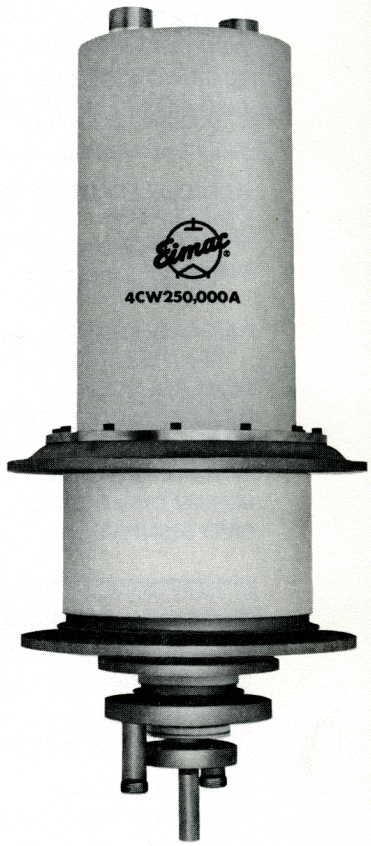
TECHNICAL DATA

# 4CW250,000V
# 4CW250,000A

WATER-COOLED
POWER TETRODE

The EIMAC 4CW250,000V/A is a ceramic/metal, water-cooled, power tetrode intended for use at the 250 to 500 kilowatt output power level. It is recommended as a Class C amplifier or oscillator; a Class AB rf linear amplifier; a Class AB push-pull af amplifier or modulator; a plate or screen modulated Class C rf amplifier; or for pulse modulator or regulator service. The 4CW250,000V is supplied with a Vaclon® pump attached. On the 4CW-250,000A, no Vaclon pump is attached.




Shown with anode water jacket.

## GENERAL CHARACTERISTICS[1]

### ELECTRICAL

| | | |
|---|---|---|
| Filament: Thoriated Tungsten | | |
| Voltage | 12.0 ± 0.6 | V |
| Current, at 12.0 volts | 660 | A |
| Amplification Factor (Average): | | |
| Grid to Screen | 4.5 | |
| Direct Interelectrode Capacitance (grounded cathode) [2] | | |
| Cin | 765 | pF |
| Cout | 124 | pF |
| Cgp | 6.0 | pF |
| Frequency or Maximum Rating: | | |
| CW | 50 | MHz |

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the 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.

### MECHANICAL

| | |
|---|---|
| Maximum Overall Dimensions: | |
| Length (4CW250,000V) | 32.93 in; 837.0 mm |
| (4CW250,000A) | 30.46 in; 774.0 mm |
| Diameter | 13.06 in; 330.0 mm |
| Net Weight | 98 lb; 44.5 kg |
| Operating Position | Vertical, base up or down |
| Maximum Operating Temperature: | |
| Ceramic/Metal Seals | 200°C |
| Cooling | Liquid |
| Base | Special |
| Recommended Anode Water Jacket (not supplied) | SK-1720 |



Printed in U.S.A.

## RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

| | | |
|---|---|---|
| DC PLATE VOLTAGE | 20,000 | VOLTS |
| DC SCREEN VOLTAGE | 2,500 | VOLTS |
| DC PLATE CURRENT | 40 | AMPERES |
| PLATE DISSIPATION | 250,000 | WATTS |
| SCREEN DISSIPATION | 3,500 | WATTS |
| GRID DISSIPATION | 1,500 | WATTS |

TYPICAL OPERATION (Frequencies to 50 MHz)
Class AB, Peak Envelope or Modulation Crest Conditions

| | | | |
|---|---|---|---|
| Plate Voltage | 15 | 20 | kVdc |
| Screen Voltage | 1.8 | 1.8 | kVdc |
| Grid Voltage [1/2] | -500 | -500 | Vdc |
| Zero-Signal Plate Current | 0.20 | 0.20 | Adc |
| Single-Tone Plate Current | 20 | 23 | Adc |
| Single-Tone Screen Current[2] | 1.1 | 1.2 | Adc |
| Peak rf Grid Voltage [2] | 500 | 500 | v |
| Plate Dissipation | 80 | 130 | kW |
| Plate Output Power | 220 | 330 | kW |
| Resonant Load Impedance | 325 | 435 | Ω |

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

## RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

| | | |
|---|---|---|
| DC PLATE VOLTAGE | 20,000 | VOLTS |
| DC SCREEN VOLTAGE | 2,500 | VOLTS |
| DC PLATE CURRENT | 40 | AMPERES |
| PLATE DISSIPATION | 250,000 | WATTS |
| SCREEN DISSIPATION | 3,500 | WATTS |
| GRID DISSIPATION | 1,500 | WATTS |

TYPICAL OPERATION (Frequencies to 50 MHz)

| | | | |
|---|---|---|---|
| Plate Voltage | 16.0 | 19.0 | kVdc |
| Screen Voltage | 800 | 800 | Vdc |
| Grid Voltage | -800 | -800 | Vdc |
| Plate Current | 23.5 | 32.5 | Adc |
| Screen Current[1] | 2.4 | 3.5 | Adc |
| Grid Current [1] | 1.15 | 2.5 | Adc |
| Calculated Driving Power | 2.24 | 3.00 | kW |
| Plate Dissipation | 100.0 | 155.0 | kW |
| Plate Output Power | 275.0 | 460.0 | kW |
| Resonant Load Impedance | 300 | 275 | Ω |

1. Approximate value.

## PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

| | | |
|---|---|---|
| DC PLATE VOLTAGE | 17,500 | VOLTS |
| DC SCREEN VOLTAGE | 2,000 | VOLTS |
| DC PLATE CURRENT | 30 | AMPERES |
| PLATE DISSIPATION [1] | 167,000 | WATTS |
| SCREEN DISSIPATION [2] | 3,500 | WATTS |
| GRID DISSIPATION [2] | 1,500 | WATTS |

1. Corresponds to 250,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 50 MHz)

| | | |
|---|---|---|
| Plate Voltage | 14.0 | kVdc |
| Screen Voltage | 800 | Vdc |
| Grid Voltage | -800 | Vdc |
| Plate Current | 29.0 | Adc |
| Screen Current[1] | 3.5 | Adc |
| Grid Current [1] | 2.0 | Adc |
| Peak af Screen Voltage[1](100% modulation) | 800 | v |
| Peak rf Grid Voltage[1] | 1160 | v |
| Calculated Driving Power | 2320 | W |
| Plate Dissipation | 119.0 | kW |
| Plate Output Power | 285.0 | kW |
| Resonant Load Impedance | 210 | Ω |

1. Approximate value.

## AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB

ABSOLUTE MAXIMUM RATINGS (per tube)

| | | |
|---|---|---|
| DC PLATE VOLTAGE | 20,000 | VOLTS |
| DC SCREEN VOLTAGE | 2,500 | VOLTS |
| DC PLATE CURRENT | 40 | AMPERES |
| PLATE DISSIPATION | 250,000 | WATTS |
| SCREEN DISSIPATION | 3,500 | WATTS |
| GRID DISSIPATION | 1,500 | WATTS |

1. Approximate value.

TYPICAL OPERATION (Two Tubes), Sinusoidal Wave

| | | | |
|---|---|---|---|
| Plate Voltage | 15.0 | 20.0 | kVdc |
| Screen Voltage | 1.8 | 1.8 | kVdc |
| Grid Voltage [1/3] | -500 | -500 | Vdc |
| Zero-Signal Plate Current | 0.20 | 0.20 | Adc |
| Max. Signal Plate Current | 40.0 | 46.0 | Adc |
| Max. Signal Screen Current [1] | 1.1 | 1.2 | Adc |
| Peak af Grid Voltage [2] | 500 | 500 | v |
| Max. Signal Plate Dissipation | 160.0 | 260.0 | kW |
| Plate Output Power | 440.0 | 660.0 | kW |
| Load Resistance (plate to plate) | 650 | 870 | Ω |

2. Per Tube.
3. Adjust to give stated zero-signal plate current.

## PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

| | | | |
|---|---|---|---|
| DC PLATE VOLTAGE | 40,000 VOLTS | PLATE DISSIPATION | 250,000 WATTS |
| DC SCREEN VOLTAGE | 2,500 VOLTS | SCREEN DISSIPATION | 3,500 WATTS |
| PEAK CATHODE CURRENT | 350 AMPERES | GRID DISSIPATION | 1,500 WATTS |

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

| RANGE VALUES FOR EQUIPMENT DESIGN | Min. | Max. | |
|---|---|---|---|
| Filament: Current at 12 volts | 620 | 700 | A |
| Interelectrode Capacitances[1] (grounded cathode connection) | | | |
| Cin | 730 | 800 | pF |
| Cout | 112 | 136 | pF |
| Cgp | 4.0 | 8.0 | pF |

1. Capacitance values are for a cold tube.

# APPLICATION

## MECHANICAL

*MOUNTING* - The 4CW250,000V/A must be mounted vertically, anode up or down. The tube may be supported by the anode flange or the screen flange.

*COOLING* - The EIMAC SK-1720 water jacket is available for use with the 4CW250,000A and V. Because of the small size of this cooler, high frequency operation is possible. It is essential that high purity water be used to minimize power loss and corrosion of metal fittings. Good distilled or de-ionized water will have a resistance of 1 to 2 megohms per $cm^3$. Water should be discarded if resistivity falls to 50,000 ohms $cm^3$.

Since the tube anode is usually at high potential to ground, water connections to the anode are made through insulating tubing. These insulating sections should be long enough so that column resistance is above 100,000 ohms per 1000 plate supply volts.

The table below lists minimum cooling water requirements at various plate dissipation levels.

| Plate Dissipation (kilowatts) | Water Flow (GPM) | Pressure Drop (PSI) |
|---|---|---|
| 100 | 25.0 | 3.5 |
| 150 | 37.5 | 3.7 |
| 200 | 50.0 | 4.0 |
| 250 | 60.0 | 6.0 |
| 300 | 73.0 | 9.0 |

The filament supports of the 4CW250,000V/A are water cooled. Approximately 0.5 GPM should circulate through each of the filament connectors with a pressure drop of 20 PSI. Filament connector assemblies, SK-1710, provide electrical and water connections. Two sets of SK-1710 are required.

It is recommended that the water cooled control grid connector, SK-1712, be used. Water flow of approximately 0.5 GPM should circulate through the grid connector. The pressure drop across the grid connector is low. A convenient way to make water connection is to series connect the grid cooling water with the outer filament cooling water path.

The outer filament water path has a lower pressure drop than the inner filament water path making this connection practical.

*VacIon ® High Vacuum Pump –*
Model 913-0011

This pump is included as standard equipment on the 4CW250,000V. It permits periodic checking of the vacuum condition of tubes in storage. It may be used to restore the vacuum of a tube which has been accidentally damaged by overheating in service.

Accessories required for VacIon ® pump operation but not supplied with the tube are:
Permanent magnet, Model 913-0011.
Control unit, Model 921-0006 for 60 Hz power.
Control unit, Model 921-0026 for 50 Hz power.

## ELECTRICAL

*FILAMENT OPERATION* - The peak emission at rated filament voltage of the EIMAC 4CW-250,000V/A is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW250,000V/A by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW250,000V/A. At some value of filament voltage there will be a noticeable reduction in plate current or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked.

Filament starting current must be limited to a maximum of 1800 amperes.

*GRID OPERATION* - The 4CW250,000V/A grid is rated at 1,500 watts of dissipation and protective measures should be included in circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of dc grid current and peak positive grid voltage.

*SCREEN DISSIPATION* - The power applied to the screen grid must not exceed 3,500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of RMS screen current and RMS screen voltage.

Plate voltage, plate load and bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to remove screen power at the occurrence of any such conditions.

*PLATE DISSIPATION* - The plate dissipation of 250 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW250,000V/A is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 167,000 watts.

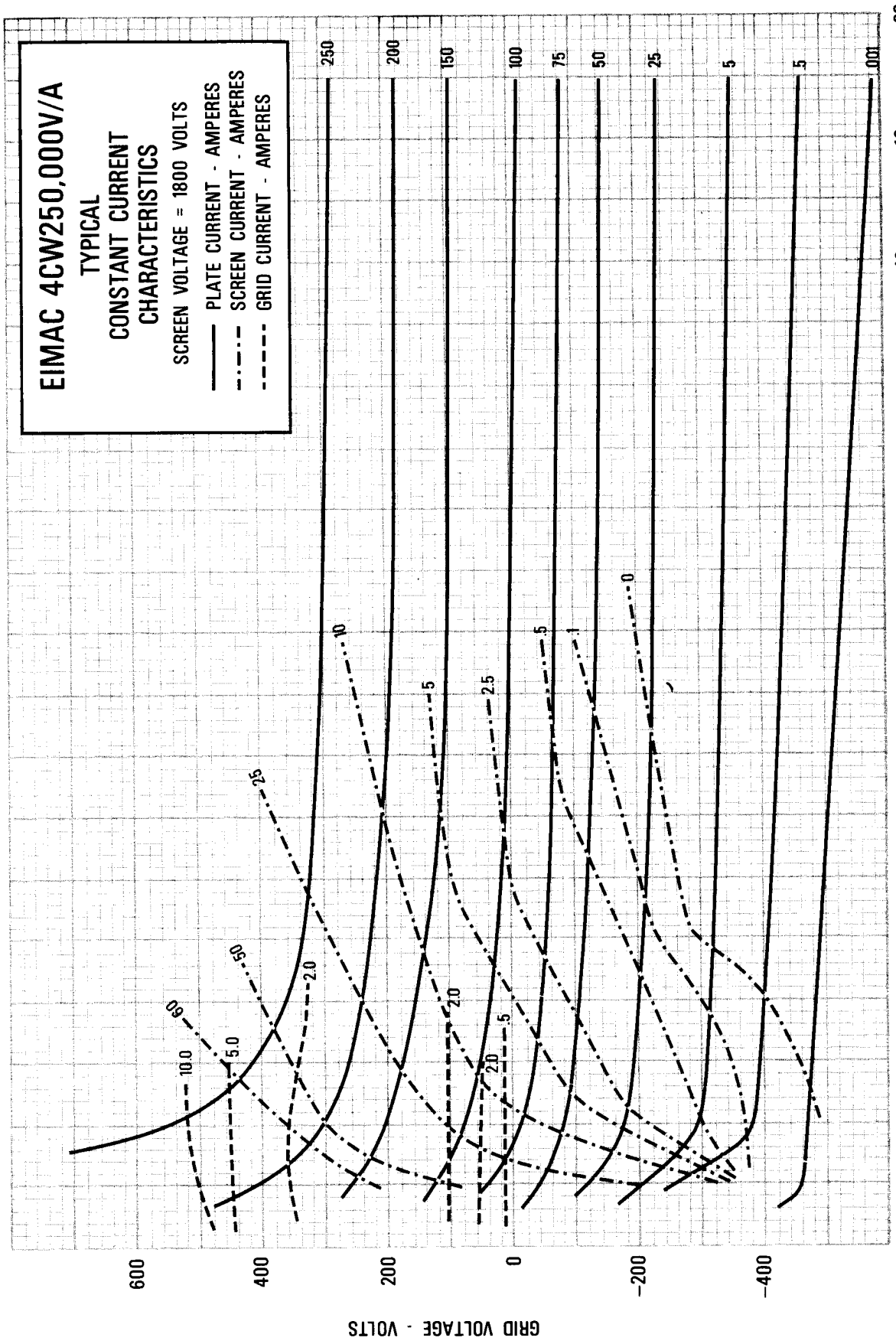
*HIGH VOLTAGE* - Normal operating voltages used with the 4CW250,000V/A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage 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.

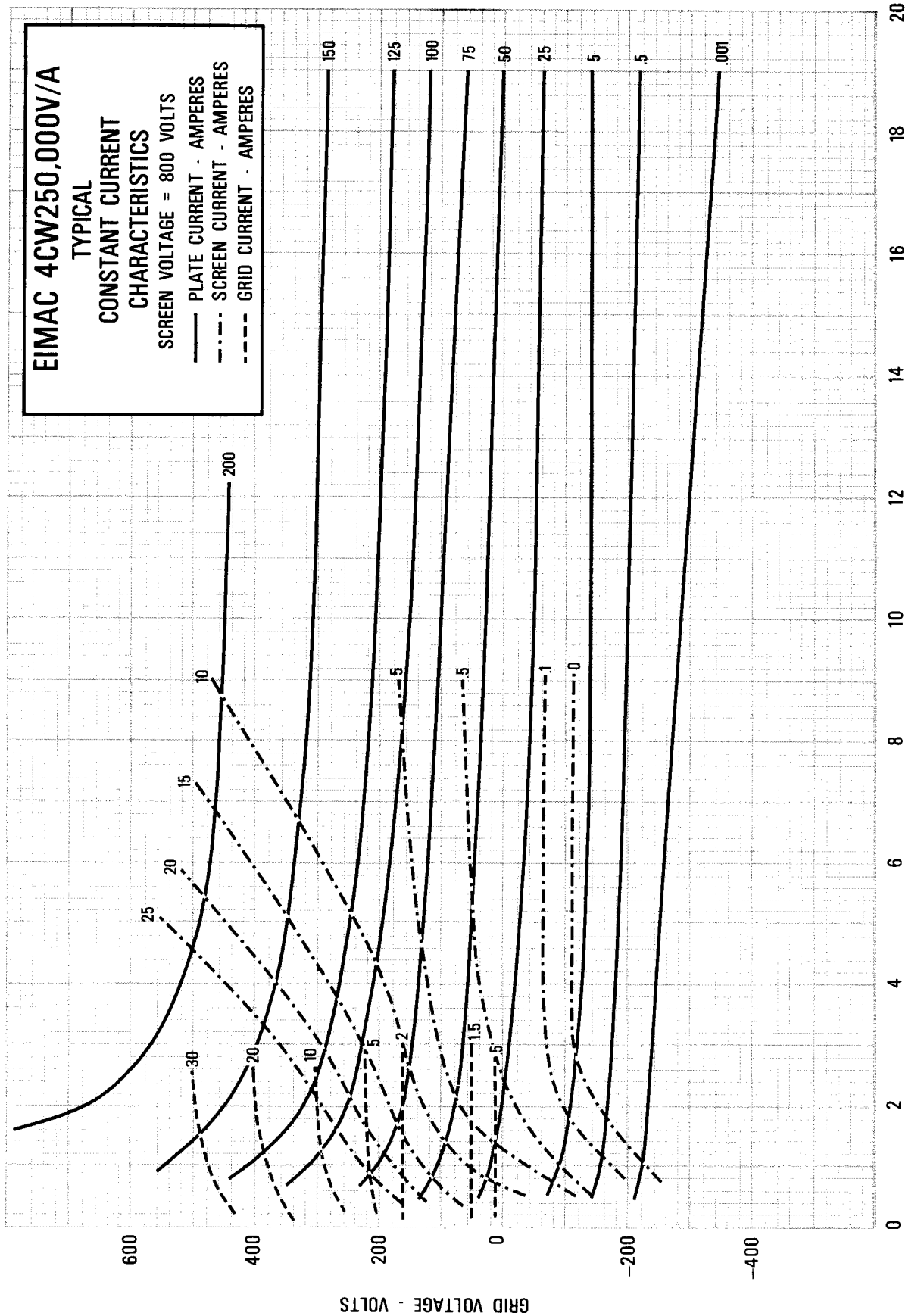
*X-RADIATION* - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW250,000V/A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube 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 the 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 requirement 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 be better able to locate an equipment malfunction can result in serious X-ray exposure.

*RADIO FREQUENCY RADIATION* - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

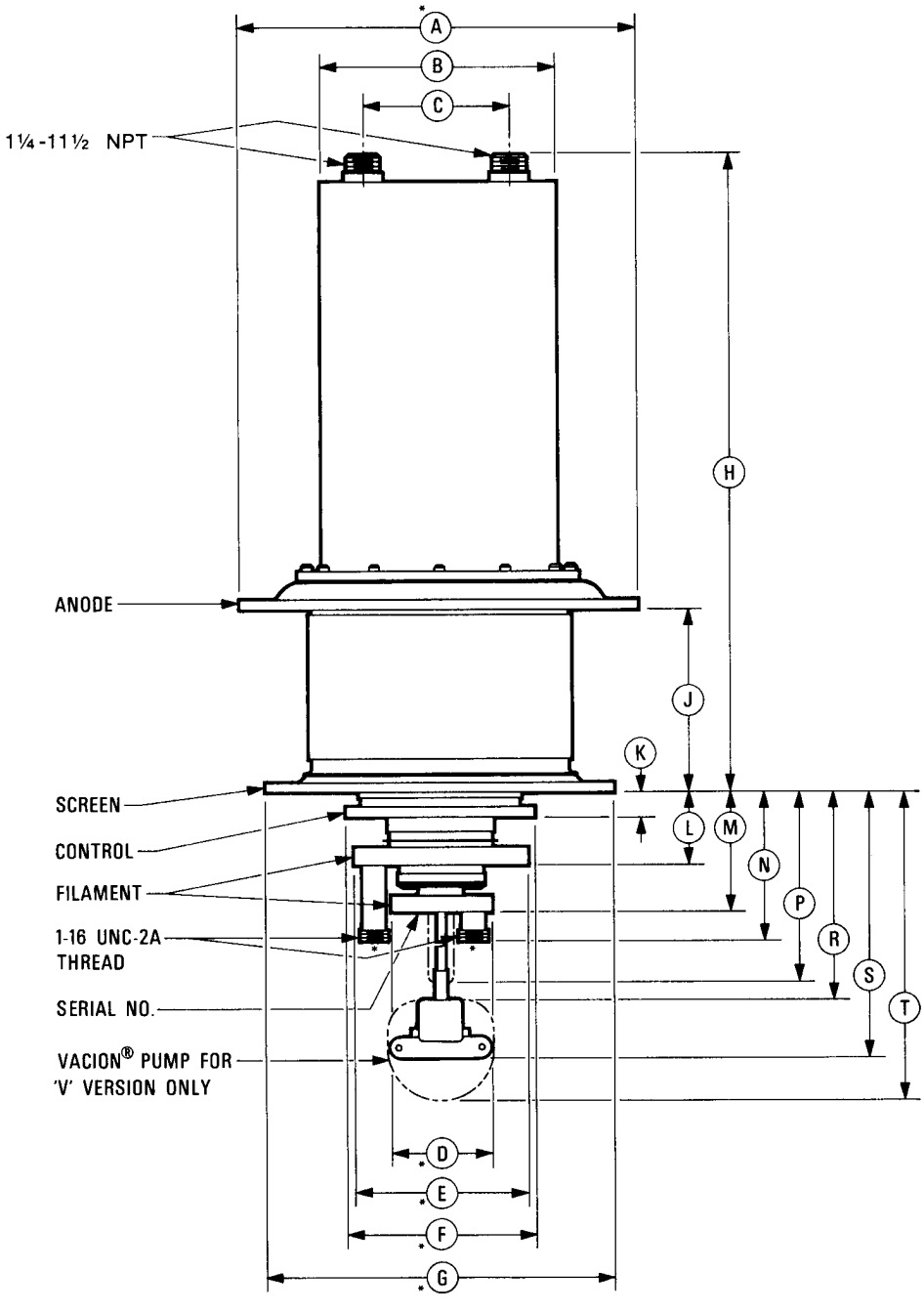
*SPECIAL APPLICATION* - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070, for information and recommendations.

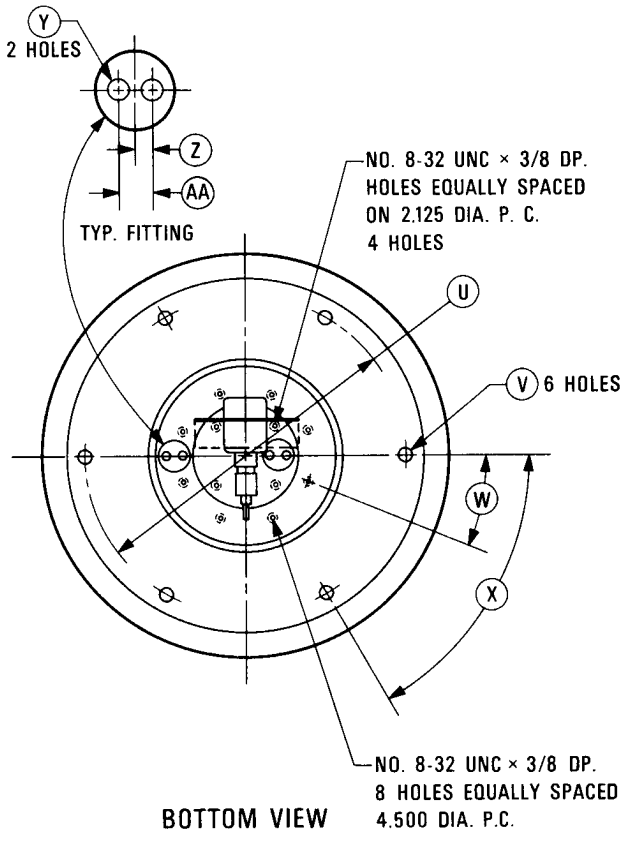

EIMAC 4CW250,000V/A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
GRID VOLTAGE - VOLTS
600
400
200
0
-200
-400
PLATE VOLTAGE - KILOVOLTS
0
2
4
6
8
10
12
14
16
18
20
CURVE #3464


EIMAC 4CW250,000V/A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
150
125
100
75
50
25
5
.5
.001
200
30
25
20
15
10
20
10
5
2
1.5
.5
5
.5
1
0
600
400
200
0
−200
−400
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - KILOVOLTS
CURVE #3465

| DIMENSIONAL DATA | | | | | | |
|---|---|---|---|---|---|---|
| DIM. | INCHES | | | MILLIMETERS | | |
| | MIN. | MAX. | REF. | MIN. | MAX. | REF. |
| A | 12.937 | 13.062 | -- | 328.60 | 331.77 | -- |
| B | 7.937 | 8.062 | -- | 201.60 | 204.77 | -- |
| C | 4.437 | 4.562 | -- | 112.70 | 115.87 | -- |
| D | 3.437 | 3.562 | -- | 87.30 | 90.47 | -- |
| E | 5.937 | 6.062 | -- | 150.80 | 153.97 | -- |
| F | 6.437 | 6.562 | -- | 163.50 | 166.67 | -- |
| G | 11.937 | 12.062 | -- | 303.20 | 306.37 | -- |
| H | 23.437 | 23.562 | -- | 595.30 | 598.47 | -- |
| J | 6.250 | 6.375 | -- | 158.75 | 161.93 | -- |
| K | 0.750 | 0.875 | -- | 19.05 | 22.23 | -- |
| L | 2.437 | 2.562 | -- | 61.90 | 65.07 | -- |
| M | 4.062 | 4.187 | -- | 103.17 | 106.35 | -- |
| N | 5.000 | 5.125 | -- | 127.00 | 130.18 | -- |
| P | -- | 6.900 | (3) | -- | 175.26 | (3) |
| R | 6.750 | 7.375 | (3) | 171.45 | 187.33 | (3) |
| S | 8.750 | 9.375 | (3) | 222.25 | 238.13 | (3) |
| T | -- | 11.250 | (3) | -- | 285.75 | (3) |
| U | -- | -- | 11.000 | -- | -- | 279.40 |
| V | -- | -- | 0.375 | -- | -- | 9.53 |
| W | -- | -- | 22.5° | -- | -- | 22.5° |
| X | -- | -- | 60.0° | -- | -- | 60.0° |
| Y | -- | -- | 0.261 | -- | -- | 6.63 |
| Z | -- | -- | 0.219 | -- | -- | 5.56 |
| AA | -- | -- | 0.438 | -- | -- | 11.13 |

NOTES:
1. REF. DIMS. ARE FOR INFO.ONLY AND ARE NOT REQ'D. FOR INSP. PURPOSES.
2. (*) CONTACT SURFACES.
3. 'P' DIM. APPLIES TO 'A' VERSION ONLY. R, S & T DIMS. APPLY TO 'V' VERSION ONLY.




BOTTOM VIEW