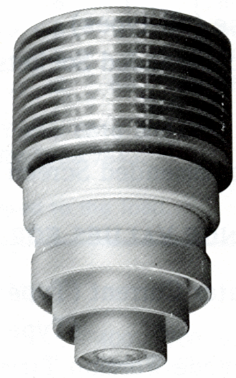
TECHNICAL DATA

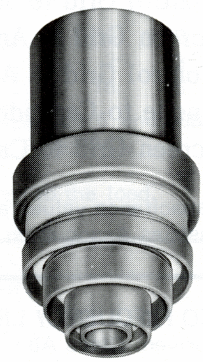
6816
6884
7843

RADIAL-BEAM POWER TETRODES

The EIMAC 6816, 6884, and 7843 are compact external anode ceramic/metal radial-beam tetrodes for use in rf power amplifier or oscillator service, linear rf power amplifier applications, and as audio amplifiers or modulators. The 6816 has a 6.3 volt heater, while the 6884 has a 26.5 volt heater, and both are designed for transverse-flow forced-air cooling of the anode. The 7843 has a 26.5 volt heater and its anode is designed for conduction cooling.

All three types have an F1 rating of 1215 MHz for full-rated power input, and are tested to give a useful power output of 80 watts at 400 MHz and 40 watts at 1200 MHz.


6816/6884


7843

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated Unipotential

Heater Voltage (6816)	6.3 ± 10%	V
Heater Current (at 6.3 V)	2.0	A
Heater Voltage (6884, 7843)	26.5 ± 10%	V
Heater Current (at 26.5 V)	0.53	A

Amplification Factor (Average):

Grid to screen	18

Direct Interelectrode Capacitances [2]

Control Grid to Cathode	13.0	pF
Control Grid to Screen Grid	17.5	pF
Screen Grid to Anode	4.7	pF
Control Grid to Anode	0.05	pF
Anode to Cathode	0.01	pF
Screen Grid to Cathode	0.33	pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as a result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	6816 & 6884	7843
Length	1.930 In; 49.02 mm	1.955 In; 49.66 mm
Diameter	1.265 In; 32.13 mm	1.120 In; 28.45 mm
Net Weight	2.0 oz; 56.7 gm	1.7 oz; 48.2 gm
Operating Position	Any	Any

(Effective 11-15-71)

Printed in U.S.A.

Cooling:

Type 6816, 6884	Forced Air
Type 7843	Conduction Cooled

Operating Temperature, Maximum, all three types:

Ceramic/Metal Seals and Anode Core	250°C
Base (all types)	Special Coaxial
Recommended Sockets (Screen Grid bypass capacitor included):	Erie 2948-000 E.F. Johnson 124-152-1 Jettron 89-001
Recommended Screen Grid bypass capacitor (separate unit):	Erie 2929-001

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current (Type 6816, at 6.3 volts)	1.84	2.26	V
(Type 6884, 7843, at 26.5 volts)	0.48	0.60	A
Cathode Warmup Time (all types)	60	---	Sec
Interelectrode Capacitances [1]			
Control Grid to Cathode	11.0	15.0	pF
Control Grid to Screen Grid	15.0	20.0	pF
Screen Grid to Anode	4.2	5.2	pF
Control Grid to Anode	---	0.065	pF
Anode to Cathode	---	0.013	pF
Screen Grid to Cathode	0.20	0.45	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER

Grid-driven, Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT [1]	.180	AMPERE
PLATE DISSIPATION [2]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz) Class AB1 Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [3]	-18	-18	Vdc
Zero Signal Plate Current	40	40	mAdc
Single-Tone Plate Current	100	100	mAdc
Two-Tone Plate Current	75	75	mAdc
Single-Tone Screen Current [4]	8	4	mAdc
Two-Tone Screen Current [4]	3.5	2	mAdc
Resonant Load Impedance	2200	3500	Ω
Useful Power Output [5] PEP	25	40	W
Distortion Products [6] 3rd:	-35	-30	dB
5th:	-40	-35	dB

1. The maximum rating for a signal having a minimum peak-to-average power ratio less than 2.0, such as single-tone operation, is 180 mAdc. During short periods of circuit adjustment under single-tone conditions, the average anode current may reach the level of 250 mAdc.
2. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
3. Adjust for the specified zero-signal plate current.
4. Approximate value.
5. Approximate value delivered to the load.
6. Referenced against one tone of a two equal-tone signal.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM Telephony

(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.180	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

TYPICAL OPERATION

	400 MHz		1200 MHz	
Plate Voltage	400	900	900	Vdc
Screen Voltage	200	300	300	Vdc
Grid Voltage	-35	-30	-22	Vdc
Plate Current	150	170	170	mAdc
Screen Current [2]	5	1	1	mAdc
Grid Current [2]	3	10	4	mAdc
Driving Power [2]	3	3	5	W
Useful Power Output [3]	23	80	40	W

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Approximate value.
3. Approximate power delivered to the load.

PLATE MODULATED POWER AMPLIFIER

Class C Telephony

(Key-Down Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	800	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.150	AMPERE
PLATE DISSIPATION [1]	75	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

TYPICAL OPERATION AT 400 MHz

Plate Voltage	400	700	Vdc
Screen Voltage	200	250	Vdc
Grid Voltage	-20	-50	Vdc
Plate Current	100	130	mAdc
Screen Current [2]	5	10	mAdc
Grid Current [2]	5	10	mAdc
Peak Screen Voltage [2] (100% modulation)	150	150	v
Driving Power [2]	2	3	W
Useful Power Output [3]	16	45	W

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Approximate value.
3. Approximate power delivered to the load.

AUDIO FREQUENCY POWER AMPLIFIER & MODULATOR Grid-driven, Class AB_1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.180	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Adjust for specified zero signal plate current.
3. Approximate value.

TYPICAL OPERATION, Class AB_1

Values are for 2 tubes

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [2]	-15	-15	Vdc
Peak Drive Voltage, grid-to-grid	30	30	v
Zero Signal Plate Current	80	80	mAdc
Maximum Signal Plate Current	200	200	mAdc
Zero Signal Screen Current [3]	0	0	mAdc
Maximum Signal Screen Current [3]	20	20	mAdc
Effective Load Resistance (plate to plate)	4330	7000	Ω
Maximum Signal Power Output [3]	50	80	W

AUDIO FREQUENCY POWER AMPLIFIER & MODULATOR Grid-driven, Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.180	AMPERE
DC GRID CURRENT	0.030	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for type 7843.
2. Adjust for specified zero signal plate current.
3. Approximate value.

TYPICAL OPERATION, Class AB_2

Values are for 2 tubes

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [2]	-15	-15	Vdc
Peak Drive Voltage, grid-to-grid	46	46	v
Zero Signal Plate Current	80	80	mAdc
Maximum Signal Plate Current	355	355	mAdc
Zero Signal Screen Current [3]	0	0	mAdc
Maximum Signal Screen Current [3]	25	25	mAdc
Maximum Signal Grid Current [3]	15	15	mAdc
Effective Load Resistance (plate to plate)	2450	3960	Ω
Driving Power [3]	0.3	0.3	W
Maximum Signal Power Output [3]	85	140	W

APPLICATION

ELECTRICAL

HEATER/CATHODE OPERATION - The rated heater voltage for the 6884 and the 7843 is 26.5 volts, and for the 6816, 6.3 volts, as measured at the base of the tube. Variations must be restricted to plus or minus ten percent, and where long life and consistent performance are factors, variation from the nominal value should be held to plus or minus five percent.

Because the cathode is subjected to considerable back bombardment (transit-time heating) as the frequency is increased, with resultant increase in cathode temperature, the heater voltage should be reduced in some applications, depending on operating conditions and frequency, to prevent overheating of the cathode and resultant short tube life.

ANODE CURRENT - The 6816, 6884, and 7843 are rated for 180 mAdc of continuous anode current. During short periods of circuit adjustment under CW or single-tone conditions, the average anode current may be as high as 250 mAdc, but care must be taken to keep the time period when the current is above the rating as brief as possible in order to prevent tube overheating.

HIGH VOLTAGE - The 6816, 6884, and 7843 operate at voltages which can be deadly and the equipment must be designed properly and operating precautions must be followed. Equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

MECHANICAL

MOUNTING & SOCKETING - The 6816, 6884, and 7843 may be mounted in any position. Sockets such as the E.F. Johnson 124-152-1, Erie 2948-000, Jettron 89-001, or equivalent may be used as long as there are no unusual circumstances which would allow the ceramic/metal base seal temperatures to exceed the rated maximum of 250°C. Mounting should be such that free movement of air past the base by convection is possible, or when forced-air cooling is being provided for the anode, some of this air may be bled off to provide for come circulation past the tube base.

The 7843 mounting is normally controlled by its heat-sink configuration and location. If air movement is restricted in the base area, the socket may also require coupling to a heat sink in order to limit base seal temperatures.

VIBRATION - These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this are expected, it is suggested the EIMAC 7457 be employed.

COOLING (6816 & 6884) - Forced-air cooling must be provided to maintain the anode core and seal temperatures within the maximum rating. For best cooling efficiency a close-fitting insulated cowl assembly should be used to direct air past the anode cooling fins, and with such a cowl 12 cfm of air at 50°C maximum at sea level is sufficient to limit the anode core temperature to 225°C. With a short section of cowl, the required pressure drop to produce this air flow is approximately 0.1 inch of water. At higher altitudes, additional air is required. For 10,000 feet, for example, flow rate and pressure drop values will both increase by a factor of 1.46. The equipment designer is cautioned to allow for some air circulation around the base of the tube to maintain temperatures well within ratings, and if necessary some of the air available for anode cooling should be bled into the vicinity of the base to provide a small amount of forced circulation.

COOLING (7843) - This tube is designed for use in a conduction-cooled system, where tube anode heat is transferred to a heat sink, which in turn may be cooled by natural (free) convection, forced-air convection, liquid cooling, or a combination of these methods. Anode dissipation is normally limited only by the allowable temperature rise for the seals and the anode core. The nominal dissipation rating of 115 watts may be realized with relatively simple heat sink configurations, with higher dissipation levels possible with more thorough designs. In all cases, however, the cooling system must maintain the anode and ceramic/metal seal temperatures below 250°C, and in cases where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

Intimacy of contact and pressure are two factors which will effect transfer of heat from the tube anode to the heat sink. A good thermally conductive compound should be used in the interface between the anode and the sink to reduce thermal resistance of the joint. Examples of commercially available thermal joint compound are:

WAKEFIELD 120-Wakefield Engineering Co., Wakefield, MA 01880.
DOW CORNING 340-Dow Corning Corp., Midland, MI 48640.
ASTRODYNE THERMAL BOND 312-Astrodyne Inc., Burlington, MA 01803.
G.E. INSULGREASE G641-General Electric Co., Cleveland, OH 44117.

The designer is cautioned to allow for some movement in the socket mount to assure that the anode makes good contact to its heat sink without interference. If the tube anode and the sink are not making intimate contact, heat transfer will be seriously affected. The designer is encouraged to use temperature-sensitive paint or other temperature-sensing devices in connection with any equipment design before the layout is finalized.

GRID OPERATION - The maximum rated dc grid bias voltage is -100 volts and the maximum grid dissipation rating is 1.0 watts. In normal applications the grid dissipation will not approach the maximum rating.

At operating frequencies above the 100 MHz region, driving-power requirements for amplifiers increase noticeably. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory VHF/UHF operation of the tube in a stable amplifier is indicated by grid current values below approximately 15 mAdc.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 25,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen grid is 4.5 watts, and the screen input power should be kept below this level. The product of peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode. A series regulator circuit can be used only when an adequate bleeder resistor is provided.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be on before screen voltage can be applied.

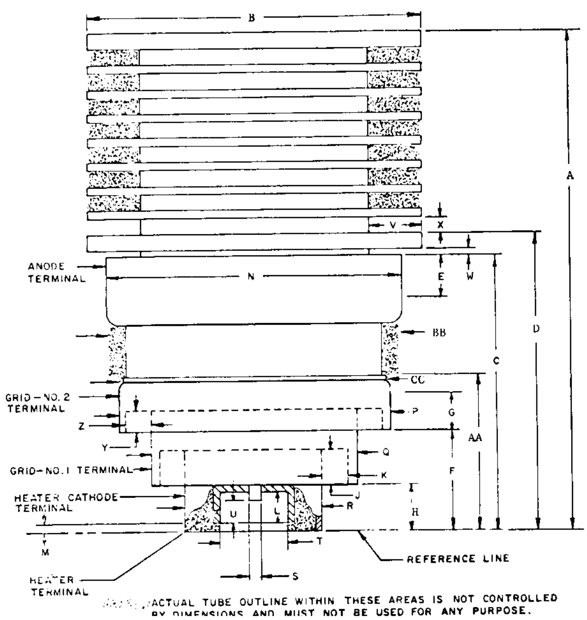
MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is a good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event one tube fails.

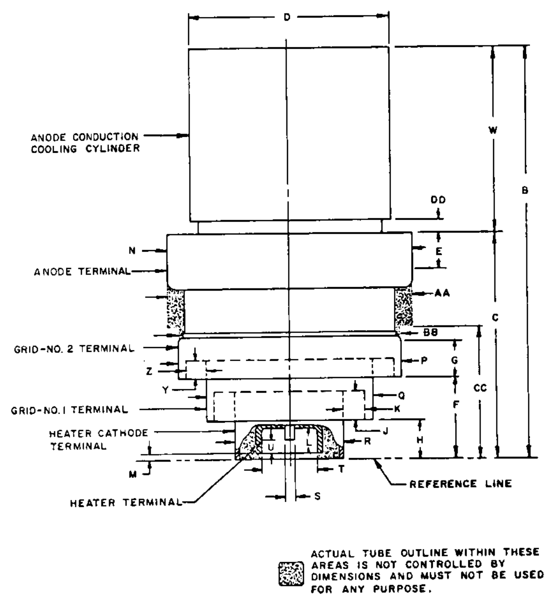
VHF OPERATION - The 6816, 6884, and 7843 are suitable for use in the VHF/UHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is increased by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the additional capacitance values which will exist in any normal application. Actual measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate any of these tubes under conditions widely different from those given here, write to Power Grid Division, Attention: Applications, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.



6816/6884



7843

DIMENSIONAL DATA (6816/6884)

DIM.	INCHES MIN.	INCHES MAX.	INCHES REF.	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF.
A	1.830	1.930	- -	46.48	49.02	- -
B	1.235	1.265	- -	31.37	32.13	- -
C	1.000	1.060	- -	25.40	26.92	- -
D	1.090	1.180	- -	27.26	29.97	- -
E	0.165	- -	- -	4.19	- -	- -
F	0.350	0.390	- -	8.89	9.91	- -
G	0.140	- -	- -	3.56	- -	- -
H	0.160	0.190	- -	4.06	4.83	- -
J	0.120	- -	- -	3.05	- -	- -
K	0.095	- -	- -	2.41	- -	- -
L	0.100	- -	- -	3.05	- -	- -
M	- -	0.050	- -	- -	1.27	- -
N	1.085	- -	- -	27.56	- -	- -
P	0.985	- -	- -	25.02	- -	- -
Q	0.735	- -	- -	18.67	- -	- -
R	0.480	- -	- -	12.19	- -	- -
S	- -	0.072	- -	- -	1.83	- -
T	0.240	0.260	- -	6.10	6.60	- -
U	0.054	- -	- -	1.37	- -	- -
V	0.200	- -	- -	5.08	- -	- -
W	0.035	- -	- -	0.89	- -	- -
X	0.050	- -	- -	1.27	- -	- -
Y	0.060	- -	- -	1.52	- -	- -
Z	0.090	- -	- -	2.29	- -	- -
AA	0.600	- -	- -	15.24	- -	- -
BB	- -	1.120	- -	- -	28.45	- -
CC	- -	1.020	- -	- -	25.91	- -

NOTE: With the cylindrical surfaces of anode terminal, screen grid terminal, control grid terminal, heater-cathode terminal, and heater terminal clean, smooth, and free from burrs, the tube shall enter a gage which defines diameters which are concentric within 0.001 inch (0.03 mm), with diameters as follows:

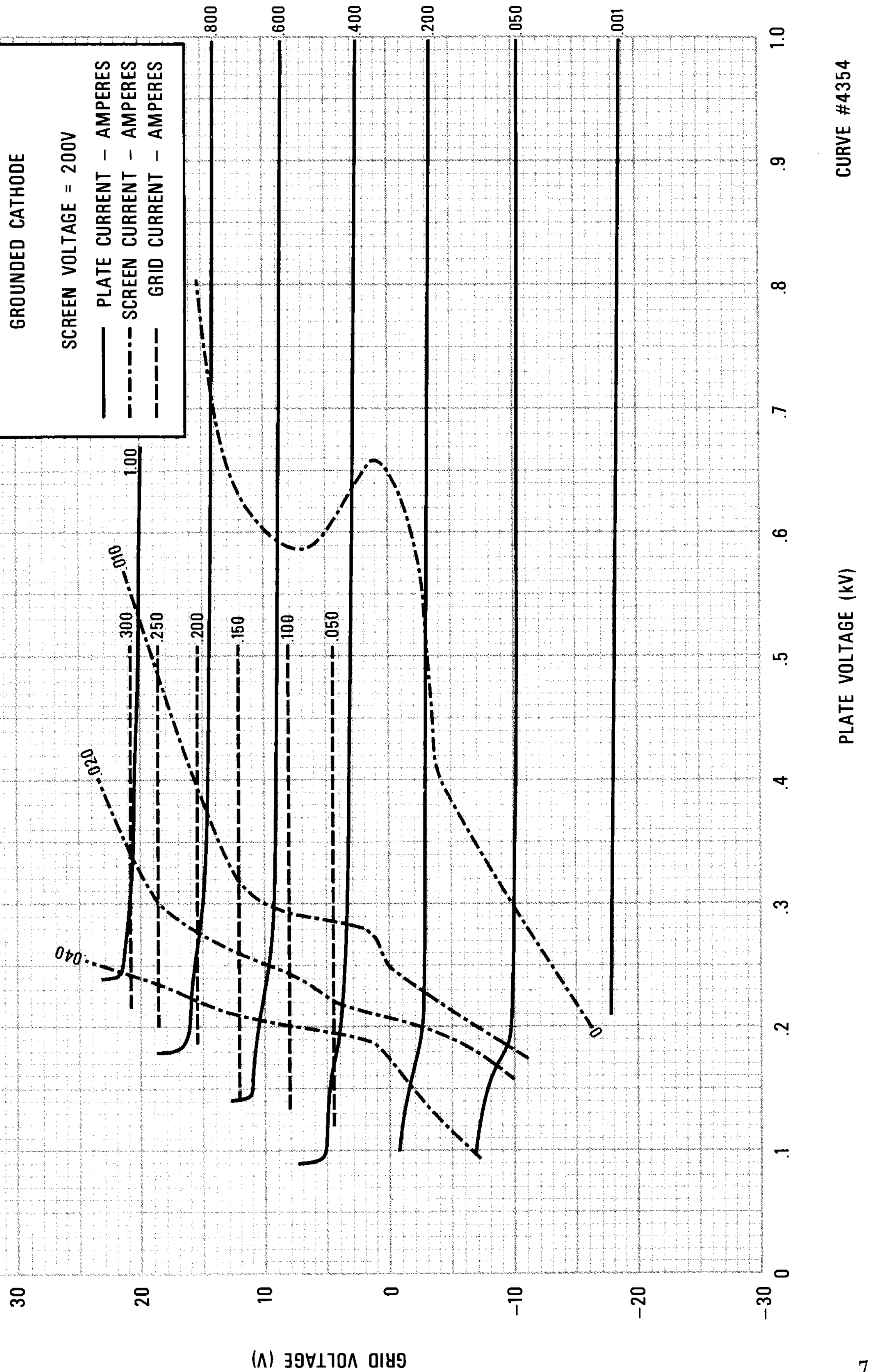
Radiator band	1.316 In.	33.43 mm
Anode terminal	1.120	28.45
Grid No. 2 (screen) terminal	1.020	25.91
Grid No. 1 (control) terminal	0.765	19.43
Heater-cathode terminal	0.520	13.21
Heater terminal	0.240	6.10
Axial Pin	0.072	1.83

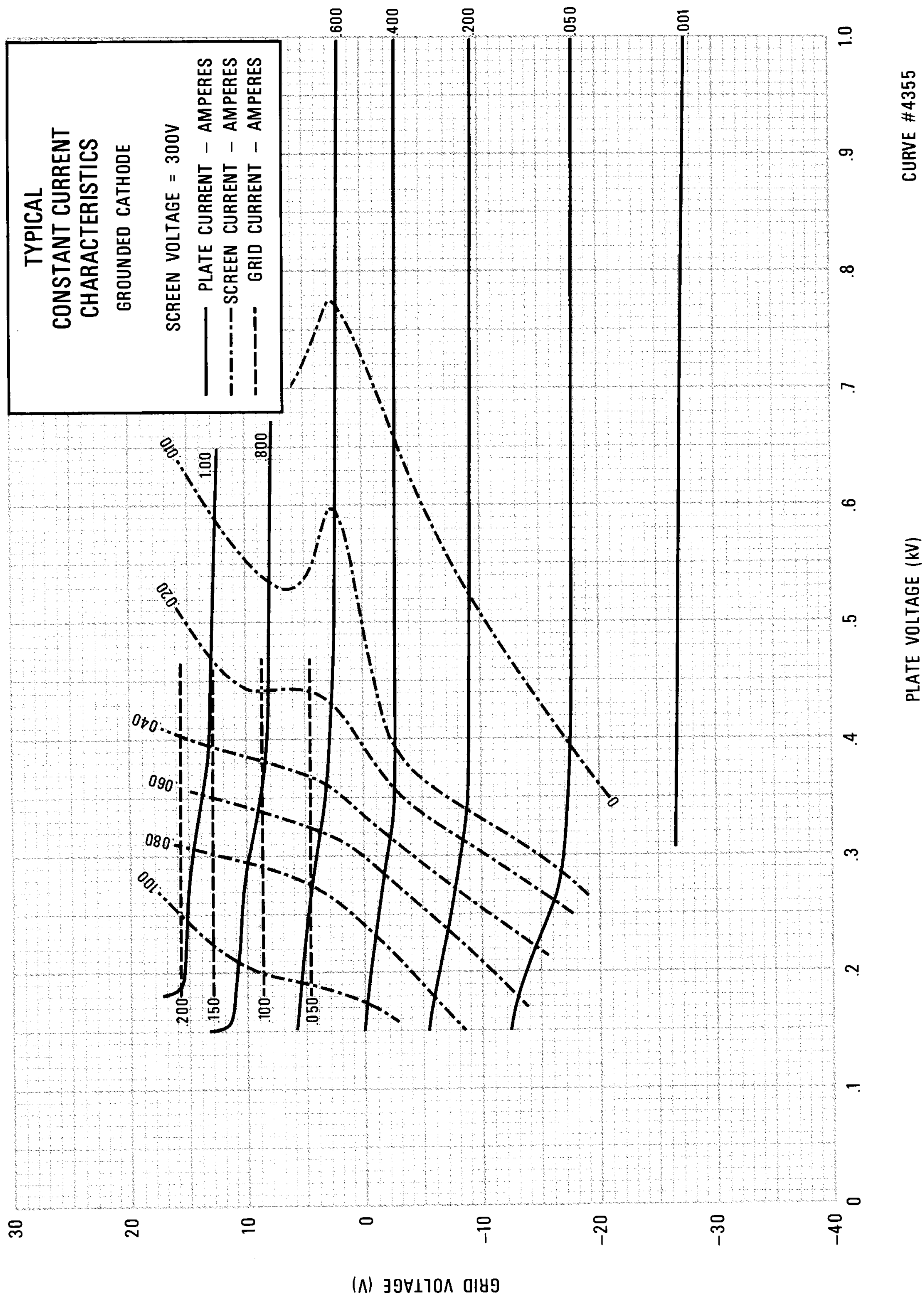
DIMENSIONAL DATA (7843)

DIM.	INCHES MIN.	INCHES MAX.	INCHES REF.	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF.
B	1.805	1.955	- -	45.85	49.66	- -
C	0.990	1.080	- -	25.15	27.43	- -
D	0.895	0.905	- -	22.73	22.99	- -
E	0.165	- -	- -	4.19	- -	- -
F	0.340	0.410	- -	8.64	10.41	- -
G	0.140	- -	- -	3.56	- -	- -
H	0.150	0.200	- -	3.81	5.08	- -
J	0.120	- -	- -	3.05	- -	- -
K	0.095	- -	- -	2.41	- -	- -
L	0.100	- -	- -	2.54	- -	- -
M	0	0.050	- -	0	1.27	- -
N	1.085	- -	- -	27.56	- -	- -
P	0.985	- -	- -	25.02	- -	- -
Q	0.735	- -	- -	18.67	- -	- -
R	0.480	- -	- -	12.12	- -	- -
S	- -	0.072	- -	- -	1.83	- -
T	- -	0.260	- -	- -	6.60	- -
U	0.054	- -	- -	1.37	- -	- -
W	0.780	- -	- -	19.81	- -	- -
Y	0.060	- -	- -	1.52	- -	- -
Z	0.090	- -	- -	2.29	- -	- -
AA	- -	1.120	- -	- -	28.45	- -
BB	- -	1.020	- -	- -	25.91	- -
CC	0.600	- -	- -	15.24	- -	- -
DD	0	- -	- -	0	- -	- -

NOTE: With the cylindrical surfaces of anode terminal, screen grid terminal, control grid terminal, heater-cathode terminal, and heater terminal clean, smooth, and free from burrs, the tube shall enter a gage which defines diameters which are concentric within 0.001 inch (0.03 mm), with diameters as follows:

Anode proper	0.952 In.	24.19 mm
Anode terminal	1.120	28.45
Grid No. 2 (screen) terminal	1.020	25.91
Grid No. 1 (control) terminal	0.765	19.43
Heater-cathode terminal	0.520	13.21
Heater terminal	0.240	6.10
Axial pin	0.072	1.83


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 200V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
.800
.600
.400
.200
.050
.001
1.00
.010
.020
.040
0
.300
.250
.200
.150
.100
.050
30
20
10
0
–10
–20
–30
GRID VOLTAGE (V)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
PLATE VOLTAGE (kV)
CURVE #4354



TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 300V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
.600
.400
.200
.050
.001
1.00
.800
.200
.150
.100
.050
.010
.020
.040
.060
.080
.100
0
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
PLATE VOLTAGE (kV)
30
20
10
0
–10
–20
–30
–40
GRID VOLTAGE (V)
CURVE #4355