TECHNICAL DATA

INDUSTRIAL MEDIUM-MU POWER TRIODE EI3060J/3CW40,000A3

The Eimac EI3060J/3CW40,000A3 is a water-cooled, ceramic/metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated for 40 kilowatts of plate dissipation with low water flow and pressure drop. Input of 160 kilowatts is permissible up to 100 megahertz. This tube is designed to be a direct replacement for the RS3060CJ.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage ..... 10.0 ± 0.5 V
- Current @ 10.0 volts ..... 190 A

Direct Interelectrode Capacitances (grounded cathode)[2]
- Cin ..... 103 pF
- Cout ..... 2.6 pF
- Cgp ..... 48 pF

Amplification Factor 22

Frequency of Maximum Rating (CW) ..... 100 MHz

MECHANICAL

Overall Dimensions:
- Length ..... 14.75 in; 375 mm
- Diameter (anode mounting flange) ..... 7.28 in; 185 mm

Net Weight ..... 16.5 lb; 7.5 kg

Operating Position ..... Vertical, base up or down

Maximum Operating Temperature:
- Ceramic/Metal Seals & Envelope ..... 220°C

Cooling ..... Water & Forced Air

Base ..... Coaxial

[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. CPI Eimac Division 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.

EI3060J/3CW40,000A3

RADIO FREQUENCY INDUSTRIAL OSCILLATOR
Filtered DC Power Supply

Class C

ABSOLUTE MAXIMUM RATINGS:

Anode Voltage	14.0	Kilovolts
Anode Current	15.0	Amperes
Grid Voltage	-1.5	Kilovolts
Grid Current No Load	2.8	Amperes
Grid Current Max. Load	2.0	Amperes
Anode Input Power	160	Kilowatts
Anode Dissipation	40	Kilowatts
Grid Power	1.2	Kilowatts

*Approximate Values

TYPICAL OPERATION LOADED CONDITIONS:

Anode Voltage	8.0	10.0	13.0	kVdc
Anode Current	8.0	9.1	12.1	Adc
Grid Voltage	-750	-850	-950	Vdc
Grid Current*	1.75	1.8	1.75	Adc
Peak Grid Voltage*	1180	1400	1440	V
Grid Resistance	430	470	540	Ohms
Driving Power*	2000	2400	2400	W
Anode Input Power	64	91	157	kW
Anode Dissipation*	12	18.6	35	kW
Anode Output Power*	50	70	120	kW
Approx. Load Impedance	530	580	550	Ohms

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage (feedback) to obtain the specified anode current at the specified bias and anode voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current @ 10.0 volts	190	200	A
Interelectrode Capacitances[1] (grounded cathode)			
Cin	98	108	pF
Cout		3.8	pF
Cgp	46	51	pF

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

APPLICATION

MOUNTING & SOCKETING – The tube must be operated with its axis vertical. The base of the tube may be up or down at the option of the equipment designer. The tube contains a thoriated-tungsten filament and should be protected from shock and vibration.

STORAGE – If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage. Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish that it has not been damaged and operates properly. If the tube is still in storage 6 months later it should be operated in the equipment for 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

COOLING - The tube anode is cooled by circulating water through the water jacket. The table below shows minimum water flow rates for various anode dissipation levels. The cooling water inlet temperature should not exceed 35°C, and system pressure should never exceed 145 psi (10 bar).

When the tube is mounted with the anode up the outer cooler pipe should be used as the water inlet. If the tube is mounted anode down the center cooler pipe should be used as the water inlet.

ANODE POWER KW	FLOW		PRESSURE DROP	
	gal/min	liters/min	psi	mbar
0	3	10	3	175
10	3	10	3	175
20	4	16	5	375
30	6	24	12	800
40	8	31	19	1300

A major factor affecting long life of water-cooled tubes is the condition of the cooling water. If the water is contaminated deposits will form on parts of the anode and water jacket and can cause localized heating of the anode and eventual failure of the tube.

Cooling water must be well filtered with effectiveness equivalent of a 40-mesh screen to avoid the possibility of blockage of any cooling passages.

Ideally, to insure minimum electrolysis, water resistivity should be maintained above one megohm per cubic centimeter. With this tube water resistivity should be maintained above fifty thousand ohms per cubic centimeter and preferably above 250 thousand ohms per cubic centimeter. Water resistivity can be continuously checked in the reservoir by readily available instruments. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes. Eimac Application Bulletin #16, WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS, is available on request; it contains considerable detail on purity effects and system maintenance.

Forced-air cooling of the base is also required with 100 cfm (3.0 m^3/minute) of air at 50°C maximum directed into and around the base of the tube to cool the grid and filament contact and seal areas. Application Bulletin #20, TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES, is available on request and gives measurement technique information.

Both anode and base cooling must be applied before or simultaneously with electrode voltages, including the filament. Cooling should normally continue about three minutes after removal of electrode voltages to allow the tube to cool down properly.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow temperatures will rise to levels which are detrimental to long life. If the coolant lines become obstructed the coolant jacket may actually rupture from generated steam pressure.

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 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.

FILAMENT OPERATION - With a new tube, or one which has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter material mounted within the filament structure to absorb any residual gas molecules which have accumulated during storage. Once normal operation has been established a minimum filament warm-up time of five seconds is normally enough.

Eimac Application Bulletin #18, EXTENDING TRANSMITTER TUBE LIFE, gives information on the effect of filament voltage on life expectancy.

Note that both anode (liquid) and base (air) cooling is required when the filament of the tube is operating, even though no other voltages are applied to the tube.

Filament voltage should be measured at the tube base, using a known-accurate (preferably plus or minus one percent) rms-responding meter. Variation in voltage should be limited to no more than five percent for consistent tube performance.

LOAD FAULTS – In self- excited oscillators large load variations or faults can cause potentially dangerous changes in tube efficiency, which in turn can increase anode dissipation to a very high level. If this occurs tube damage can result even though anode current is near the normal operating value. The circuit designer is therefore cautioned to suitably proportion the circuit constants to minimize this effect, and to be sure anode cooling water flow is adequate to handle worst-case dissipation conditions.

GRID OPERATION – The maximum no load grid current rating is 2.8 amperes dc. This value should not be exceeded except during tuning for very short periods, and over-current protection in the grid circuit should be provided. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 1.2 kilowatts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the grid and the cathode to guard against excessive voltage.

FAULT PROTECTION - In addition to normal cooling interlocks and an anode over-current interlock, it is good practice to protect the tube from internal damage which could result from occasional arcing at high anode voltage. In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case an arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, may be required. The test for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AGW copper wire. The wire will remain intact if protection is adequate. Eimac Application Bulletin #17, FAULT PROTECTION, contains considerable detail and is available upon 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, 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 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 eliminates any capacitance reading to "ground". The test is performed on a cold tube, and in the case of the EI3060J/3CW40,000A3 no special shielded fixture is used. 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 manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, 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 mounting which represents approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The EI3060J/3CW40,000A3 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed 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 the primary circuits of the power supplies 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.

RF RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

HOT SURFACES - Air-cooled surfaces 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.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, contact the Application Engineering Dept., CPI Eimac Division, San Carlos, Calif. 94070 for information and recommendations.

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 and are exposed to power tubes, or equipment that 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.

HIGH VOLTAGE – Normal operating voltages can be deadly. Remember the HIGH VOLTAGE CAN KILL.

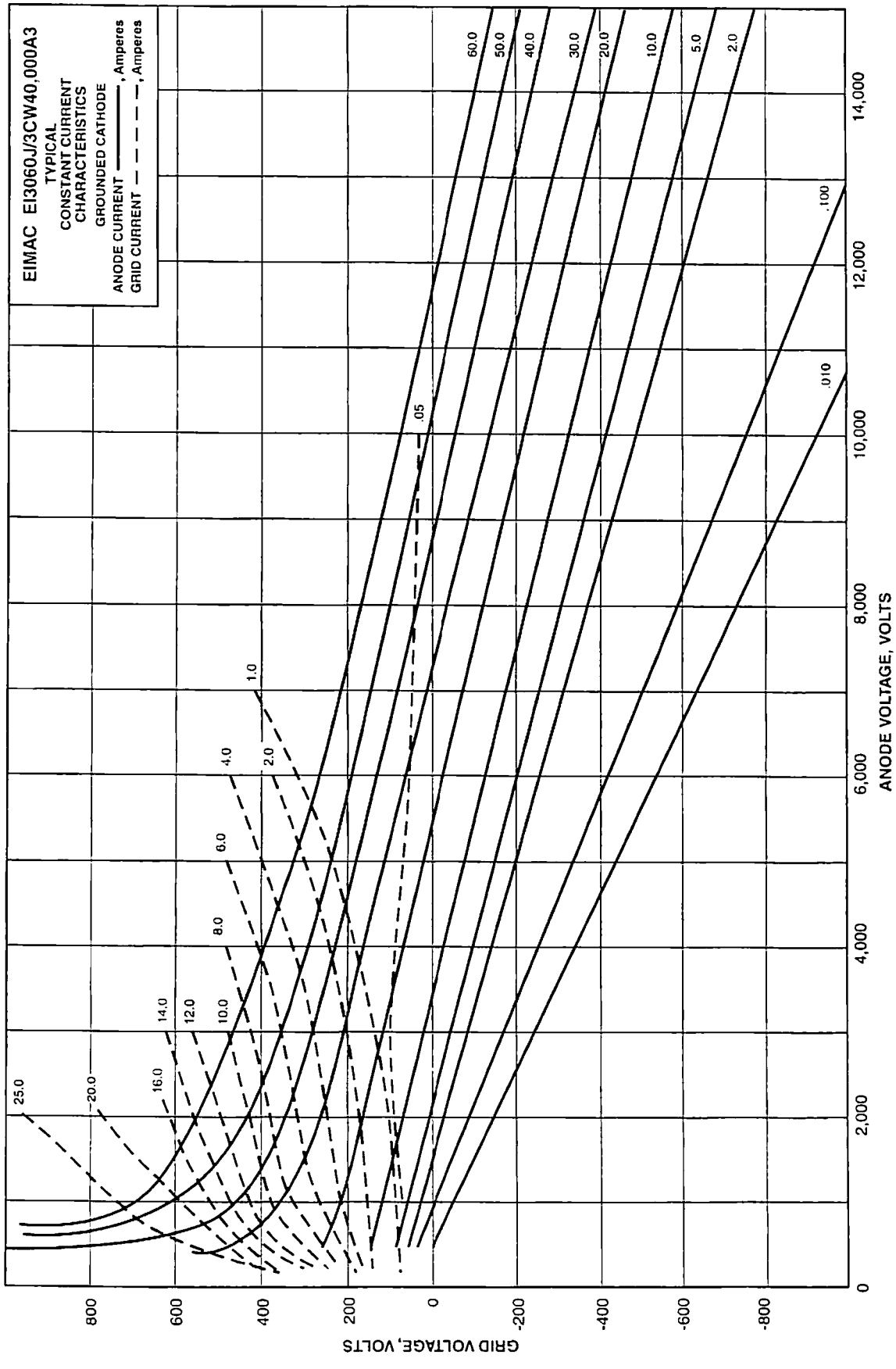
LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

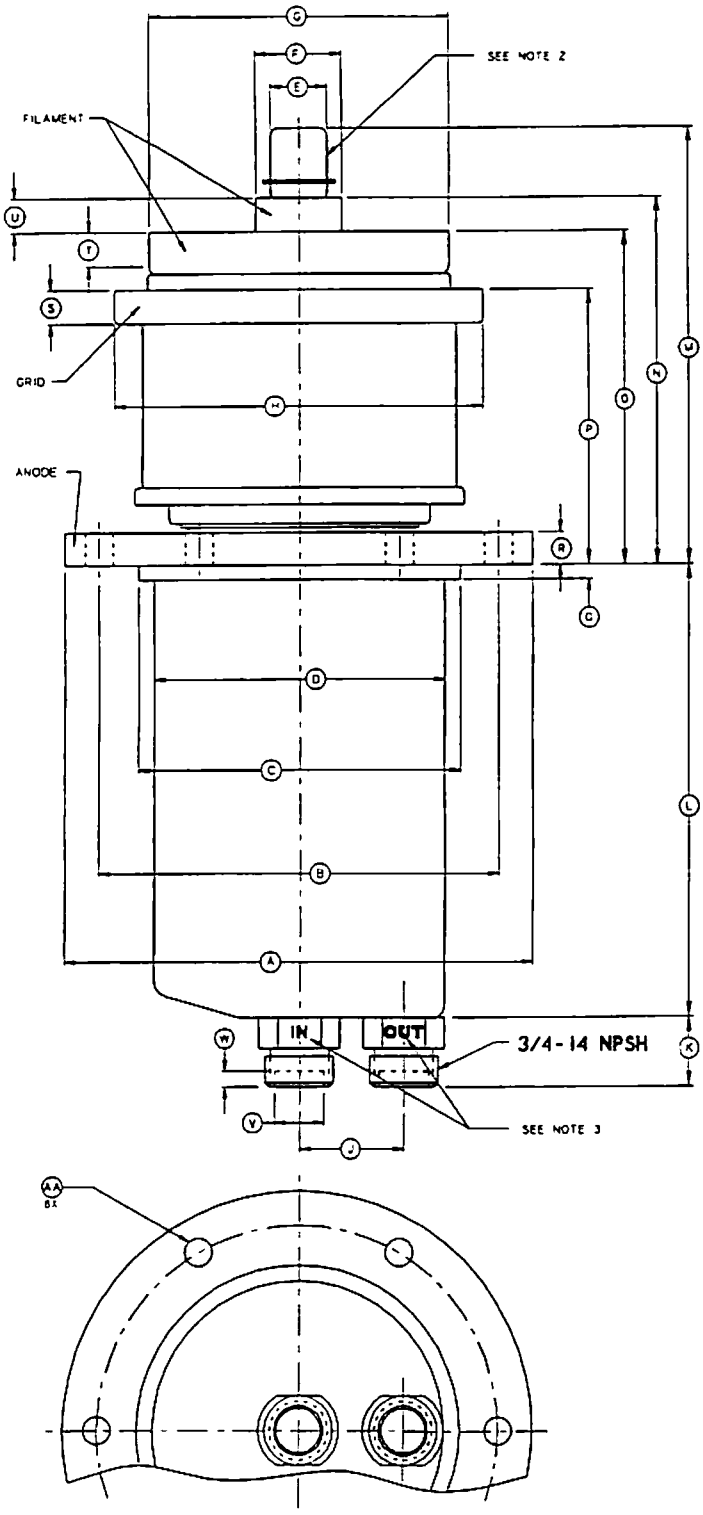
RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE AFFECTED.

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

HOT SURFACES – Surfaces of tubes can reach temperatures of several hundred °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 CPI, Eimac Division Application Engineering at 650/592-1221.


EIMAC EI3060J/3CW40,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
ANODE CURRENT ———, Amperes
GRID CURRENT — — — —, Amperes
60.0
50.0
40.0
30.0
20.0
10.0
5.0
2.0
1.0
.100
.010
.05
25.0
20.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
800
600
400
200
0
-200
-400
-600
-800
GRID VOLTAGE, VOLTS
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
ANODE VOLTAGE, VOLTS



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A			7.283			185
B			6.220			158
C			5.000			127
D			4.528			115
E			.866			22
F	1.334	1.344		33.88	34.14	
G	4.626	4.666		117.50	119.52	
H	5.728	5.768		145.49	146.51	
J			1.614			41
K	1.023	1.083		25.98	27.51	
L	6.787	7.037		172.39	178.74	
M	6.651	6.749		166.65	171.43	
N			5.590			142
O			5.059			128.5
P			4.154			105.5
Q			.217			5.5
R			.492			12.5
S			.472			12
T			.551			14
U			.512			13
V			.768			19.5
W			.236			6.0
AA			.433			11.00

NOTES:

1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. NOT TO BE USED AS A TERMINAL.
3. IF TUBE IS MOUNTED ANODE UP THE COOLING WATER HAS TO FLOW CONTRARY TO THE MARKED DIRECTION (IN & OUT)

wireless solutions

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Printed in USA 08/01