RAYTHEON

TECHNICAL INFORMATION SERVICE

Technical Information

6814

SUBMINIATURE MEDIUM-MU TRIODE

The 6814 is a heater-cathode type medium-mu triode of subminiature construction designed primarily for multivibrator, frequency divider, and other electronic computer applications requiring high reliability during on-off service. To assure reliable operation in these applications, it is controlled by a 500 hour Interface Life Test and for minimum zero bias plate current and cut-off voltage during 1000 hour High Temperature Life Test. The flexible terminal leads may be soldered or welded directly to the terminals of circuit components without the use of sockets. Standard 8-pin subminiature sockets may be used by cutting the leads to a suitable length.

MECHANICAL RATINGS: (Absolute Ratings)

Impact Acceleration	450	G
Fatigue (Vibrational Acceleration for Extended Periods)	2.5	G
Bulb Temperature	165	°C
Altitude	80,000	Ft.

ELECTRICAL DATA (3)

Ratings and Normal Operations	MIL-E-1 Symbol	Test Limit or Absol. Min.	Norm. Test Cond.	Test Limit or Absol. Max.	MIL-E-1 Units
Heater Voltage	Ef	6.0	6.3	6.6	V
Plate Voltage	Eb	---	100	275(2)	Vdc
Peak Plate Forward Voltage	eb	---	---	600(2)	v
Plate Dissipation	Pp	---	---	2.2	Watts
DC Grid Voltage	Ec	-55	0	5.5	Vdc
Peak Grid Voltage	eg	-220	---	27.5(1)	v
Average Positive Grid Current	Ic	---	---	5.5(1)	mAdc
Peak Positive Grid Current	ic	---	---	110(1)	ma
Cathode Current Average	Ik	---	---	22	mAdc
Peak	ik	---	---	440(1)	ma
Heater Cathode Voltage	Ehk	---	0	±200	v
Grid Circuit Res.	Rgl	---	---	1.0	meg.
Cathode Resistance	Rk	---	150	---	ohms
		TESTS			
Amplification Factor	Mu	25	29	33	
Transconductance	Sm	5000	6000	7000	μmhos
Plate Resistance	rp	---	4800	---	ohms
Heater Current	If	138	150	162	mA
Heater Cathode Leakage Ehk=±100 Vdc	Ihk	---	---	5	μA
Plate Current	Ib	7.5	10	12.5	mAdc
Plate Current Ebb=140 Vdc; Rp=2700 ohms; Rg=60 kilohms; Ec1=-8.5 Vdc	Ib	---	---	100	μAdc

MECHANICAL DATA

ENVELOPE ..... Glass T-3

OUTLINE 8-1

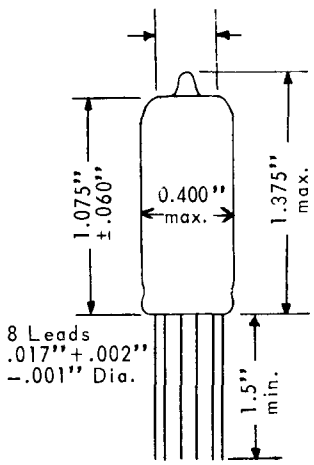
BASE ..... E8-10 Submin., Button Flexible Leads

BASING 8DK

CATHODE .. Coated Unipotential

MOUNTING POSITION ..... Any

PHYSICAL DIMENSIONS



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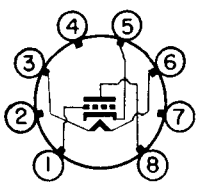


TERMINAL CONNECTIONS:

Lead 1 Grid
Lead 2 N.C.
Lead 3 Heater
Lead 4 N.C.
Lead 5 Cathode
Lead 6 Heater
Lead 7 N.C.
Lead 8 Plate

ELECTRICAL DATA (3) (cont'd.)

Ratings and Normal Operations	MIL-E-1 Symbol	Test Limit or Absol. Min.	Normal Test Conditions	Test Limit or Absol. Max.	MIL-E-1 Units
Plate Current Eb=125 Vdc; Ec=+3 Vdc Rp=2700 ohms; Rg=60 kilohms	Ib	14	15.5	---	mAdc
Low Freq. Vibration freq.=40 cps; G=15; Rp=10 k; Ck=1000 μf	Ep	---	---	50	mVac
INTERELECTRODE CAPACITANCES (No Shield)					
Grid to Plate	Cgp	1.1	---	1.8	μμfd
Input	Cin	1.6	---	2.8	μμfd
Output	Cout	0.5	---	0.9	μμfd

SPECIAL TESTS AND RATINGS TO INSURE RELIABILITY

Randomly selected statistical samples are subjected to the following tests.

Shock Test–	450 G. 30° hammer angle in Navy High Impact Shock machine. Sample subjected to twenty (20) impact accelerations, five impact accelerations in each of four different positions.
Fatigue Test–	2.5 G. Sample subjected to vibrational acceleration of 2.5 G for 96 hours (32 hours in each of three positions). The sinusoidal vibration is applied at a fixed frequency between 25 and 60 cycles per second.
Glass Strain–	A sample is subjected to a forty-eight hour holding period at room temperature. The sample is immersed in water at 97–100 °C for 15 seconds and immediately immersed in water at not more than 5 °C. The sample is then dried at room temperature for 48 hours and inspected for evidence of air leaks.
Heater Cycling– Life Test	A sample is subjected to 2000 on–off heater cycles at the following conditions: Ef=7.0 volts; Ehk=140 Vac and other elements floating. At the conclusion of this test the tubes will not show open heater or cathode circuits or heater to cathode shorts.
Stability Life Test–	Sample is operated for 2 and 20 hours to assure initial electrical stability (Δ_tIb $\angle$10 %). Tubes are operated with a plate voltage of 250 Vdc and an Ehk of +200 Vdc. Rk=1000 ohms.
Survival Rate– Life Test	Sample is operated 100 hours to assure electrical stability (Ib $\rightarrow$13 mAdc) and freedom from inoperatives. Tubes operated under Stability Life Test Conditions.
Intermittent Life– Test	1000 hours. Sample is operated under Survival Rate conditions with a minimum envelope temperature of 165 °C.
Cathode Interface– Life Test	500 hours. Sample is operated with Ef=6.9 V, other electrodes disconnected. (Interface Resistance<50 ohms).
Altitude–	Sample is subjected to a pressure=21 ±2 mm Hg (80,000 ft.) at 300 Vac to insure freedom from flashover or corona at the pins of the tube.

APPLICATION NOTES

(1) The absolute maximum ratings for pulse characteristics apply to a square topped pulse of 1000 cps. frequency and 1.0 percent duty factor. The total DC and peak heater cathode voltage shall not exceed 200 volts and the max. positive DC heater with respect to cathode voltage shall never exceed +100 Vdc.

(2) When the load impedance is of such type that the instantaneous voltage at the plate never exceeds the supply voltage, the supply voltage may be 300 Vdc, provided the maximum rated average dissipation is never exceeded on any electrode.

(3) CAUTION---To Electronic Equipment Design Engineers: Special attention should be given to the temperature at which the tubes are to be operated. Reliability will be seriously impaired if maximum bulb temperature is exceeded. The life expectancy may be reduced if conditions other than those specified for life test are imposed on the tube and will be reduced appreciably if maximum ratings are exceeded. Both reliability and performance will be jeopardized if filament voltage ratings are exceeded. Life and reliability of performance are closely related to the degree that regulation of the heater voltage is maintained at its center rated value.

ACCEPTANCE CRITERIA

The following tests shall be performed.

For the purpose of inspection, use applicable paragraphs of Spec. MIL-E-1.

For misc. requirements see 3.6.

Par. No.	Test	Conditions	AQL	Inspection Level or Code	Symbol	LIMITS Min.	LIMITS Bogie	LIMITS Max.	Units
GENERAL									
3.1	Qualification	Required for JAN marking	---	---	---	---	---	---	---
3.6	Performance		---	---	---	---	---	---	---
QUALIFICATION (see note 3)									
---	Cathode	Coated unipotential	---	---	---	---	---	---	---
3.4.3	Base Connections	Outline E8-10	---	---	---	---	---	---	---
MEASUREMENT ACCEPTANCE TESTS, PART 1 (see note 4)									
4.9.1	Mechanical-production tests	Outline 8-1	---	---	---	---	---	---	---
4.10.4.1	Plate Current (1)	Eb=125 Vdc; Ec=+3 Vdc; Rp=2700 ohms; Rg=0.06 Meg.	0.65	II	Ib	14	15.5	---	mAdc
4.10.5.2	Grid Voltage	Eb=140 Vdc; Rp=2700 ohms; Rg=0.06 Meg. Ec/Ib=100 μAdc	0.65	II	Ec	---	---	-8.5	Vdc
4.10.6.1	Total grid current	Eb=150 Vdc; Rk=220 ohms; Rg=1.0 Meg.	0.65	II	Ic1	0	---	-0.4	μAdc
4.10.8	Heater Current		0.65	II	If	138	---	162	mA
4.10.15	Heater-cathode leakage	Ehk=+100 Vdc Ehk=-100 Vdc	0.65	II	Ihk Ihk	--- ---	--- ---	5.0 5.0	μAdc μAdc
4.7.5	Continuity and shorts	(See note 5)	0.4	II	---	---	---	---	---
MEASUREMENT ACCEPTANCE TESTS, PART 2									
4.8	Insulation of electrodes	g-all=-100 V p-all=-300 V	2.5	I	R R	50 50	--- ---	--- ---	Meg. Meg.
4.9.12.1	Low Pressure Voltage Breakdown	Pressure=21±2 mm Hg; voltage=300 Vac	6.5	See Note 6	---	---	---	---	---
4.9.19.1	Low frequency vibration	F=40 cps; G=15; Rp=10,000 ohms; Ck=1000 μf	2.5	I	Ep	---	---	50	mVac
4.10.4.1	Plate current (2)	Ef=5.7 V; Eb=125 Vdc; Ec=+3 Vdc; Rp=2700 ohms; Rg=0.06 Meg	2.5	I	Ib	13	---	---	mAdc
4.10.4.1	Plate current (3)		6.5	L6	Ib	7.5	---	12.5	mAdc
4.10.6.2	Grid emission	Ef=7.5 V; Rg1=1.0 Meg; Ec1=-8.5 Vdc (see note 7)	2.5	I	Ic1	0	---	-0.5	μAdc
4.10.9	Transconductance		2.5	I	Sm	5000	---	7000	μmhos

Par. No.	Test	Conditions	AQL	Inspection Level or Code	Allowable Defects per characteristic		Symbol	LIMITS		Units
					First Sample	Combined Sample		Min.	Max.	
MEASUREMENT ACCEPTANCE TESTS, PART 2 (cont'd.)										
4.10.11.1	Amplification factor		6.5	L6	---	---	Mu	25	33	---
4.10.14	Direct Interelectrode Capacitance	No Shield No Shield No Shield	6.5	Code F	---	---	Cgp Cin Cout	1.1 1.6 0.5	1.8 2.8 0.9	μμf μμf μμf
DEGRADATION RATE ACCEPTANCE TESTS (see note 8)										
4.9.5.3	Subminiature lead fatigue		2.5	Code F	---	---	---	4	---	arcs
4.9.20.5	Shock test	Hammer angle = 30° (see note 9)	---	---	---	---	---	---	---	---
4.9.20.6	Fatigue test	G=2.5; fixed frequency; F=25 min, 60 max.	6.5	See Note 6	---	---	---	---	---	---
---	Post Shock and fatigue test end points	Vibration	---	---	---	---	Ep	---	200	mVac
		Heater-cathode leakage								
		Ehk=+100 Vdc	---	---	---	---	Ihk	---	15	μAdc
		Ehk=-100 Vdc	---	---	---	---	Ihk	---	15	μAdc
		Plate Current (1)	---	---	---	---	Ib(1)	13	---	mAdc
		Grid Voltage	---	---	---	---	Ec	---	-8.5	Vdc
4.9.6.3	Glass Strain	See note 10	6.5	I	---	---	---	---	---	---
ACCEPTANCE LIFE TESTS (see note 8)										
4.11.7	Heater-cycling life test	Ef=7.0 V; 1 min on. 4 min. off; Ehk=140 Vac; Eb=Ec=0 (see note 11)	2.5	Code H	---	---	---	---	---	---
---	Stability Life Test	Ef=6.3 V; Eb=250 Vdc; Ec=0; Ehk=+200 Vdc; Rk=1000; Rg=1.0 Meg; TA=room (see note 12)	1.0	Code I	---	---	---	---	---	---
---	Life test end point (Stability) (2 and 20 hours)	Change in plate current (1) of individual tubes	---	---	---	---	Δ_tIb	---	10	%
4.11.3.1(b)	Survival Rate Life Test	Stability Life test conditions, or equivalent (see notes 13 and 14)	---	Code II	---	---	---	---	---	---
4.11.4	Life Test end points (Survival rate) (100 hours)	Continuity and shorts (see note 5)	0.65	---	---	---	---	---	---	---
		Plate Current (1)	1.0	---	---	---	Ib	13	---	mAdc
4.11.5	Intermittent life test operation	Survival rate life test conditions; TE=+165°C min. (see notes 15 and 16)	---	---	---	---	---	---	---	---
4.11.4	Life-test end points (intermittent) (500 hours)	(See note 17)								
		Inoperatives	---	---	1	3	---	---	---	---
		Plate current (1)	---	---	1	3	Ib	13	---	mAdc

Par. No.	Test	Conditions	AQL	Inspection Level or Code	Allowable Defects per characteristic		Symbol	LIMITS		Units
					First Sample	Combined Sample		Min	Max	
4.11.4 (cont'd.)		Grid Voltage	---	---	1	3	Ec	---	-8.5	Vdc
		Grid Current	---	---	1	3	Ic	0	-0.6	μAdc
		Heater-cathode leakage								
		Ehk=+100 Vdc	---	---	2	5	Ihk	---	10	μAdc
		Ehk=-100 Vdc					Ihk	---	10	μAdc
		Heater current	---	---	2	5	If	136	166	mA
		Insulation of electrodes								
		g-all	---	---	2	5	R	25	---	Meg
		p-all					R	25	---	Meg
		Total defectives	---	---	4	8	---	---	---	---
4.11.4	Life test end points (intermittent) (1000 hours)	(See note 17)								
		Inoperatives	---	---	2	5	---	---	---	---
		Plate Current (1)	---	---	2	5	Ib	13	---	mAdc
		Grid Voltage	---	---	2	5	Ec	---	-8.5	Vdc
		Grid Current	---	---	2	5	Ic	0	-0.6	μAdc
		Insulation of electrodes								
		g-all	---	---	3	6	R	25	---	Meg
		p-all					R	25	---	Meg
		Total defectives	---	---	5	10	---	---	---	---
4.11.8	Cathode interface life test	Ef=6.9 V; other elements disconnected (see note 18)	---	---	---	---	---	---	---	---
4.11.4	Life test end points (interface) (500 hours)	Ef=5.7±0.05 Vdc; Eb=100 Vdc; Ec/Ib=1.0 mAdc (see note 19)	---	---	1	3	Ri	---	50	ohms
4.9.18	Container drop	Required								
	Preparation for delivery	(See note 20)								

Note 1: The absolute-maximum ratings for pulse characteristics apply to a square-topped pulse of 1,000 cps frequency and 1.0 percent duty factor.

Note 2: The requirements of 6.5.1.1 shall apply with the following exception: When the load impedance is of such type that the instantaneous voltage at the plate never exceeds the supply voltage, the supply voltage may be 300 Vdc, provided the maximum rated average dissipation is never exceeded on any electrode.

Note 3: All tests listed herein shall be performed during qualification; however, these two tests are normally performed during qualification inspection only.

Note 4: The AQL for the combined defectives for attributes in measurement acceptance tests, part 1, excluding inoperatives and mechanical, shall be 1 percent.

Note 5: Tubes shall be tested for continuity of all possible circuits, for shorts between the tube elements, and for air leaks. During both continuity and short testing, the tube under test shall be tapped at least three times in each of two planes 90° to 120° apart with a tapper, which shall be adjusted to give an impulse of approximately one-half sine wave of 300±50 microseconds duration, as measured 10 percent from the base, and having a minimum average amplitude equivalent to 40 G's peak acceleration.

During tapping, the tube shall be supported only by the socket and light finger or soft cushioned mechanical pressure on the dome of the bulb. The finger or mechanical pressure on the dome of the bulb shall be used only when necessary to prevent the tube from coming out of the socket and shall be so applied that it offers negligible restraint to lateral motion at the top of the bulb.

The tap blows shall be delivered to the tube approximately two-thirds up on the seated height.

NOTES (cont'd.)

Note 5: (cont'd.) The tapper impulse shall be measured with a Gulton Manufacturing Company type A-305 accelerometer, or equivalent, mounted in a standard production type (replaceable cap and clips) 7-pin socket and having no other support. The tap blows shall be delivered to the accelerometer at the approximate midpoint of its seated height and in a direction parallel to the plane of maximum sensitivity of the accelerometer. The output of the accelerometer shall be coupled through a cathode follower and low-pass filter-amplifier combination to a suitable calibrated oscilloscope. The low-pass filter shall have a minimum high-frequency cutoff at 5,000 cycles per second. The Gulton KA-1 test set, on 5-kc filter position, possesses appropriate characteristics.

The tube under test shall be connected to the shorts test equipment in such a manner that a specified minimum sensitivity is maintained between all elements in the tube. Except for heater to cathode, a short circuit shall be defined as an equivalent resistance between adjacent elements which persists for a period of time in excess of that determined by a limiting curve of resistance versus time duration passing through the following points: 600,000 ohms, constant value (permanent shorts); 500,000 ohms, 500 microseconds; 100,000 ohms, 100 microseconds; and 1,000 ohms, 60 microseconds. For heater to cathode, the minimum sensitivity shall be 10 percent of the above resistance value.

The maximum voltage between adjacent elements during shorts test shall be 70 Vdc, and the minimum shall be 20 Vdc.

Tubes which give an indication of one or more of the following shall be rejected as inoperable:

(a) Either a permanent or tap short at any time during the tapping procedure.
(b) Any open circuit.
(c) Air leaks (see 4.7.6).

Note 6: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. When one lot has passed, the 30-day rule shall apply. In the event of lot failure, the lot shall be rejected and the succeeding lots shall be subjected to this test, until a lot passes. Standard MIL-STD-105, sample size code letter F, shall apply.

Note 7: Prior to this test, tubes shall be preheated a minimum of 5 minutes at the conditions indicated below. The 3-minute test is not permitted. Test immediately after preheating. Grid emission shall be the last test performed on the sample selected for the grid emission test.

Ef V	Eb Vdc	Ec Vdc	Rk ohms	Rg1 Meg
7.5	150	0	220	1.0

Note 8: *Destructive tests.* Tubes subjected to the following destructive tests are not to be delivered on the contract or order:

4.9.5.3 Subminiature lead fatigue
4.9.20.5 Shock test
4.9.20.6 Fatigue test
4.11.7 Heater-cycling life test
4.11.5 Intermittent life-test operation
4.11.8 Cathode interface life test

Note 9: A grid resistor of 0.1 megohm shall be added; however, this resistor will not be used when a thyratron-type short indicator is employed.

Note 10: The following modifications apply to 4.9.6.3:

(a) Replace fifth sentence with the following: The holder shall be in accordance with Drawing 245-JAN, and the tubes shall be immersed quickly.

(b) Replace seventh sentence with the following: After the 5-second submersion period, the tubes shall be removed and allowed to return to room temperature on a wooden surface.

Note 11: The no-load to steady full load regulation of heater voltage supply shall be not more than 3.0 percent. This test shall be made on a lot-by-lot basis. A failure or defect shall consist of an open heater, open cathode circuit, or a heater-cathode short.

Note 12: *Stability life test.*

(a) Life test samples shall be selected from a lot at random in such a manner as to be representative of the lot. If such a selection results in a sample containing tubes which are outside the initial specification sheet limits for the relevant life test end-point characteristics, such tubes shall be replaced by randomly selected acceptable tubes.

NOTES (cont'd.)

Note 12: (cont'd.)

(b) Serially mark all tubes of the sample.

(c) Record referenced characteristic measurements on the entire sample after a maximum operation of 15 minutes under specified voltage and current conditions.

(d) The regular stability life test sample shall be operated at specified stability life test conditions or equivalent for 20±4 hours with an intermediate down-period reading point at 2 hours (±30 minutes). Intermittent or continuous operation may be used. The regular stability life test shall be in effect initially and shall continue in effect until eligibility criteria for the reduced hours stability life test have been met.

(e) *Reduced hours stability life test:*

1. Eligibility for reduced hours stability life test shall be as follows: No lot failure due to the regular stability life test has occured in the preceding five consecutive lots.

2. Reduced hours stability life test shall be conducted for 2 ±1/2 hours. Acceptance shall be based on the stability life test end-point limit. One lot failing the reduced hours stability life test shall result in loss of eligibility for the reduced hours stability life test.

3. The stability life test sample from the first lot accepted each month shall continue on stability life test to the 20±4 hours duration. Failure of this sample to meet the regular stability life test end-point limit shall result in loss of eligibility for the reduced hours stability life test.

(f) Life test shall be conducted (see 4.11 and 4.11.5) except that the following shall be substituted for 4.11.1(b): The mean electrode potentials, except heater or filament, may be established at values differing by not more than 5 percent from the specified values, provided the same average electrode dissipations are obtained that occur with the specified voltages. Fluctuations of all voltages, including heater or filament voltage, shall be as small as practicable.

(g) Record referenced characteristics measurements at the specified reading period. Referenced characteristic measurements shall be taken immediately following the specified reading periods or tubes shall be preheated 15 minutes under specified voltage and current conditions, and immediately measured following the specified reading periods. The 15-minute preheat shall be considered as part of the test time.

(h) A defective shall be defined as a tube having a change in referenced characteristic greater than that specified on the specification sheet at either the 2-hour or the 20-hour reading point.

(i) A resubmitted lot shall be subjected to all measurement acceptance tests except mechanical inspection, capacitance, vibration, and low-pressure voltage breakdown tests.

Note 13: The sampling and testing procedures for survival-rate life test shall be as specified in 20.2.5.2 to 20.2.5.2.4, inclusive, of Appendix C.

Note 14: For survival-rate life test, the equivalent stability life-test conditions shall be as specified in 20.2.5.2.5 of Appendix C.

Note 15: *Intermittent life tests.* Sampling and acceptance procedures for these tests shall be as specified in 20.2.5.3 of Appendix C.

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

Note 17: Order for evaluation of life-test defects: See 4.11.3.1.2.

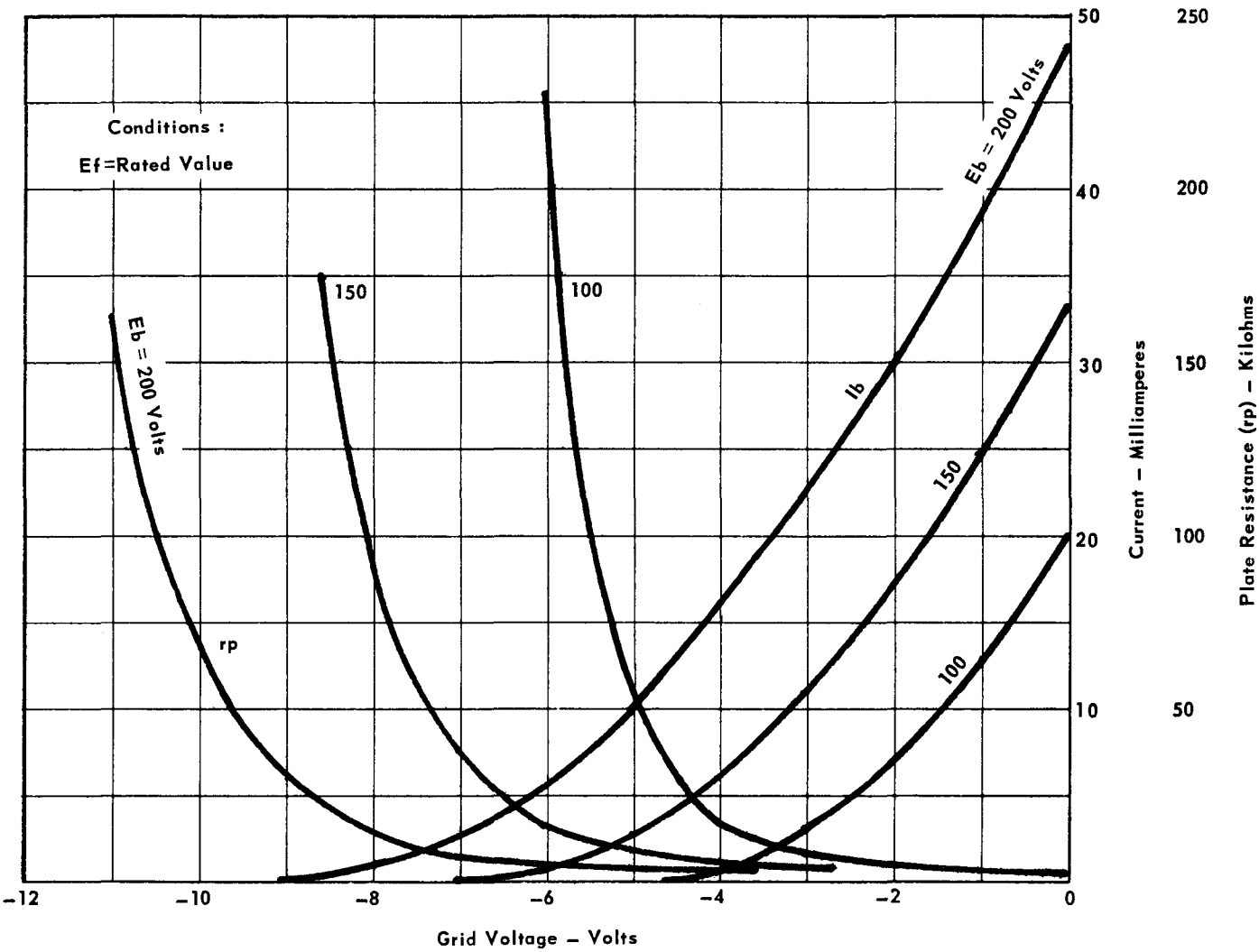
Note 18: The life-test sample shall consist of 20 tubes, and not more than two tube failures shall be permitted. In the event of rejection of the first sample due to failure of more than two tubes, a second sample of 40 tubes shall be selected from the lot. Acceptance shall then be based on the combined first and second samples. The total tube failures from the combined first and second samples shall not exceed five. A life-test defect is defined as a failure to meet the life test end point limits as specified on the tube specification sheet. The life test sample shall be read at zero hours and 500 hours (+48 hours, −24 hours)

NOTES (cont'd.)

Note 19: Preheat approximately 5 minutes prior to testing, using Ef=6.0 V; other electrodes disconnected. No other test shall be made from the start of the cathode interface life test until after the measurement of the end-point characteristic, following completion of the indicated minimum number of life-test hours.

Note 20: Tubes shall be prepared for domestic or overseas shipment, as specified in the contract or order, in accordance with Specification MIL-E-75/1. Rough handling (container drop) test (d) and container size C shall apply.

AVERAGE TRANSFER CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS

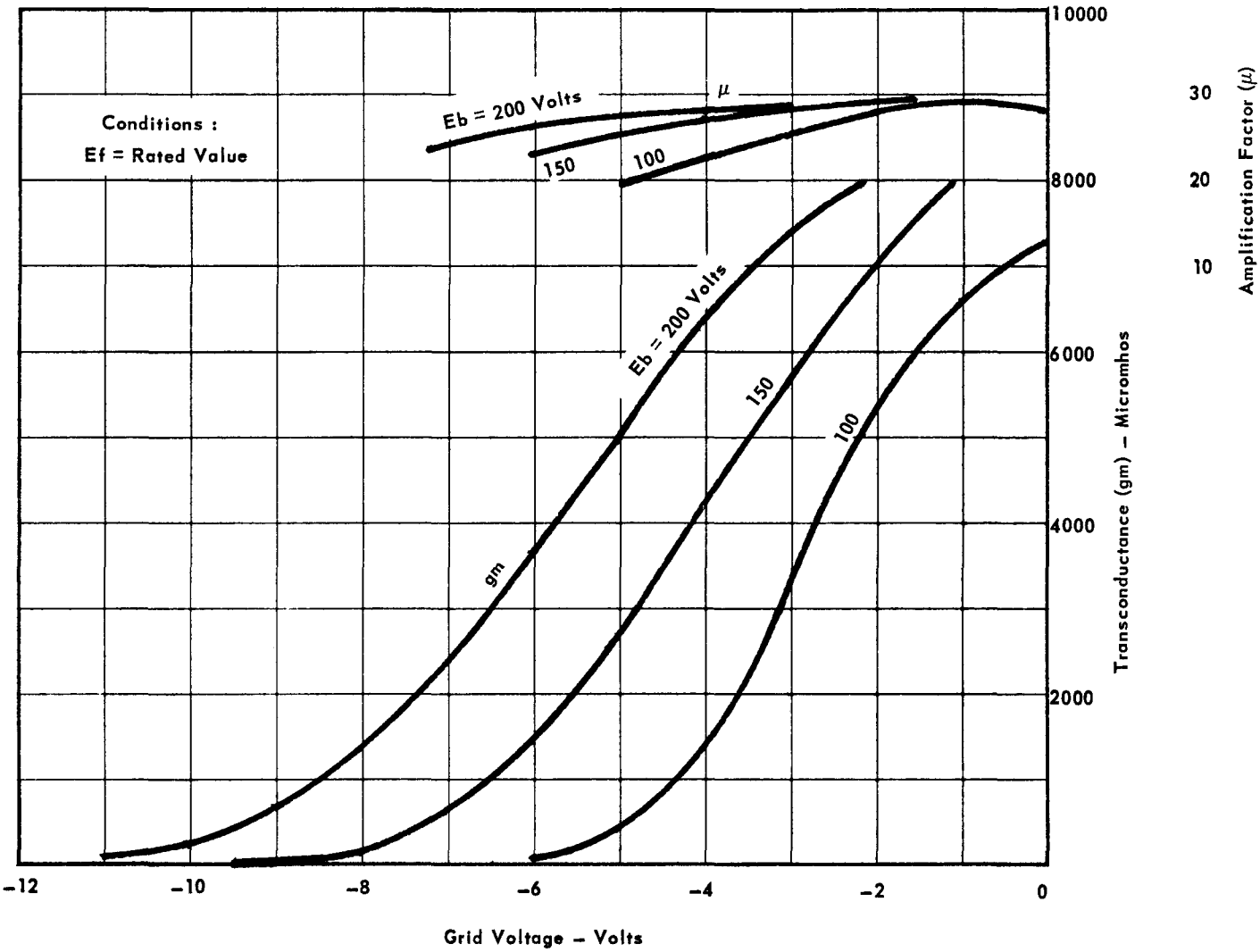
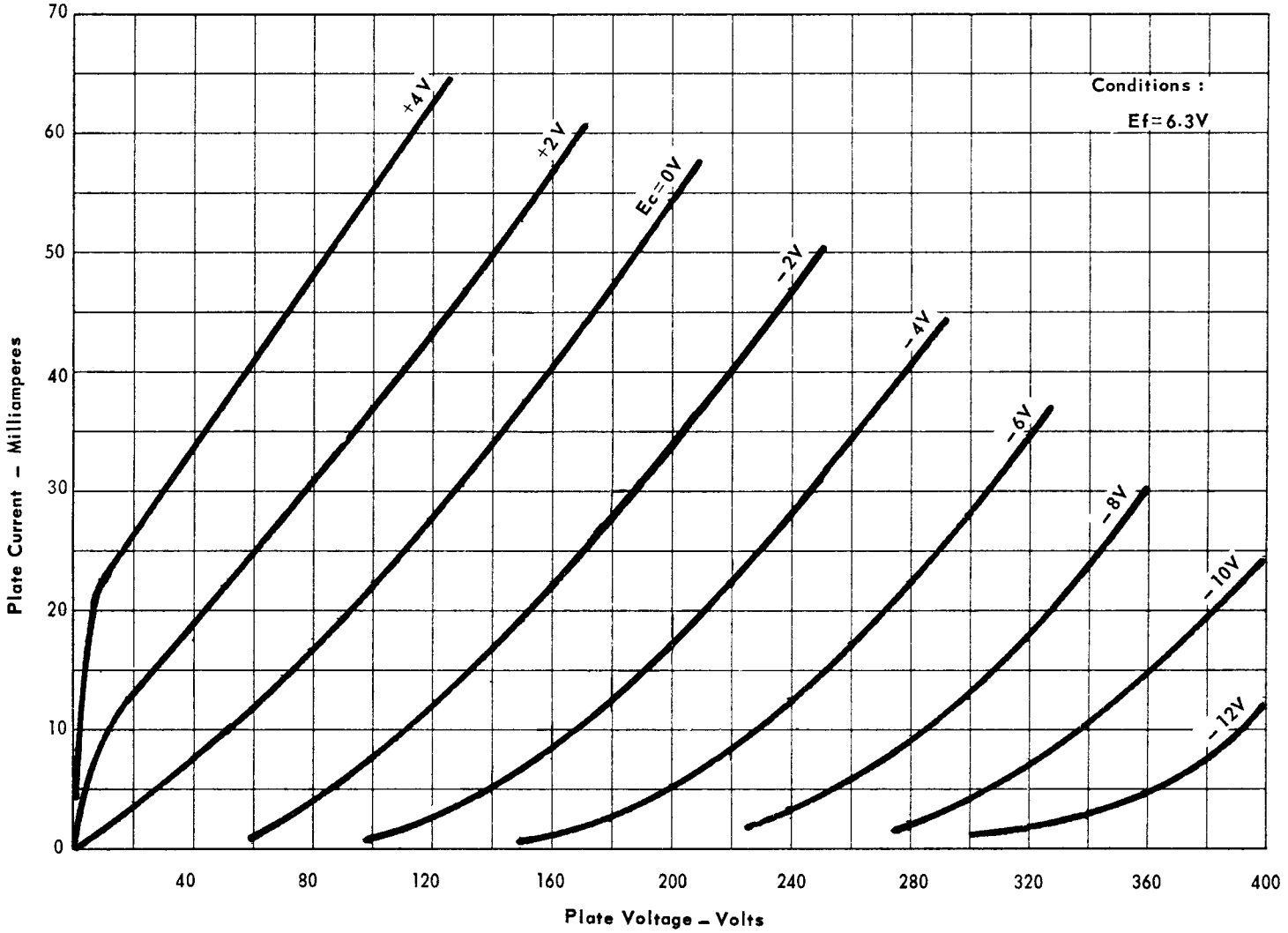



PLATE CURRENT vs. PLATE VOLTAGE