The Eimac 4CM300,000GA is a ceramic/metal, multiphase-cooled (water/vapor) power tetrode designed to be used as an exact replacement for the Thomson TH537. This tube has a thoriated tungsten mesh filament and pyrolytic graphite grids which provide high dissipation combined with low secondary emission characteristics.

Base coaxial contact rings are provided for the filament, grid, and screen terminals, and these terminals are cooled with forced air. The maximum anode dissipation rating is 300 kilowatts steady state, with multiphase cooling.

**GENERAL CHARACTERISTICS**

**ELECTRICAL**

Filament: Thoriated Tungsten
Voltage (DC or AC) ........................................ 18.0 Volts
Current at 18.0 volts nominal .................. 430 Amperes
Peak Maximum Filament Inrush Current at Turn-on ................................ 860 Amperes
Amplification Factor, average
Grid to Screen .............................................. 4.3
Maximum Frequency of CW Ratings¹ .................. 50 MHz
Highest Useless Frequency With
Reduced Ratings¹ ........................................ 110 MHz
Direct Interelectrode Capacitance (nominal values)²
\[
\begin{align*}
C_{g1k} & = 310 \text{ pF} \\
C_{g2k} & = 26 \text{ pF} \\
C_{p} & = 0.8 \text{ pF} \\
C_{g1p} & = 510 \text{ pF} \\
C_{g2p} & = 4.5 \text{ pF} \\
C_{g3p} & = 75 \text{ pF}
\end{align*}
\]

**MECHANICAL**

Maximum Overall Dimensions:
Length ..................................................... 22.0 in; 56.0 cm
Diameter .................................................. 12.3 in; 31.1 cm
Net Weight (approximate) ......................... 125 lbs; 57 kg
Operating Position ................................ Vertical, base down
Cooling.................................................. Water & Forced Air
Maximum Operating Temperature:
Envelope and Ceramic/Metal Seals .......... 200°C

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

²Capacitance values are nominal, measured with no special shielding but otherwise in accordance with Electronics Industries Association Standard RS-191.
PLATE MODULATED RADIO FREQUENCY
POWER AMPLIFIER:
Class C Telephony
Control & Screen Grids also modulated

Absolute Maximum Ratings:
- DC Plate Voltage: 13.0 Kilovolts
- DC Screen Voltage: 1200 Volts
- DC Grid Voltage: -800 Volts
- Peak Cathode Current: 325 Amperes
- Plate Dissipation: 300 Kilowatts
- Screen Dissipation: 5 Kilowatts
- Grid Dissipation: 2 Kilowatts

TYPICAL OPERATION:
- Frequencies to 30 MHz
- Carrier Conditions
- DC Plate Voltage: 11.0 Kilovolts
- DC Screen Voltage: 1000 Volts
- DC Grid Voltage: -550 Volts
- Peak RF Drive Voltage: 700 Volts
- DC Plate Current: 36 Amperes
- DC Screen Current: 1.3 Amperes
- DC Grid Current: 2.0 Amperes
- Plate Input Power: 400 Kilowatts
- Driving Power: 2.4 Kilowatts
- Plate Dissipation: 90 Kilowatts
- Screen Dissipation: 4.0 Kilowatts
- Grid Dissipation: 600 Watts
- Plate Output Power: 300 Kilowatts

AUDIO FREQUENCY POWER AMPLIFIER
OR MODULATOR:
Class AB

APPLICATION

MECHANICAL

MOUNTING AND HANDLING - The 4CM300,000GA must be mounted vertically and with the base down. When mounted, the weight of the tube must be supported by its anode flange, which is at the level of the reference plane shown on the outline drawing.

Because the tube filament structure is made of thoriated-tungsten wire, which is quite brittle when cold, the tube should be left in its original shipping container until ready for use. Upon arrival, the tube should be inspected for shipping damage, but once removed from its protective pack, the tube should be handled with considerable care.

ANODE COOLING - The anode is cooled with water circulating through the structure. Multi-phase cooling provides efficient anode heat removal and allows extra capacity for temporary overloads. The inlet and outlet connections are clearly marked on top of the jacket and it is important they be used as indicated.

Tube life can be seriously compromised by water conditions. With contaminated water, deposits will form on the anode, causing localized anode heating and eventual tube failure. To minimize electrolysis and power loss, water resistance at 25°C should always be 0.5 megohm per cubic centimeter or higher. Relative water resistance can be continuously monitored in the reservoir using readily available instruments. Suitable water flow, temperature, and pressure protection devices must be used.

For the full-rated anode dissipation of 300 kW and with inlet water at 60°C maximum, a flow of 40 gallons (150 liters) of water per minute must be passed through the anode cooler jacket. At this flow rate the pressure drop across the cooler...
will never be exceeded under usual conditions of supply
air at 25°C maximum at sea level is forced through the
this flow rate at a back pressure of 158 mm of water.

Temperatures of the ceramicmetal seals and the lower
envelope areas are the controlling and final limiting factor,
and the maximum allowable temperature is 200°C.
Temperature-sensitive paints are available for use in
checking temperatures in these areas before equipment
design and air-cooling arrangements are finalized. Well
filtered air must be used and suitable flow and temperature
interlocks provided.

For more detailed information, Application Bulletin #16,
"Water Purity Requirements in Liquid-Cooling Systems," is available upon request.

BASE COOLING - In a typical transmitter, the tube base
requires air cooling. A minimum of 53 cfm (1.5 m^3/min) of
air at 25°C maximum at sea level is forced through the
socket from a high-pressure blower. Maximum air inlet
temperature is 45°C, and the blower must be able to supply
this flow rate at a back pressure of 158 mm of water.
Temperatures of the ceramicmetal seals and the lower
envelope areas are the controlling and final limiting factor,
and the maximum allowable temperature is 200°C.
Temperature-sensitive paints are available for use in
checking temperatures in these areas before equipment
design and air-cooling arrangements are finalized. Well
filtered air must be used and suitable flow and temperature
interlocks provided.

For more detailed information, Application Bulletin #20,
"Temperature Measurements with Eimac Power Tubes," is available upon request.

All cooling must be applied before or simultaneously with
the electrode voltages, including the filament, and should
be maintained for at least three minutes after all voltages
are removed to allow for tube cool-down.

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 condition. In
order not to exceed these ratings, the equipment designer’s
responsibility is to determine an average design value for
each rating by a safety factor so that the absolute values
will never be exceeded under 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.

HIGH VOLTAGE - Normal operating voltages used with
this tube 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.

FILAMENT MANAGEMENT PROGRAM - A properly ex-
cuted filament management program extends tube life.
The program addresses two filament life issues: 1. how to
extend filament electron emission life by optimizing the
filament heating power. 2. how to reduce filament distortion
by minimizing the filament thermal cycling. For more
detailed information, Application Bulletin #18, “Extended
Transmitter Tube Life” is available upon request.

Operating Procedures - The theoretical filament operating
voltage is 18.0 Volts RMS. Actual practice dictates the
operating voltage can be less than 18.0 Volts. The control
and screen grid power dissipations produce an additive heat
source to the filament resulting in a higher than desired
filament operating temperature. The control and screen
operating conditions should be conveyed to CPI Eimac’s
Application Engineering Department to determine an optimum
operating filament voltage.

Excessive filament thermal cycling can cause filament
mechanical distortion and result in degradation of the tube’s
electrical performance. For optimum life, the average filament
on/off cycle rate should not exceed 1 cycle per day.
Following CPI Eimac’s standby mode procedure (see below)
does not constitute an on/off cycle each time the filament is
reduced to the recommended standby voltage.

A new tube must have the filament voltage maintained at 18.0
volts for 30 minutes minimum prior to the application of any
other tube voltages. Filament voltage must be measured at
the tube socket with an accurate rms responding ammeter.

Standby Mode Procedure - To improve tube life, reduce the
installed tube’s filament voltage to 15 Volts whenever the tube
is not in active duty.

Forced air cooling must be maintained on the tube stem to
ensure the ceramicmetal seat temperature does not ex-
ceed 200°C while the tube is operated in the standby mode.
In addition, the anode cooling water flow must be main-
tained at a level which ensures the outlet water temperature
never exceeds 100°C.

Voltage Ramp Up/Down Procedures - To raise the filament
voltage to the operational voltage, gradually increase the
voltage over a minimum period of 90 seconds. Conversely,
lowering the filament voltage gradually over a minimum
period of 90 seconds is recommended.

In case of a fault condition which removes filament voltage
for a period less than 30 seconds, full filament voltage can be
applied immediately. If the failure time exceeds 30 sec-
onds, follow the linear programmed schedule of 90 sec-
onds.
The heater surge current should not exceed 860 Amps peak during the first cycle after voltage is applied to the filament.

**PLATE OPERATION** - The 300 kW plate dissipation maximum rating may be exceeded for very brief periods during setup or tuning. When used as a plate-modulated rf amplifier under carrier conditions, anode dissipation is limited to 200 kilowatts.

**GRID OPERATION** - The maximum grid dissipation is 2000 Watts, and protective measures should be taken to ensure that this rating is not exceeded. Grid dissipation is approximately equal to the product of dc grid current and peak positive grid voltage. A protective spark-gap might be connected between the control grid and the cathode to guard against excessive voltage.

**SCREEN OPERATION** - The maximum screen grid dissipation is 5000 Watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and dc screen current. With screen modulation and/or cathode drive, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Suitable protective circuitry must be provided to remove the screen power in case of a fault condition. A protective spark-gap should be connected between the screen grid and the cathode to guard against excessive voltage. The spark-gap setting should be 5 kV or less, as specified by the transmitter manufacturer.

**FAULT PROTECTION** - In addition to the normal plate over-current, screen current, and coolant interlocks, the tube must be protected from damage caused by an internal arc which may occur at high plate voltage. No more than 50 joules of energy may be dissipated in the tube structure. A protective resistance of 10 - 50 ohms should be connected in series with the tube anode (in the B+ lines) to absorb power supply stored energy if an internal arc occurs. If the power supply stored energy is high, an electronic crowbar in the circuitry design is recommended. This type circuit will discharge power supply capacitors in a few microseconds after the start of an arc.

To conduct a protection test for each electrode supply, short circuit each HV power supply to ground through a vacuum switch or other suitable high-speed, high-voltage switch and a 6 inch (15.24 cm) length of #30 AWG (0.255 mm) soft copper wire. If the total energy delivered is less than 50 joules, the wire will remain intact, verifying adequate tube protection. For more detailed information, Application Bulletin #17, "Fault Protection," is available upon request.

**INTERELECTRODE CAPACITANCE** - In most applications, the internal interelectrode capacitance of a tube is influenced by many variables, such as stray capacitance to the chassis from the tube terminals and associated wiring. To control capacitance values with the tube, as the key component involved, the industry and military services use a standard test described in Electronic Industries Association Standard RS-191. The test is performed on a cold tube, and in the case of the 4CM300,000GA, with no shielding. Other factors being equal, controlling internal tube capacitance in this way usually assures interchangeability of tubes over a period of time.

**SPECIAL APPLICATIONS** - To operate this tube under conditions different from those listed here, contact CPI Eimac Marketing Department in San Carlos, CA at 650/592-1221 or fax 650/592-9988.

**OPERATING HAZARDS**

Proper use and safe operating practices of 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. Please review the following hazards as well as the detailed operating hazards sheet enclosed with each tube, or request a copy from Eimac.

**HIGH VOLTAGE** - Normal operating voltages can be deadly. Remember that high voltage can kill.

**LOW VOLTAGE, HIGH-CURRENT CIRCUITS** - Jewelry should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

**RF RADIATION** - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. Cardiac pacemakers may be affected.

**HOT WATER** - Water used to cool tubes may reach scalding temperatures. Touching the cooling system or rupture of the cooling system can cause serious burns.

**HOT SURFACES** - Surfaces of tubes can reach and maintain temperatures of several hundred °C even several minutes after all power is removed.
GROUND CATHODE
CONSTANT CURRENT CHARACTERISTICS

GRID VOLTAGE - VOLTS

PLATE VOLTAGE - KILOVOLTS

4CM300,000GA
SCREEN VOLTAGE 1000
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT

20 A
10 A
5 A
200 A
180 A
140 A
100 A
40 A
10 A
100 mA
1. Reference dimensions are for info only and are not required for inspection purposes.

2. (*) Contact surface.