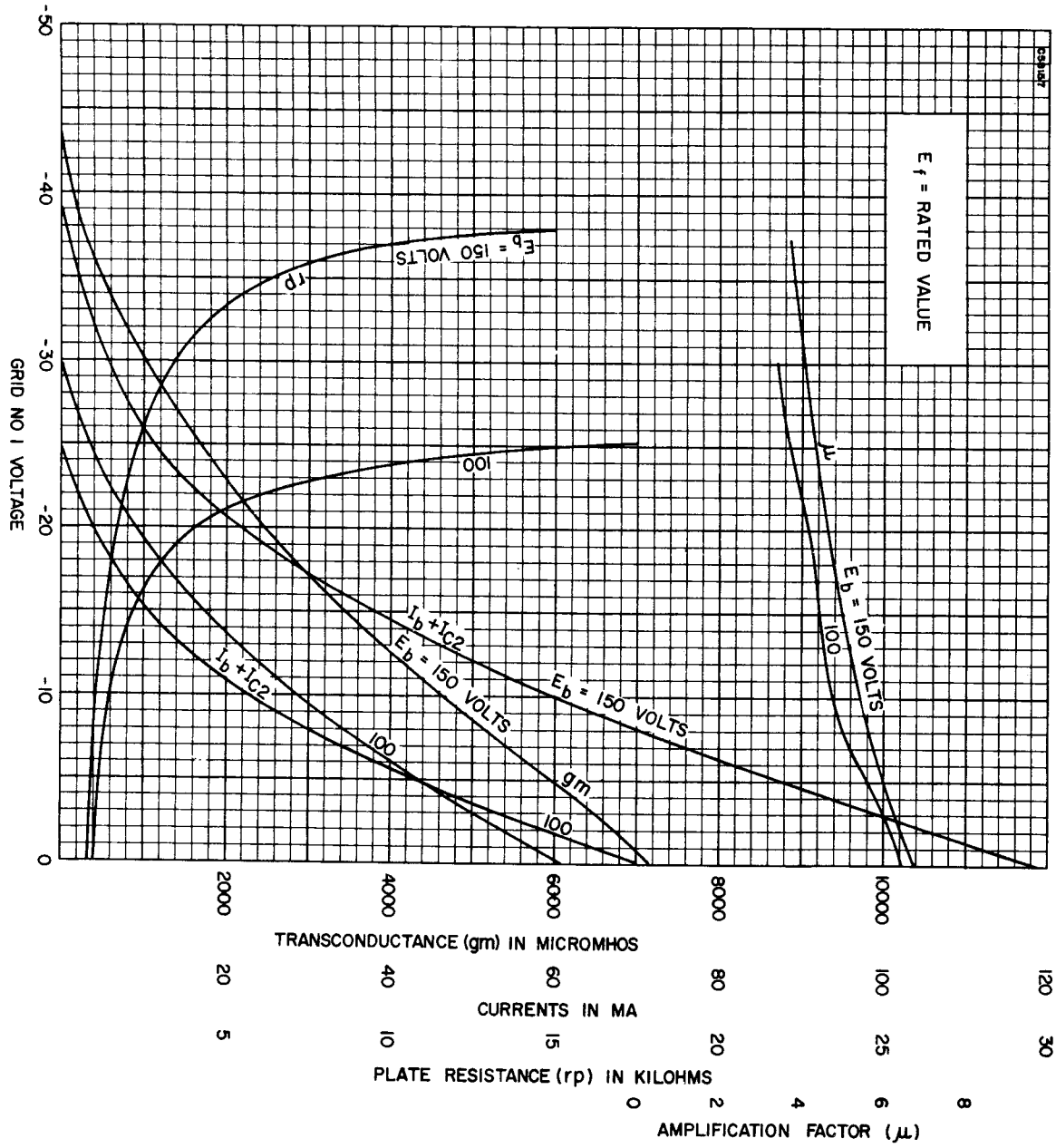
AVERAGE TRANSFER CHARACTERISTICS
(TRIODE CONNECTED)



MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DK
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250 °C	
Altitude[2]	80,000 Ft.	
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16} nvt	
Dose Rate (neutrons/sq. cm/sec.)	10^{12} nv	

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V
Heater Current	175 mA

DIRECT INTERELECTRODE CAPACITANCES (Unshielded)

Grid to Plate	1.0 μμf
Input	1.6 μμf
Output	0.75 μμf

RATINGS[1] (Absolute Maximum)

Heater Voltage[3]	6.3 (−12, + 10%) V
Plate Voltage	250 Vdc
Peak-Plate Forward Voltage[4]	360 v
Plate Dissipation	1.5 W
Cathode Current	15 mAdc
DC Grid Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid Circuit Resistance	1.0 Meg

CHARACTERISTICS

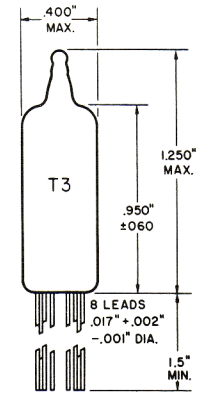
Plate Voltage	100 Vdc
Cathode Resistor	270 Ohms
Plate Current	9.0 mAdc
Amplification Factor	16.5
Transconductance	3800 μmhos
Grid Voltage for Ib = 150 μAdc Max.	−11.5 Vdc
Grid Voltage for Ib = 5 μAdc Min.	−8.5 Vdc

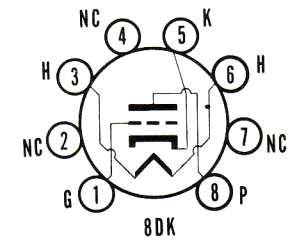
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6946 is a general purpose medium-mu triode designed specifically for guided missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6946 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
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NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltage (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center-rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *MIL-E-1D Par. 6.51.1 does not apply. Peak voltage shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage . . . . . 6.3 V
Plate Voltage . . . . . 100 Vdc
Grid Voltage . . . . . 0 V
Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1 . 0 V
Cathode Resistor MIL-E-1 Par. 3.2.26.1 . . . . 270 Ohms

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	165	—	175	—	185	mA
4.10.15	Heater-Cathode Leakage	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	5.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	5.0	μAdc
4.10.6.1	Grid Current:							
	Rg = 1.0 Meg	0.65	0	—	—	—	−0.4	μAdc
4.10.4.1	Plate Current (1): ALD = 2.6	—	—	7.9	9.0	10.1	—	mAdc
4.10.4.1	Plate Current (1):	0.65	6.0	—	—	—	12.0	mAdc
4.10.4.1	Plate Current (2):							
	Ec = −11.5 Vdc; Rk = 0 Ohms	0.65	—	—	—	—	150	uAdc
4.10.9	Transconductance (1): ALD = 690 Sm	—	—	3500	3800	4100	—	μmhos
4.10.9	Transconductance (1): Sm	0.65	3000	—	—	—	4600	μmhos
4.7.5	Continuity and Shorts (Inoperatives)	0.4	—	—	—	—	—	
4.9.1.1	Mechanical:							
	Envelope JEDEC 3-11	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes	2.5	—	—	—	—	—	
	Eg-all = −100 V	—	500	—	—	—	—	Meg
	Ep-all = −300 V	—	500	—	—	—	—	Meg
4.10.9	Transconductance (2):							
	Ef = −5.5 V △ Sm	2.5	—	—	—	—	15	%
4.10.4.1	Plate Current (3):							
	Ec1 = −8.5; Rk = 0	2.5	5.0	—	—	—	—	μAdc
4.10.6.2	Grid Emmission (Ic1): Notes 3 & 4							
	Ef = 7.5 V; Ec = −11.5 Vdc;							
	Rg = 1.0 Meg; Rk = 0 Ohms	2.5	0	—	—	—	−0.5	μAdc
4.10.3.2	AF Noise: Note 5							
	Esig. (Cal.) = 50 mVac; Ec = −4							
	Vdc; Rg = 0.1 Meg; Rp = 0.01 Meg;							
	Rk = 0 Ohms	2.5	—	—	—	—	—	
4.10.11.1	Amplification Factor	6.5	14.0	—	16.5	—	19.0	
4.10.7.5	Pulse Emission: Note 6							
	Ef = 6.0 V; e pulse = 50 v;							
	tp = 25 μsec; prr = 200 pps	6.5	—	—	—	—	—	
	ik	—	200	—	—	—	—	ma
	△ ik/tp	—	—	—	—	—	20	%
----	Hum: Note 7							
	Ef = 6.3 Vac @ 400 cps; Eb = Ec = 0;							
	Rk = .005 Meg	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Note 8	6.5	—	—	—	—	20	secs
4.10.14	Capacitance: No Shield	6.5	—	—	—	—	—	
	Cgp	—	0.72	—	1.0	—	1.22	μμf
	Cin	—	1.2	—	1.6	—	2.0	μμf
	Cout	—	0.55	—	.75	—	0.93	μμf
4.9.12.1	Low Pressure Voltage Breakdown: Note 9							
	Pressure = 21 ±2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1):							
	Rp = 10,000 Ohms; Ck = 1000 μf;							
	F = 40 cps; G = 10	1.0	—	—	—	—	25	mVac
----	White Noise Vibration: Notes 10 & 11							
	Rp = 10,000 Ohms; Ck = 1000 μf	2.5	—	—	—	30	60	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	5	10	mVac

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Degradation Rate Acceptance Tests, Note 4								
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 12 Hammer Angle = 30°	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 9 and 13 G = 10; Variable Frequency	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points							
	Vibration (1):	—	—	—	—	—	75	mVac
	Heater-Cathode Leakage							
	Ehk = +100 Vdc	—	—	—	—	—	15	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	15	μAdc
	Change in Transconductance (1)							
	of Individual Tubes △ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain:	4.0	—	—	—	—	—	
Acceptance Life Tests, Note 4								
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 14 Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec = Eb = 0 V	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 14 Ef = 10 V; Ehk = +200 Vdc; Rhk = 0; 10 secs. on, 4 min. off	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 15 Eb = 250 Vdc; Ehk = +200 Vdc; Rg = 1.0 Meg; TA = Room; Rk = 200 Ohms	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points: Change in Transconductance (1) of Individual Tubes △ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 16 Ebb = 250 Vdc; Rk = 510 Ohms; Rp = 0.01 Meg; Rg = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Grid Current	2.5	0	—	—	—	−0.1	μAdc
	Heater-Cathode Current: Ihk	0.65	—	—	—	—	10	μAdc
	Electrode Insulation:	6.5	—	—	—	—	—	
	Rp-all	—	200	—	—	—	—	Meg
	Rg1-all	—	200	—	—	—	—	Meg

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	MAX.	Units
4.11.5	Intermittent Life Test: Notes 17 & 18 Survival Rate Life Conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points (200 Hours)					
	Inoperatives: Note 19	—	—	—	—	
	Grid Current	0	−1.0	0	−1.5	μAdc
	Heater Current	165	190	160	195	mA
	Change in Transconductance (1) of					
	Individual Tubes; △ Sm/t	—	20	—	25	%
	Transconductance (2): △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage					
	Ehk = ±100 Vdc	—	10	—	15	μAdc
	Insulation of Electrodes					
	p-all	200	—	25	—	Meg
	g-all	200	—	25	—	Meg
	Transconductance (1) Average Change					
	Avg. △ Sm/t	—	15	—	—	%

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
Acceptance Life Tests, Note 4, (Cont'd.)		
----	Individual Lot Acceptance	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 18	
	Failure Rate Class 1	
	Inoperatives:	5
	Failure Rate Class 2	
	Combined defectives to Limits (1)	
	Including Inoperatives:	16
	Failure Rate Class 3	
	Combined defectives to F. R. 3 Limits	
	Including Inoperatives:	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Rk/k	Rg1
V	Vdc	Vdc	ohms	Meg
7.5	250	0	2000	1.0

4: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

5: The rejection level shall be set at the VU meter reading obtained during calibration.

6: The pulse shall be applied to the plate and grid tied together. It shall be a square wave meeting the pulse shape requirement of MIL-E-1, par. 4.10.7.5, and in addition, the maximum amplitude shall occur within the first 20% of tp. The pulse shall be applied by means of a driving circuit which produces the specified pulse voltage directly at the plate and grid terminals with respect to cathode.

Peak currents shall be measured by means of a high impedance oscilloscope or equivalent device connected across a 1.0 ohm cathode resistor whose value is known to an accuracy of 1% The specified limit, ik, refers to the maximum of the pulse amplitude. The variation of the output pulse amplitude, ik (tp), between 2% tp and 80% tp shall not exceed the specified limit where tp is as defined in MIL-E-1, par. 4.10.7.5.

7. Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

8: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

9: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105 Sample Size Code Letter F shall apply.

10: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

11: For variables sampling procedure, use MIL-E-1, Appendix C, par. 20.2.4.2.2.

12: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

13: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

14: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

15: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

16: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

ACCEPTANCE CRITERIA NOTES (Continued)

17: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

18: 1.0 **Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 **The Failure Rate Control:**

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The Failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

19: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Sylvania Premium Subminiature Type 6946 is a medium-mu triode designed specifically for guided missile service. It is especially well suited to a wide variety of low-frequency applications. These include resistance coupled amplifiers, sync clippers, blocking oscillators and multivibrators. Resistance-coupled amplifier data is shown in the accompanying table and circuit.

The 6946 may also be used as a v h f oscillator or Class-C amplifier. A curve of power output vs frequency at a constant input is shown in Figure 1 for oscillator service. Figure 2 shows the variation of input resistance with frequency.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. In addition, vibrational output when the tube is subjected to wide band (White Noise) vibration is held to a very low value. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown

APPLICATION DATA (Continued)

for both peak and rms output. A further discussion of the white noise vibrational test is included in the frontal section of this manual.

The 6946 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

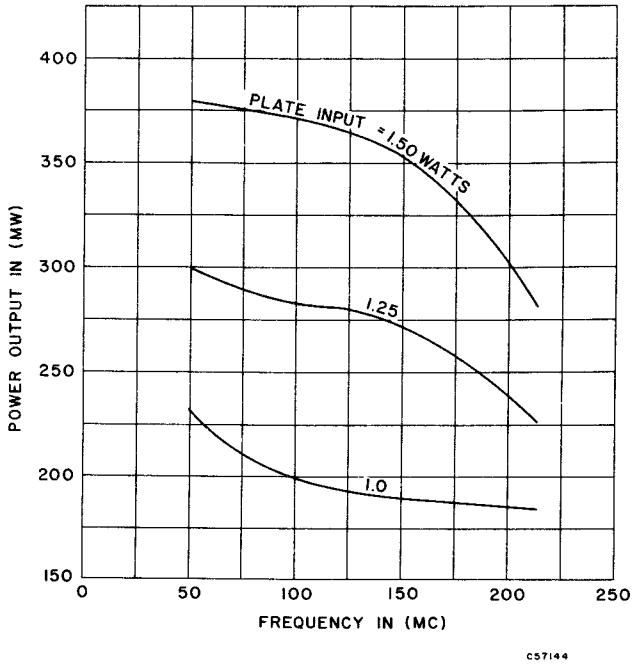


Figure 1—Oscillator performance curve.

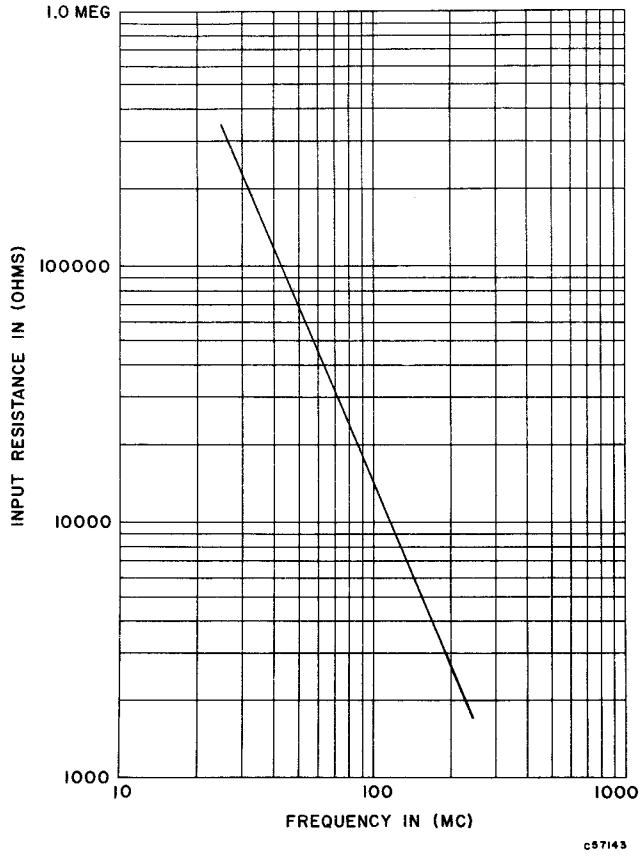


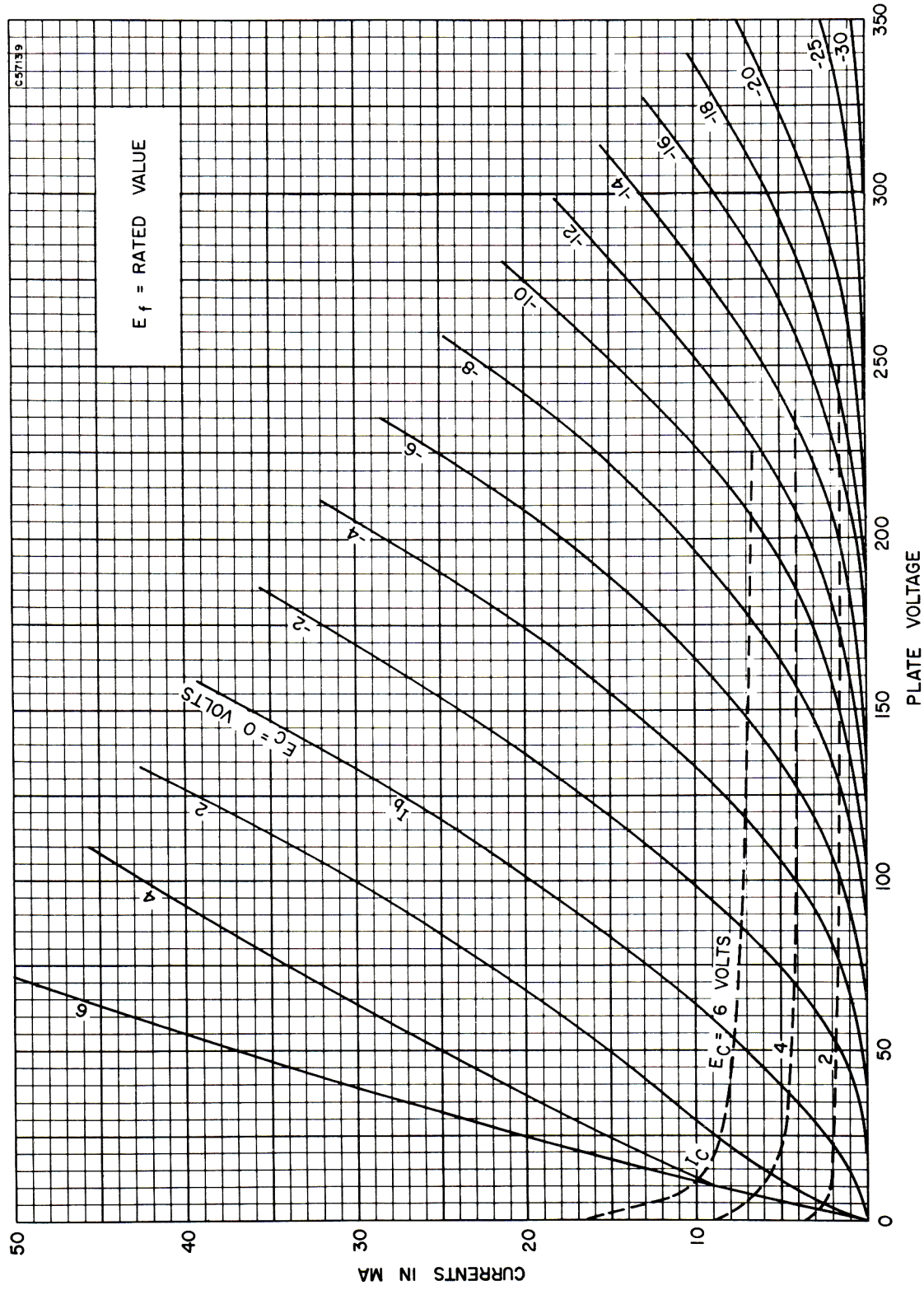
Figure 2—Input resistance vs frequency.

RESISTANCE COUPLED AMPLIFIER DATA

	Ebb = 100 Volts						Ebb = 150 Volts						Ebb = 250 Volts					
Rb (megohms)	.047		0.10		0.27		0.10		0.27		0.47		0.10		0.27		0.47	
Rcf (megohms)	.10	.27	.10	.47	.27	.47	.10	.47	.27	.47	.10	.27	.10	.47	.27	.47	.10	.27
Rk (ohms)	2200	2200	3300	4700	10,000	12,000	2700	4700	8200	10,000	8200	12,000	3300	4700	8200	12,000	6800	10,000
Ib (ma)	1.04	1.04	.61	.55	.23	.22	.96	.82	.37	.35	.25	.22	1.55	1.30	0.63	0.52	.43	.40
Ec (volts)	−2.29	−2.29	−2.01	−1.17	−2.32	−2.68	−2.59	−3.86	−3.03	−3.52	−2.03	−2.60	−5.12	−6.10	−5.16	−6.23	−2.92	−4.00
Eb (volts)	49	49	37	44	35	37	51	64	47	51	32	46	90	114	75	104	45	58
Esig (volts RMS)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Eout (volts RMS)	1.12	1.19	1.13	1.19	.92	.95	1.04	1.05	1.00	1.00	.87	.94	1.07	1.08	1.06	1.04	0.97	1.03
Gain	11.2	11.9	11.3	11.9	9.25	9.50	10.4	10.5	10.0	10.0	8.70	9.40	10.7	10.8	10.6	10.4	9.7	10.3
% Distortion	0.34	0.33	0.34	0.37	0.37	0.36	0.36	0.39	0.39	0.37	0.36	0.46	0.39	0.47	0.43	0.50	0.32	0.40
Esig (volts RMS)*	1.15	1.16	0.94	1.38	1.34	1.60	1.54	2.34	1.96	2.32	0.92	1.64	2.60	3.80	3.10	3.93	1.43	2.68
Eout (volts RMS)	11.2	13.8	10.6	16.3	12.3	15.2	16.0	24.5	19.6	23.2	7.95	15.4	27.4	41.0	32.9	40.0	13.9	27.2
Gain	9.70	11.9	11.3	11.8	9.20	9.50	10.4	10.4	10.0	10.0	8.65	9.40	10.5	10.8	10.6	10.2	9.7	10.2
% Distortion	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

*Maximum signal for 5% distortion or ⅛ microampere grid current.

AVERAGE PLATE CHARACTERISTICS



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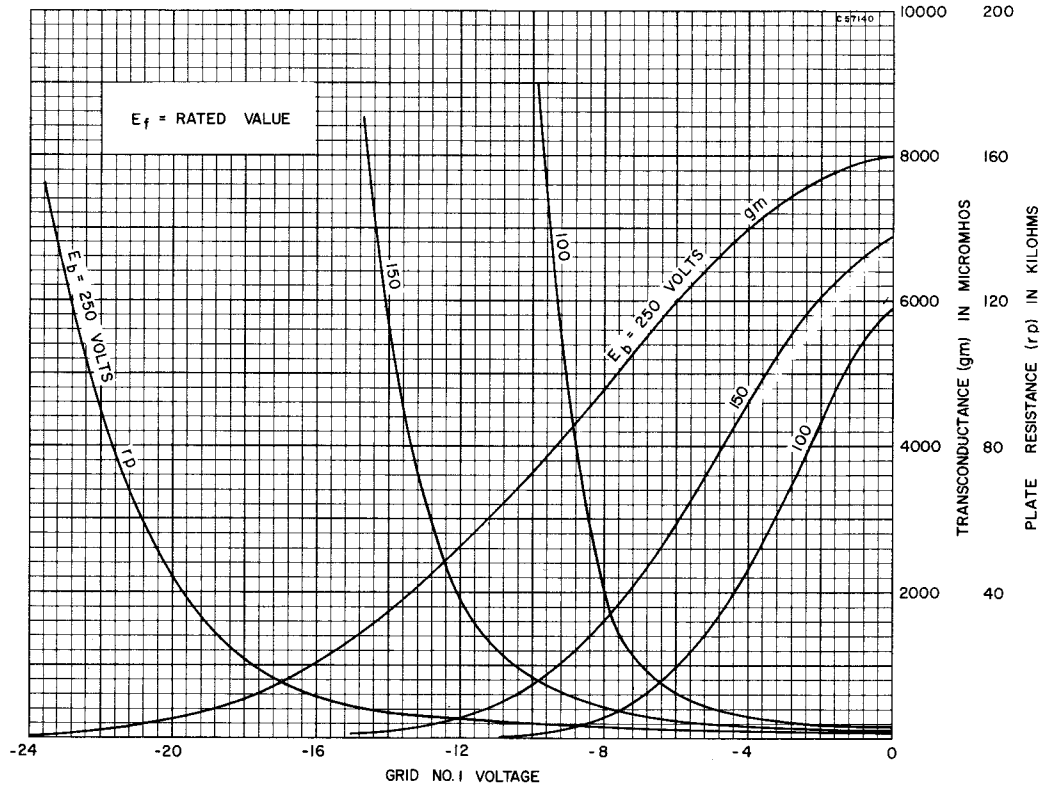
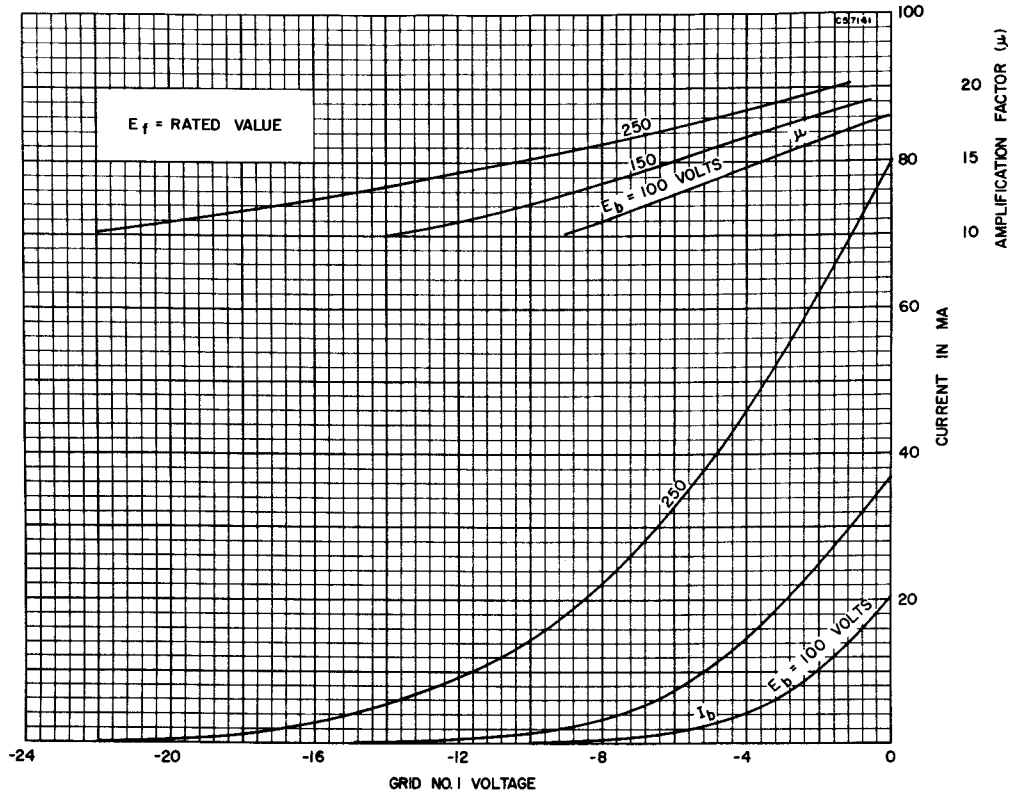
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DG
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250 °C	
Altitude[2]	80,000 Ft.	
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16} nvt	
Dose Rate (neutrons/sq. cm/sec.)	10^{12} nv	

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V	
Heater Current	350 mA	

DIRECT INTERELECTRODE CAPACITANCES (Unshielded)

Grid to Plate (Each Section)	1.2 μμf	
Input (Each Section)	1.6 μμf	
Output		
Section No. 1	0.20 μμf	
Section No. 2	0.25 μμf	
Grid to Grid	0.013 μμf	Max.
Plate to Plate	0.45 μμf	Max.

RATINGS[1] (Absolute Maximum — Each Section)

Heater Voltage[3]	6.3 (−12, + 10%) V	
Plate Voltage	250 Vdc	
Peak-Plate Forward Voltage[4]	360 v	
Plate Dissipation	0.75 W	
Plate Current	13 mAdc	
DC Grid Voltage		
Positive Value	0 Vdc	
Negative Value	55 Vdc	
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	200 v	
Heater Negative with Respect to Cathode	200 v	
Grid Circuit Resistance	1.0 Meg	

CHARACTERISTICS (Each Section)

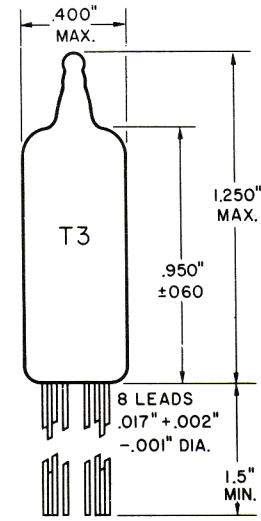
Plate Voltage	150 Vdc	
Cathode Resistor	270 Ohms	
Plate Current	6.5 mAdc	
Amplification Factor	35	
Transconductance	4000 μmhos	
Grid Voltage for Ib = 50 μAdc Max.	−9.0 Vdc	

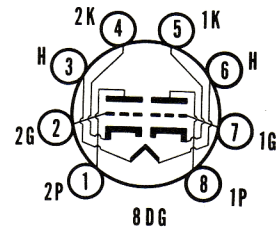
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6947 is a general purpose medium-mu double triode designed specifically for guided-missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6947 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
Sylvania Electric Products Inc.

NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltage (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center-rated value of 6.3 volts. The Min. and Max. values are 5.5 and 6.9 volts respectively.*
4. *MIL-E-1D Par. 6.5.1.1 does not apply. Peak voltage shown should not be exceeded.*

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage . . . . . 6.3 V
Plate Voltage . . . . . 150 Vdc
Grid Voltage . . . . . 0 V
Heater-Cathode Voltage MIL-E-1 Par. 3.2.26.1 . 0 V
Cathode Resistor MIL-E-1 Par. 3.2.26.1 . . . . 270 Ohms

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1.

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Measurements Acceptance Tests, Part 1, Note 1								
4.10.8	Heater Current	0.65	330	—	350	—	370	mA
4.10.5	Heater-Cathode Leakage: Note 3	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	5.0	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	5.0	μAdc
4.10.6.1	Grid Current: Note 3							
	Rg = 1.0 Meg	0.65	0	—	—	—	−0.3	μAdc
4.10.4.1	Plate Current (1): ALD = 2.3: Note 3	—	—	5.7	6.5	7.3	—	mAdc
4.10.4.1	Plate Current (1): Note 3	0.65	4.5	—	—	—	8.5	mAdc
4.10.4.1	Plate Current (2): Note 3							
	Ec = −9.0 Vdc; Rk = 0 Ohms	0.65	—	—	—	—	50	μAdc
4.10.9	Transconductance (1): ALD = 900 Sm Note 3	—	—	3700	4000	4300	—	μmhos
4.10.9	Transconductance (1): Sm: Note 3	0.65	3200	—	—	—	4800	μmhos
4.7.5	Continuity and Shorts (Inoperatives)	0.4	—	—	—	—	—	
4.9.1.1	Mechanical: Envelope JEDEC 3-11	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes: Note 3	2.5	—	—	—	—	—	
	Eg-all = −100 V	—	500	—	—	—	—	Meg
	Ep-all = −300 V	—	500	—	—	—	—	Meg
4.10.4.1	Plate Current (1): Difference							
	Between Sections	2.5	—	—	—	—	1.5	mAdc
4.10.9	Transconductance: Note 3							
	Ef = 5.5 V Δ Sm	2.5	—	—	—	—	15	%
4.10.6.2	Grid Emission: Notes 3, 4, & 5							
	Ef = 7.5 V; Ec = −9.0 Vdc; Rg = 1.0 Meg; Rk = 0 Ohms	2.5	0	—	—	—	−0.5	μAdc
4.10.3.2	AF Noise: Notes 6 and 7							
	Esig. (Cal.) = 65 mVac; Ck = 1000 μf; Rg = 0.1 Meg; Rp = 0.01 Meg; Rk = 135 Ohms	2.5	—	—	—	—	—	
4.10.11.1	Amplification Factor: Note 3	6.5	30	—	35	—	40	
----	Pulse Emission: Notes 3 and 8							
	Ef = 6.0 V; e Pulse = 50 v; tp = 25 μsec; Prr = 200 pps	6.5	—	—	—	—	—	
	ik	—	200	—	—	—	—	mA
	Δ ik/tp	—	—	—	—	—	20	%
----	Hum: Notes 3 and 9							
	Ef = 6.3 Vac @ 400 cps; Rk/k = 0.005 Meg	2.5	—	—	—	—	15	mv pk-pk
----	Operation Time: Notes 3 and 10	6.5	—	—	—	—	20	secs
4.10.14	Capacitance: No Shield	6.5	—	—	—	—	—	
	Cgp; Note 3	—	0.9	—	1.2	—	1.5	μμf
	Cin; Note 3	—	1.2	—	1.6	—	2.0	μμf
	Cout; Section 1	—	0.15	—	0.20	—	0.25	μμf
	Cout; Section 2	—	0.19	—	0.25	—	0.31	μμf
	Cgg	—	—	—	—	—	0.013	μμf
	Cpp	—	—	—	—	—	0.45	μμf
4.9.12.1	Low Pressure Voltage Breakdown: Note 11							
	Pressure = 21±2 mm Hg; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.19.1	Vibration (1):							
	Rp = 10,000 Ohms; Ck = 1000 μf; F = 40 cps; G = 10	1.0	—	—	—	—	25	mVac
----	White Noise Vibration: Notes 3, 12 & 13							
	Rp = 10,000 Ohms; Ck = 1000 μf	2.5	—	—	—	50	150	mv pk-pk
	Peak Acceleration = 15 G	2.5	—	—	—	5	25	mVac

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits — Note 2 Min.	LAL	Bogey	UAL	Max.	Units
Degradation Rate Acceptance Tests, Note 4								
4.9.5.3	Subminiature Lead Fatigue	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Note 14							
	Hammer Angle = 30°	20	—	—	—	—	—	
4.9.20.6	Fatigue: Notes 3, 11, and 15							
	G = 10, Variable Frequency	6.5	6	—	—	—	—	Hours
----	Post Shock and Fatigue Test End Points							
	Vibration (1):	—	—	—	—	—	75	mVac
	Heater-Cathode Leakage							
	Ehk = +100 Vdc	—	—	—	—	—	15	μAdc
	Ehk = −100 Vdc	—	—	—	—	—	15	μAdc
	Change in Transconductance (1)							
	of Individual Tubes △ Sm	—	—	—	—	—	15	%
4.9.6.3	Glass Strain	4.0	—	—	—	—	—	
Acceptance Life Tests, Note 4								
4.11.7	Heater Cycling Life Test (1): (2000 Cycles Min.) Note 16 Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec = Eb = 0 V	2.5	—	—	—	—	—	
4.11.7	Heater Cycling Life Test (2): (300 Cycles Min.) Note 17 Ef = 10 V; Ehk = +200 Vdc; Rhk = 0; 10 secs on, 4 min. off	10.0	—	—	—	—	—	
4.11.3.1	Stability Life Test: Note 17 Eb = 250 Vdc; Ehk = +200 Vdc; Rg/g = 1.0 Meg; TA = Room; Rk/k = 1600 Ohms	—	—	—	—	—	—	
4.11.4	Stability Life Test End Points: Change in Transconductance (1) of Individual Tubes △ Sm	1.0	—	—	—	—	15	%
4.11.3.1	Survival Rate Life Test: (100 Hours) Note 18 Ebb = 250 Vdc; Rk/k = 420 Ohms; Rp/p = 0.02 Meg; Rg/g = 1.0 Meg; TA = Room	—	—	—	—	—	—	
4.11.4	Survival Rate Life Test End Points:							
	Continuity and Shorts (Inoperatives)	0.65	—	—	—	—	—	
	Transconductance (1) Sm	1.0	2800	—	—	—	—	umhos
	Grid Current	2.5	0	—	—	—	−0.3	μAdc
	Heater-Cathode Leakage: ±Ihk	0.65	—	—	—	—	10	μAdc
	Insulation of Electrodes:							
	p-all	6.5	200	—	—	—	—	Meg
	g1-all	6.5	200	—	—	—	—	Meg

MIL-E-1 Ref.	Test	LOT ACCEPTANCE LIMITS (1) MIN.	MAX.	FAILURE RATE CLASS (3) LIMITS MIN.	MAX.	Units
4.11.5	Intermittent Life Test: Notes 19 & 20 Survival Rate Life Conditions; T Envelope = 250°C Min.	—	—	—	—	
4.11.4	Intermittent Life Test End Points: (200 Hours)					
	Inoperatives: Note 21	—	—	—	—	
	Grid Current	0	−1.0	0	−1.5	μAdc
	Heater Current	330	380	320	390	mA
	Change in Transconductance (1) of Individual Tubes △ Sm/t	—	20	—	25	%
	Transconductance (2): △ Sm/Ef	—	15	—	25	%
	Heater-Cathode Leakage					
	Ehk = ±100 Vdc	—	10	—	15	μAdc
	Insulation of Electrodes					
	p-all	200	—	25	—	Meg
	g-all	200	—	25	—	Meg
	Transconductance (1) Average Change					
	Avg. △ Sm/t	—	15	—	—	%

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	ALLOWABLE DEFECTIVES
	Acceptance Life Tests, Note 4, (Cont'd.)	
----	Individual Lot Acceptance	
	Total Inoperatives	2
	Total Defectives	5
----	Failure Rate Tests: Note 20	
	Failure Rate Class 1	
	Inoperatives:	5
	Failure Rate Class 2	
	Combined defectives to Limits (1)	
	Including Inoperatives:	16
	Failure Rate Class 3	
	Combined defectives to F.R. 3 Limits	
	Including Inoperatives:	8

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Test each section separately.

4: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Rk/k	Rg1
V	Vdc	Vdc	ohms	Meg
7.5	250	0	1600	1.0

5: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

6: Tie 1k to 2k, 1g to 2g and 1p to 2p.

7: The rejection level shall be set at the VU meter reading obtained during calibration.

8: The pulse shall be applied to the plate and grid tied together. It shall be a square wave meeting the pulse shape requirement of MIL-E-1, par. 4.10.7.5, and in addition, the maximum amplitude shall occur within the first 20% of tp. The pulse shall be applied by means of a driving circuit which produces the specified pulse voltage directly at the plate and grid terminals with respect to cathode.

Peak currents shall be measured by means of a high impedance oscilloscope or equivalent device connected across a 1.0 ohm cathode resistor whose value is known to an accuracy of 1%. The specified limit, ik, refers to the maximum of the pulse amplitude. The variation of the output pulse amplitude, ik (tp), between 20% tp and 80% tp shall not exceed the specified limit where tp is as defined in MIL-E-1, par 4.10.7.5.

9: Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

10: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

11: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

12: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

13: For variables sampling procedure, use MIL-E-1, Appendix C, par. 20.2.4.2.2.

14: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

14: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

16: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

17: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

ACCEPTANCE CRITERIA NOTES (Continued)

18: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

19: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

20: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification. The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 The Failure Rate Control:

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The Failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissible as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

21: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Sylvania Premium Subminiature Type 6947 is a medium mu double triode having separate cathode connections for each section. It is intended as a general purpose tube and is particularly useful in applications where power requirements are such that the 6947 may be employed rather than two high power single triodes. Among the many uses for this type are a number of low frequency amplifier and oscillator configurations. To insure optimum performance in pulse applications this type is subjected to a pulse emission test as shown in the accompanying data. The tube must, under the specified pulse operating conditions, deliver a minimum specified current. A further discussion of this test is included in the general section of this manual.

Resistance coupled amplifier data is shown in the accompanying table.

The Type 6947 may also be used as a vhf amplifier. Instability, however, may be noted with cascode arrangements at frequencies above approximately 100 mc. The 6947 has a low noise figure which makes it particularly well suited to applications as an IF amplifier in the 30 to 60 mc region. Input resistance is plotted as a function of frequency in Figure 1.

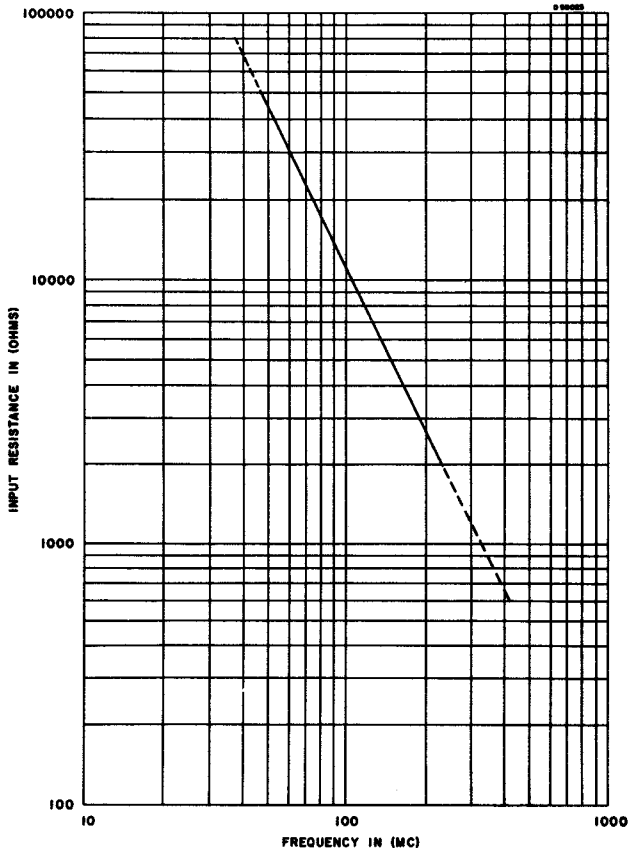


Figure 1—Input resistance vs frequency.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. In addition, vibrational output when the tube is subjected to wide band (White Noise) vibration is held to a very low value. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibrational test is included in the frontal section of this manual.

The 6947 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is described by the life tests, specified on the attached pages. The actual life expectance of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

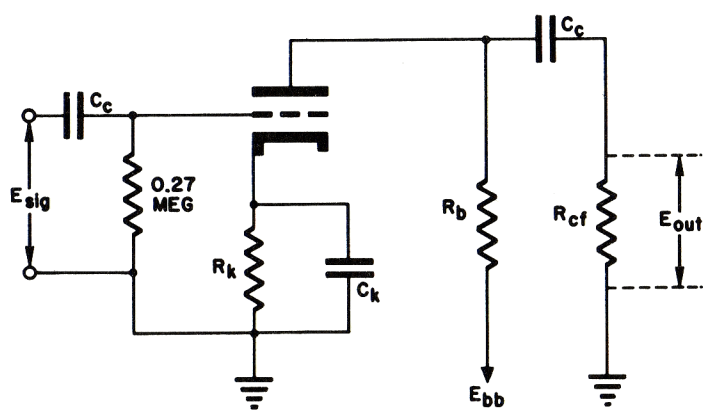
When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

RESISTANCE COUPLED AMPLIFIER DATA
SELF-BIAS OPERATION

	Ebb = 100 Volts								Ebb = 150 Volts							
Rb (Megs)	.047		.10		.27		.47		.047		.10		.27		.47	
Rcf (Megs)	.10	.27	.10	.47	.27	.47	.47	1.0	.10	.27	.10	.47	.27	.47	.47	1.0
Rk (Ohms)	1800	2200	3300	3900	8200	10,000	12,000	15,000	1200	1500	2200	3300	5600	6800	10,000	12,000
Ib (Ma)	.72	.67	.41	.37	.17	.16	.11	.10	1.30	1.18	.72	.62	.30	.28	.18	.15
Ec (Volts)	−1.30	−1.45	−1.35	−1.45	−1.42	−1.60	−1.34	−1.53	−1.56	−1.77	−1.58	−2.05	−1.70	−1.95	−1.78	−1.83
Eb (Volts)	65	68	58	62	52	55	46	50	97	93	76	76	66	71	65	77
Esig (Volts RMS)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Eout (Volts RMS)	1.70	1.79	1.70	1.93	1.80	1.89	1.89	1.95	1.95	2.03	1.95	2.11	2.06	2.12	2.05	2.06
Gain	17.0	17.9	17.0	19.3	18.0	18.9	18.9	19.5	19.5	20.3	19.5	21.1	20.6	21.2	2.05	20.6
% Distortion	0.80	0.54	0.82	0.44	0.64	0.55	0.58	0.53	0.40	0.37	0.42	0.35	0.40	0.38	0.44	0.45
Esig (Volts RMS)*	.45	.52	.43	.56	.50	.60	.51	.67	.70	.85	.67	.97	.81	.97	.87	1.08
Eout (Volts RMS)	7.6	9.15	7.2	10.8	8.8	11.0	9.4	13.0	13.6	17.2	13.0	20.4	16.6	20.5	17.7	22.3
Gain	16.9	17.6	16.7	19.3	17.6	18.3	18.4	19.4	19.4	20.2	19.4	21.0	20.5	21.1	20.3	20.6
% Distortion	5.0	5.0	5.1	4.4	5.0	5.0	4.6	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

	Ebb = 250 Volts							
Rb (Megs)	.047		.10		.27		.47	
Rcf (Megs)	.10	.27	.10	.47	.27	.47	.47	1.0
Rk (Ohms)	820	1000	1500	2200	4700	5600	8200	10,000
Ib (Ma)	2.57	2.47	1.40	1.24	0.56	0.53	0.32	0.30
Ec (Volts)	−2.10	−2.47	−2.11	−2.73	−2.63	−2.96	−2.64	−3.00
Eb (Volts)	127	132	107	123	96	104	96	106
Esig (Volts RMS)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Eout (Volts RMS)	2.28	2.40	2.23	2.38	2.25	2.30	2.23	2.29
Gain	22.8	24.0	22.3	23.8	22.5	23.0	22.3	22.9
% Distortion	0.35	0.33	0.36	0.39	0.39	0.42	0.47	0.50
Esig (Volts RMS)*	1.22	1.42	1.15	1.67	1.40	1.74	1.55	1.88
Eout (Volts RMS)	27.8	33.5	25.6	39.8	31.5	40.0	34.5	43.0
Gain	22.8	23.5	22.2	23.8	22.5	23.0	22.3	22.8
% Distortion	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

*Maximum signal for ⅛ μa grid current or 5.0% distortion.



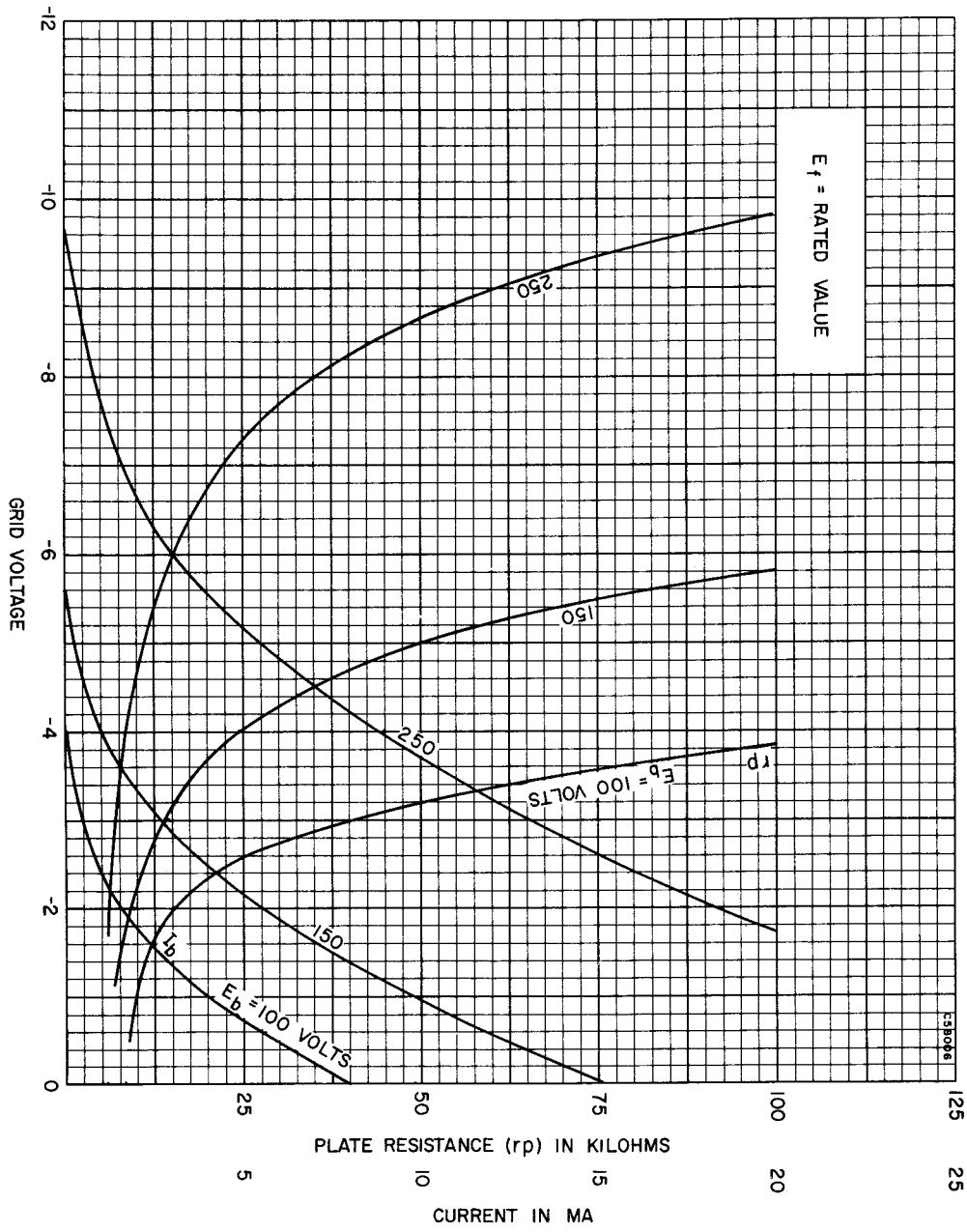
C_K LARGE ENOUGH TO NEGLECT DEGENERATION AND
C_C LARGE ENOUGH TO NEGLECT VOLTAGE DROP

D56024

Resistance Coupled Amplifier Circuit

6947

AVERAGE TRANSFER CHARACTERISTICS



SYLVANIA GUIDED MISSILE TUBES

6948

MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JEDEC 3-11
Basing	8DG
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Bulb Temperature	250	°C
Altitude[2]	80,000	Ft.
Radiation		
Total Dosage (*S* neutrons/sq. cm/sec.)	10^{16}	nvt
Dose Rate (neutrons/sq. cm/sec.)	10^{12}	nv

DURABILITY CHARACTERISTICS

Impact Acceleration (¾ msec Duration)	450 G	Max.
Fatigue (Vibrational Acceleration for Extended Periods)	10 G	Max.

FAILURE RATE RATING

Class (1) — Inoperatives	1.3%/200 Hours
Class (2) — All end points	5.4%/200 Hours
Class (3) — All end points	2.7%/200 Hours

ELECTRICAL DATA

HEATER CHARACTERISTICS

Heater Voltage[3]	6.3 V
Heater Current	350 mA

DIRECT INTERELECTRODE CAPACITANCES (Unshielded)

Grid to Plate (Each Section)	0.75 μμf	
Input (Each Section)	1.6 μμf	
Output		
Section No. 1	0.20 μμf	
Section No. 2	0.25 μμf	
Grid to Grid	0.014 μμf	Max.
Plate to Plate	0.86 μμf	Max.

RATINGS[1] (Absolute Maximum — Each Section)

Heater Voltage[3]	6.3 (−12, + 10%) V
Plate Voltage	250 Vdc
Peak-Plate Forward Voltage[4]	360 v
Plate Dissipation	0.5 W
Plate Current	10 mAdc
DC Grid Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid Circuit Resistance	1.0 Meg

CHARACTERISTICS (Each Section)

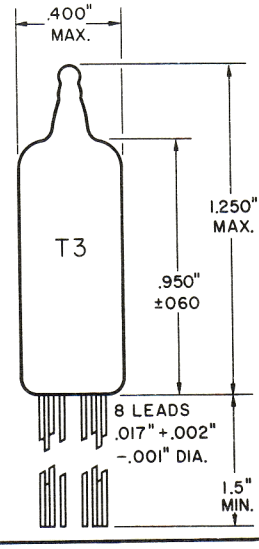
Plate Voltage	100 Vdc
Cathode Resistor	1500 Ohms
Plate Current	0.8 mAdc
Amplification Factor	70
Transconductance	1650 μmhos
Grid Voltage for Ib = 50 μAdc Max.	−3.5 Vdc

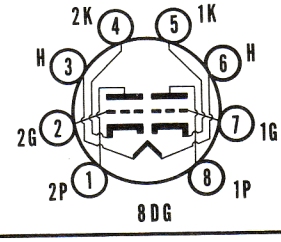
QUICK REFERENCE DATA

The Sylvania Premium Subminiature Type 6948 is a general purpose high-mu double triode designed specifically for guided-missile service.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered.

The 6948 is manufactured and inspected to meet the applicable specification for reliable operation.





sylvania electronic tubes

A Division of
Sylvania Electric Products Inc.

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests, Part 1, excluding Inoperatives and Mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: For Variables Sampling Procedure, see MIL-E-1, Appendix C, Paragraph 20.2.4.

3: Test each section separately.

4: Prior to this test, tubes shall be preheated for 5 minutes at the conditions indicated below. Test within three seconds after preheating. Three minute test is not permitted. Grid Emission is a destructive test so tubes subjected to it are not to be accepted under this specification, nor are subsequent tests to be performed on the same tubes.

Ef	Eb	Ec1	Rk/k	Rg1
V	Vdc	Vdc	ohms	Meg
7.5	250	0	1300	1.0

5: Destructive Tests: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature Lead Fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater Cycling Life Tests (1) & (2)
4.11.5	Intermittent Life Test
4.10.6.2	Grid Emission

6: Tie 1k to 2k, 1g to 2g and 1p to 2p.

7: The rejection level shall be set at the VU meter reading obtained during calibration.

8: Maximum total distortion of the filament supply voltage shall be 5%. The frequency response of the peak-to-peak measuring device from 20 cps to 5000 cps must be within 0.5 db of its response at 400 cps. Ground all leads except those for the cathodes and heater lead #3. Measure Hum voltage across specified Rk in each cathode separately.

9: Insert a cold tube into the test socket having all Plate Current (1) conditions applied and record Ib continuously for three minutes. Plate Current must reach 85% of the three minute figure within the time indicated.

10: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. In the event of lot failure, the lot shall be rejected and the succeeding lot shall be subjected to this test. Once a lot has passed, the 30-day rule shall apply. MIL-STD-105, Sample Size Code Letter F shall apply.

11: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "WHITE NOISE" spectrum which is free from discontinuities from 100 cps to 5000 cps and such that the RMS value of acceleration for frequencies outside this band shall constitute no more than five percent of the total RMS acceleration. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 ± 0.2 G's RMS acceleration. With this the case, the RMS value of acceleration for any bandwidth within the specified spectrum is equal to:

$$Grms = 2.3 \sqrt{3.32 \log_{10} (f2/f1)}$$

where f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

Half the tubes in the sample shall be vibrated in position X1, the other half in position X2.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (250 Kohms or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 30 db at 13,000 cps. For reading the peak-to-peak value of output voltage, the filter output shall be fed directly to the input of a Ballantine Model 305 peak-to-peak electronic voltmeter or equal, while the RMS value shall be measured with a Hewlett Packard Model 400 C or equal. The impedance of the plate and screen voltage supplies shall not exceed that of a 40 μf capacitor at 10 cps.

12: For variables sampling procedure, use MIL-E-1, Appendix C, par. 20.2.4.2.2.

13: A grid resistor of 0.1 meg shall be added; however, this resistor will not be used when a thyratron type short indicator is employed.

14: The tubes shall be rigidly mounted on a table vibrating at a constant acceleration level of 10 G. The frequency of vibration shall be varied from 30 cps to 3000 cps and back to 30 cps, with the period of the sweep cycle being three minutes. The rate of change of frequency with time shall be such that the frequency varies logarithmically with time. The tubes shall be vibrated for a total of six hours, that is, two hours in each of the three positions X1, X2, and Y1. Filament voltage only shall be applied to the tube under test.

15: The no load to steady state full load regulation of the heater voltage supply shall be not more than 3.0%.

16: The sampling and testing procedure for the Stability Life Test shall be in accordance with MIL-E-1, Appendix C, Section 20.2.5.1.

17: For Survival Rate Life Test, the sampling and testing procedure shall be as defined in Sections 20.2.5.2 to 20.2.5.2.5 inclusive of MIL-E-1, Appendix C.

18: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40B and S, or small diameter elements welded to a ring of 0.025-inch diameter phosphor bronze placed in contact with the envelope. The envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5 percent) under normal conditions, is determined to operate at or above the minimum specified temperature in any socket of the life-test rack.

19: **1.0 Intermittent Life Test Evaluation:** The life test conducted in accordance with this specification shall be evaluated in two separate procedures. The first will be an evaluation on an individual lot basis in a similar manner to the one normally specified for reliable tubes. The second evaluation is the determination of a failure rate and its compliance to this specification.

The life test will be conducted in accordance with MIL-E-1 procedures for reliable tubes except that the sampling plan will be changed from the presently specified double sampling plan to a single sampling plan with n = 40. Individual lot acceptance will be based on this sample size and the conformance of the lot to the maximum allowable defectives for inoperatives and also for combined defectives as specified.

2.0 The Failure Rate Control:

a. Purpose: It is the purpose of this specification to establish a means by which the Military may monitor and evaluate the failure rate of this tube type in order to provide a statistically valid description of this parameter that may be utilized in computing the reliability of equipments in which this type is used.

b. Description: The failure rates on this type shall be evaluated using the life test information gathered on individual lots. Only those lots that pass the life test criteria for individual lots shall be used in the calculations for failure rates. The failure rate shall be based on a 5 lot moving average with the cumulative number of failures for each failure rate class plotted on their respective failure rate charts (See Charts 1, 2 and 3). Non-conformance of a tube to the 200 hour end points shall be considered a failure.

The Failure rate charts consist of a plot of consecutive lots manufactured with each point indicating the cumulative number of failures in the last five lots as evaluated against the specified criteria. In the operation of this procedure, each time a new lot is added, the number of defects from the earliest lot is dropped from the accumulation of defectives so that each plotted point on the chart will represent a total sample size of 200 tubes.

Any lot which fails the individual lot acceptance criteria shall not be included in the cumulations for failure rate charts. However, the number of defectives for such a failing lot should be plotted on the failure rate chart in its chronological order with the other lots. This point is plotted for information only.

c. Qualification: In order to become a qualified source to this specification, it is mandatory that the manufacturer supply data on charts 1, 2 and 3 indicating that his failure rate is within the acceptable limits. A total quantity of 200 tubes life tested for 200 hours is required and this should be

ACCEPTANCE CRITERIA NOTES (Continued)

representative of two or more consecutively manufactured lots (e.g., 100 tubes from each of 2 lots or 40 from each of 5 lots). In the event more than 40 tubes per lot are used in the life test sample in order to accelerate qualification for failure rate, only the first 40 tubes life tested per lot shall be evaluated for the individual lot acceptance criteria.

d. Maintenance of Failure Rate: When the manufacturer has become a qualified source to this specification and has received proper approval from the Military, those lots utilized for qualification and subsequent lots where the 5 lot moving evaluation failure rate continues within the specification, are to be considered acceptable to this specification and may be marked and shipped accordingly.

e. Non-conformance of Failure Rate: The failure rate will be considered non-conforming when the total number of defectives (for the particular failure rate under evaluation) accumulated from the past 5 lot life test exceeds the number permissable as contained in the specification and on the failure rate chart. The lot of tubes which caused the failure rate limit to be violated shall be considered as acceptable and can be marked and shipped in accordance with this specification. When a failure rate criteria has been violated, the manufacturer has lost qualification to this specification and cannot mark and ship any subsequent lots to this specification without being requalified.

f. Requalification for Failure Rate: Since all three failure rates specified in this specification are computed from the same life test data, a violation of 1 failure rate requires requalification for all three failure rates. Requalification shall follow the same procedure as for original qualification. Starting after the last lot which rendered disqualification, a life test sample of 200 tubes from the next two new consecutive lots will be required to conform to this specification before qualification is reinstated to the manufacturer.

g. Charts: Each manufacturer intending or planning to supply tubes to this specification must forward his qualification data in the form of the three failure rate charts to the Military. These charts must be duly approved and signed by the Resident Government Inspector as representing the factual results of the life tests which were conducted in complete accordance with MIL-E-1 and this specification.

20: An inoperative as referenced in Life Tests shall be defined as a tube having one (1) or more of the following defects: Discontinuity (Ref. 4.7.1), Permanent Shorts (Ref. 4.7.2), Air Leaks (Ref. 4.7.6).

APPLICATION DATA

The Sylvania Premium Subminiature Type 6948 is a high mu, double triode of subminiature construction intended primarily for application as a low level, resistance coupled amplifier. In such circuits the high mu of the 6948 can easily yield a voltage gain of 50 for each section.

Resistance coupled amplifier data is shown in the accompanying tables for both cathode bias and zero bias operation. In zero bias circuits a grid circuit resistance of from 5 to 10 megohms should be employed to reduce contact potential loading and provide better plate current balance between sections and/or individual tubes.

The 6948 is particularly useful in applications where the power requirements permit the use of two tubes in one envelope.

This type is characterized by extraordinary freedom from interelement short circuits of short term duration, by high resistance to interelement leakage, and by stable performance. It is designed for service at high altitudes and where severe conditions of mechanical shock, vibration and high temperature are encountered. These characteristics give the type special value in guided missile applications.

Tube durability under extreme vibration for extended periods is assured by more stringent fatigue-testing techniques. Excitation for the fatigue test varies in frequency from 30 cps to 3,000 cps and back to 30 cps. Three minutes are required to sweep through one complete cycle. The sweep-frequency vibration has a constant acceleration level of 10 G in contrast to the 2.5 G level formerly used on most reliable receiving tube types. The sweep-frequency cycle is repeated continuously for two hours in each of three positions, totalling six hours.

To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave and a peak level of 15 g's. Limits are shown for both peak and rms output. A further discussion of the white noise vibration test is included in the frontal section of this manual.

The 6948 is manufactured and inspected to meet the applicable specification for reliability. Life expectancy is described by the life tests, specified on the attached pages. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

When operated under conditions common to on-off control applications, the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

6948

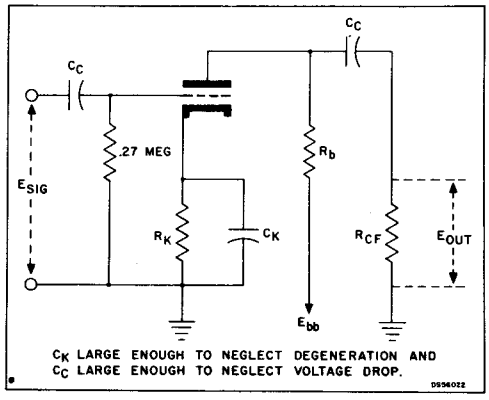
RESISTANCE COUPLED AMPLIFIER DATA
ZERO BIAS OPERATION

	Ebb = 100 Volts						Ebb = 150 Volts						Ebb = 250 Volts					
Rb (Megs)	0.1		0.27		0.47		0.1		0.27		0.47		0.1		0.27		0.47	
Rcf (Megs)	.27	.47	.47	1.0	.47	1.0	.27	.47	.47	1.0	.47	1.0	.27	.47	.47	1.0	.47	1.0
Rk (Ohms)																		
Ib (Ma)	.40	.40	.20	.20	.13	.13	.75	.75	.35	.35	.22	.22	1.49	1.49	.67	.67	.40	.40
Ec (Volts)																		
Eb (Volts)	60	60	46	46	39	39	75	75	56	56	47	47	101	101	69	69	60	60
Esig (Volts RMS)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Eout (Volts RMS)	3.75	3.95	4.10	4.40	3.95	4.30	4.55	4.75	4.82	5.10	4.60	4.95	5.45	5.66	5.66	5.90	5.40	5.70
Gain	37.5	39.5	41.0	44.0	39.5	43.0	45.5	47.5	48.2	51.0	46.0	49.5	54.5	56.6	56.6	59.0	54.0	57.0
% Distortion	1.90	1.80	1.70	1.40	2.00	1.60	1.00	.90	1.00	.84	1.20	0.95	0.51	0.48	0.56	0.50	0.68	0.58
Esig (Volts RMS) *	0.22	0.24	0.24	0.27	0.22	0.26	0.34	0.36	0.36	0.41	0.33	0.40	0.59	0.63	0.60	0.69	0.51	0.64
Eout (Volts RMS)	7.6	8.65	9.05	11.0	8.10	10.4	14.0	15.4	15.8	18.8	14.0	18.0	28.1	31.5	29.8	35.9	24.8	32.7
Gain	34.5	36.0	37.7	40.7	36.8	40.0	41.1	42.8	43.9	45.9	42.3	45.0	47.6	50.0	49.7	52.0	48.7	51.1
	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

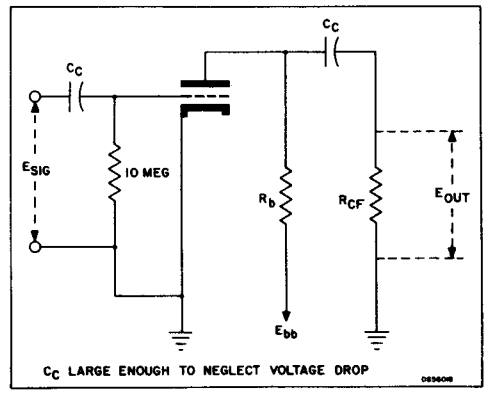
SELF BIAS OPERATION

	Ebb = 100 Volts						Ebb = 150 Volts						Ebb = 250 Volts					
Rb (Megs)	.10		.27		.47		.10		.27		.47		.10		.27		.47	
Rcf (Megs)	.27	.47	.47	1.0	.47	1.0	.27	.47	.47	1.0	.47	1.0	.27	.47	.47	1.0	.47	1.0
Rk (Ohms)	2700	2700	5600	6800	8200	10,000	2200	1800	3900	4700	5600	6800	1200	1200	2700	2700	3900	4700
Ib (Ma.)	.37	.37	.18	.17	.12	.11	.58	.63	.30	.27	.20	.18	1.17	1.18	0.55	0.55	0.35	0.32
Ec (Volts)	−1.00	−1.00	−1.02	−1.13	−1.00	−1.12	−1.27	−1.13	−1.16	−1.28	−1.09	−1.24	−1.40	−1.42	−1.48	−1.48	−1.35	−1.52
Eb (Volts)	62	62	50	54	42	46	91	86	68	75	57	63	132	131	100	100	86	96
Esig (Volts RMS)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Eout (Volts RMS)	3.66	3.90	4.00	4.08	3.90	4.10	4.00	4.33	4.55	4.60	4.45	4.60	4.80	5.10	5.02	5.28	4.90	5.00
Gain	36.6	39.0	40.0	40.8	39.0	41.0	40.0	43.3	45.5	46.0	44.5	46.0	48.0	51.0	50.2	52.8	49.0	50.0
% Distortion	2.1	1.9	1.9	1.7	2.2	1.8	1.3	1.0	1.2	1.0	1.3	1.0	0.54	0.52	0.55	0.50	0.64	0.54
Esig (Volts RMS) *	0.21	0.22	0.23	0.26	0.20	0.25	0.32	0.37	0.36	0.39	0.32	0.38	0.56	0.62	0.59	0.66	0.52	0.64
Eout (Volts RMS)	7.50	8.26	8.90	10.5	7.55	9.90	12.6	15.8	15.4	17.9	13.8	17.2	26.6	31.3	29.0	34.6	25.1	32.0
Gain	35.7	37.5	38.7	40.3	37.7	39.6	39.3	42.7	42.7	45.9	43.2	45.2	47.4	50.5	49.2	52.4	48.2	50.0
% Distortion	4.9	4.8	5.0	5.0	4.7	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.8	5.0	5.0

*Max. signal for 5% distortion or ⅛ μa of grid current.

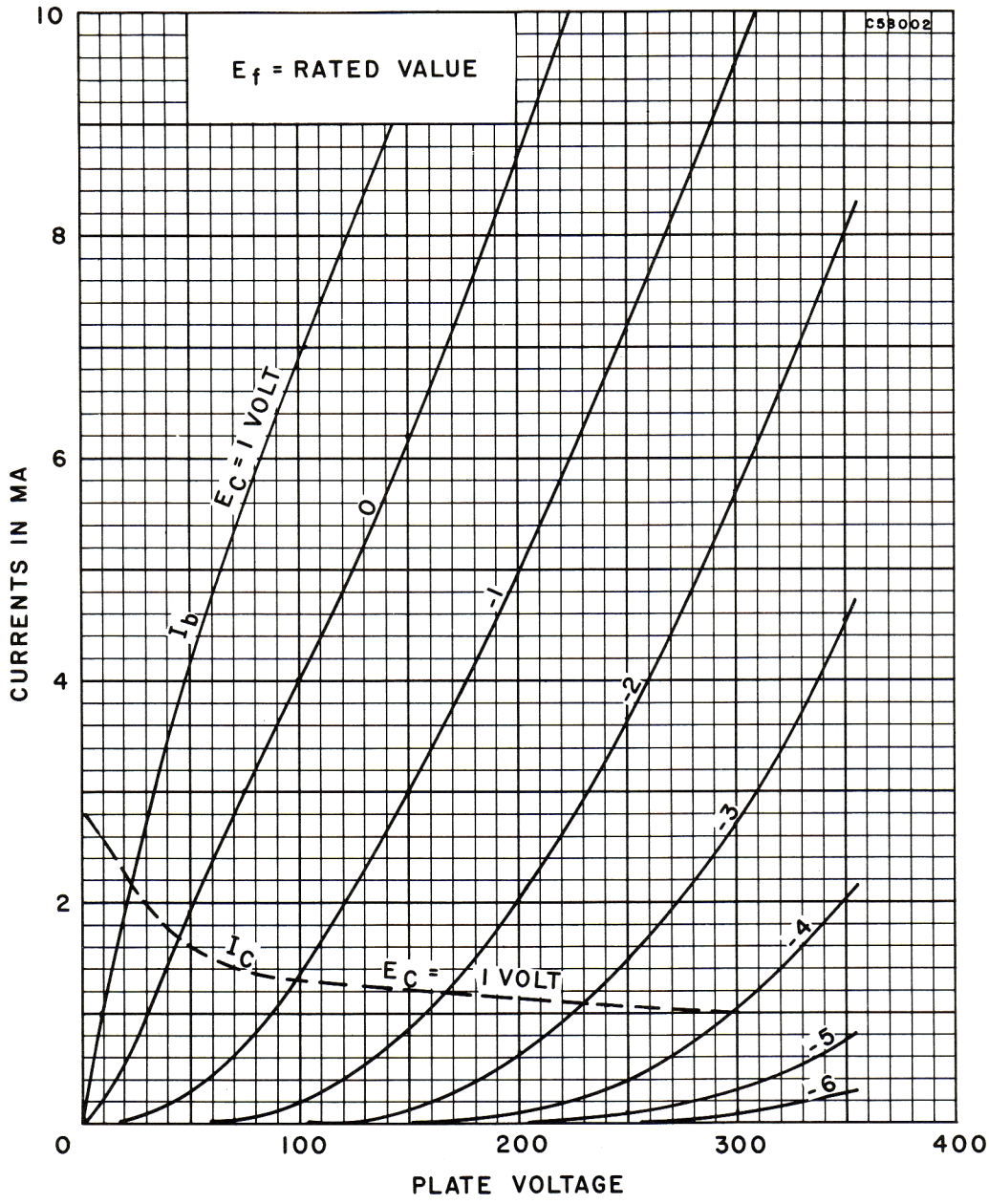


Resistance coupled amplifier circuit (Self-Bias).

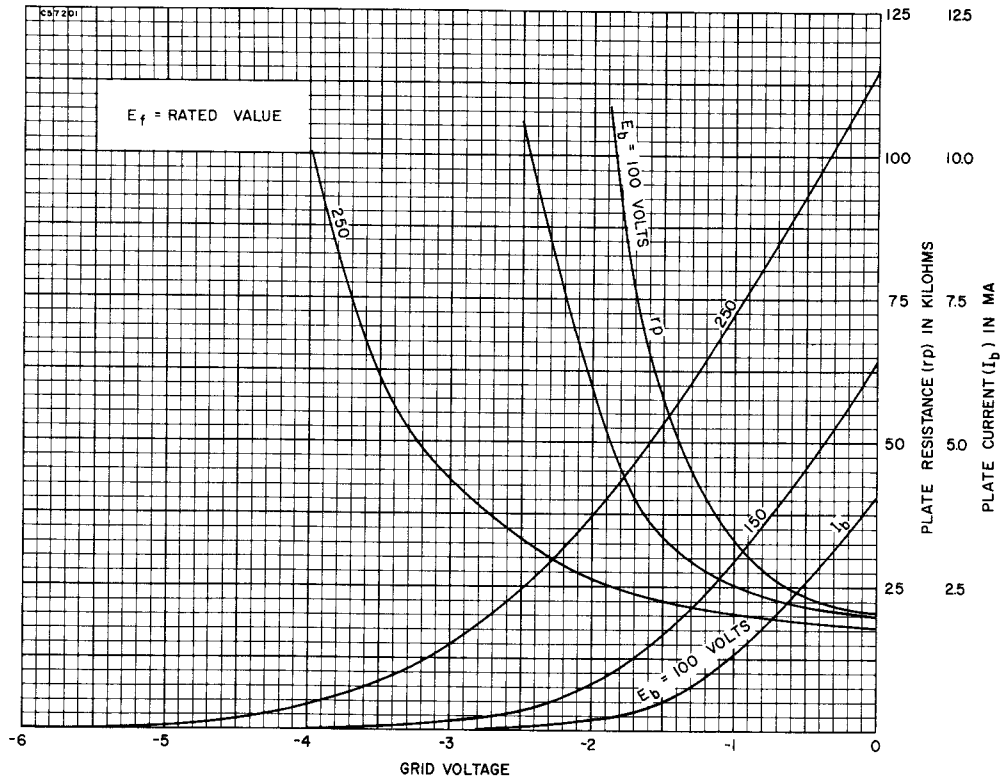


Resistance coupled amplifier circuit (Zero-Bias).

AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS