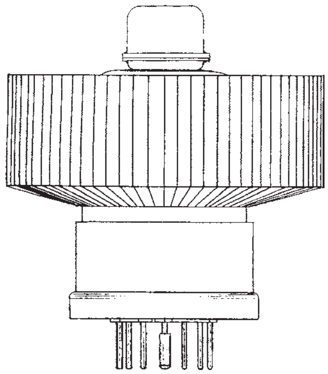

3CPX1500A7

High-Mu Power Triode

The Penta Laboratories 3CPX1500A7 is a rugged ceramic/metal high-mu power triode, designed with beam-forming cathode and control-grid geometry to allow the simplicity of design and circuit advantages of a triode with the gain of a tetrode.

The 3CPX1500A7 is intended for pulse modulator or pulse regulator service, with a pulse plate current rating of 50 amperes, and a voltage holdoff rating 10,000 volts in air, with forced-air cooling of the andoe, or 15,000 volts when immersed in a suitable dielectric liquid which is also used for tube cooling.

General Characteristics[1]

Electrical

Cathode: Oxide Coated, Unipotential

Heater:		
Voltage	5.5 ± 0.25	V
Current (Ef = 5.5 volts)	11.2	A
Transconductance (Average, with Ib = 1.0 Adc)	55,000	μmhos
Amplification Factor (Average)	200	
Direct Interelectrode Capacitiances (grounded cathode)[2]		
Cin	38.5	pF
Cout	0.1	pF
Cgp	10	pF

1. Characteristics and operating values based upon performance tests. These figures may change without notice as a result of additional data or product refinement. Penta Laboratories 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.

Revised 09 November 2009

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Mechanical

Maximum Overall Dimensions:		
Length	4.02 (102)	inch (mm)
Diameter	3.38 (86)	inch (mm)
Net Weight	26 (735)	ounce (gram)
Operating Position	Any	
Maximum Operating Temperature:		
Ceramic/Metal Seals or Anode Core	250°	C
Base	Special 7-pin	
Recommended Air-System Socket		
Grounded Cathode	PSK-2200	
Grounded Grid	PSK-2210	
Recommended Air Chimney	PSK-2216	

Range of Values for Equipment Design

	Min.	Max.	
Heater Current (Ef = 5.5 Volts)	10.2	12.2	Amperes
Cathode Warm-up Time	90	---	Seconds
Interelectrode Capacitances (grounded cathode connection)[1]			
Cin	36.0	41.0	pF
Cout	---	0.2	pF
Cgp	9.2	11.2	pF

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

Pulse Modulator or Switch Tube Service

Absolute Maximum Ratings

	In Air	In Oil	
Heater Voltage	5.5±5%	5.5±5%	Volts
DC Plate Voltage	10.0	15.0	Kilovolts
DC Grid Voltage	-200	-200	Volts
Peak Plate Current[1]	50	50	Amperes
Pulse Length and Duty	See Derating Chart		
Plate Dissipation[2]	1500	1500	Watts
Grid Dissipation	25	25	Watts

Typical Operation - Pulse Modulator Service

Plate Voltage	10.0	15.0	kVdc
Pulse Plate Current	40	40	a
Grid Voltage	-125	-150	Vdc
Pulse Positive Voltage[3]	340	340	v
Pulse Grid Current[3]	1.5	1.5	a
Pulse Duration	2.0	2.0	µs
Duty	0.0006	0.0006	
Pulse Driving Power[3]	697	735	w
Pulse Output Power[3]	306	506	kw
Pulse Output Voltage[3]	7.68	12.68	kv

1. Pulse length, pulse plate voltage, and duty are interrelated; see Derating Chart.
2. Plate dissipation values shown are nominal; capability is dependandt on cooling technique and equipment design. In all cases the ABSOLUTE MAXIMUM temperature ratings should not be exceeded, and for best life and consisitent performance operation at lower temperatures in normally benificial.
3. Approximate value.

Application Considerations

Mounting

The 3CPX1500A7 may be mounted in any position. The PSK-2200 and PSK-2210 sockets are designed to hold the tube and make all base contacts, and for applications where forced-air cooling is to be used, the matching air chimney , PSK2216 is available.

Cooling

The 3CPX1500A7 may be either forced-air cooled or liquid-immersion cooled in a suitable dielectric coolant fluid. The maximum temperature limit for external tube surfaces and the anode core is 250°C. but it should be noted that, where long life and consistent performance are important design factors, operation at somewhat lower temperatures is normally beneficial. The air cooling data shown will maintain tube temperatures below 225°C with 50°C cooling air.

When the tube is liquid-immersed, circulation of the dielectric fluid will normally be required and the designer is cautioned to assure sufficient tube cooling for the maximum dissipation level likely to ever be reached with some safety factor allowance.

Base-to-Anode Air Flow (sea level)

Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H_2O
500	7.5	0.10
1000	22.5	0.20
1500	35	0.41

Base-to-Anode Air Flow (10,000 ft.)

Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H_2O
500	11.0	0.15
1000	32.5	0.29
1500	51	0.60

Note:
1. Tube mounted in PSK-2200 socket with PSK-2210 chimney.
2. An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

Filament/Cathode Operation

Pulse current capabiity of the 3CPX1500A7 is dependant on cathode temperature, which in turn is dependant on heater voltage. When the full rated (ib=50 amperes maximum) anode current is requried, the heater voltage should be operated at 5.5 volts and not deviate from this nominal value by more than plus or minus five percent. When a lower value of anode current (ib=24 amperes maximum) is adequate for the application, the heater voltage should be reduced to 5.0 volts, plus or minus five percent, and tube life expectancy will be greatly imporved. In cases where better tube life expectancy and consistent performance are factors, regulation to better than five percent will normally be beneficial at either heater voltage level. Voltage should be measured with a know accurate rms-responding meter.

Anode Current

For pulse service, either as a switch tube or modulator, or for voltage regulator applications, an anode current (during the pulse) of up to 50 amperes is available, with Ef=5.5 volts, or up to 24 amperes with Ef=5.0 volts. Peak current capability, pulse length, and duty factor are interrelated and the Pulse Derating Data should be consulted. For pure dc service, the anode current should be limited to 1.0 ampere.

High Voltage

For air operation, anode voltage should not exceed 10 kVdc at sea level. This value allows some safety factor, but does assume a clean tube with no buildup of dirt or grime across the insulating ceramic. At higher altitudes a reduction in voltage may be required to preclude the possibility of external tube flashover. When the tube is immersed in a liquid dielectric coolant with suitable insulating properties the allowable anode voltage is 15 kVdc at any altitude.

The operating voltages for this tube must be considered as potentially lethal and the equipment must be designed properly and operating precautions must be followed. The equipment must include safety enclosures for the high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge the high voltage condensers whenever access doors or covers are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

Plate Surge-Limiting Impedance

Tubes such as the 3CPX1500A7 are built with closely spaced electrodes. This results in high voltage gradients even at normal operating voltages. A high-energy arcover between electrodes may be destructive, and therefore a series impedance in the anode lead is recomended, or the anode supply should be designed so that it has sufficient self impedance to limit the short-curciut current to 10 times the maximum pulse-current rating. Normal overload protection techniques should also be used in the anode circuit to prevent tube damage in the event of a fault condition.

X-ray Radiation Hazard

High-vacuum tubes operating at voltages higher than about 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 3CPX1500A7, operating at its rated voltages and currents, is a potential X-ray hazard, with only limited shielding afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirements for, or the adequacy of, shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to better locate an equipment malfunction can result in serious X-ray exposure.

Grid Operation

The maximum rated dc grid bias voltage for the 3CPX1500A7 is -200 Vdc and the maximum grid dissipation is 25 watts. In normal applications the grid dissipation will not approach the maximum rating.

The circuit designer should be aware that grid secondary emission effects typically occur with a tube of this size and must be considered. This effect has to do with tube geometry, the materials used in such grid structures and operating potentials. The Constant Current Characteristics plots (see page 7 and 8) show both positve and negative (secondary) grid current flow as being typical.

A driver stage which works into such a non-linear load normally must be designed in such a manner as to tolerate this condition, such as swamping the drivers so that the change in load due to forward or reverse grid current is a small percentage of the total load the driver works into.

Plate Operation

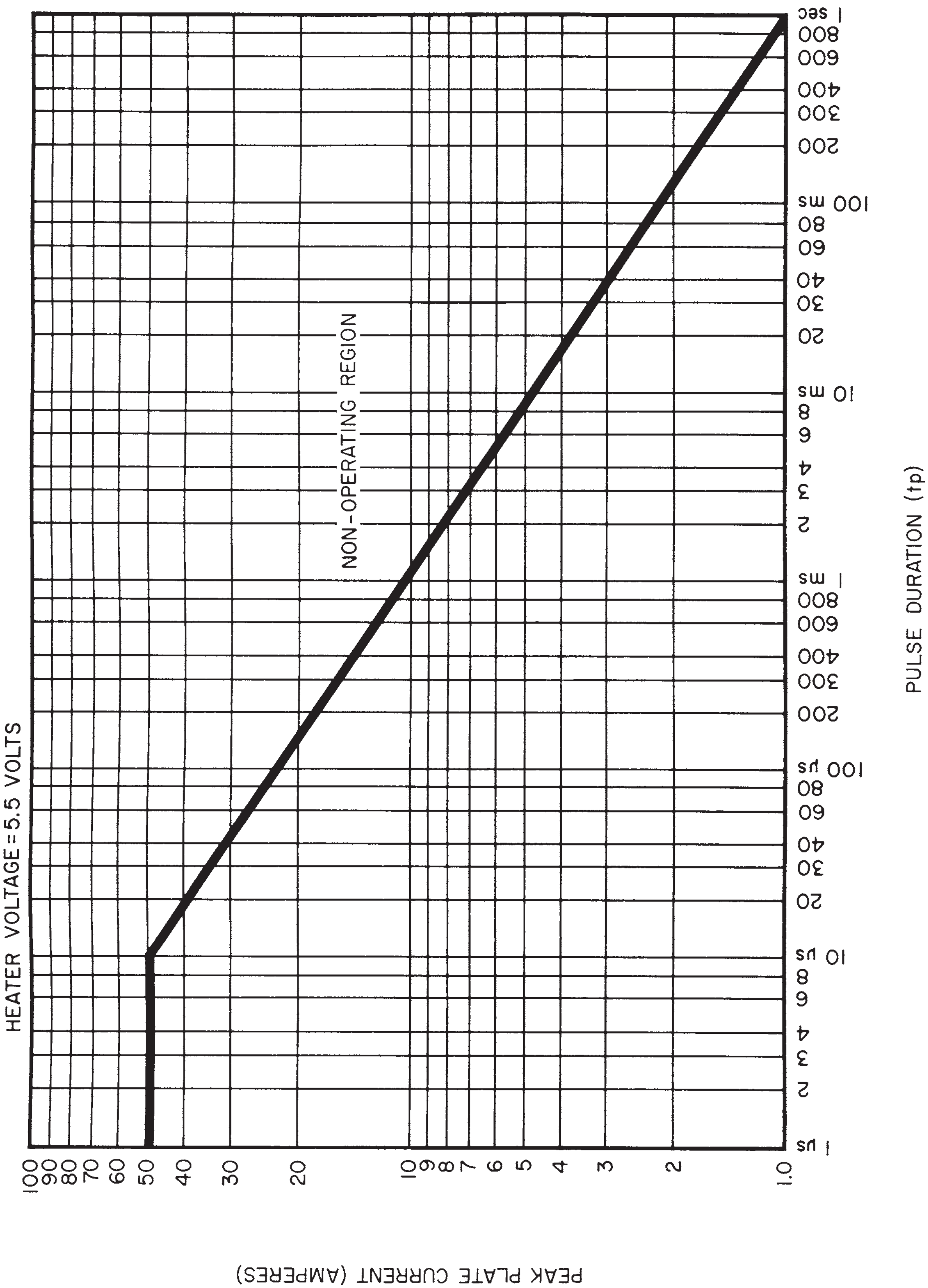
The anode of the 3CPX1500A7 is nominally rated for the dissipation values shown on page 2 depending on the type of cooling used. When the tube is immersed in a liquid dielectric coolant, with proper circulation, and (if required) provisions for dielectric fluid cooling, dissipation capabiltiy is actually limited only to tube temperature, especially in the seal areas and the anode core.

In pulse service, average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value, however, if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times allow plate current to flow for longer periods of time in the high tube-voltage-drop region.

Interelectrode Capacitance

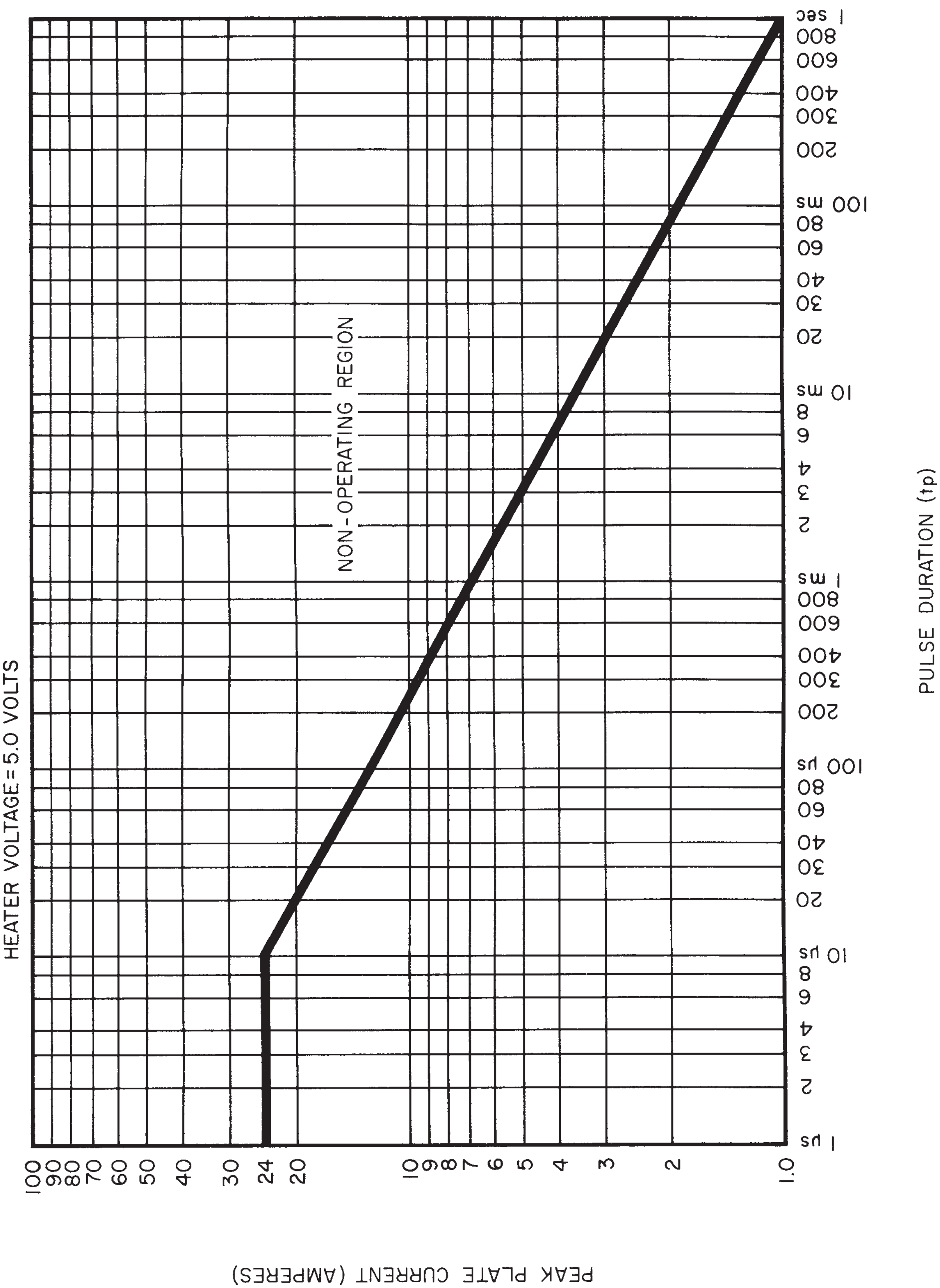
The actual internal interelectrode capacitance of a tube is influenced by many varialbes in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Militaty Services use a standard test procedure as described in Electreonic 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 eleminates 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; manufacture's technical data, or test specifications, normally are taken in accordance with Standards RS-191.

The equipment designer is therefore cautioned to make allowances for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.



PULSE DERATING DATA, TYPE 3CPX1500A7 - PULSE MODULATOR OR REGULATOR SERVICE

Peak (pulse) plate current capability is dependent on pulse duration (tp) and duty factor (Du). Maximum peak plate current for a given value of tp is shown. Maximum Du may then be derived from the relationship: $1.0 = ib \sqrt{Du}$



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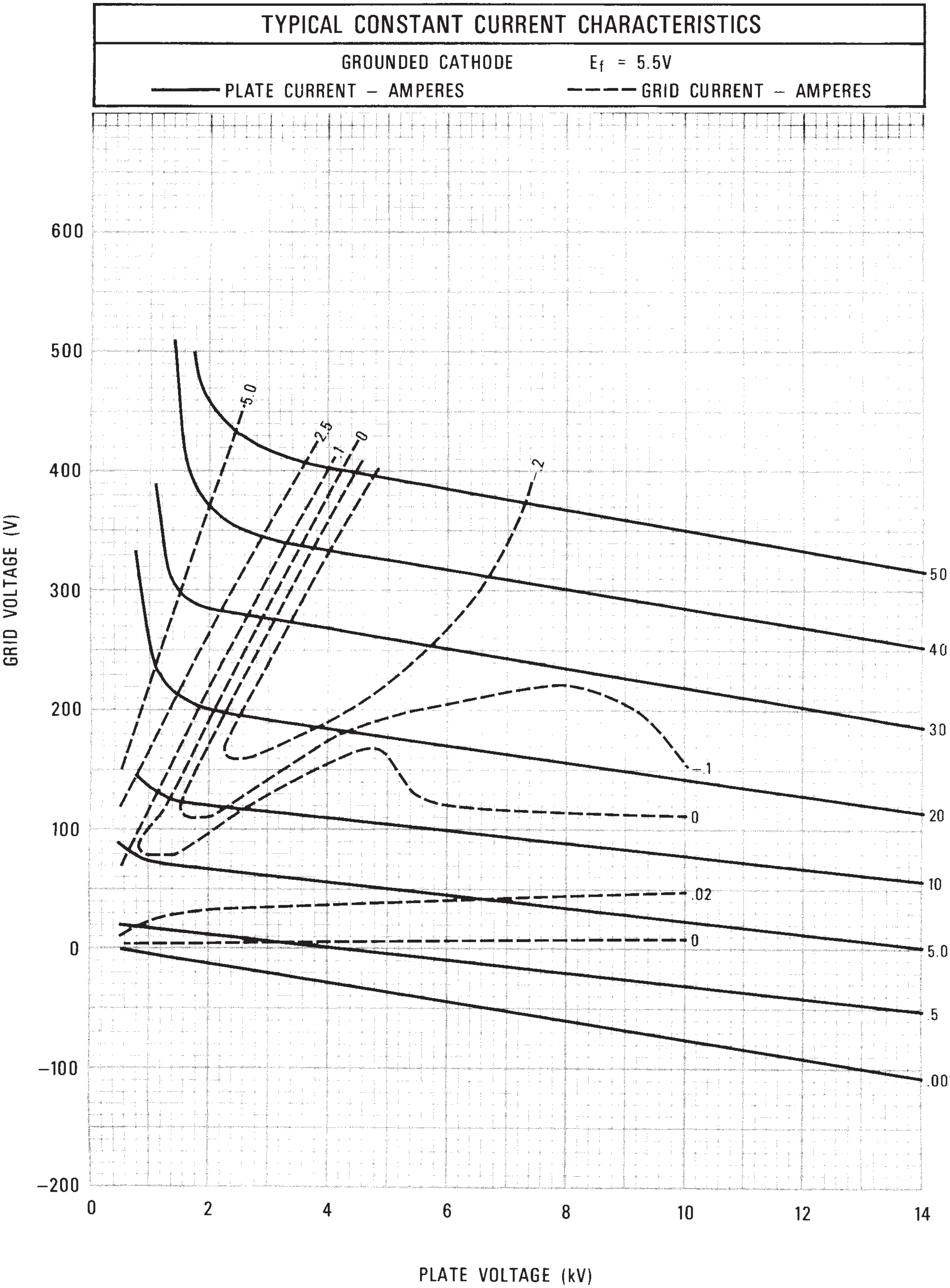
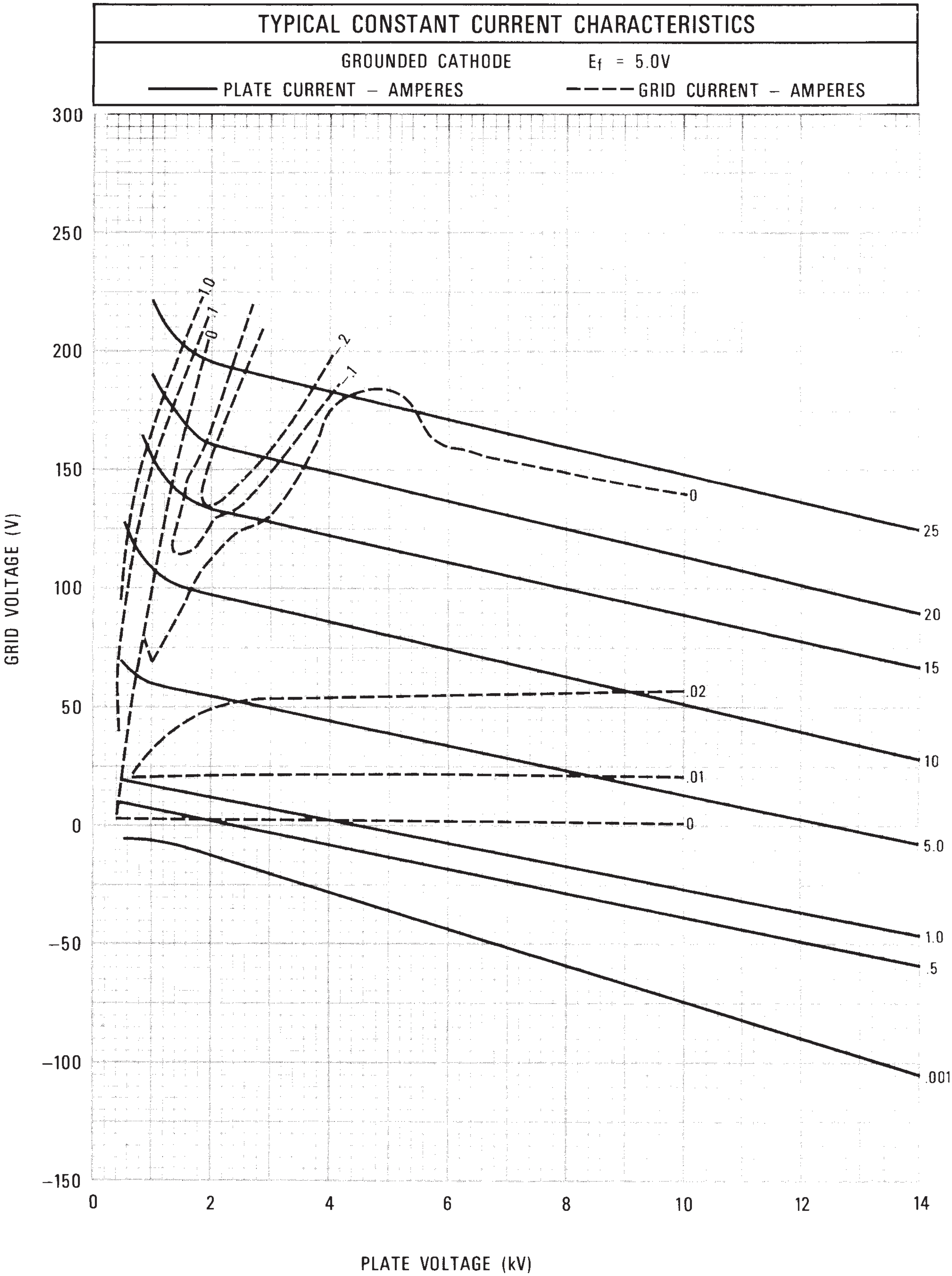
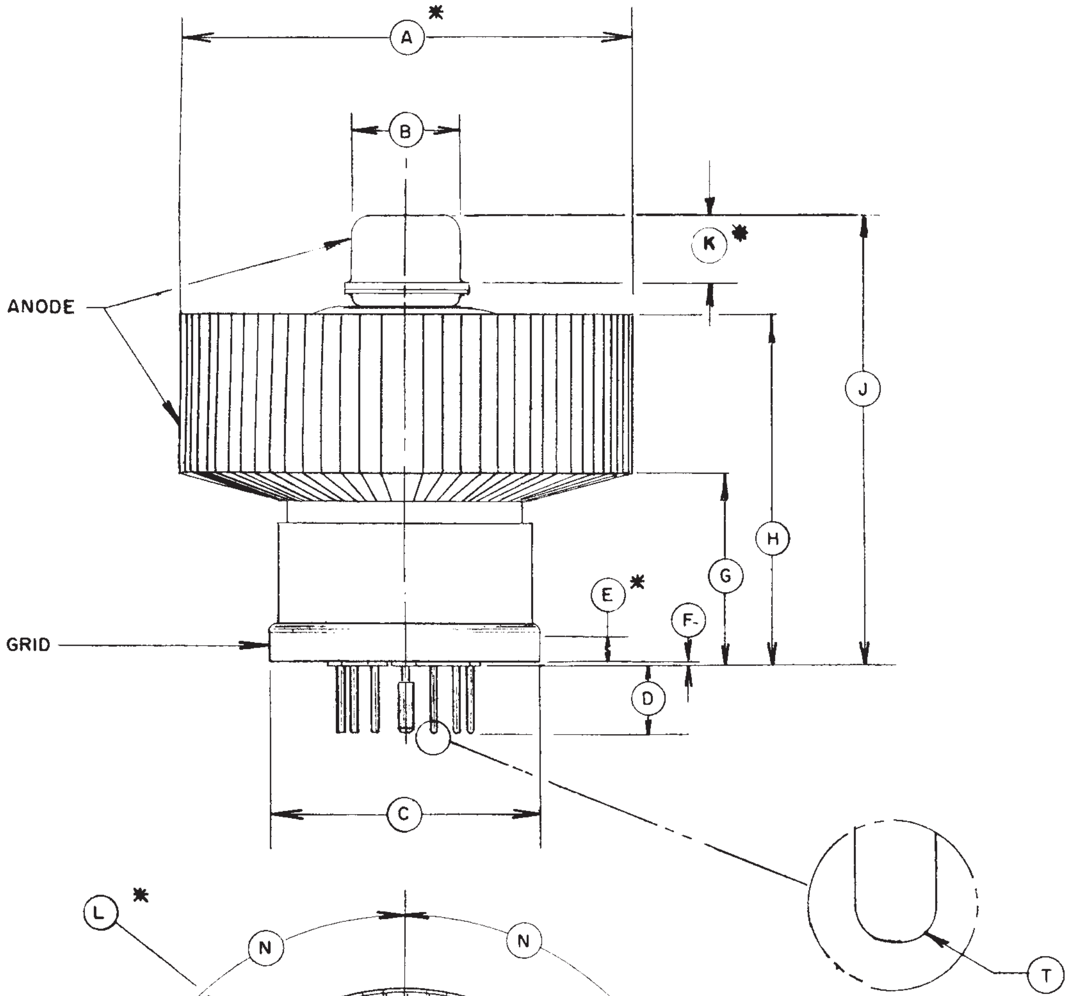


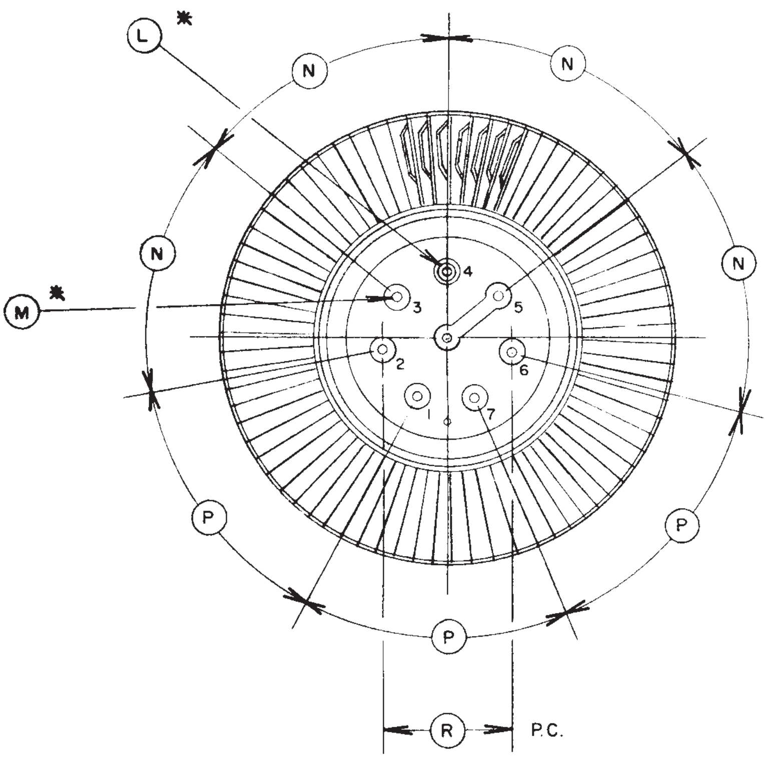
TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
Ef = 5.5V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
600
500
400
300
200
100
0
−100
−200
0
2
4
6
8
10
12
14
PLATE VOLTAGE (kV)
50
40
30
20
10
5.0
.5
.001
5.0
2.5
1
0
2
1
0
.02
0

3CPX1500A7 High-Mu Power Triode



3CPX1500A7 High-Mu Power Triode





PIN CONNECTIONS

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	- -	85.09	85.85	- -
B	0.810	0.820	- -	20.57	20.83	- -
C	1.995	2.015	- -	50.67	51.18	- -
D	0.438	0.562	- -	11.13	14.27	- -
E	0.235	- -	- -	5.97	- -	- -
F	0.000	0.040	- -	0.00	1.02	- -
G	1.350	1.475	- -	34.29	37.46	- -
H	2.550	2.675	- -	64.77	67.94	- -
J	3.250	3.420	- -	82.55	86.87	- -
K	0.470	0.530	- -	11.94	13.46	- -
L	0.120	0.127	- -	3.05	3.23	- -
M	0.056	0.062	- -	1.42	1.57	- -
N	- -	- -	51°	- -	- -	51°
P	- -	- -	52°	- -	- -	52°
R	- -	- -	1.000	- -	- -	25.40
T	0.020R	- -	- -	0.51 R	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE
3. DIMENSION T APPLIES TO ALL BUT CENTER PIN.