Communications & Power Industries

INDUSTRIAL POWER TRIODE EI3021CJ

The CPI EI3021CJ is a ceramic/metal power triode designed for use in industrial oscillator service. This tube is a direct replacement for the RS3021CJ and uses a water cooled anode with a dissipation rating of 20 kilowatts.

CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.7± 0.3 V
Current at 5.7 Volts	135 A
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cgk	56 pF
Cgp	21.5 pF
Cpk	0.3 pF
Amplification Factor (average)	120
Frequency of Maximum Ratings (CW)	40 MHz
Frequency of Reduced Ratings (CW)	120 MHz

MECHANICAL:

Overall Dimensions:	
Length	9.72 in; 247 mm
Diameter	5.12 in; 130 mm
Weight (approx.)	9.04 lbs. 4.1 kg
Operating Postition	Vertical, Base Up or Down
Maximum Operating Temperature:	
Ceramic/Metal Seals & Envelope	250° C
Cooling	Water and 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.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current @ 6.3 Volts	**31**	**37**	**A**
Interelectrode Capacitances [1] (grounded cathode)			
Cin	**29.2**	**42.2**	**pF**
Cout	**0.5**	**1.5**	**pF**
Cgp	**16.8**	**23.2**	**pF**

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

The values listed above represent specified limits for the product and are subject to change. The data should be used for basic information only. Formal, controlled specifications may be obtained from CPI for use in equipment design.

ISO 9001

For information on this and other CPI products, visit our website at: **www.cpii.com**, or contact: CPI MPP, Eimac Operation, 607 Hansen Way, Palo Alto, CA 94303
TELEPHONE: 1(800) 414-8823. FAX: (650) 592-9988 | EMAIL: powergrid@cpii.com

INDUSTRIAL POWER TRIODE EI3021CJ

RADIO FREQUENCY AMPLIFIER
Class B, grounded grid, cathode driven

ABSOLUTE MAXIMUM RATINGS[1]:

ANODE VOLTAGE	14.0 kVdc
ANODE CURRENT	5.0 Adc
GRID VOLTAGE	-800 Vdc
ANODE DISSIPATION	20 kW
GRID DISSIPATION	500 Watts

TYPICAL OPERATION frequency to 40 MHz:

ANODE VOLTAGE	5.0	9.0	kVdc
ZERO-SIGNAL ANODE CURRENT	0.4	0.3	Adc
ANODE CURRENT	2.9	2.75	Adc
GRID BIAS VOLTAGE	-35	-75	Vdc
GRID CURRENT*	1.15	0.7	Adc
DRIVING POWER*	710	660	W
ANODE OUTPUT POWER*	10	17	kW
ANODE LOAD IMPEDANCE	1100	1900	Ohms
ANODE DISSIPATION	4.4	7.6	kW

* Approximate Values

RADIO FREQUENCY OSCILLATOR
Class C, grounded cathode

ABSOLUTE MAXIMUM RATINGS:

ANODE VOLTAGE	14.0 kVdc
ANODE CURRENT	5.0 Adc
GRID VOLTAGE	-800 Vdc
ANODE DISSIPATION	20 kW
GRID DISSIPATION	500 Watts

TYPICAL OPERATION frequency to 40 MHz:

ANODE VOLTAGE	5	7	10	kVdc
ANODE CURRENT	2.5	2.73	2.50	Adc
CATHODE BIAS VOLTAGE	-160	-200	-290	Vdc
GRID CURRENT*	1.3	1.2	0.9	Adc
DRIVING POWER	450	460	420	W
ANODE OUTPUT POWER*	10	15	20	kW
ANODE LOAD IMPEDANCE	1050	1400	2100	Ohms
ANODE DISSIPATION	2.7	3.6	4.4	kW

* Approximate Values

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.

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APPLICATION

MOUNTING & SOCKETING – The tube must be operated with its axis vertical. The base of the EI3021CJ 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 50°C, and system pressure should never exceed 87 psi (6.0 bar). Outlet water temperature must never exceed 70°C.

When the tube is mounted in the normal position with the anode down the water must flow in the arrow-marked direction. If the tube is mounted with the anode up, cooling water must flow opposite to the arrows marked on the anode cooler.

Cooling requirements listed below are for water at an inlet temperature of 35°C:

ANODE POWER KW	FLOW		PRESSURE DROP	
	gal/min	liters/min	psi	mbar
0	0.7	2.65	.07	5
10	2.1	8	1.2	85
15	3.2	12	2.7	190
20	4.1	15.5	4.4	300

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 meg-ohm per cubic centimeter at 25°C. Water resistivity can be continuously checked in the reservoir by readily available instruments. A relative water resistance check can be made 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 contains considerable detail.

Forced-air cooling of the base is also required with 0.7 m^3/min of air at 50°C maximum directed onto the tube contact terminals.

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 the tube. 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 - This tube is designed for commercial service, with no more than one normal off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at CPI for additional information.

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With a new tube, or one that has been in storage for some period of time, operation with filament voltage only, at the nominal value of 5.7 volts, 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 sufficient.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communications service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations. Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter.

When cold, the resistance of a thoriated tungsten filament is very low, therefore the initial starting (inrush) current when filament voltage is applied can be many times the normal (hot) current; this can be detrimental to the longevity of a filament structure. Filament inrush current should never exceed a value of twice the nominal rated current. The use of a special impedance-limited filament transformer or other “step-start” circuitry in the supply side (primary) of the filament transformer is recommended.

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

GRID OPERATION – The maximum allowable grid dissipation for the EI3021CJ is 500 Watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. This value should not be exceeded except during tuning for very short periods. A grid over-current protection circuit with interlock set to trip-off above approx. 2.1 Ampere should be provided; the actual value of current used for the trip point depends on the value of anode current that occurs during normal operating conditions for a given application. In conventional cathode driven circuits, a protective spark-gap device should be connected between the dc cathode return and ground to help guard against excessive voltage that may exist under fault conditions.

FAULT PROTECTION - In addition to normal cooling interlocks and anode and grid over-current interlocks, it is good practice to protect the tube from internal damage which could result from potential arcing at high anode voltage. In all cases some protective resistance, at least 5 Ohms, should be used in series with the tube’s anode supply 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.

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 in a special shielded fixture. 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 EI3021CJ 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.

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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 the hazard, and the published OSHA (Occupational Safety and Health Administration) or other local recommendations to limit prolonged exposure of rf radiation should be followed.

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.

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 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.

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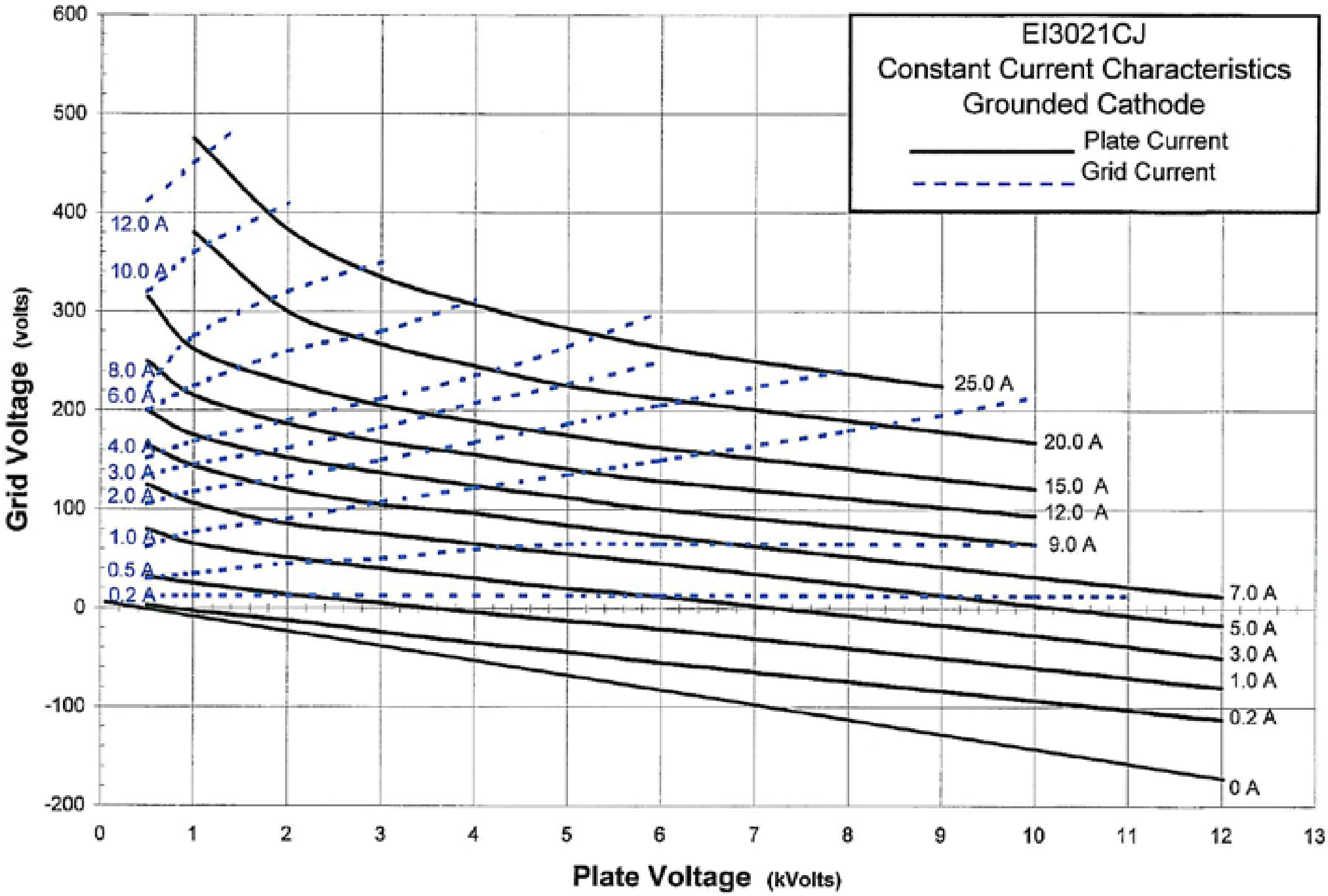

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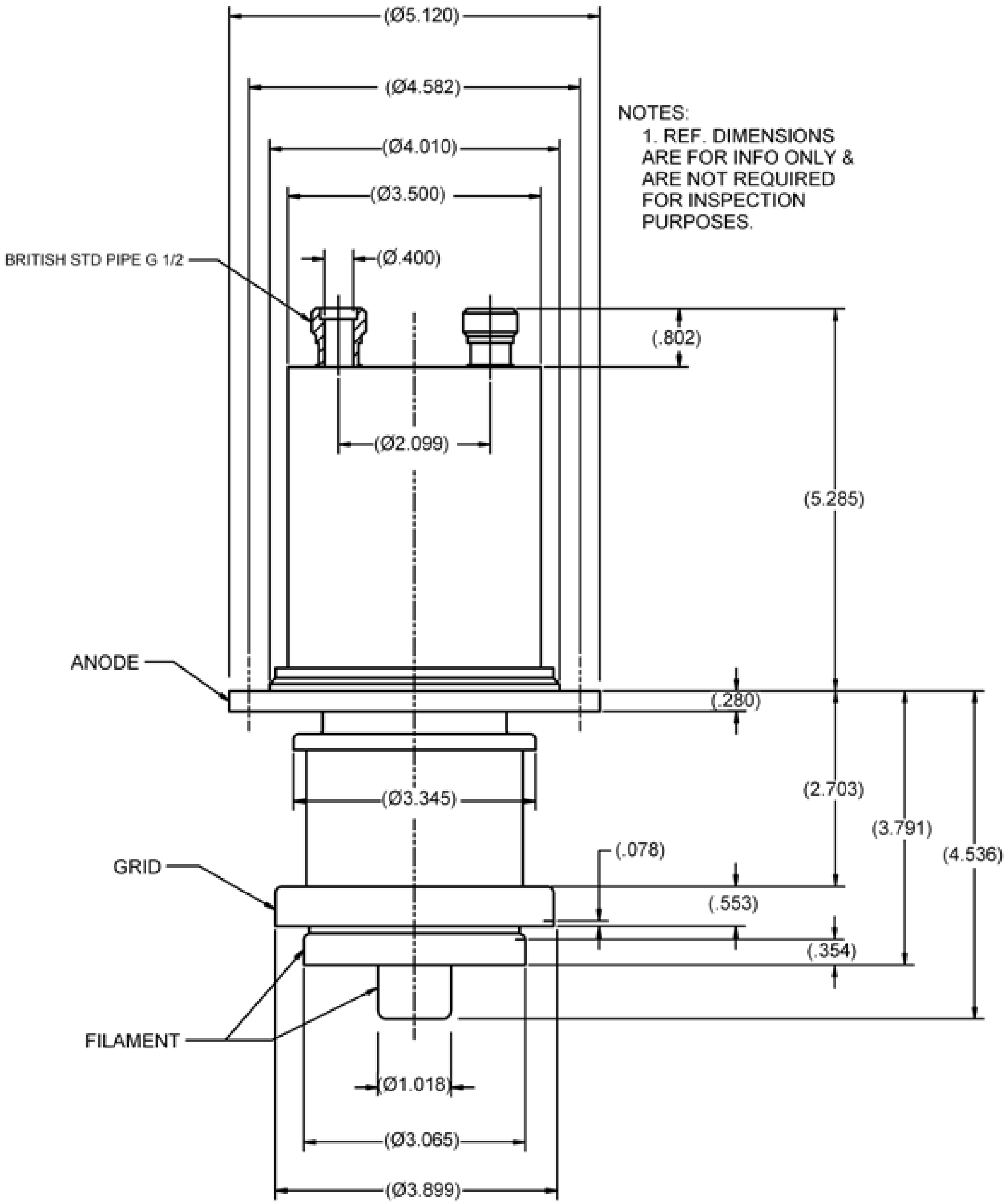

OUTLINE DRAWING
(Dimensions in mm)

CPI00308