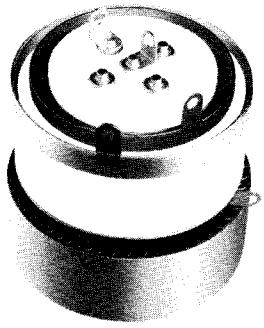
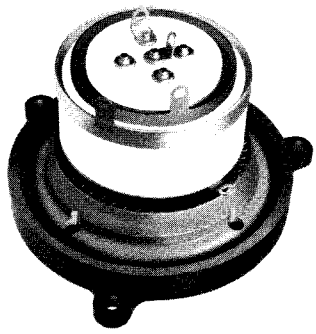
TECHNICAL DATA

4CPL1000 A/B/C SWITCH TUBE



4CPL1000A



4CPL1000B

4CPL1000C

The 4CPL1000 series tubes are designed for switch-tube, pulse modulator, or voltage regulator service. They will pass anode current up to 8 amperes for pulses up to 100 microseconds duration, and derated values of anode current at longer pulse durations.

The tubes have an oxide cathode and electrical connections are made to solder tabs which are integral to the tube elements.

All three are designed for immersion cooling in a liquid dielectric fluid such as COOLANOL 25® or FLOCOOL 180® where specified. With proper design of the cooling system each tube type is capable of an anode dissipation of 1000 watts. With proper forced-air cooling, each anode can dissipate 300 watts.

The three tubes are electrically identical, and differ mechanically only in anode configuration. The 4CPL1000A mounting is at the option of the equipment designer. The 4CPL1000B provides a flange and rubber support for environmental stress absorbtion. The 4CPL1000C provides an integral anode mounting flange.

The tubes are rated to operate at an anode voltage up to 15 kVdc when immersed in the recommended liquid dielectric cooling fluid, and when so-immersed the voltage rating is not altitude-dependent.

G E N E R A L C H A R A C T E R I S T I C S [1]

ELECTRICAL

Cathode: Oxide-coated Unipotential

Voltage	6.3 V
Current, at 6.3 V	4.9 A
Cathode Warmup Time (before application of high voltage)	120 Sec

Direct Interelectrode Capacitance [2]

Cg1k	26 pF
Cg1g2	33 pF
Cg2p	5.3 pF
Cg1p	0.1 pF
Cpk	0.1 pF
Cg2k	27 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured with no special shielding but otherwise in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, with Solder-tab Terminals
Operating Position	Any
Maximum Operating Temperatures: Anode Core and Ceramic/Metal Seals	250°C
Cooling	Forced Air, or Immersion in Special Liquid Dielectric
Maximum Overall Dimensions:	
4CPL1000A Length	2.71 In; 68.83 mm
Diameter	2.05 In; 51.94 mm
4CPL1000B Length	2.71 In; 68.83 mm
Diameter (nominal)	3.00 In; 76.20 mm
4CPL1000C Length (nominal)	2.68 In; 68.07 mm
Diameter	2.75 In; 69.85 mm
Tube Weight:	
4CPL1000A	10.2 oz; 290 gms
4CPL1000B	11.6 oz; 328 gms
4CPL1000C	10.8 oz; 306 gms

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RANGE VALUES FOR EQUIPMENT DESIGN:

	Min.	Max.	
Heater: Current at 6.3 Volts	4.4	5.4	A
Cathode Warmup Time (before application of high voltage)	120	---	Sec
Interelectrode Capacitance [1]			
Cg1k	20.0	32.0	pF
Cg1g2	25.0	41.0	pF
Cg2p	4.3	6.3	pF
Cg1p	---	0.2	pF
Cpk	---	0.2	pF
Cg2k	---	30.0	pF

1 Capacitance values are for a cold tube as measured with no special shielding but otherwise in accordance with Electronic Industries Association Standard RS-191.

PULSE MODULATOR OR SWITCH TUBE SERVICE

ABSOLUTE MAXIMUM RATINGS:

HEATER VOLTAGE	6.3 + 5%	VOLTS
DC PLATE VOLTAGE ##	15.0	KILOVOLTS
PEAK POS. PLATE VOLTAGE ##	20.0	KILOVOLTS
DC PLATE VOLTAGE **	7.0	KILOVOLTS
DC SCREEN VOLTAGE	700	VOLTS
DC GRID VOLTAGE	-150	VOLTS
PEAK PLATE CURRENT #	8.0	AMPERES

PULSE DURATION & DUTY #	See Derating	Chart
PLATE DISSIPATION ##	1000	WATTS
PLATE DISSIPATION **	300	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	4	WATTS

\# Pulse duration, peak current and duty are inter-related. See DERATING CHART.

In liquid dielectric coolant with proper technique and design.

** In air with recommended minimum cooling; voltage rating shown is for sea level.

A P P L I C A T I O N

MECHANICAL

MOUNTING - The tubes may be operated in any position, with orientation normally controlled by the anode mounting configuration and factors effecting circulation of the liquid immersion dielectric coolant.

BASE CONNECTIONS - All base connections are by means of solder tabs. These are attached directly to the tube electrode terminations on the base seals with a high-temperature solder. Care must be exercised by the user when attaching leads to these tabs; only a low-power soldering iron, such as a pencil type, should be used and application of heat should be held to the minimum required to make a good solder connection using standard 60-40 lead/tin solder. The leads should not place strain against the terminals; strain relief loops should be provided.

COOLING - During operation the tube must be adequately cooled to maintain all surfaces and the anode core below the maximum temperature rating. It may be completely immersed in COOLANOL 25® (Monsanto Company), or FLOCOOL 180® (Chevron USA Inc) where specified. For a plate dissipation of 1000 watts coolant must be forced through the anode heat exchanger at a rate of 0.5 gallon per minute, with incoming coolant temperature not to exceed 60°C, and a resultant pressure drop across the anode heat exchanger of approximately 0.15 psi. Normal system pressure should not exceed 130 to 170 psig, though the tube is capable of withstanding an imploding test pressure of 225 psig. At the flow rate specified above surface temperatures of the tube will not exceed 150°C for an anode dissipation of 1000 watts.
If the tube is not liquid immersed, forced-air cooling must be used, with a maximum anode dissipation of 300 watts. A minimum flow of 8 cfm of air at 50°C maximum at sea level must be passed through the anode cooling fins. The pressure drop across the anode cooler at this flow will be approximately 0.3 inch of water. Some or all the cooling air should pass by the base of the tube to provide cooling for the seals and solder terminals. Above sea level, cooling requirements will be higher; at 5000 feet elevation both air flow and pressure drop will increase by a factor of 1.2, and at 10,000 feet they will both increase by a factor of 1.46 .
In all cases the temperature of the anode core and the metal/ceramic seals is the final criteria and temperature sensitive paints are available to allow measurements before any design is finalized. EIMAC Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HEATER/CATHODE OPERATION - The rated heater voltage for 4CPL1000-series tubes is 6.3 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.3 volt for long life and consistent performance. One side of the heater is internally connected to the cathode. Heater voltage should be applied for a minimum of 120 seconds before voltage is applied to the other tube elements, to allow the cathode to reach operating temperature.

STANDBY OPERATION - When equipment is designed for very low duty operation, where standby periods (no high voltage applied to the tube) of many hours or even days at one time are anticipated, it is good engineering practice to include circuitry for reduction of the heater voltage of an oxide-cathode tube during the standby periods. This will greatly minimize release of cathode sublimation products within the tube. A reduction in heater voltage of 10% from the nominal value is recommended during long standby periods, with simultaneous return to normal voltage when the equipment is switched from STANDBY to OPERATE. A reduction in heater voltage of more than 10% is possible if operation is not attempted for several seconds after switching from the STANDBY to the OPERATE mode.

PULSE ANODE CURRENT - For pulse service, as a switch tube or modulator, or for voltage regulator applications, an anode current (during the pulse) of 8 amperes is available with pulses up to 100 microseconds duration. Peak current capability, pulse duration and duty factor are interrelated and for a pulse duration over 100 microseconds the DERATING CHART should be consulted. For pure dc service anode current should be limited to 0.6 ampere with any of the 4CPL1000 series tubes.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors 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.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. These tubes, operating at rated voltages and currents, are a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of high voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

PLATE OPERATION - The anode of the 4CPL1000-series of tubes is nominally rated for 1000 watts of dissipation capability. This capability is dependent on the use of liquid-immersion cooling with a dielectric fluid of suitable characteristics and proper circulation and cooling of the coolant fluid.
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 if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high tube-voltage-drop region.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved. Some means of protection is advised in all cases, and it is recommended that a series resistor be used in the anode circuit to limit peak current and help dissipate the energy in the event of a tube or circuit arc. A series impedance in the positive plate power supply lead is recommended (or the anode supply should be designed so that it has sufficient self impedance to limit the short circuit current to 10 times the maximum pulse current rating), together with a protective spark gap such as the Siemens #B1-C145 connected between cathode and grid, will help protect the tube in the event of an internal arc. A maximum of four (4) joules total energy may be permitted to dissipate into an internal grid-to-cathode arc. Amounts in excess of this will permanently damage the cathode or the grid structure. Additional information is found in EIMAC Application Bulletin #17 "FAULT PROTECTION", available on request.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, 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 Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. The test is performed on a cold tube, with no special shielding in the case of the 4CPL1000-series. The capacitance values shown in the technical data are taken in accordance with this procedure.
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the application.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

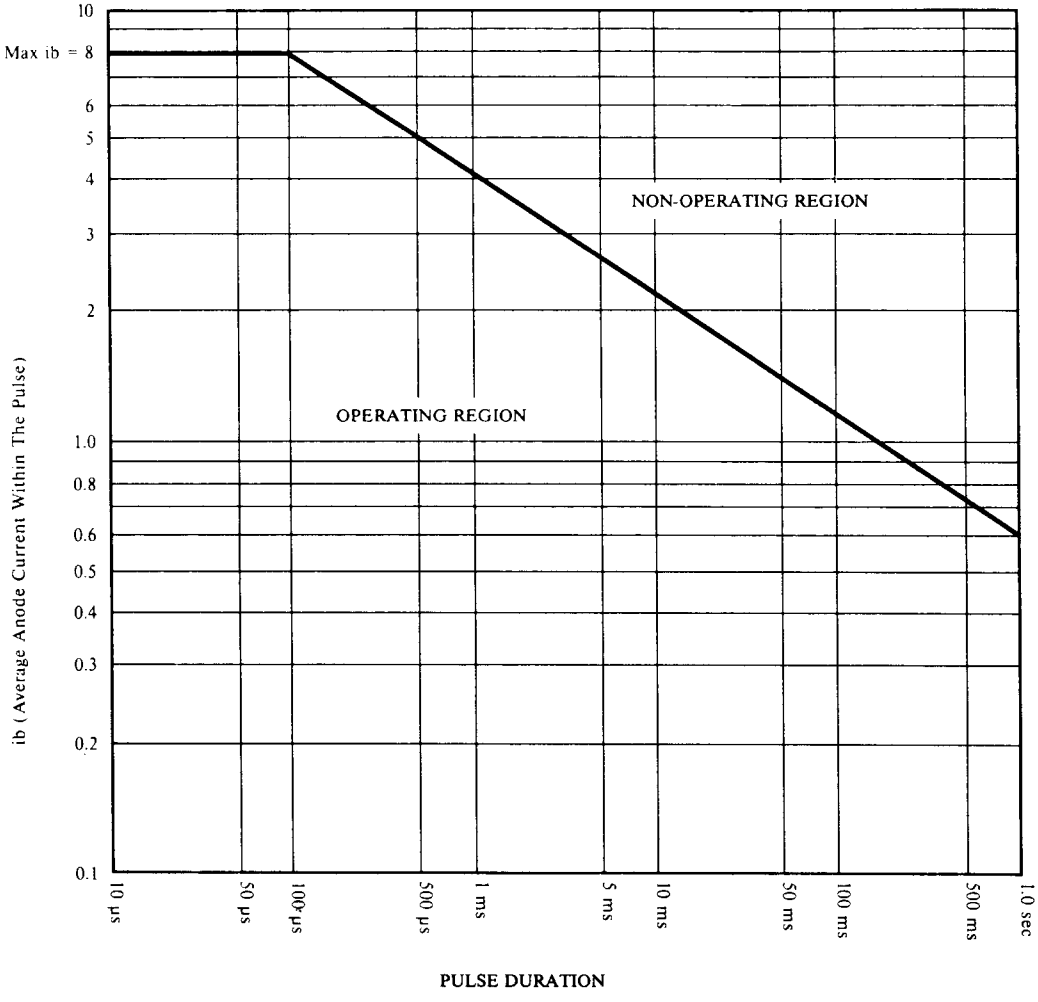
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Always remember that HIGH VOLTAGE CAN KILL.

b. X-RAY RADIATION - High voltage tubes can produce dangerous X-Radiation and shielding may be required to protect operating personnel.

c. HOT DIELECTRIC COOLANT - The dielectric coolant used to cool tubes of this type may reach high temperatures. Touching or rupture of the cooling system may cause serious burns.

d. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is removed.

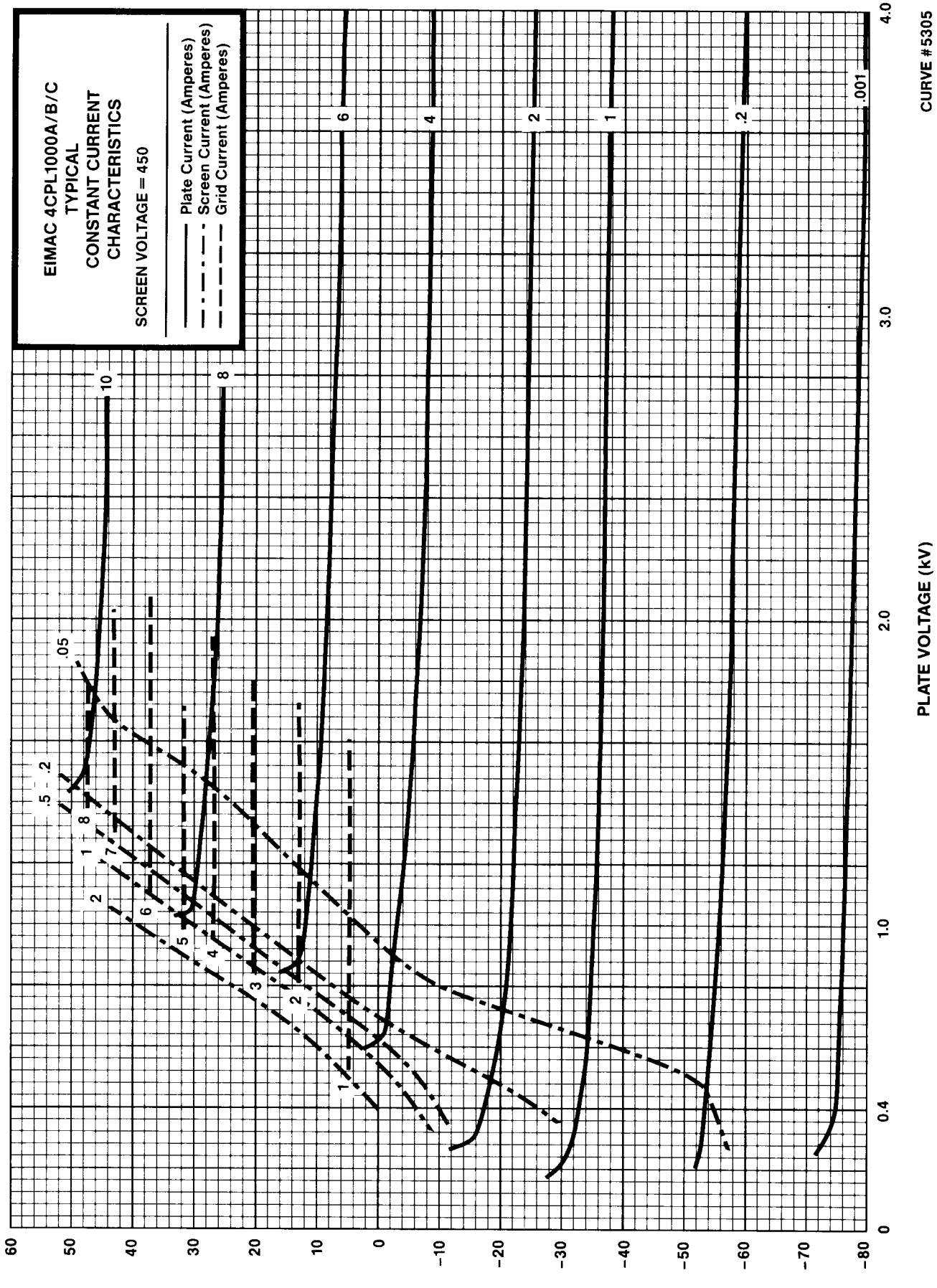
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Tube Division, 301 Industrial Way, San Carlos CA 94070.

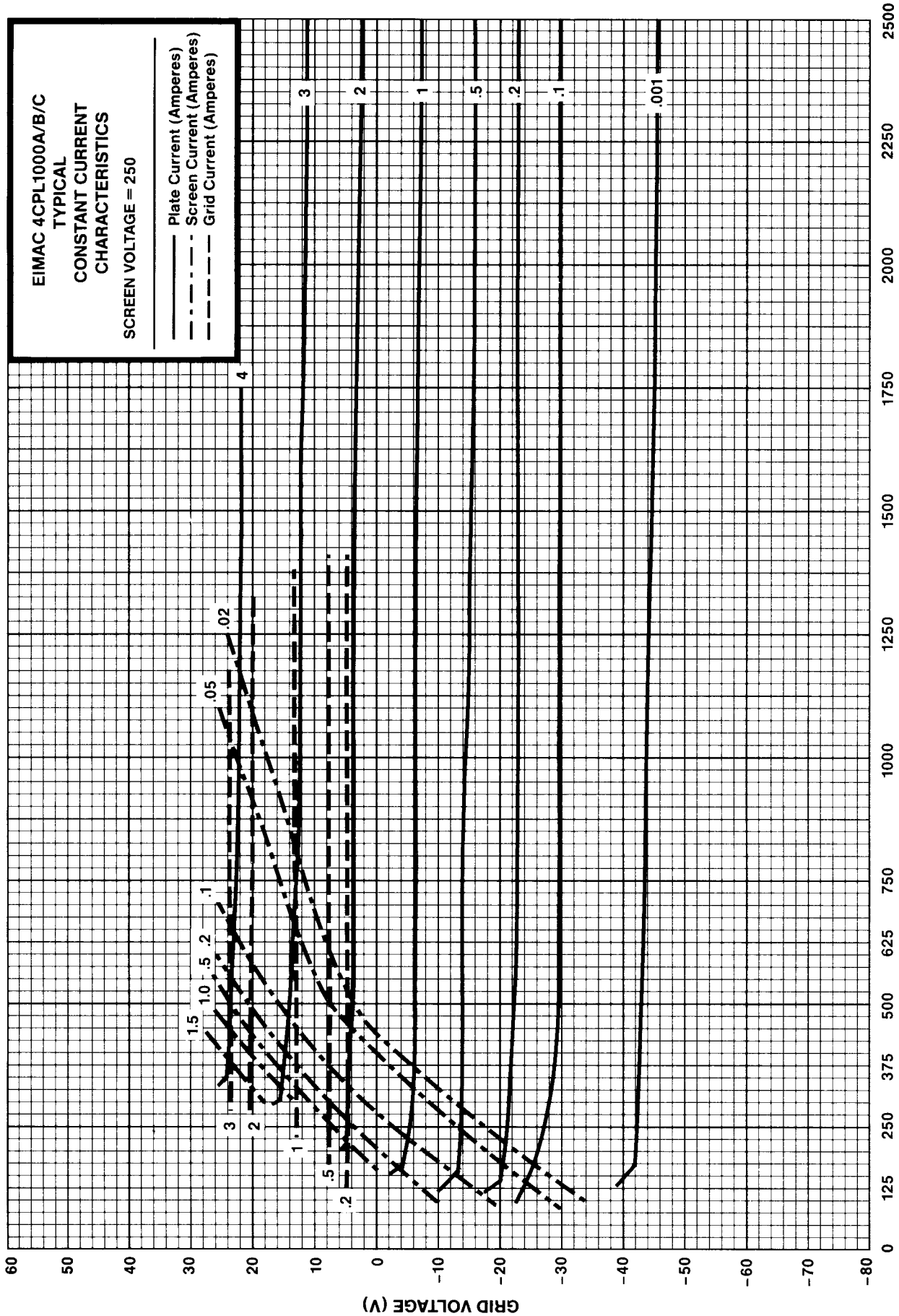


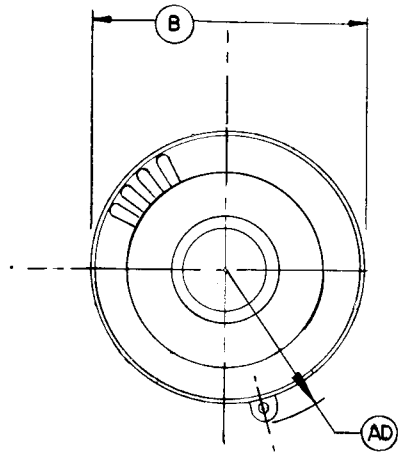
PULSE MODULATOR OR REGULATOR SERVICE

Pulse anode current (ib) capability is dependent on pulse duration (tp) and duty factor (Du). Maximum ib for a given tp is shown; maximum Du may be derived from the relationship:

$$0.6 = ib \sqrt{Du}$$

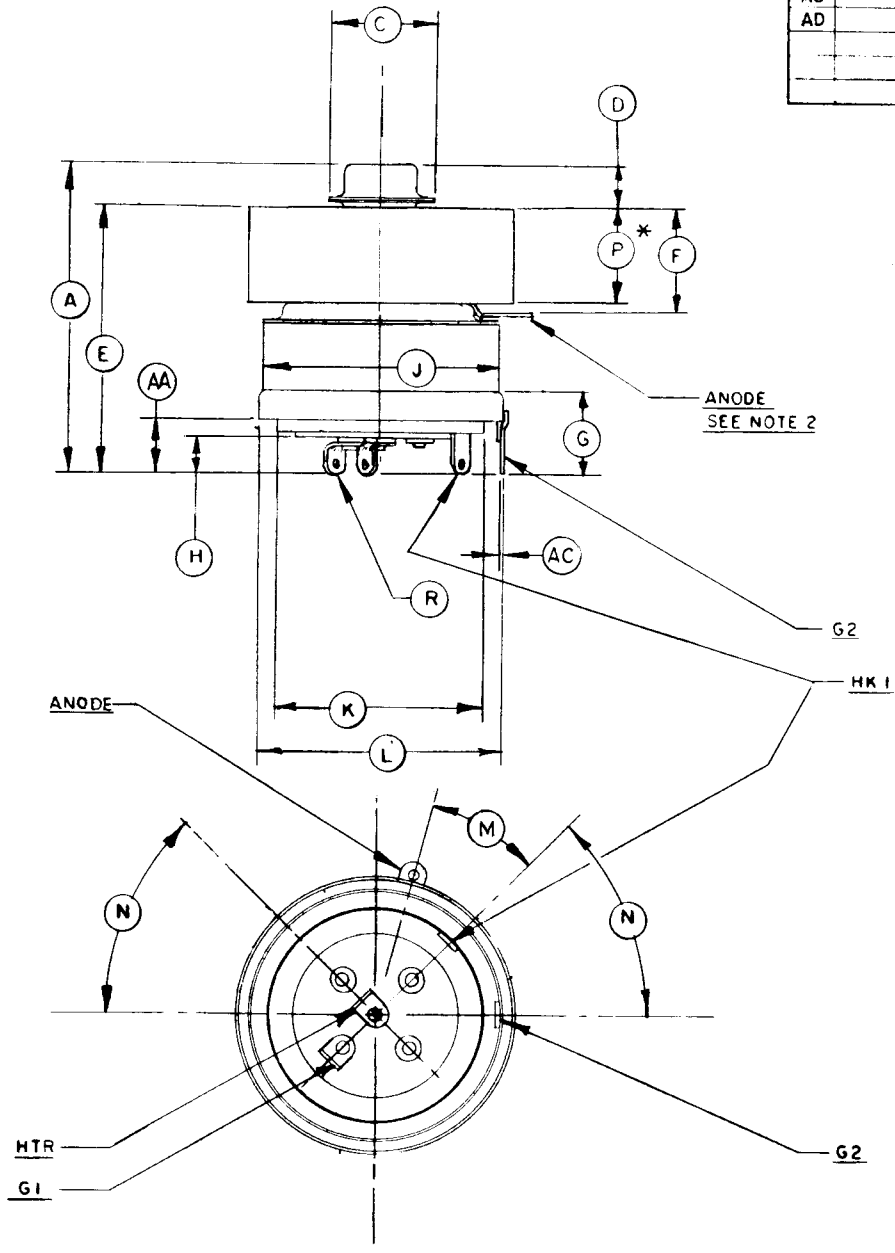

EIMAC 4CPL1000A/B/C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 450
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5305


EIMAC 4CPL1000A/B/C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 250
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (V)
CURVE #5345



4CPL1000A

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF.	MIN.	MAX	REF
A	2.650	2.710		67.31	68.83	
B	2.035	2.045		51.69	51.94	
C		.750			19.05	
D		.390			9.91	
E		2.380			60.45	
F			.820			20.83
G			.545			13.84
H			.260			6.60
J			1.850			46.99
K			1.600			40.64
L		1.950			49.53	
M			30°			
N			45°			
P	.735	.775		18.67	19.68	
R	.095	.105		2.41	2.67	
AA			.340			8.64
AB						
AC			.020			.51
AD		1.200			30.48	

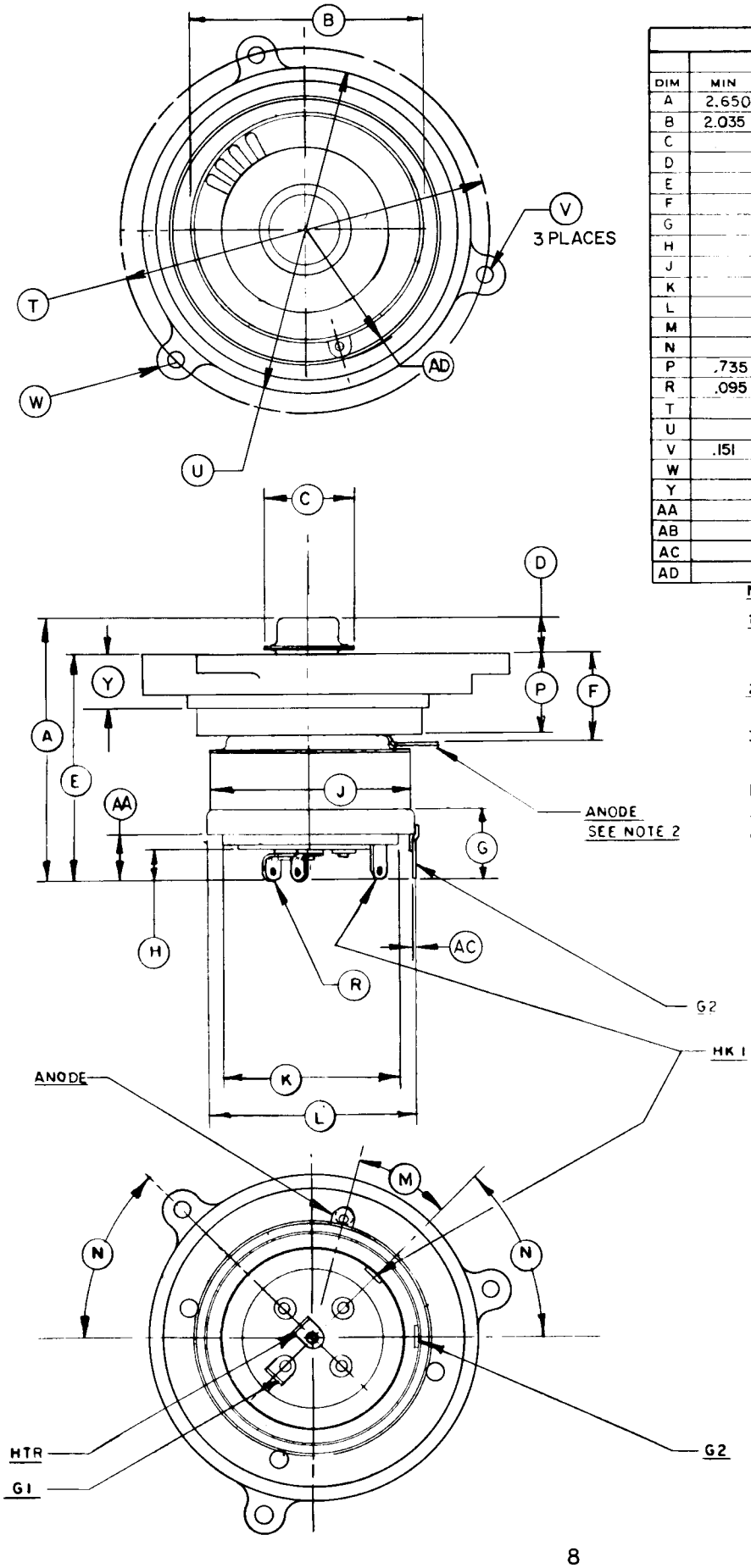


NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. ANODE TAB IS ROTATED 75° SEE BOTTOM VIEW FOR TAB ORIENTATION.
3. (*) CONTACT SURFACE.

NOTE

SEE SECTION TITLED "BASE CONNECTIONS" ON PAGE 2 BEFORE SOLDERING OPERATION IS PERFORMED.



4CPL1000B

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF.	MIN.	MAX	REF
A	2.650	2.710		67.31	68.83	
B	2.035	2.045		51.69	51.94	
C		.750			19.05	
D		.390			9.91	
E		2.380			60.45	
F			.820			20.83
G			.545			13.84
H			.260			6.60
J			1.850			46.99
K			1.600			40.64
L		1.950			49.53	
M			30°			
N			45°			
P	.735	.775		18.67	19.68	
R	.095	.105		2.41	2.67	
T			3.375			85.73
U			3.000			76.20
V	.151	.157		3.84	3.99	
W			.190R			4.8R
Y			.510			12.95
AA			.340			8.64
AB						
AC			.020			.51
AD		1.200			30.48	

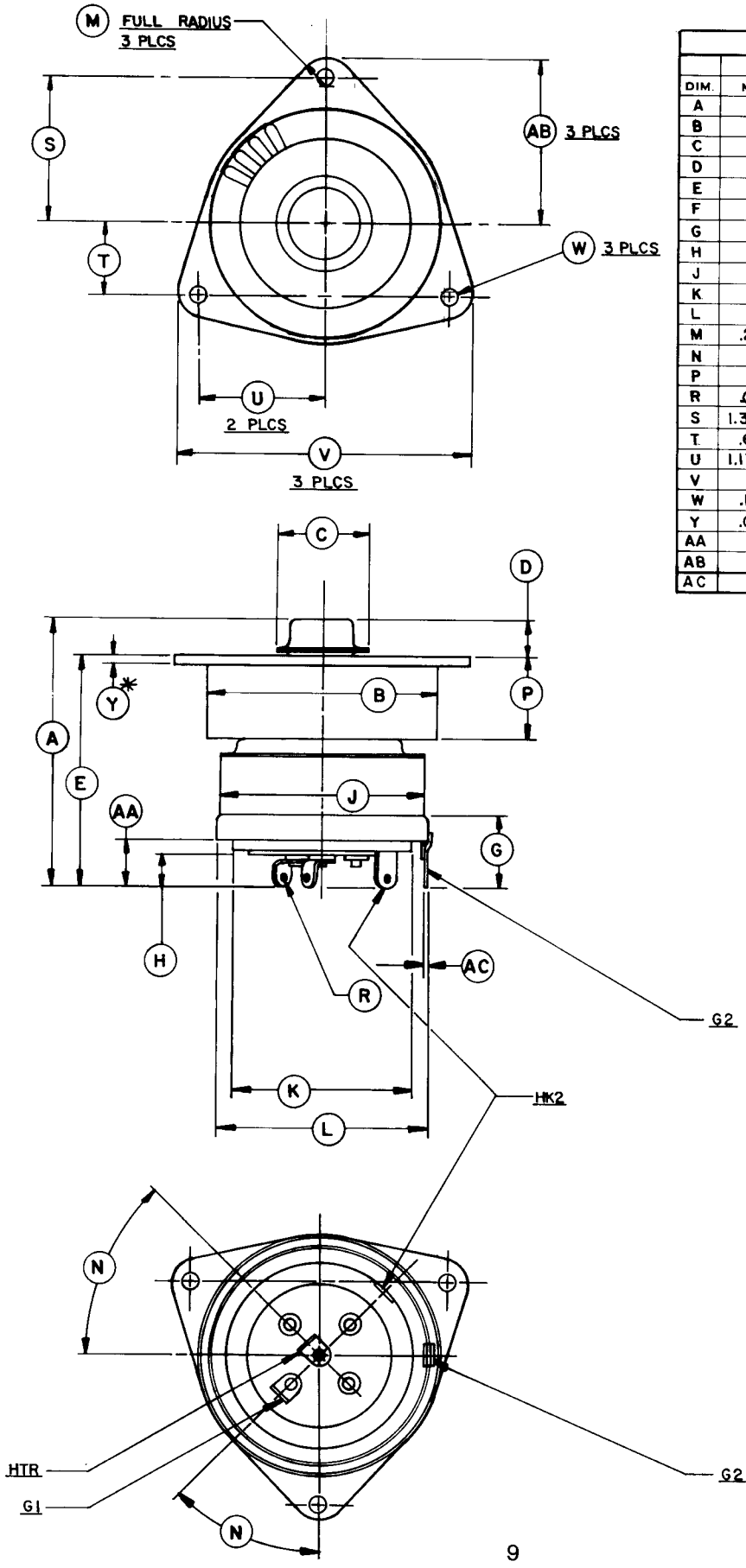
NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. ANODE TAB IS ROTATED 75° SEE BOTTOM VIEW FOR TAB ORIENTATION.
3. (⊕) CONTACT SURFACE.

NOTE

SEE SECTION TITLED "BASE CONNECTIONS" ON PAGE 2 BEFORE SOLDERING OPERATION IS PERFORMED.

4CPL1000C



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A			2.680			68.07
B		2.055			52.20	
C		.750			19.05	
D		.390			9.91	
E		2.380			60.45	
F						
G			.545			13.84
H			.260			6.60
J			1.850			46.99
K			1.600			40.64
L		1.950			49.53	
M	.245	.255		6.22	6.48	
N			45°			
P		.790			20.07	
R	.095	.105		2.41	2.67	
S	1.308	1.316		33.22	33.43	
T	.652	.660		16.56	16.76	
U	1.132	1.140		28.75	28.96	
V		2.750			69.85	
W	.165	.171		4.19	4.34	
Y	.080	.100		2.03	2.54	
AA			.340			8.64
AB			1.500			38.10
AC			.020			.51

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (✱) CONTACT SURFACE.
3. ORIENTATION OF PIN TABS TO COOLER FLANGE IS AS SHOWN.

NOTE

SEE SECTION TITLED "BASE CONNECTIONS" ON PAGE 2 BEFORE SOLDERING OPERATION IS PERFORMED.