See new data sheet
Feb 91.

8989
4CX12,000A
VHF
RADIAL BEAM
POWER TETRODE

TECHNICAL DATA

The EIMAC 8989 is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings up to 220 MHz.

The 8989 has a gain of over 18 dB in FM broadcast service, and is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service. The anode is rated for 15 kilowatts of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

## GENERAL CHARACTERISTICS[1]

ELECTRICAL

| | | |
|---|---|---|
| Filament: Thoriated Tungsten | | |
| Voltage | 7.5 ± 0.37 | V |
| Current @ 7.5 volts | 120 | A |
| Amplification Factor, average | | |
| Grid to Screen | 6.7 | |
| Direct Interelectrode Capacitances (grounded cathode): | | |
| Cin | 160 | pF |
| Cout | 18.5 | pF |
| Cgp | 1.0 | pF |
| Direct Interelectrode Capacitances (grid and screen grounded): | | |
| Cin | 70 | pF |
| Cout | 18.6 | pF |
| Cpk | 0.1 | pF |
| Frequency of Maximum Ratings (CW) | 220 | MHz |

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

(Revised 3 Feb 81 - supersedes Dec 78)

MECHANICAL

Maximum Overall Dimensions:

| | |
|---|---|
| Length (height) | 9.84 in; 24.99 cm |
| Diameter | 7.76 in; 19.71 cm |
| Net Weight (approximate) | 14 lbs; 6.4 kg |
| Operating Position | Axis vertical, base up or down |
| Cooling | Forced Air |
| Operating Temperature, Maximum: | |
| Ceramic/Metal Seals & Anode Core | 250 °C |
| Base | Special, concentric |
| Recommended Air System Socket | EIMAC SK-300A |
| Recommended Air Chimney | EIMAC SK-336 |

---

RADIO FREQUENCY POWER AMPLIFIER
OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

| | | |
|---|---|---|
| DC PLATE VOLTAGE | 10.0 | KILOVOLTS |
| DC SCREEN VOLTAGE | 2000 | VOLTS |
| DC PLATE CURRENT | 3.5 | AMPERES |
| PLATE DISSIPATION | 15.0 | KILOWATTS |
| SCREEN DISSIPATION | 300 | WATTS |
| GRID DISSIPATION | 150 | WATTS |

TYPICAL OPERATION (frequencies to 30 MHz)

| | | |
|---|---|---|
| Plate Voltage | 9.0 | kVdc |
| Screen Voltage | 750 | Vdc |
| Grid Voltage | -250 | Vdc |
| Plate Current | 2.83 | Adc |
| Screen Current [1] | 135 | mAdc |
| Grid Current [1] | 63 | mAdc |
| Peak rf Grid Voltage [1] | 335 | v |
| Calculated Drive Power | 23 | W |
| Plate Dissipation [1] | 5.47 | kW |
| Plate Output Power [1] | 20 | kW |
| Load Impedance | 1590 | Ω |

1 Approximate value

TYPICAL OPERATION, COMMERCIAL FM SERVICE

(measured values at frequency shown, in EIMAC cavity amplifier)

| | | | |
|---|---|---|---|
| Frequency of Operation | 90.5 | 108.1 | MHz |
| Plate Voltage | 9.95 | 10.0 | kVdc |
| Screen Voltage | 600 | 800 | Vdc |
| Grid Voltage | -300 | -300 | Vdc |
| Plate Current | 3.08 | 2.81 | Adc |
| Screen Current | 200 | 130 | mAdc |
| Grid Current | 41 | 32 | mAdc |
| Driving Power | 245 | 275 | W |
| Useful Power Output [1] | 22.9 | 22.5 | kW |
| Efficiency | 74.7 | 80.2 | % |
| Gain | 19.7 | 19.1 | dB |

1 Delivered to the load

---

## APPLICATION

MOUNTING - The 8989 must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-300A and air chimney SK-336 are recommended for use with the 8989. The use of the recommended air flow through this socket provides effective forced-air cooling of the tube base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below the rated maximum.

The cooling characteristics of the tube are shown in the attached graph. The designer is cauted to keep in mind that this is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

It is considered good engineering practice to design for maximum anode core temperature of 225°C, and temperature-sensitive paints are available for checking tube temperatures before any design is finalized. It is also considered good practice to add a 15% safety factor to the indicated airflow, and allow for variables such as dirty air filters, rf seal heating at VHF, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special cooling is required in the center of the stem (base), by means of special air directors or some other provision. An air interlock system should be incorporated into the design to

automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cool-down.

FILAMENT OPERATION - The rated nominal filament voltage for the 8989 is 7.5 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent. During application of filament voltage the inrush current should be limited to no more than twice normal current.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely effect equipment operation. This is done by measuring some important parameter of performance (such as power output or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 8989 must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The 8989 control grid has a maximum dissipation rating of 150 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

SCREEN OPERATION - The power dissipated by the screen grid of the 8989 must not exceed 300 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend on loading, driving power, and the carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 300 watts in the event of circuit failure. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The 8989 may exhibit reversed (negative) screen current under some operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen currents which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, and this is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to normal plate overcurrent interlock and screen current interlock, it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is very high, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

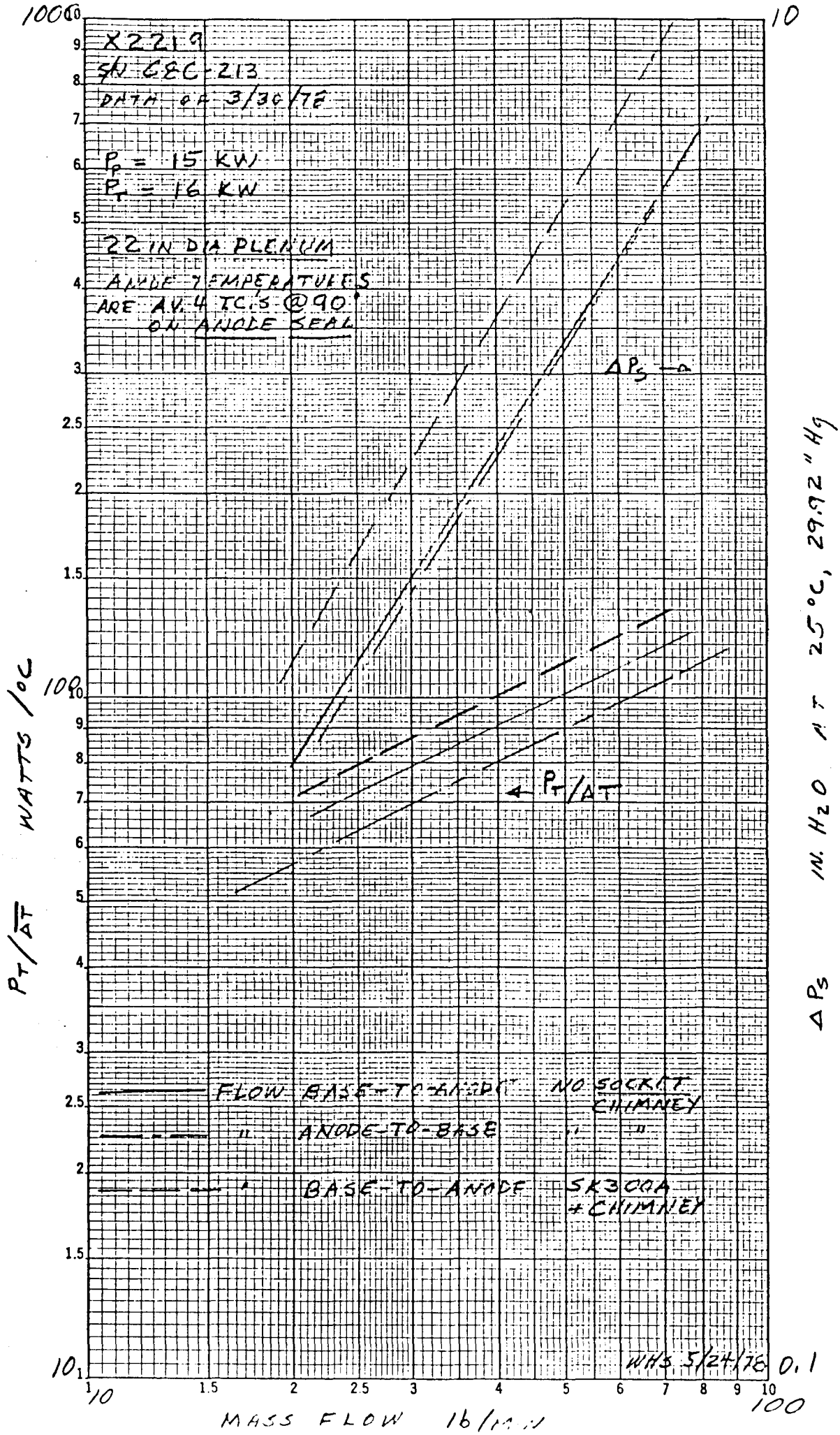
EIMAC APPLICATION BULLETIN #17 titled "FAULT PROTECTION" is available on request and includes detailed information on this subject.

HIGH VOLTAGE - Normal operating voltages used with the 8989 are deadly and the equipment must be designed properly and operating precautions must be followed. All equipment must be designed so that no one can come into 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.

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, 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, 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 eliminate 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 tube manufacturers. The capacitance values shown in the manufacturer's technical data, or test specification, normally are taken in accordance with Standard RS-191.

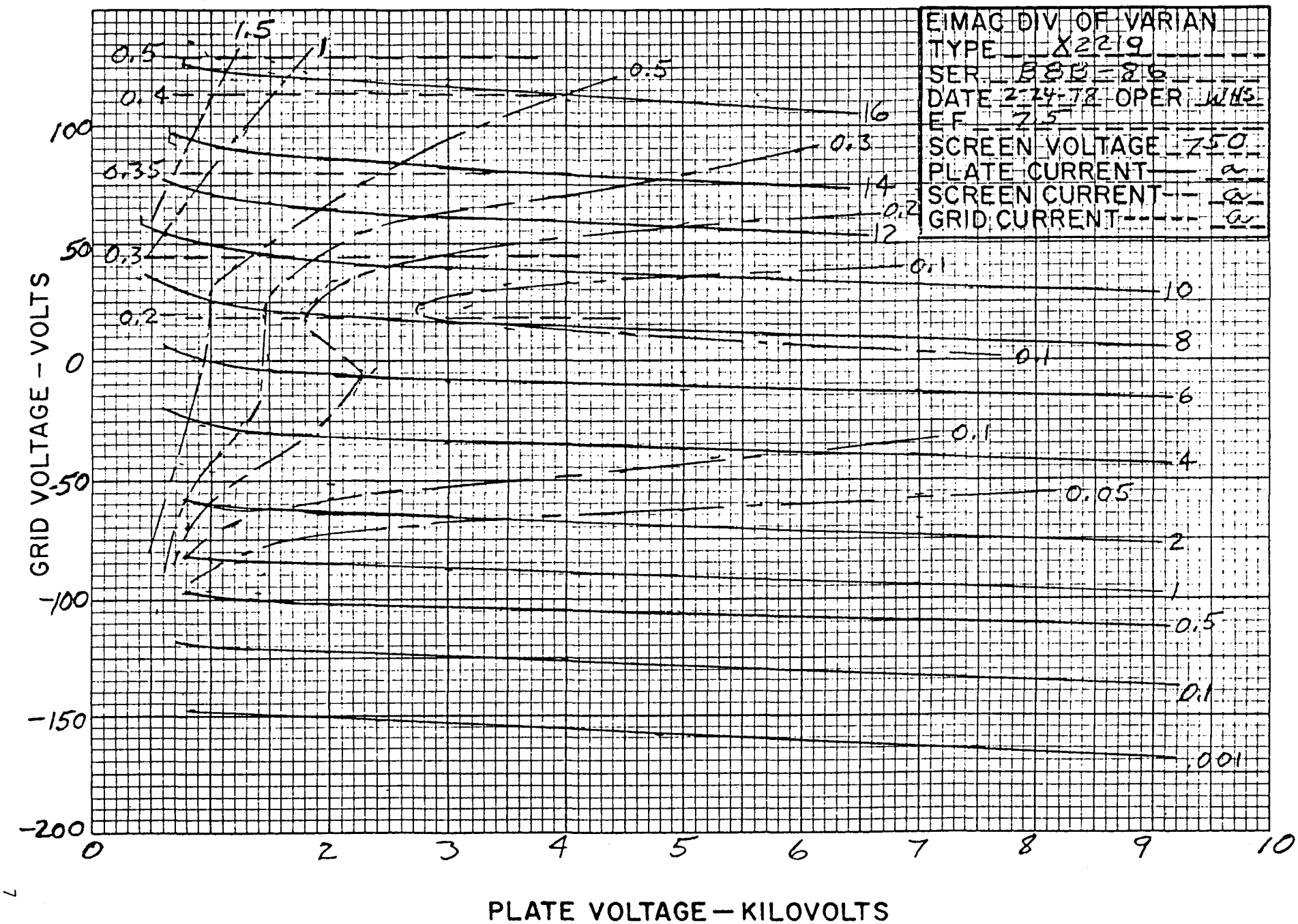
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, Varian EIMAC Division, 301 Industrial Way, San Carlos, CA 94070 for recommendations.




K+E LOGARITHMIC 359-103 KEUFFEL & ESSER CO. MADE IN U.S.A. 2 X 1 CYCLES

# GROUNDED CATHODE
# CONSTANT CURRENT CHARACTERISTICS

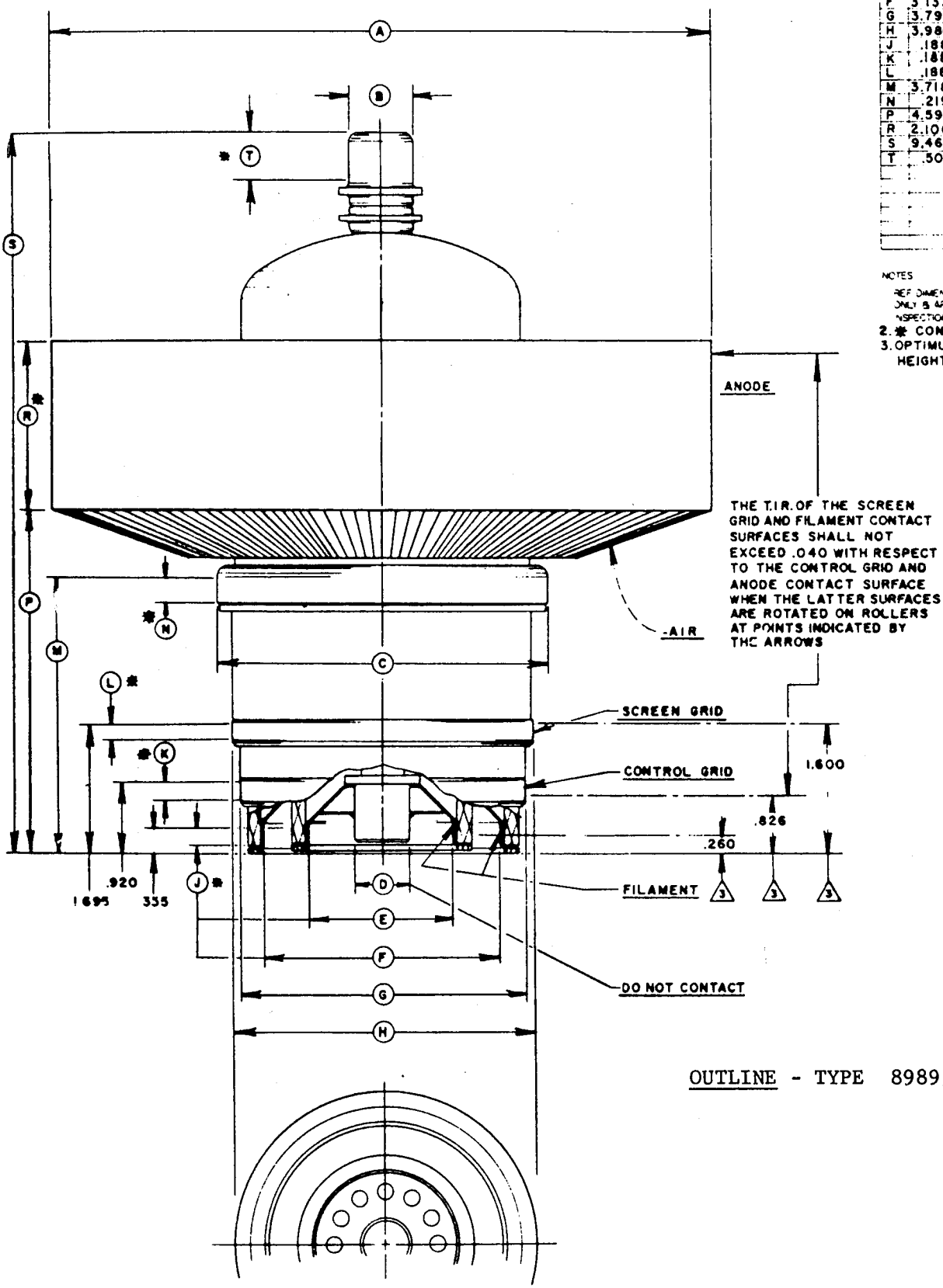



4846

| DIMENSIONAL DATA | | | | | | |
|---|---|---|---|---|---|---|
| | INCHES | | | MILLIMETERS | | |
| DIM | MIN. | MAX. | REF. | MIN. | MAX. | REF. |
| A | 7.700 | 7.760 | | | | |
| B | .855 | .895 | | | | |
| C | 4.406 | 4.468 | | | | |
| D | .600 | .760 | | | | |
| E | 1.896 | 1.936 | | | | |
| F | 3.133 | 3.173 | | | | |
| G | 3.792 | 3.832 | | | | |
| H | 3.980 | 4.020 | | | | |
| J | .188 | | | | | |
| K | .188 | | | | | |
| L | .188 | | | | | |
| M | 3.718 | 3.781 | | | | |
| N | .219 | | | | | |
| P | 4.593 | 4.656 | | | | |
| R | 2.100 | 2.200 | | | | |
| S | 9.465 | 9.840 | | | | |
| T | .500 | | | | | |

NOTES

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. ✱ CONTACT SURFACE.
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES




OUTLINE - TYPE 8989/4CX12,000A