



## **VKT2438 Series**

### **CW EXTENDED INTERACTION**

### **OSCILLATOR**

### **INSTALLATION & OPERATING**

### **INSTRUCTIONS MANUAL**

PREPARED BY:

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## **CW EXTENDED INTERACTION OSCILLATOR**

## **INSTALLATION AND OPERATING INSTRUCTIONS**

### **SECTION 1 - INTRODUCTION**

This manual contains the instructions required to install and operate a CW Extended Interaction Oscillator (EIO).

Specific information is contained on the Test Data Sheet for the particular EIO shipped (Appendix). For further information regarding this product or for additional copies of this manual or the Test Data sheet please contact your CPI representative:

CPI Canada Inc  
45 River Drive,  
Georgetown, Ontario  
Canada L7G 2J4

Phone Number: 905-877-0161

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Email : [marketing@cmp.cpii.com](mailto:marketing@cmp.cpii.com)

## SECTION 2 - PROTECTIVE MEASURES

### 2.0 GENERAL

Equipment, in which the EIOs are used, should provide protection to personnel as described below. In addition, to protect the EIO, installation and operating precautions must be observed, and absolute ratings must not be exceeded.

### 2.1 PERSONNEL

#### 2.1.1 High Voltage

**WARNING:** *VOLTAGES REQUIRED FOR THE OPERATION OF EIKS CAN BE DANGEROUS AND POTENTIALLY FATAL TO PERSONNEL. EQUIPMENT MUST BE DESIGNED WITH PROTECTIVE DEVICES SUCH AS PHYSICAL SHIELDS AND FAILSAFE INTERLOCK CIRCUITS ON ACCESS PANELS TO PREVENT ACCIDENTAL CONTACT WITH HIGH VOLTAGE. SOME COLLECTOR DESIGNS OPERATE AT DEPRESSED VOLTAGE POTENTIAL. THUS THE COLLECTOR BECOMES AN EXPOSED HIGH VOLTAGE SURFACE AND IS EXTREMELY DANGEROUS TO LIFE. COOLING SYSTEMS MUST BE DESIGNED TO PREVENT ACCIDENTAL CONTACT WITH THE HIGH VOLTAGE ON THE COLLECTOR. LIQUID COOLED AND AIR COOLED DEPRESSED COLLECTORS HAVE UNIQUE REQUIREMENTS TO ENSURE SAFE OPERATION OF THE EIK.*

#### 2.1.2 Air Cooled Collector Hazard

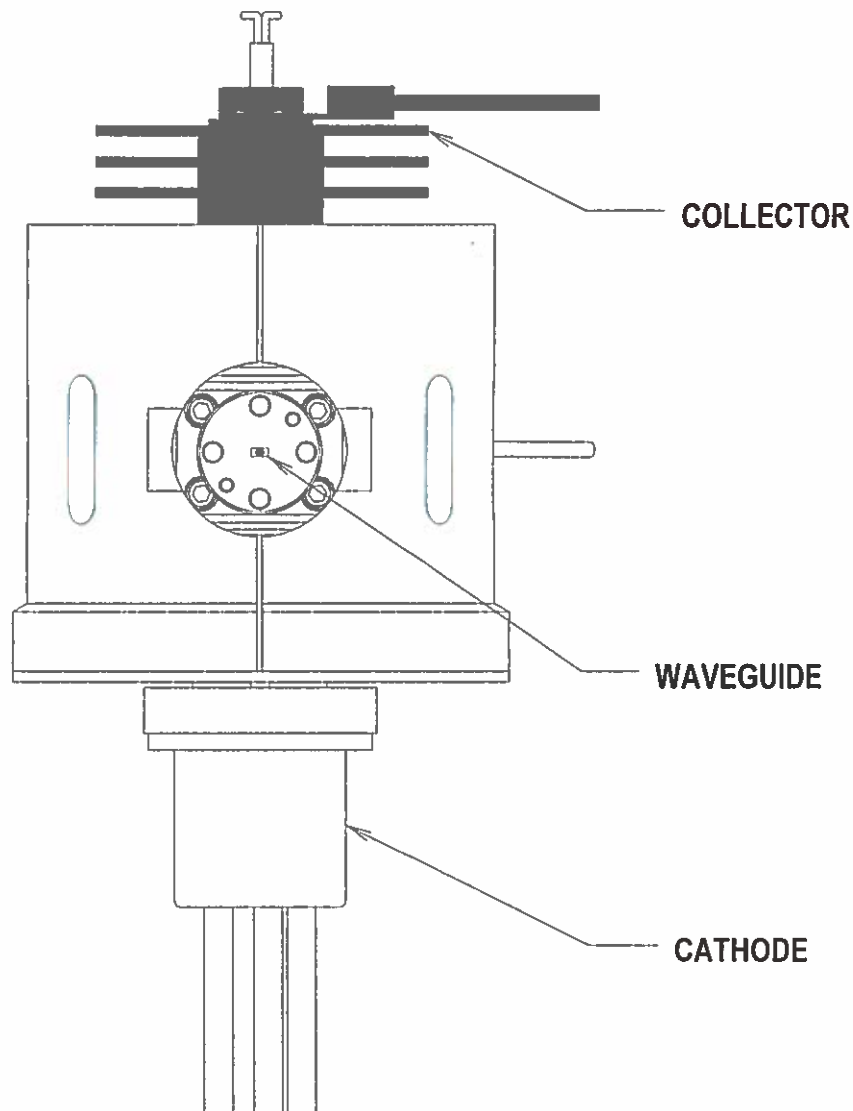
Installers and operators need to be aware of a potential *high voltage hazard* when operating air-cooled EIKs with depressed voltage collectors and the need to ensure that the installation presents no risk of electrical shock.

If the EIK collector is not directly grounded, and is to be operated either above or below ground potential, then the collector becomes an exposed high voltage surface. **Contact with this surface can be fatal.** The shaded area in Figure 1 indicates the high voltage surfaces on the collector.

The EIK must be installed inside a grounded enclosure. This enclosure must have provision to allow cooling air to flow past the EIK and prevent contact with high voltage surfaces of the collector by an operator/installer directly or with any type of tool.

Protective devices such as physical shields and failsafe interlock switch circuits, etc., must be installed and functioning to prevent physical contact with the collector.

Do not attempt to operate the EIK until it has been determined that all precautions have been taken to protect personnel from all hazards.



**Figure 1**  
**HIGH VOLTAGE SURFACES ON THE COLLECTOR**  
**(Protective Cage not Shown for Clarity)**

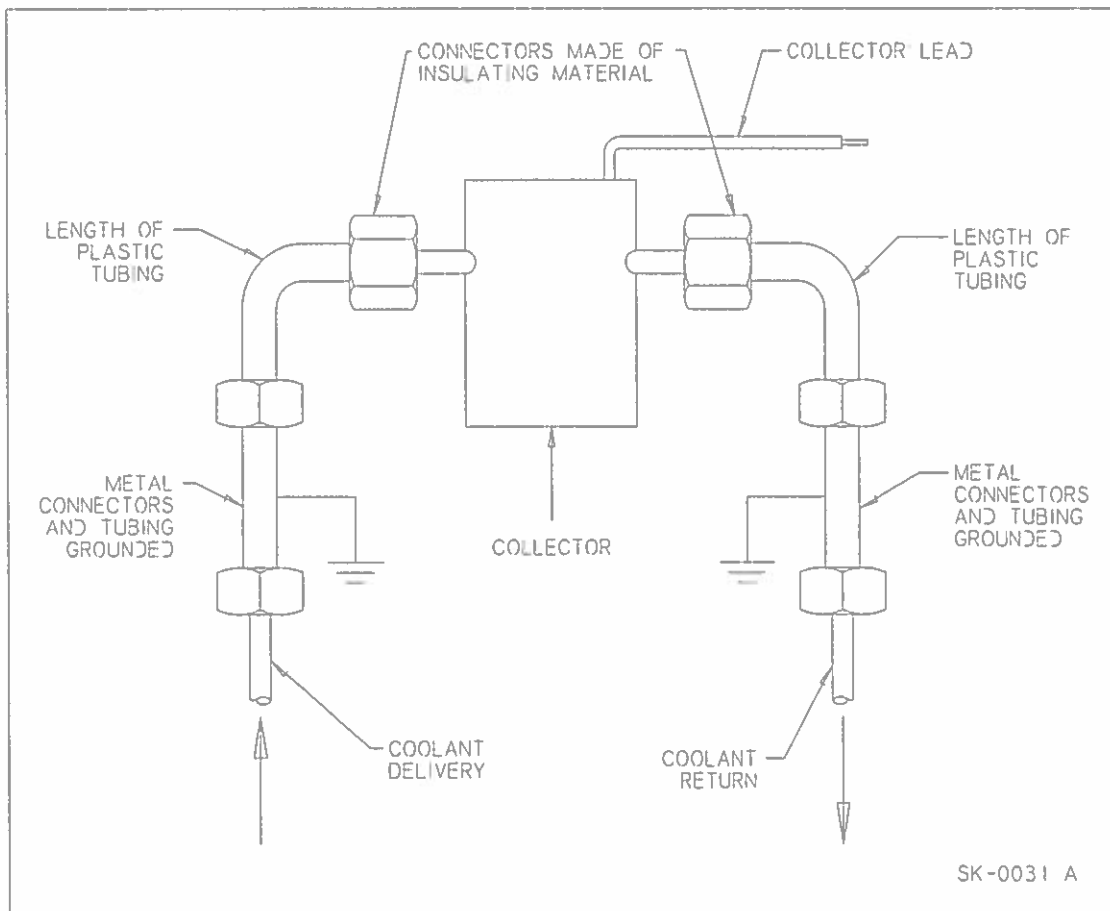
### 2.1.3 Liquid Cooled Collector Hazard

Installers and operators need to be aware of a potential **high voltage hazard** when operating liquid cooled EIKs with depressed voltage collectors and the need to ensure that the installation presents no risk of electrical shock. All coolants must be regarded as partial conductors of electricity. The following discussion assumes that the coolant lines are made of insulating material.

If the EIK collector is not directly grounded, and is to be operated either above or below ground potential, the coolant (in both flow and return lines) will equivalent to a resistor chain. A voltage distribution will exist along the lines, zero being located at the first grounded point encountered. Any part of the coolant line which is electrically conducting and not directly grounded may develop a hazardous voltage.

To prevent the above scenario, **directly ground all metal plumbing components in both flow and return coolant lines attached to the EIK**, see Figure 2. Steps must be taken to prevent contact with all electrically conducting materials. For further information please contact your CPI representative.

Do not attempt to operate the EIK until it has been determined that all precautions have been taken to protect personnel from all hazards.



**Figure 2**  
**TYPICAL CONFIGURATION TO PREVENT ELECTRICAL HAZARD**

#### 2.1.4 Microwave Radiation

**WARNING:** **PRECAUTIONS SHOULD BE TAKEN TO PREVENT EXPOSURE OF PERSONNEL TO THE MICROWAVE FIELDS PRODUCED BY THE EIK. EIK MILLIMETRE WAVE WAVEGUIDE CIRCUITS EMPLOY HIGH POWER DENSITY RF WHICH MAY RADIATE FROM ANY WAVEGUIDE FLANGE GAPS.**

Refer to: "American National Standard Safe Levels of Microwave Radiation" (ANSI C95.1 published by the I.E.E.E., 345 East 47th Street, New York, NY., 10017) for safe radiation levels.

## 2.2 EQUIPMENT

### 2.2.1 Current Limiting

While every effort has been made to ensure adequate electrode spacings within the EIO, occasional electrical breakdowns are possible. Many power supplies use large capacitors for filtering purposes which provide sufficient current, when a breakdown occurs, to damage the EIO beyond repair. It is strongly recommended that the EIO current be limited by inserting a resistor (typically, 1000 Ohms) in series with the high voltage power supplies unless peak current from the power supplies is limited in some other way.

**NOTE:** The 1k $\Omega$  resistor in the collector leads shown in Figures 1 & 2 is not primarily for arc protection, but is to ensure that the collector is always somewhat negative with respect to the EIO body.

### 2.2.2 Heater Voltage

The EIO cathode heater filament has one terminal internally tied to the cathode electrode; therefore, the heater power supply must be floated (high voltage isolated) at cathode voltage. If a DC heater supply is used, apply negative heater voltage to the heater lead (yellow lead) and positive heater voltage to the cathode lead (white lead).

### 2.2.3 Anode

The anode provides a means of controlling the output power by controlling the cathode current of the EIO; whilst the cathode voltage remains constant. The anode voltage is applied between the anode and cathode.

**NOTE:** Anode current may flow in the reverse direction through the anode power supply. The design of the anode power supply must take this factor into consideration.

### 2.2.4 Collector

The collector is insulated from the EIO body to allow for body current monitoring and for the collector potential to be depressed with respect to the body potential. It should be biased negatively with respect to the body by about a minimum of 100 volts, the actual value is not critical but prolonged operation at zero bias could reduce EIO life.

### 2.2.5 Interlock System

**CAUTION:** INTERLOCKS SHOULD BE BUILT INTO THE SYSTEM TO REMOVE OR PREVENT THE APPLICATION OF CATHODE AND ANODE VOLTAGE IF ANY OF THE ABSOLUTE RATINGS OF THE EIO ARE EXCEEDED. INSTALL COOLANT FLOW INTERLOCKS ON THE COOLANT EXHAUST SIDE OF THE EIO.



### 2.2.6 High Voltage Cables

The high voltage insulation used on the EIO wires is easily damaged by contact with sharp edges, abrasive material, or by forcing the wires into tight bends. Preserving the integrity of the insulation is essential in order to prevent high voltage arcing.

**WARNING:** *ANY MINUTE DAMAGE TO THE HIGH VOLTAGE WIRE INSULATION COULD POSE A LETHAL HAZARD. IT IS RECOMMENDED THAT THE WIRING BE ENCLOSED IN A PROTECTIVE SHIELD TO PREVENT PERSONNEL FROM COMING INTO ACCIDENTAL CONTACT.*

## SECTION 3 - INSTALLATION INSTRUCTIONS

### 3.0 HANDLING

Remove the inner shipping box from the outer shipping box. The EIO should be handled by its yoke, painted red or its aluminum base plate (usually gold alodined).

**CAUTION:** *NEVER HANDLE THE EIO BY THE COOLANT LINES, ELECTRICAL LEADS, TUNER OR COLLECTOR*

Remove the EIO from the inner shipping box, observing the precautions listed above. Retain all packing material for future EIO transportation.

**NOTE:** The steel inner liner of the shipping container is a functioning magnetic shield.

### 3.1 MOUNTING

**CAUTION:** *THE RARE EARTH PERMANENT MAGNETS CAN POSE AN ATTRACTION HAZARD. DISTURBING THE STRY EXTERNAL MAGNETIC FIELD OF THE EIO MAY DETRIMENTALLY AFFECT EIK PERFORMANCE. ALL WRENCHES AND SCREWDRIVERS USED TO MOUNT AND ALIGN THE EIK MUST BE NON-MAGNETIC. MAGNETIC MATERIALS MUST BE KEPT AT LEAST 6 INCHES (15CM) FROM THE EIK, OTHER MAGNETS MUST BE KEPT AT LEAST 12 INCHES (30CM) AWAY.*

The EIO may be mounted using holes provided with .250" hardware. Clearance is required for the electrical leads and the collector cooling assembly. (See outline drawing in the EIO specifications section in the appendix)

## 3.2 COOLING

### 3.2.1 General

This EIK must be water-cooled.

For proper operation and long life, liquid-cooled EIKs require careful attention to the maintenance of adequate water flow and purity.

The minimum flow as specified on the Test Data Sheet must be maintained at all times when the EIK is in operation. Inadequate flow of water at high temperature will cause formation of steam bubbles at the collector surface where the water is in direct contact with it. This overheating will result in permanent damage to the EIK.

Water with contaminant levels that exceed the purity requirements will cause corrosion and scaling, this includes ordinary tap water. Unchecked corrosion of the metals in the EIK coolant passages reduces operating life. Scaling obstructs cooling passages preventing efficient heat transfer resulting in overheating and permanent damage. Continuous filtering, deionizing and oxygen removal is necessary for maintaining high water purity.

For water purity requirements and further information, please refer to the application note “**EIK Water Cooling Requirements**” in the appendix.

### 3.2.2 Coolant

Deionized water is the recommended coolant for EIK's.

For protection against low temperatures, the use of water heaters or draining the system during non-operating periods is advised.

If a freezing point depressant is necessary, an *uninhibited* solution of ethylene glycol and water is the recommended coolant. Inhibited ethylene glycol cannot be used with coolant purification systems, because the inhibitors will saturate the ion-exchange resin and render it useless.

In cases where ethylene glycol is required, the coolant flow must be increased to allow for the poorer heat capacity and higher viscosity of the ethylene glycol solution. Before ethylene glycol is used in CPI EIK's, the CPI Marketing Department must be consulted for specific recommendations.

**WARNING:** **FOR LIQUID COOLED COLLECTORS, ALL METAL COMPONENTS OF THE LIQUID-COOLING SYSTEM (EXCEPT THE EIK COLLECTOR) MUST BE GROUNDED TO PREVENT CHARGE ACCUMULATION (POTENTIALLY COLLECTOR TO BODY VOLTAGE) THROUGH THE COOLANT POSING AN OPERATOR HAZARD. REFER TO SECTION 2.1.3.**

### 3.2.3 Coolant Connections

Coolant lines are attached using swagelock nuts and nylon ferrules. Excessive force must not be used when attaching the coolant hose. Adequate torque can be obtained using fingers only.

**CAUTION:** *IF MORE FORCE SEEMS TO BE REQUIRED DISMANTLE AND EXAMINE THE CONNECTION*

Cooling fluid must enter at the collector and exit at the body connector of the EIO.

A coolant flow interlock should be used to ensure proper coolant flow exiting the EIO.

A singing or hissing noise emanating from the EIO may indicate inadequate coolant flow.

**CAUTION:** *TEST WATER CONNECTIONS FOR LEAKS PRIOR TO APPLICATION OF HIGH VOLTAGES. CORRECT ANY COOLANT PROBLEMS IMMEDIATELY.*

## 3.3 CONNECTIONS

### 3.3.1 Electrical Connections

**CAUTION:** *ALTHOUGH THE HIGH VOLTAGE LEADS ARE ADEQUATELY INSULATED; THEY SHOULD BE SHIELDED FROM ACCIDENTAL CONTACT WITH PERSONNEL BY A SUITABLE GROUND SHIELD OR GROUNDED ENCLOSURE. TO PREVENT OR REDUCE CORONA, THEY MAY REQUIRE AN INCREASED AIR GAP OR INCREASED INSULATION.*

The electrical connections to the EIO are colour-coded as follows:

YELLOW	-	HEATER (-ve)
WHITE	-	CATHODE & HEATER (+ve)
BLUE	-	COLLECTOR
BROWN	-	BODY
RED	-	ANODE
PURPLE	-	BODY GROUND INTERLOCK

### 3.3.2 RF Connections

RF connections to the EIO are made through a waveguide flange. Refer to the specification section (in appendix) for the applicable waveguide size and mating flange types.

The waveguide flange connection must be made with care in order to avoid gaps between the mating surfaces. Avoid over-tightening the flange screws.

**CAUTION:**     ***IT IS ESSENTIAL THAT THE MATING FLANGE BE FLAT***

The EIO window is .002" thick.

**CAUTION:**     ***UNDER NO CIRCUMSTANCES ALLOW SOLID OBJECTS TO ENTER THE OUTPUT WAVEGUIDE***

## SECTION 4 - OPERATING PROCEDURES

### 4.0 GENERAL

Ensure that all power supplies are OFF, and that all controls are set at zero before proceeding.

The Test Data sheet lists the cathode voltage required for maximum power at discrete frequencies. The cathode voltage required for other frequencies may be obtained by interpolation.

Refer to the absolute ratings listed in the SPECIFICATIONS (in appendix) and the test data supplied with each EIO.

Set the maximum cathode current trip to the value posted on the EIO. The maximum body current trip may be set to the value specified in the absolute ratings; however, the body current is generally set a few milliamperes above the value listed on the Test Data sheet.

### 4.1 INITIALIZATION CHECKLIST

It is recommended that the following checklist be covered before applying any voltages:

1. Connect the collector to the power supply positive.
2. Connect the body (normally ground) to the power supply positive.
3. Ensure the heater, cathode and anode leads are adequately insulated; connect the leads to their respective power supplies.
4. Ensure coolant flow is adequate.
5. Ensure, by the use of trips, adjustment stops, etc. that the absolute ratings will not be exceeded. (Refer to Maximum Ratings in appendix.)
6. Connect the O/P flange and the I/P flange (where applicable) to suitable RF loads.
7. Ensure personnel will not be subject to exposure from the microwave fields.
9. Ensure personnel cannot come into contact with any high voltage.

## 4.2 CONFIGURATION 1 - Refer to Figure 3

Connect the EIO to the power supplies as shown in Figure 3. Configuration 1 is similar to the circuit used with the CPI EIK Power Supply, Model VPW2827. Protect the EIO as discussed in Section 4.0 and 4.1.

Switch the heater supply ON. When the minimum specified heater delay has elapsed, the beam power supply may be turned ON. Set the beam voltage to the value specified for the desired frequency of operation on the Test Data Sheet, an exact setting is not required.

**NOTE:** The anode voltage is referenced to the cathode. When the anode voltage is switched OFF, the anode-to-body (ground) voltage equals the beam voltage. As the anode voltage is increased, the anode-to-body voltage decreases.

Switch the anode power supply ON and increase the anode voltage until the beam current specified on the Test Data Sheet is obtained.

**CAUTION:** *DO NOT ALLOW THE ANODE TO BECOME POSITIVE WITH RESPECT TO THE BODY. THE ANODE VOLTAGE SHOULD EXCEED -50 VOLTS WITH RESPECT TO BODY WHEN THE EIO IS OPERATING.*

Adjust the tuner until the EIO oscillates at the desired frequency. With the beam voltage set correctly, the EIO should be operating at the peak power for the mode; i.e., at the maximum power consistent with the beam current specified on the Test Data Sheet for the operating frequency.

The beam voltage may be optimized to obtain the maximum possible RF power output. Varying the beam voltage produces a corresponding change in frequency due to electronic tuning.

Adjust the beam voltage to obtain the maximum possible power.

Retune the EIO to obtain maximum possible power at the required frequency.

The power output may be reduced by lowering the anode voltage.

**CAUTION:** *DO NOT, UNDER ANY CIRCUMSTANCES, EXCEED THE MAXIMUM BEAM CURRENT OR BODY CURRENT SPECIFIED IN THE OPERATING INSTRUCTIONS FOR THE INDIVIDUAL EIO*

***THE ABSOLUTE RATINGS MUST BE ADHERED TO***

Special attention should be paid to maximum current, and to the polarity and value of the anode potential.

#### 4.2.1 Turn-Off Procedure

- Switch the anode power supply OFF.
- Switch the beam power supply OFF.
- Switch the heater power supply OFF.
- Switch the mains power supply OFF.

**NOTE:** The EIO power supply, VPW2827, may be shut-down fast by switching the beam power supply OFF; the anode power supply will automatically switch OFF.

**NOTE:** Opening an interlock will have the same result.

#### 4.3 CONFIGURATION 2 - Refer to Figure 4

Connect the EIO to the power supplies as shown in Figure 4. Protect the EIO as discussed in Section 4.0 and 4.1.

Set the anode potentiometer to approximately centre position.

Switch the beam power supply ON and set the voltage to the value specified on the Test Data sheet for the desired frequency of operation; an exact setting is not required.

Set the anode voltage to provide the beam current specified on the Test Data sheet.

Adjust the tuner until the EIO oscillates at the desired frequency. With the beam voltage set correctly, the EIO should be operating at peak power for the mode; ie., at the maximum power consistent with the beam current specified in the Test Data for the operating frequency.

The beam voltage may be optimized to obtain the maximum possible RF power output. Varying the beam voltage produces a corresponding change in frequency due to electronic tuning.

Adjust the beam voltage to obtain the maximum possible power.

Retune the EIO to obtain maximum possible power at the required frequency.

Repeat the beam voltage and the tuner adjustments until maximum power has been obtained at the operating frequency.

The power output may be reduced by lowering the anode voltage with respect to the beam voltage.

**NOTE:** With this configuration, the beam current will change when the beam voltage is changed.

**CAUTION:** DO NOT, UNDER ANY CIRCUMSTANCES, EXCEED THE MAXIMUM BEAM CURRENT SPECIFIED IN THE OPERATING INSTRUCTIONS FOR THE INDIVIDUAL EIO

**THE ABSOLUTE RATINGS MUST BE ADHERED TO**



### 4.3 CONFIGURATION 2 ... cont'd

Special attention should be paid to maximum cathode current, and to the polarity and value of the anode potential.

#### 4.3.1 Turn-Off Procedure

Switch the beam power supply OFF.  
Switch the heater power supply OFF.  
Switch the mains power supply OFF.

## SECTION 5 - TUNING PROCEDURE

### 5.1 GENERAL

The tuner is located on the face of the EIO opposite to the waveguide output flange.

Tuning is achieved by the rotation of the tuning knob or operation of the tuning motor.

Clockwise rotation of the tuner INCREASES the frequency.

**CAUTION:** DO NOT ATTEMPT TO DISMANTLE THE TUNING MECHANISM CONTACT COMMUNICATIONS & POWER INDUSTRIES CANADA INC., FOR ADVICE IN THE EVENT OF TUNER MALFUNCTION

*The tuning range of the tuner is limited by mechanical stops. Damage may result if an attempt is made to tune beyond the range established by the stops. The stops normally allow the EIO to be tuned over a range greater than the frequency range specified for the EIO.*

**CAUTION:** UNNECESSARY TUNING SHOULD BE AVOIDED

### 5.2 MOTOR TUNED EIO (If Applicable)

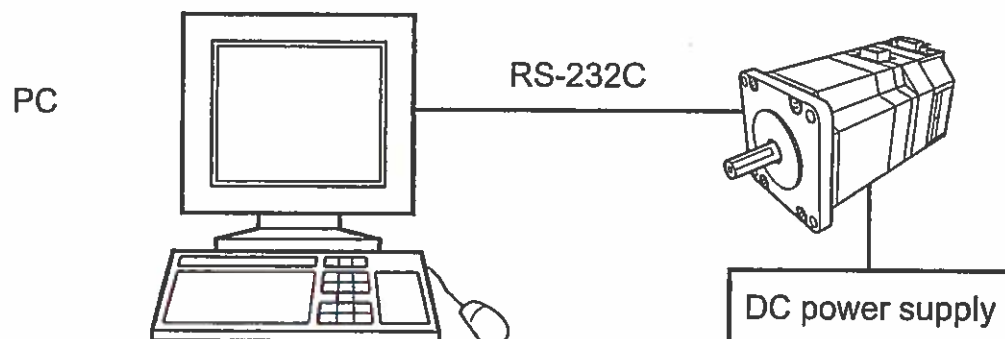
For a motor tuned EIO check that the following accessories are included.

- Power connector
- USB thumb drive with software
- USB to RS-232C cable
- Communications Cable with RS-232C connector
- Regulated DC Power Supply with Power cable

#### 5.2.1 SYSTEM CONFIGURATION

The system is configured as shown below. The USB to RS-232 cable may be required to connect the computer.

The DC power supply operates at 24 VDC.



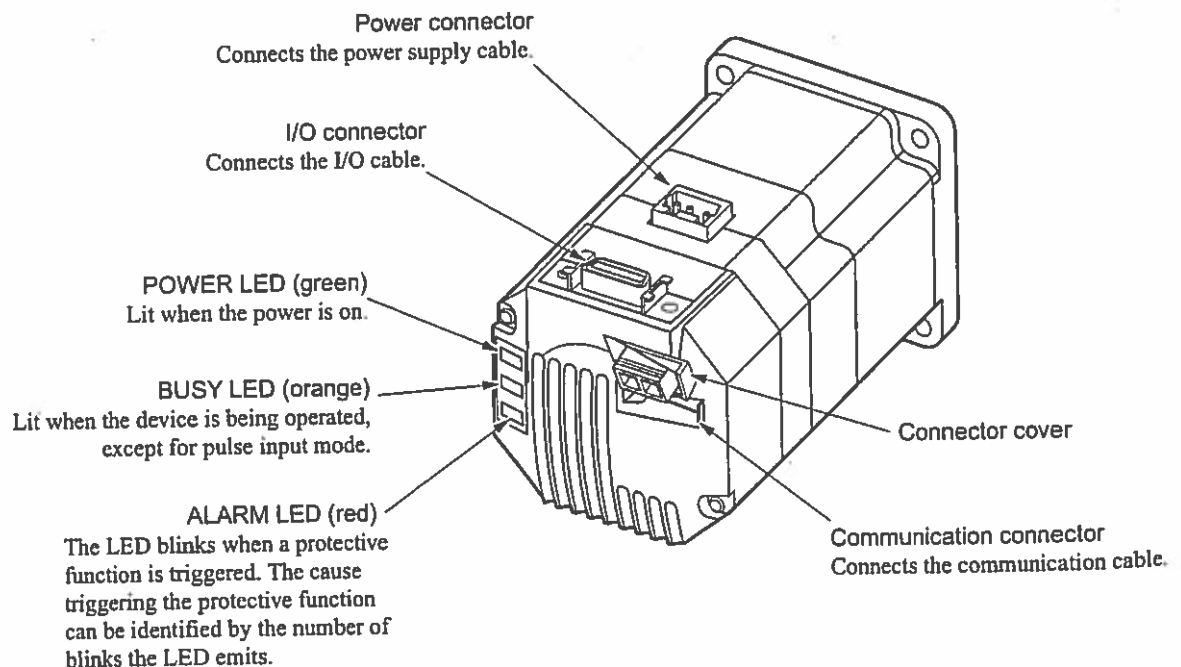
### 5.2.2 PRECAUTIONS FOR USE

This section covers limitations the user should consider when using the motor.

1. Make sure the motor's surface temperature does not exceed 100°C during use. Although the motor has a protective function for overheating, the device's bearing life may deteriorate depending on the operating conditions.
2. Do not change input voltage during operation. The motor reads the initial input voltage to set parameters for optimal performance. Reset the home frequency position after input voltage is changed.
3. Turn off power to the motor in the event of a power failure, or the motor may suddenly start when the power is restored and may cause injury or damage the EIO.
4. Keep fingers and objects away from rotating parts between the motor and EIO to prevent injury and/or damage to equipment.

### 5.2.3 MOTOR FEATURES

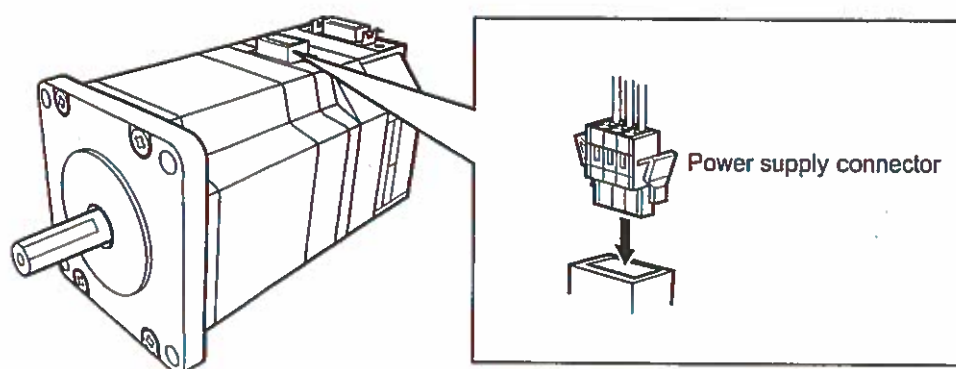
This section describes the functions of the various features found on the motor.



### 5.2.4 CONNECTING POWER TO THE MOTOR

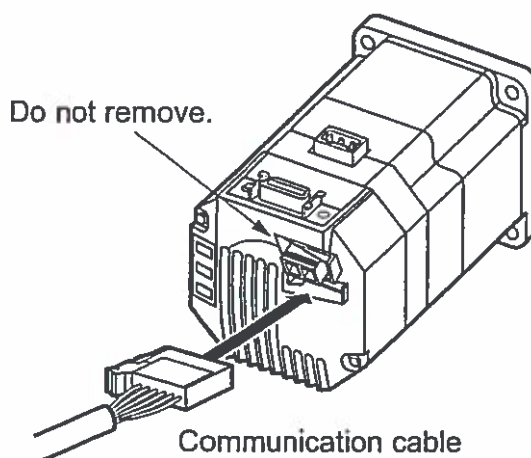
Power to the motor is supplied by a DC power supply. Using the power connector, connect the motor to the power supply. For reference the pin assignments are as follows;

Pin #	Signal	Type	Description
1	+VDC	Input	+24 VDC Power Supply
2	GND	Input	GND for Power Supply
3	FG		Frame GND



### 5.2.5 CONNECTING TO A PERSONAL COMPUTER

Connect the PC and motor together using the communication cable. Use the RS-232C communications port of the PC. A USB to RS-232C adapter may be required if the PC does not have an RS-232C port.



The pin assignments for the connector are as follows;

Pin #	Signal Name
1	GND
2	TX
3	NC
4	NC
5	RX
6	GND

Communications Specifications;

Item	Description
Electrical Characteristics	In conformance with RS-232C
Transmission Method	Start-stop synchronous method, NRZ (Non-Return Zero), full duplex
Data Length	8 bits, 1 stop bit, no parity
Transmission Speed	Selectable: 9600, 19200, 38400 bps (9800 is default)
Protocol	TTY (CR+LF)
Connector Specifications	Connector (6 lines, 6 pins)
Cable Length	15 m max. (but be as short as possible)

**NOTE:**

If the motor is in operation and communication between the computer and motor are interrupted for any reason (cable cut, program shutdown, etc) the motor will continue executing the last command. In such a case there is no way to stop the motor without removing power to the motor.

#### 5.2.6 OPERATING THE MOTOR

Refer to the software manual for instructions on loading and operating the software.

## SECTION 6 - STORAGE AND MAINTENANCE

### 6.0 GENERAL

If the EIO is to be stored for an extended period of time, it should first be inspected and operated when initially received. It is also recommended that the EIO be taken out of storage once per year and operated.

Preferred storage conditions are a vibration free and stable, clean, dry atmosphere at room temperature. It is recommended that whenever the EIO is not in use, the waveguide flange is covered, the high voltage lead wires are dressed to avoid strain, and the cooling tubes are dried.

Yearly operation of the EIO should consist of the following procedure:

1. A visual inspection, looking for damage; corrosion; shrinking or cracking of any silicone rubber, ferrous material build up around the permanent magnets.
2. Install the EIO onto a test set consisting of a power supply, a cooling system, and RF load for the EIO.
3. Verify that all the cooling interlocks are functioning before operating the EIO.
4. Turn on the heater power for a minimum of five minutes and a maximum of 15 minutes before applying high voltages. An EIO with extremely poor vacuum will exhibit significantly increased heater current at the operating heater voltage after a warm up period. If the heater current remains higher than the value on the Test Data Sheet after the warm up period then the EIO is faulty. Do not proceed any further and contact CPI.
5. Turn the beam power supply ON and set the beam voltage to the value specified for the desired frequency of operation on the Test Data Sheet.
6. Switch the anode power supply ON and slowly increase the anode voltage to the value specified on the Test Data Sheet.
7. Adjust the tuner until the EIO oscillates at the desired frequency. Operate the equipment for a minimum of one hour under these conditions.
8. Compare the resultant beam current, body current and output power against the values recorded on the Test Data Sheet. If after one hour the beam current differs by more than 5% from the Test Data Sheet, or the body current differs by more than 20% from the Test Data Sheet, Contact CPI.
9. If no significant variation in currents are noted, return the EIO to storage. Ensure the RF flange is covered, the cooling pipes are cleared and dried out and the EIO, in particular the high voltage leads, are protected from damage.

## SECTION 7 - SHIPPING INSTRUCTIONS

### 7.0 GENERAL

In the event of the EIO being returned to the manufacturer or shipped to any other point by conventional carrier:

1. Remove the EIO from the installation.
2. Cover the waveguide output and coolant lines.
3. Blow all coolant water from the coolant tubes with clean dry air.
4. Tie down the electrical leads and any other free-moving parts of the EIO.
5. Attach the EIO to the shipping base and install the EIO into the inner shipping box.
6. Protect the collector and tuner from supporting any of the EIO's weight.
7. Place the inner shipping container into the foam lined outer shipping container. (Close and seal the container.)
8. Identify the container as required by the carrier.
9. Contact CPI for an RMA number if being returned to the factory

If the original containers are not available, please contact CPI for replacement containers or for special shipping instructions.

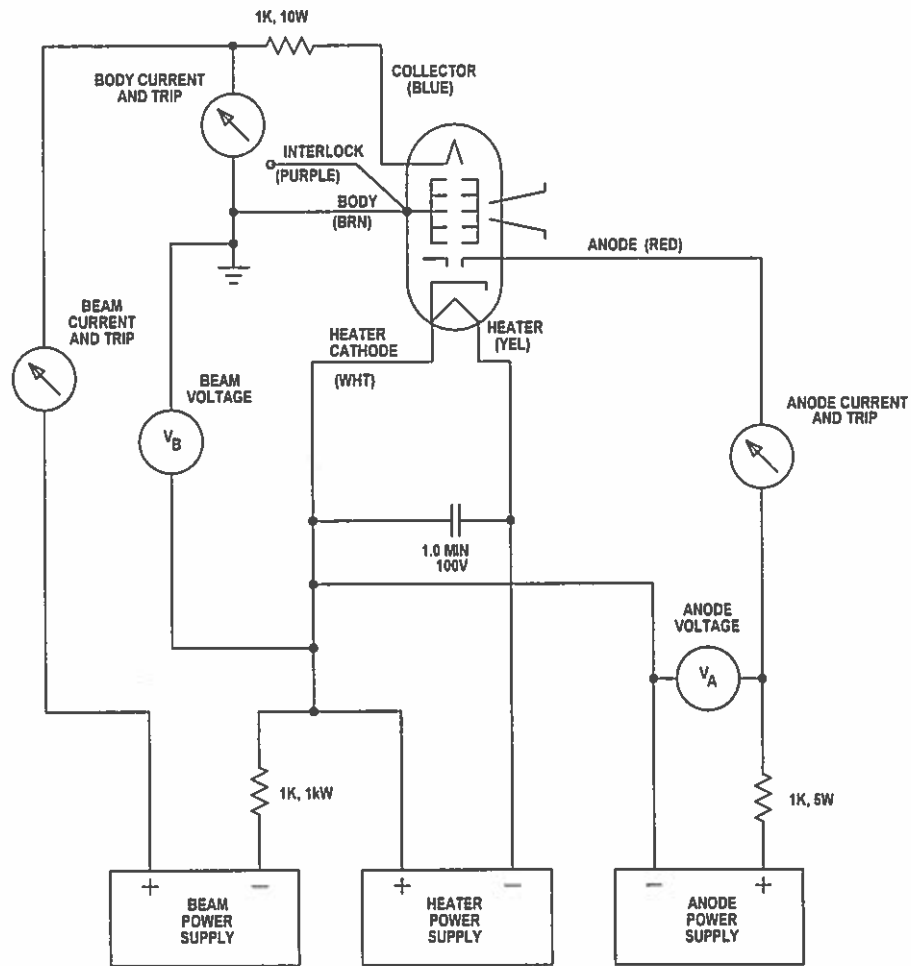
Communications & Power Industries Canada Inc.  
45 River Drive  
Georgetown, Ontario  
Canada, L7G 2J4

Phone: 905-877-0161  
Fax: 905-877-5327  
[marketing@cmp.cpii.com](mailto:marketing@cmp.cpii.com)

**SECTION 8 - ILLUSTRATIONS**

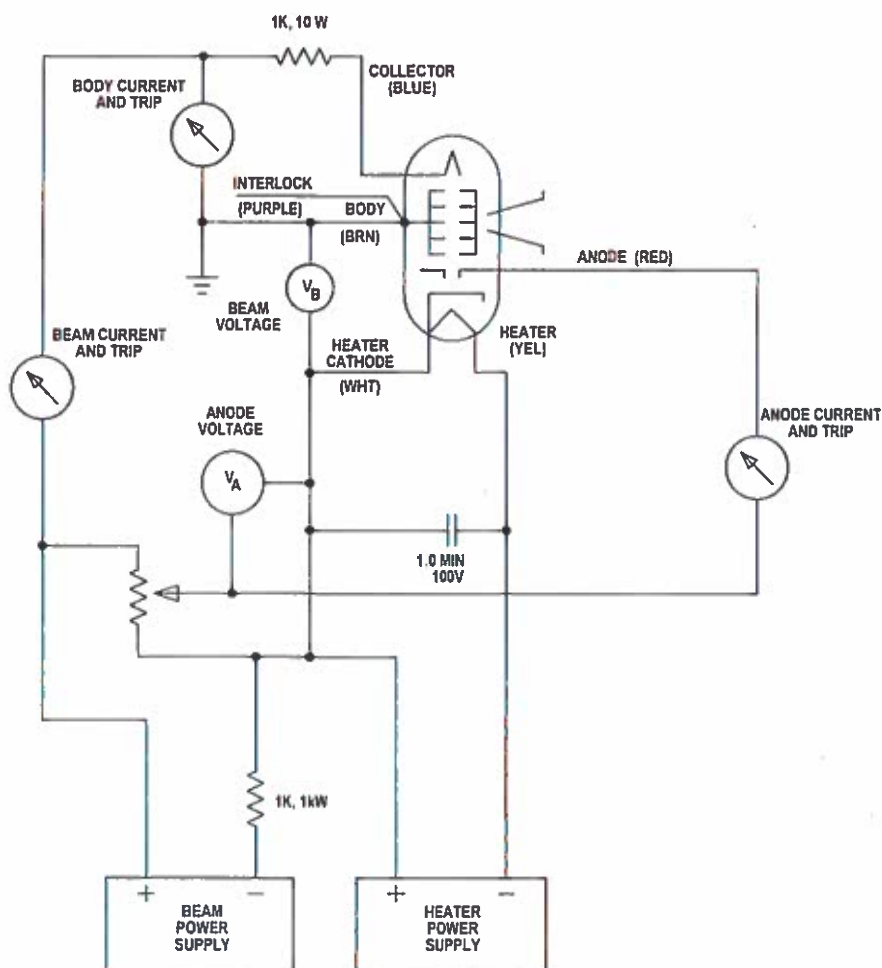
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FIGURE 6 - Power Supply Remote Connection (3-20m.)	22





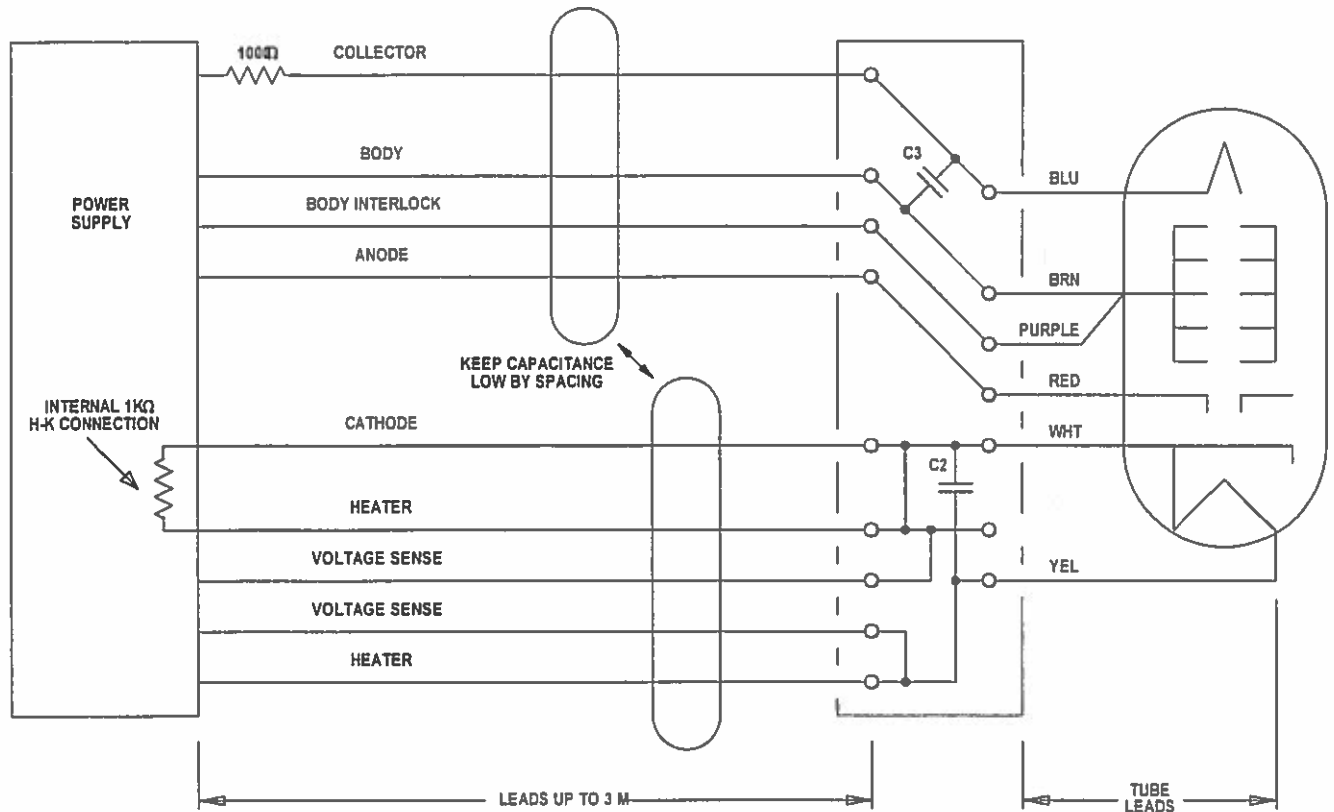
1. TRIPS MUST SHUT DOWN ANODE SUPPLY AND BEAM SUPPLY IN THIS SEQUENCE.
2. THE ANODE MUST NOT BE ALLOWED TO GO POSITIVE W.R.T BODY.
3. RESISTANCE IN OHMS. CAPACITANCE IN MICROFARADS.
4. INTERLOCK LEAD, TO BE CONNECTED TO GROUND SENSING SAFETY INTERLOCK CIRCUIT.

**Figure 3**  
**POWER SUPPLY CONFIGURATION 1**



1. TRIPS MUST SHUT DOWN ANODE SUPPLY AND BEAM SUPPLY IN THIS SEQUENCE.
2. RESISTANCE IN OHMS. CAPACITANCE IN MICROFARADS.
3. INTERLOCK LEAD TO BE CONNECTED TO GROUND SENSING SAFETY INTERLOCK CIRCUIT.

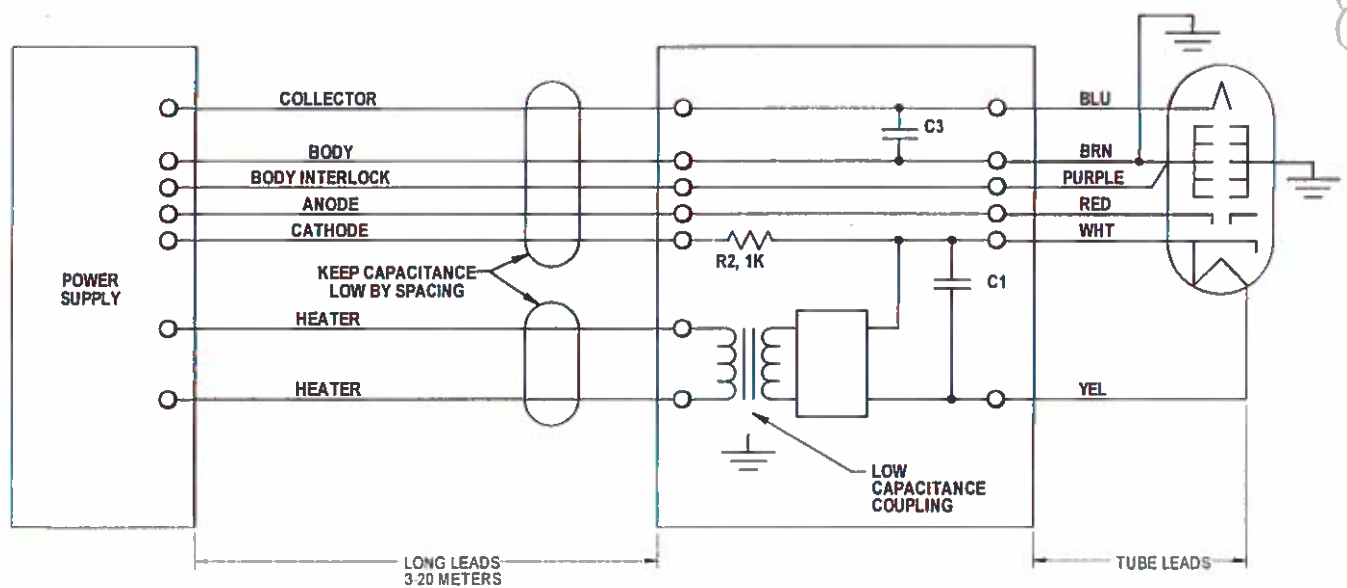
**Figure 4**  
**POWER SUPPLY CONFIGURATION 2**



1. CAPACITORS - 1 MICROFARAD 500V

MD-0571A

**Figure 5**  
**POWER SUPPLY REMOTE CONNECTION (UP TO 3 METERS)**



1. CAPACITORS - 1 MICROFARAD 500V.
2. CHECK HEATER VOLTAGE AT TUBE.
3. REMOVE:

- 1K HEATER TO CATHODE CONNECTION
- 1K CATHODE SERIES CONNECTION FROM INSIDE POWER SUPPLY

MD-0572

**Figure 6**  
**POWER SUPPLY REMOTE CONNECTION (3-20 METERS)**

## APPENDIX

8

8

8

## 1.0 INTRODUCTION

CPI Canada (CPI) has manufactured millimeter wave Extended Interaction Klystron (EIK) vacuum tubes since 1969. EIKs generate or amplify millimeter wave energy through interaction between a linear electron beam and resonant cavities similar to conventional klystrons. EIKs achieve useful performance by incorporating a slow wave bi-periodic ladder circuit to extend the interaction between electron beam and cavities. This allows EIKs to operate up to 280 GHz to-date at power levels suitable for a variety of applications.

<b><u>APPLICABLE STANDARDS</u></b>	<b>Yes/No</b>
Compliant to the United Nations IPPC standard: International Standard for Phytosanitary Measures no. 15 (ISPM #15, Wood Packaging)	YES
Compliant to the Waste Electrical and Electronic Equipment, Directive 2002/96/EC (WEEE).	NO
Compliant to the Restriction of the use of certain hazardous substances in electrical and electronic equipment, Directive 2002/95/EC (RoHS).	NO
Subject to Export License Control through design, performance, technology, or application considerations.	YES

## 2.0 SCOPE

This document details the performance specifications for the VKT2438P6M Extended Interaction Oscillator (EIOs). The VKT2438P6M is a 140.0 GHz CW Motor Tuned Extended Interaction Oscillator manufactured to CPI Canada commercial workmanship practices. This EIK is compatible with CPI CW power supply model VPW2827.

## 3.0 PERFORMANCE SPECIFICATIONS

3.1	Centre Frequency	140.0	GHz
3.2	Mechanical Tuning Range	3.0	GHz Min.
3.3	Electronic Tuning Range <sup>3,4</sup>	150	MHz typical
3.4	Power Output <sup>4,5</sup>	10.0	W min.
		20.0	W typical
3.5	Test Frequencies	138.5 to 141.5 in 0.50 steps	GHz
3.6	Temperature Coefficient (neg.)	(3.0)	MHz/°C max
3.7	Cathode Modulation Sensitivity <sup>4,5</sup>	(0.6)	MHz/V max.
3.8	Pulling Figure	N/S	

#### 4.0 POWER SUPPLY REQUIREMENTS

4.1	Cathode Voltage $V_K$ (Cathode to Body)	9.98	kV	max.
4.2	Cathode Current	100.0	mA	max.
4.3	Anode Voltage $V_A$ (Cathode to Anode) <sup>6</sup>	6.0	kV	max.
4.4	Anode Current	+1.0	mA	max.
		-200	$\mu$ A	max.
4.5	Body Current	10.0	mA	max.
4.6	Heater Voltage	5.5 to 6.3 $\pm$ 0.1	V	
4.7	Heater Current	1.1	A	max.
4.8	Heater Surge Current	3.0	A	nom.
4.9	High Voltage Delay (after heater on)	2.0	minutes	min.
4.10	Collector Voltage (cathode to collector)	70% of cathode voltage min.		

#### 5.0 COOLING

5.1	Coolant Type	Water	deionized	
5.2	Total Flow Rate	1.5	l/minute	min.
5.3	Body Flow Rate	0.5	l/minute	min.
5.4	Tuner Flow Rate	0.1	l/minute	min.
5.5	Input Water Temperature	30.0	$^{\circ}$ C	max.
5.6	Body Temperature	80.0	$^{\circ}$ C	max.
5.7	Coolant Pressure Drop <sup>8</sup>	275	kPa	max.

#### 6.0 MECHANICAL SPECIFICATIONS

6.1	Waveguide	RG-138/U (WR8)		
6.2	Waveguide Flange	Mates with UG387/U		
6.3	Waveguide Pressurization	N/R		
6.4	Input Power Connector	Flying Leads		
6.5	Lead Length	45.0	cm	min.
6.6	Coolant Hose Connectors	Swagelok type for 6.35mm (1/4") tubing		
6.7	Tuning Method	Computer controlled stepper motor (computer not supplied).		
6.8	Number of Complete Tuning Cycles	1000	min.	
6.9	Overall Dimensions	Sec Outline Dwg. 740381		
6.10	Weight	4.5	kg	max.
		4.0	kg	typical

#### 7.0 ENVIRONMENT

7.1	Ambient Temperature (operating)	10-30	$^{\circ}$ C	
	(non-operating)	0-50	$^{\circ}$ C	
7.2	Humidity	as found in typical humidity controlled laboratory.		
7.3	Altitude	3000	m	max.



## 8.0 ABSOLUTE RATINGS VALUE (not to be exceeded)<sup>7</sup>

8.1	Cathode to Voltage	10	kV
8.2	Cathode Current	Value indicated on individual tube.	
8.3	Anode Voltage (Cathode to Anode)	10	kV
8.4	Anode to Body Voltage	10	kV
8.5	Anode Current	+5.0, -1.0	mA
8.6	Collector to Body Voltage	40% of cathode voltage	
8.7	Body Current	10.0	mA
8.8	Heater Voltage	6.4	V
8.9	Heater Operating Current	1.2	A
8.10	Heater Surge Current	6.0	A
8.11	Anode Power Dissipation	20.0	W
8.12	Body Power Dissipation	200.0	W
8.13	Load VSWR	2:1	
8.14	Waveguide Pressurization	100	kPa
8.15	Water Pressure	345	kPa
8.16	Body Temperature	80.0	°C

### NOTES:

1. Abbreviations: N/S = not specified, N/A = not applicable, N/R = not required
2. Quantities in parentheses ( ) are for guidance only and are not part of the specification.
3. To half power by adjustment of cathode to body voltage only; ie at constant cathode current.
4. Matched load and anode voltage adjusted for maximum permissible cathode current as indicated on each individual tube.
5. Cathode voltage adjusted for maximum power output.
6. This voltage determines the cathode current and may be used to adjust or modulate the power output.
7. The absolute ratings are values which are not to be exceeded. Additionally, it may not be permissible to operate at two or more absolute ratings simultaneously.
8. Pressure drop will not exceed this value at minimum required flow rate. Pressures greater than this value are, however, permissible; see absolute ratings section 7.15.





Communications & Power Industries  
Canada Inc.

# CW EXTENDED INTERACTION KLYSTRON OSCILLATOR

## FINAL TEST RESULTS

MODEL NUMBER VKT2438P6M SERIAL NUMBER E1289F5

TEST FREQUENCY (GHz)	RF POWER OUTPUT (W)	CATHODE VOLTAGE (kV wrt Body)	CATHODE CURRENT (mA)	BODY CURRENT (mA)	ANODE VOLTAGE (kV wrt Cathode)	COLLECTOR VOLTAGE (kV wrt Ground)	ELECTRONIC TUNING RANGE (MHz)	POTENTIOMETER RESISTANCE (kOhms, #1 - #2)
138.5	20.48	9.50	80.0	4.9	4.43	-0.080	162	-
139.0	16.41	9.58	80.0	5.3	4.43	-0.080	174	-
139.5	19.27	9.68	80.0	4.3	4.43	-0.080	204	-
140.0	17.07	9.90	80.0	3.7	4.43	-0.080	198	-
140.5	15.89	9.92	80.0	3.7	4.43	-0.080	158	-
141.0	16.92	10.00	80.0	3.6	4.43	-0.080	154	-
141.5	14.86	10.00	80.0	3.5	4.43	-0.080	144	-

HEATER VOLTAGE: 5.8 V	HEATER CURRENT: 0.80
TEST POWER SUPPLY: VPW2827A6, S/N: H7586	ANODE CURRENT: N/A
COOLING DATA: 1.5 Litre/min De-ionized Water at 20°C	

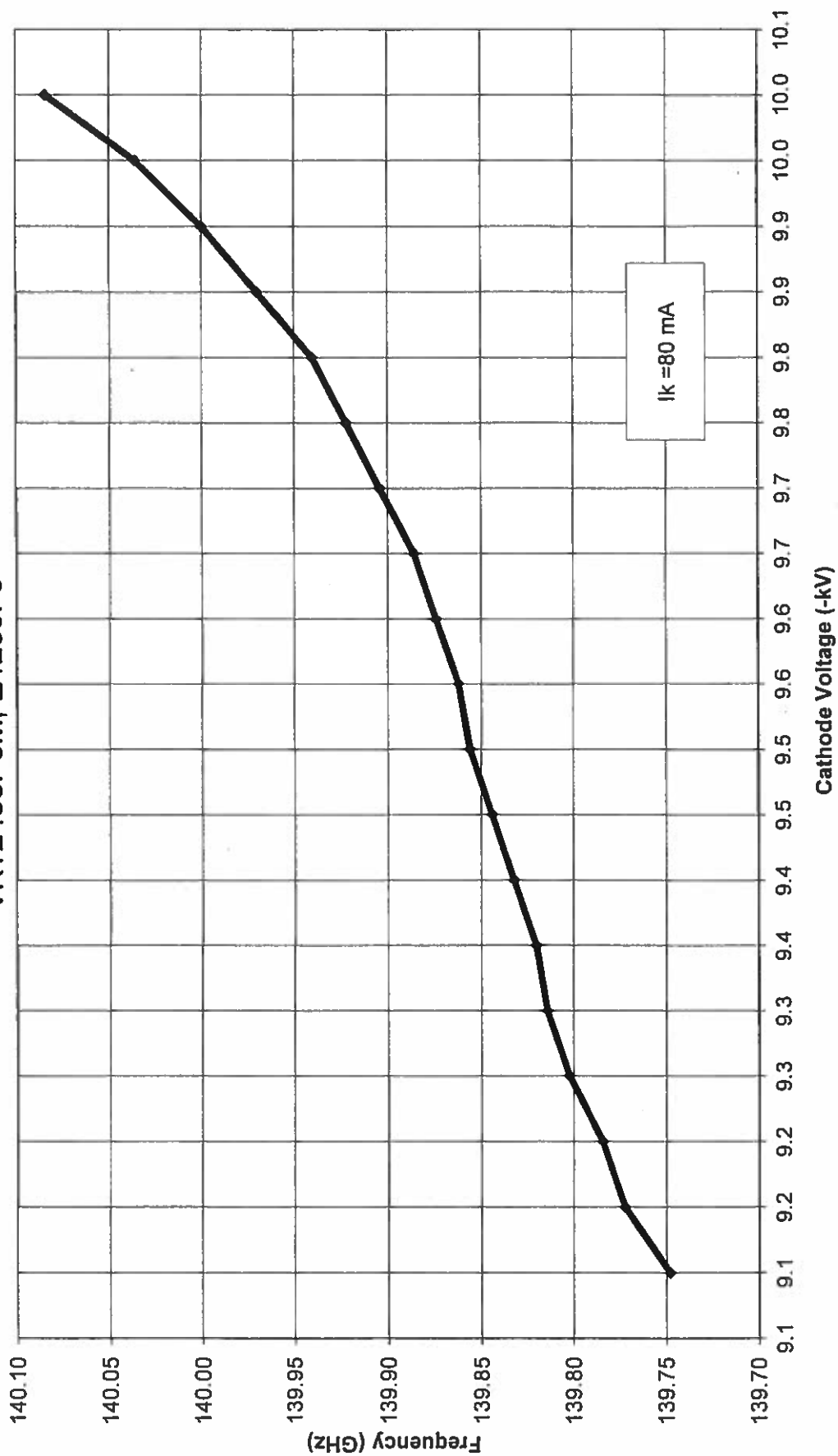
TESTED BY: I. Ifraimov	TEST DATE: June 29, 2015
INSPECTED BY:	INSPECTION DATE:
CUSTOMER: Los Alamos National Lab	SALES ORDER NUMBER: 121998



# FREQUENCY vs CATHODE VOLTAGE

VKT2438P6M, E1289F5

June 30, 2015

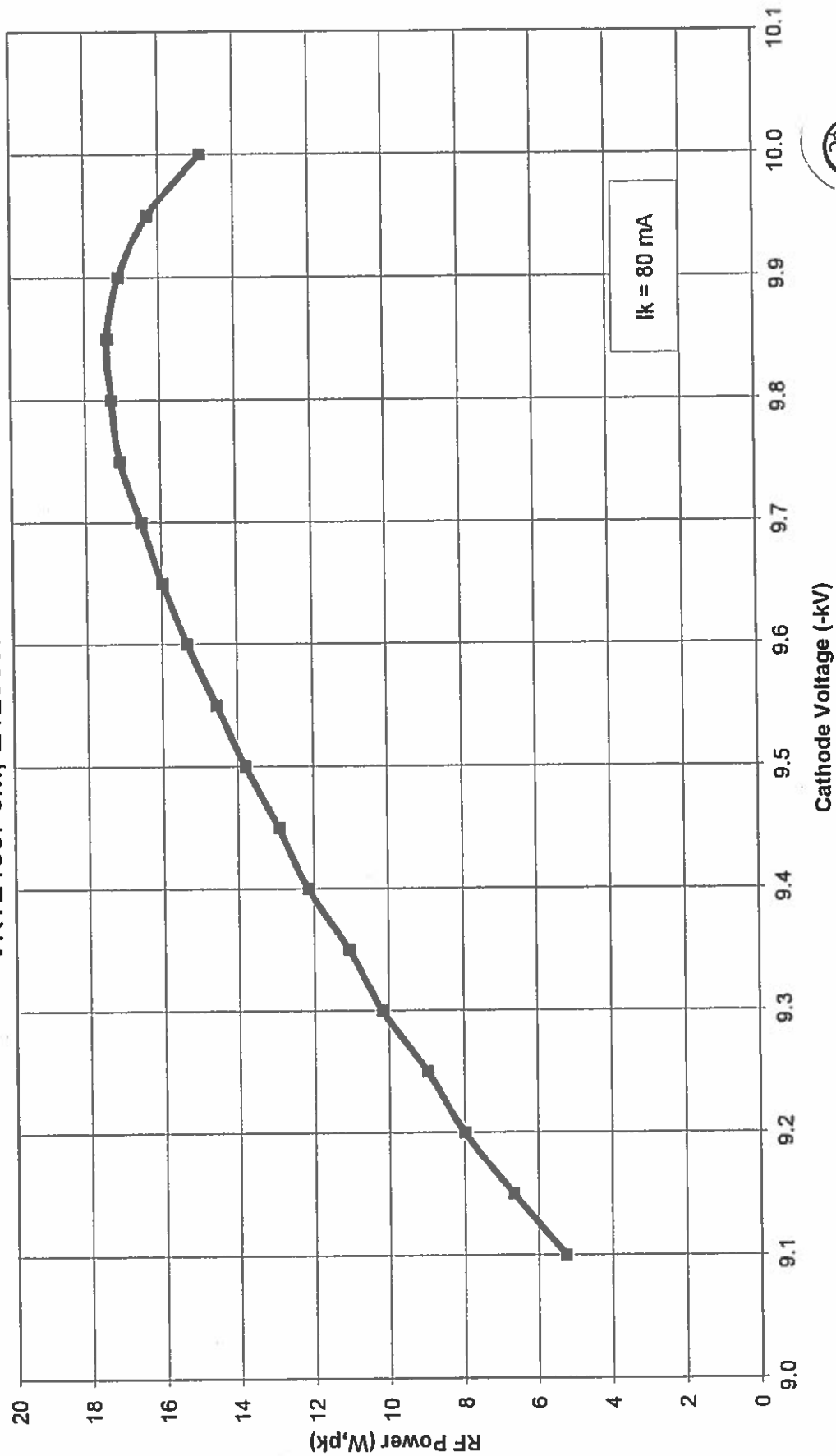




# RF POWER OUTPUT vs CATHODE VOLTAGE

June 30, 2015

VKT2438P6M, E12889F5



30  
24  
243





## OPERATING HAZARDS

### READ THIS SHEET AND TAKE ALL APPROPRIATE SAFETY PRECAUTIONS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO MICROWAVE TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. CPI PROVIDES INFORMATION ON ITS' PRODUCTS AND ASSOCIATED HAZARDS, BUT IT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES. TUBE FAILURES MAY OCCUR; TAKE APPROPRIATE ACTION THROUGH REDUNDANCY OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM THE CONSEQUENCES OF TUBE FAILURE.

ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO MICROWAVE 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.

#### OPERATING INSTRUCTIONS

This sheet, the Test Performance Sheet and the Operating Instructions can help you to operate this tube safely and efficiently. PLEASE READ THEM. The Test Performance Sheet is a record of individual product test conditions and test results from the factory. Special operating considerations and precautions will be found in the Operating Instructions. Uninformed or careless operation of this tube can result in poor performance, damage to the tube or other property, serious bodily injury and, possibly, death.

Address written questions regarding tube operation to the Marketing Manager, at the address at the bottom of this sheet.

#### WARNING - SERIOUS HAZARDS EXIST IN THE OPERATION OF MICROWAVE TUBES

The operation of microwave tubes involves one or more of 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.
- RF RADIATION** - Exposure to rf radiation can cause serious bodily injury resulting in blindness or death. Cardiac pacemakers may be affected.
- X-RAY RADIATION** - High voltage tubes can produce dangerous, possibly fatal, X-rays
- BERYLLIUM OXIDE POISONING** - The dust or fumes from beryllium oxide (BeO) ceramics used in some microwave tubes are highly toxic and can cause serious injury or death if inhaled or entering an open wound.
- CORROSIVE AND POISONOUS COMPOUNDS** - If a dielectric gas is used in the external waveguide or around

the high voltage bushing portions of some microwave tubes, highly toxic or corrosive compounds may be produced by either rf voltage breakdown or high voltage DC breakdown.

- FC-75 TOXIC VAPOUR AND FLUID** - Decomposition products of FC-75 coolant are highly toxic and can cause serious injury or death.
- IMPLOSION HAZARD** - Ceramic windows in microwave tubes can shatter on impact or crack in use, possibly resulting in injury from flying particles or from beryllium oxide (BeO) dust or fumes where BeO is used.
- HOT COOLANT AND/OR STEAM** - For liquid cooled collectors the electron collector and water used to cool it reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.
- HOT SURFACES** - Surfaces of air cooled collectors and other parts of tubes reach temperatures of several hundred degrees celsius and can cause serious burns if touched.

Additional specific information about microwave tube hazards:

#### HIGH VOLTAGE

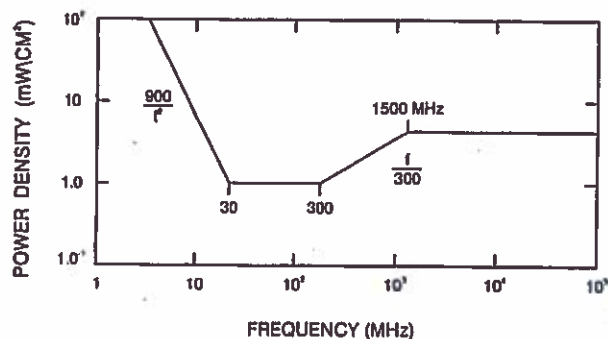
Most microwave tubes operate at voltages high enough to kill through electrical shock. Design equipment utilizing these tubes to prevent personnel from coming in contact with high voltages. Securely attach prominent hazard warnings. Personnel must always break the primary circuits of the power supply and discharge high voltage capacitors when direct access to the tube is required.

#### RADIO FREQUENCY (RF) RADIATION

EXPOSURE OF PERSONNEL TO RF RADIATION SHOULD BE MINIMIZED. PERSONNEL SHOULD NOT BE PERMITTED IN THE VICINITY OF OPEN, ENERGIZED WAVEGUIDES OR ENERGIZED ANTENNAS. It is generally accepted that exposure to high levels of rf radiation can result in severe bodily injury, including blindness. Cardiac pacemakers may be affected.

The effect of prolonged exposure to low-level rf radiation continues to be a subject of investigation and controversy. Although an absolute safe exposure limit is not defined, it is generally agreed among official standard-setting groups in the U.S. that prolonged exposure of personnel to rf radiation at frequencies of 10 MHz - 300 GHz should be limited to average power densities as represented in the profile on the other side of this sheet.

It is also generally agreed that exposure should be reduced in working areas where temperatures are above normal. This practice has been adopted as a guideline by several U.S. Government agencies, including the Occupational Safety and Health Administration (OSHA), as the standard of protection



#### RADIATION PROTECTION GUIDE AS AVERAGED OVER 0.1 HOUR PERIOD

ALL INPUT AND OUTPUT RF CONNECTIONS, WAVEGUIDE FLANGES AND GASKETS MUST BE RF LEAK-PROOF. PROPERLY MATCHED RF ENERGY ABSORBING LOAD ATTACHED NEVER LOOK INTO OR EXPOSE ANY PART OF THE BODY TO AN ANTENNA OR OPEN WAVEGUIDE WHILE THE TUBE IS ENERGIZED. MONITOR THE TUBE AND RF SYSTEM FOR RADIATION LEAKAGE AT REGULAR INTERVALS AND AFTER SERVICING.

#### X-RAY RADIATION

As voltages increase beyond 15 kilovolts, metal-body tubes are capable of producing progressively more dangerous X-ray radiation. Provide adequate X-ray shielding on all sides of these tubes, particularly the cathode and collector ends, as well as the modulator and pulse transformer tanks. Check X-ray levels. NEVER OPERATE HIGH VOLTAGE TUBES WITHOUT ADEQUATE X-RAY SHIELDING IN PLACE. MONITOR THE TUBE AFTER SERVICING AND AT REGULAR INTERVALS FOR POSSIBLE CHANGES IN X-RAY LEVELS DUE TO AGING.

#### DANGER - BERYLLIUM OXIDE, LEAD AND COBALT

Some microwave tubes contain Beryllium Oxide (BeO) ceramics: usually the output waveguide window or around the cathode. Lead is another material used in microwave tubes, usually as an X-ray shield around the collector area of high power microwave tubes. Cobalt is a constituent in samarium cobalt magnets used in certain microwave tubes.

Do not perform any operations on parts containing BeO, lead or cobalt which produce dust or fumes; for example, sand or grit blasting, grinding, cutting or acid cleaning.

CHRONIC EXPOSURE TO THE HIGHLY TOXIC DUST AND FUMES OF BERYLLIUM OXIDE, LEAD AND COBALT CAN RESULT IN SERIOUS LONG-TERM HEALTH EFFECTS.

#### BERYLLIUM OXIDE WINDOWS

If a broken window is suspected, carefully remove the tube from its waveguide and seal the output flange of the tube with tape. Because BeO warning labels may be obliterated or removed, we urge you to contact CPI, before performing any work on ceramics in any CPI microwave tube. Some tubes have BeO ceramics internal to the vacuum envelope. Take precautions to protect personnel working in the disposal or salvage of tubes containing BeO and lead. All such personnel should be made aware of the hazards involved and the necessity for great care and attention to safety precautions.

#### CORROSIVE AND POISONOUS COMPOUNDS

External output waveguides and cathode high voltage bushings of microwave tubes are sometimes operated in systems that use a dielectric gas to impede microwave or high

voltage breakdown. If breakdown does occur, the gas may decompose and combine with impurities, such as air or water vapour, to form highly toxic and corrosive compounds. Examples are Freon gas which may form LETHAL PHOSGENE, and sulfur hexafluoride (SF<sub>6</sub>) gas which may form highly toxic and corrosive sulfur or fluorine compounds such as BERYLLIUM FLUORIDE. When breakdown does occur in the presence of these gases, VENTILATE THE AREA TO OUTSIDE AIR, AVOID BREATHING ANY FUMES OR TOUCHING ANY LIQUIDS WHICH DEVELOP. TAKE PRECAUTIONS APPROPRIATE FOR BERYLLIUM COMPOUNDS AND FOR OTHER HIGHLY TOXIC AND CORROSIVE SUBSTANCES before permitting personnel to perform any work on or near the tube. If a coolant other than pure water is utilized, follow the precautions supplied by the coolant manufacturer.

#### DANGER -FC-75 TOXIC VAPOUR AND FLUID HAZARD

Decomposition products of FC-75 are highly toxic. Decomposition may occur through exposure to temperatures above 200 °C, to liquid fluorine or alkali metals (lithium, potassium or sodium) or to ionizing radiation. Known thermal decomposition products include perfluoroisobutylene (PFIB; {CF<sub>3</sub>}, C=CF<sub>2</sub>) which is highly toxic in small concentrations. If FC-75 has been exposed to temperatures above 200 °C through fire, electric heating, prolonged electric arcs, or has been exposed to alkali metals or strong ionizing radiation, strictly avoid breathing any resulting fumes or vapours, thoroughly ventilate the area, and strictly avoid contact with the FC-75. Under such conditions, promptly replace the FC-75 and handle and dispose of the contaminated FC-75 as a toxic waste.

#### IMPLOSION HAZARD

Due to the internal vacuum in microwave tubes, the glass or ceramic output window can shatter inward (implode) if struck with a hard object or subjected to mechanical shock. Flying debris could result in bodily injury, including cuts and puncture wounds and, if made of BERYLLIUM OXIDE ceramic, produce highly toxic dust or fumes. DO NOT BREATHE SUCH DUST OR FUMES.

#### HOT COOLANT AND/OR STEAM

High temperatures occur in the electron collector portion of microwave tubes during operation. Coolant channels used for cooling also reach high temperatures (100 °C or above), and the hot coolant is under pressure (typically as high as 100 psi). Some collectors are cooled by boiling the coolant and forming steam.

A rupture of the coolant channel or the coolant or steam line or other contact with hot portions of this tube could scald or burn. Carefully check that all fittings and connections are secure and monitor backpressure for changes in cooling system performance. Replace Any defective fittings and tighten any loose fittings or connections. If backpressure is increasing above normal operating values, shut the system down and clear the restriction.

#### HOT SURFACES

The electron collector portion of microwave tubes is often air-cooled or conduction cooled. The air cooled external surface normally operates at a high temperature (typically 200 °C to 300 °C). Other portions of the tube may also reach high temperatures, especially the cathode insulator and the cathode/heater surfaces. All hot surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to prevent and avoid any bodily contact with these surfaces both during and for a reasonable cool-down period after tube operations.





## LIMITED WARRANTY

### MICROWAVE TUBES, EQUIPMENT AND COMPONENTS

Communications & Power Industries Canada Inc. ("CPI") warrants its Microwave Tubes, Equipment and Components ("Products") in accordance with the CPI Warranty General Provisions on the reverse side and the following. In case of conflict with CPI Warranty General Provisions, the following shall govern:

#### WARRANTY

CPI warrants the Products it manufactures to be free from defects in material and workmanship and to be in substantial compliance with operational features of CPI's published specifications at the time of sale. CPI's warranty shall begin on date of shipment and continue for the period of time specified on CPI's quotation or as agreed in writing by CPI, per the agreed Warranty Code.

#### WARRANTY CODES AND MAXIMUM WARRANTY PERIODS

Warranty Code	Pro-rata and Maximum Periods Maximum Hours of Filament or Heater Operation	Maximum Months
WU	Unlimited	*
B	100	6
E	200	12
G	500	12
K	1000	12
L	2000	12
S	5000	12
V	7500	18
W	7500	24

\* As specified in CPI's quotation.

When one of these Warranty Codes is stated in CPI's quotation, or otherwise stated in writing by CPI to the Customer, the price includes the warranty coverage specified. Warranties other than as specified above may be purchased for an additional charge. For CPI Tube Products, if no period of time is stated, then the warranty is limited to thirty (30) days from date of shipment. CPI Equipment and passive Components (including power supplies, X-Ray Products, electromagnets, solenoids, filters, loads, circulators, couplers, waveguide windows, diplexers, and other passive devices) if no other period of time is stated are warranted for unlimited hours of operation during not more than a twelve (12) month period following their date of shipment from CPI.

#### REMEDIES/ADJUSTMENTS

If CPI's examination confirms that a Product has failed from causes covered by this warranty through no fault of Customer within the applicable maximum hours of filament or heater operation or the maximum number of months after shipment specified above, whichever first occurs, CPI will at CPI's option either: (1) repair or replace the Product at no cost to Customer or (2) make an equitable adjustment on the price paid for the Product.

For CPI Tube Products the equitable adjustment will be calculated as follows:

- either refund a pro-rata portion of the original purchase price of Customer, or
- apply such pro-rata amount as a credit on a replacement order for a new Product. Any such refund or credit shall be determined as follows:

Adjustment = (Applicable Selling Price) multiplied by

$$\frac{(\text{Maximum Warranted Hours} - \text{Total Operating Hours at Failure})}{\text{Maximum Warranted Hours}}$$

#### WARRANTY CONDITIONS

- Repairs and adjustments must be made (or directed in writing) by authorized CPI personnel only. Unauthorized repairs or adjustments will void the warranty.
- The Customer must give CPI written notice of Product failure prior to the end of the Product warranty period. CPI shall determine probable hours of Product usage when no accurate records can be found.

3. The Product must have been used under normal operating conditions within the respective CPI-specified ratings and in accordance with CPI operating instructions. CPI shall make the sole final determination as to whether failure occurred in normal operation (under warranty) or whether the Product was subjected to other than normal operation (excluded from warranty).

4. The Customer must return the failed Product and a completed Warranty Claim Form within 45 days following its written notice of failure.

5. The warranty period remaining on the date CPI received notice of failure shall apply to the repaired or replaced Product from the date of reshipment to Customer. No new warranty period shall apply except on paid replacements.

6. Customer shall be responsible for and shall immediately file claims against the carrier in cases of loss or damage to Products during either the initial shipment to Customer or the Customer's return to CPI for repair or replacement.

7. CPI shall have no warranty obligation other than as specified by the Warranty Code on CPI's quotation, or otherwise to the Customer in writing. If "No Warranty" is specified, CPI makes no express or implied warranties, and disclaims MERCHANTABILITY and FITNESS for any particular purpose, use or application, and Customer releases CPI from any warranty liability whatsoever.

8. Subject to the WARRANTY REPLACEMENT AND ADJUSTMENT provisions of CPI Standard Terms and Conditions of Sale (paragraph 10), the following WARRANTY RETURN PROCEDURES apply:

- Before initiating return procedures, determine that the Product is itself at fault. Please call the local CPI Field Office or Communications & Power Industries Canada Inc. for assistance in determining the problem and in obtaining satisfactory performance from the Product. This may save shipping time and expense and may minimize equipment downtime.
- If examining the Product at your facility confirms that the Product is at fault: (1) Contact Communications & Power Industries Canada Inc. for instructions on return of the Product. Communications & Power Industries Canada Inc., Customer Service, will issue to the Customer a Return Material Authorization (RMA) Number. The Customer must identify to CPI the Product type and serial number of the Product and a description of the circumstances giving rise to the warranty claim. If the Product is being returned from outside Canada, the Customer will be provided special instructions regarding customs and ship to information. The Customer must follow these instructions when returning the Product against the RMA, otherwise, costly duty and brokerage charges may be incurred and charged to the Customer. (2) Ship the Product prepaid, whether in or out of warranty. Products repaired by CPI under a valid warranty claim will be returned to the Customer with return transportation prepaid by CPI. Products repaired out of warranty will be returned at the Customer's expense. (3) Return the Product along with a fully complete Warranty Claim Form via a means of transportation acceptable to CPI to minimize the possibility of shipping damage. CPI reserves the right to reject any warranty claim on any Product returned without a Warranty Claim Form, any Product that has been altered, or that has been shipped by an unacceptable means of transportation. Return Products in their original container, or if unavailable contact Communications & Power Industries Canada Inc. for instructions, and unless an alternate ship to address is provided along with the RMA number, ship to:

Communications & Power Industries Canada Inc.  
45 River Drive  
Georgetown, Ontario, L7G 2J4 Canada  
Attn: Returned Products/Customer Service  
Tel: (905) 877-0161

# WARRANTY

## (General Provisions)

CPI Products, Software and Services are warranted in accordance with these general warranty provisions, as well as the supplemental warranty terms and conditions on the reverse side applicable to specific individual Products.

### 1. General Warranty Statement

CPI warrants products, parts and accessories manufactured and sold by CPI ("Products") and firmware and software media furnished by CPI in or for use with Products ("Software") to be free from defects in material and workmanship and in substantial compliance with operational features of published CPI specifications at the time of sale. CPI makes no warranty that the operation of any Software will be uninterrupted or error free. Warranty for services provided by CPI in connection with Products ("Services") shall be as stated in CPI terms and conditions of service for specific Products.

### 2. Warranty Periods

CPI's warranty shall begin and continue for the period(s) specified on the reverse side, or as stated on CPI's quotation, or as agreed in writing by CPI, under the conditions below and on the reverse side.

### 3. Warranty Remedies

Buyer's sole and exclusive remedy under warranty shall be repair or, at CPI's option, replacement of defective Products, parts, accessories or Software. CPI shall determine whether Product or Software malfunctions require repair or replacement under warranty. If in CPI's opinion such repair or replacement is not feasible, or if such remedy fails of its essential purpose, CPI may refund or credit a portion of any sums paid by Buyer for the Product, Software or Service. In-warranty repair or replacement parts are warranted only for the unexpired portion of the original warranty period.

### 4. General Exclusions from Coverage

CPI's warranties shall not apply to the extent that malfunction is caused in CPI's reasonable opinion by (1) accident, abuse, alteration, misuse or neglect, (2) failure to use Products under normal operating conditions or environment, or within CPI specified ratings, or according to any operating instructions provided by CPI, (3) lack of routine care or maintenance as indicated in any CPI operating or maintenance instructions, (4) failure to use or take any proper precautions under the circumstances, (5) user modification of any Product or Software, or (6) latent defects discovered after expiration of the applicable warranty period. Additional exclusions from coverage may apply to individual Products, Software or Services.

### 5. Other Supplies Warranties

Warranties given by other suppliers of equipment, accessories, components or computer software not owned by CPI but incorporated by CPI on or into Products are passed on to Buyer, shall be subject to all exclusions and limitations on CPI warranty liability, and shall apply exclusively to the equipment, accessories, components or computer software of which they are a part. CPI shall not have any warranty liability with respect to warranties provided by such other suppliers, nor shall CPI have any liability for failure of such supplier to perform under its warranty.

### 6. Exclusion of Implied Warranties

*This limited warranty is expressly in lieu of and EXCLUDES all other express or implied warranties including but not limited to warranties of MERCHANTABILITY and of FITNESS for a particular purpose, use, or application.*

### 7. Limitations on Damages and Liability

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## WARRANTY CLAIM FORM FOR MICROWAVE TUBES, EQUIPMENT AND COMPONENTS

PROPER COMPLETION OF THIS FORM IS VITALLY IMPORTANT TO THE  
PROMPT AND EFFICIENT HANDLING OF PRODUCT WARRANTY CLAIMS.

I. This claim form, properly completed, must accompany any returned Product and be received by Communications & Power Industries Canada Inc. ("CPI") prior to expiration of the adjustment period. Compliance with this requirement assures the user of the most prompt and thorough service possible. A Product returned within the adjustment period, but without the completed Warranty Claim Form, will be treated as out of warranty.

II. Complete the following information regarding the Product being returned:

- A. Product Type: CPI Part No. \_\_\_\_\_ Serial No. \_\_\_\_\_  
Customer Part No. \_\_\_\_\_
- B. Customer Purchase Order No. \_\_\_\_\_  
Date of Purchase Order \_\_\_\_\_
- C. Control Specification Number \_\_\_\_\_ Dated \_\_\_\_\_  
(Check one) Document of CPI ☐ your Company ☐
- D. Contract Warranty (either CPI Warranty code or specification paragraph)  
\_\_\_\_\_  
Filament Hours \_\_\_\_\_ Warranty Adjustment Began \_\_\_\_\_  
Adjustment Time \_\_\_\_\_ (months) Expires \_\_\_\_\_

III. Claim is made against warranty based on the following:

- A. Specification(s) not met by the Product (list by specification and paragraph number):  
\_\_\_\_\_  
\_\_\_\_\_

SC3802 (01/03)

**PLEASE FILL IN FOR FAILED PRODUCT**

Place an "X" in the appropriate box to show what variance from normal was seen at the time of tube failure.

Product Serial No.	Date Instld	Date Failed	Filament Hours	Radiate Hours	Filament Current		Beam Current		Helix or Body Current		HI Voltage Arcs		W/G Arcs		Coolant Flow		Mech. Problems		Electro- Magnet Current	
Type No.					Lo	Hi	Lo	Hi	Nm	Hi	No	Y	No	Y	Nm	Lo	No	Y	Nm	Lo

\*It is necessary to have the Product serial number rather than the system serial number.

B. Describe the circumstances and/or sequence of events under which the Product failed. Include remarks relating to installation problems, system anomalies, etc. \_\_\_\_\_

IV. System used in \_\_\_\_\_  
Serial No. \_\_\_\_\_

V. Purchaser's Name \_\_\_\_\_  
Address \_\_\_\_\_

Claim made by: \_\_\_\_\_

Person to contact for additional information:

Name \_\_\_\_\_

Telephone \_\_\_\_\_

VI. Repair or Replacement to be sent to:

Name \_\_\_\_\_

Address \_\_\_\_\_

(Signature) \_\_\_\_\_

(Date) \_\_\_\_\_

Return completed form promptly, with Product, to:

Communications & Power Industries Canada Inc.  
45 River Drive  
Georgetown, ON  
Canada, L7G 2J4  
Attn: Returned Products/Customer Service

Telephone: (905) 877-0161  
FAX: (905) 877-5327



INSTALLATION AND OPERATING  
INSTRUCTIONS MANUAL FOR

**VPW2827A6**

EXTENDED INTERACTION KLYSTRON  
CW POWER SUPPLY

Canada Microwave Division  
Communications & Power Industries  
45 River Drive, Georgetown, Ontario, Canada, L7G 2J4

*Rev. July 2013*

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## **1.0 INTRODUCTION**

This manual contains the instructions required to install and operate a millimeter wave CW Extended Interaction Klystron (EIK) with a VPW2827A6 power supply. The A6 version includes provisions for operating specific EIKs that require an anode voltage as a fixed ratio of cathode voltage.

Please read this manual thoroughly before installing and operating the EIK sub-system.

Test performance data for specific EIK integrations is found in the Appendix section of this manual. Submit requests for additional copies of this manual or EIK test performance data, to:

Canada Microwave Division  
Communications & Power Industries  
45 River Drive  
Georgetown, Ontario  
Canada, L7G 2J4  
905-877-0161  
905-877-5327 (FAX)  
[marketing@cmp.cpii.com](mailto:marketing@cmp.cpii.com)

## **2.0 ACRONYMS AND ABBREVIATIONS**

CPI	-	Communications & Power Industries
CMP	-	Communications & Medical Products Division (Canada)
Ea	-	Anode Voltage
Eb	-	Collector Voltage
EIK	-	Extended Interaction Klystron
Ef	-	Filament (Heater) Voltage
Ek	-	Cathode Voltage
Ik	-	Cathode Current
Iw	-	Body Current
wrt	-	with respect to

### **3.0 THEORY OF OPERATION**

The VPW2827A6 CW EIK power supply provides all required electronic power conditioning to safely operate a CPI CW Extended Interaction Klystron.

A minimum configuration RF sub-system would consist of a CW power supply, an appropriate EIK cooling unit, a CW EIK and associated RF components.

The CW EIK power supply processes AC power input at connector jack (or line cord) J1 and supplies all necessary EIK operating voltages at (high voltage connector) J3. EIK interlock functions are enabled through (low voltage connector) J2. The supplied EIK remote connection and mounting unit connects to J2 and J3. Alternatively, a customer designed and manufactured remote connection can be substituted.

In standby mode, current is provided to the EIK filament to facilitate cathode warm-up to operating temperature.

After the high voltage delay (filament warm-up) period has expired, cathode high voltage ("OPERATE ON") may be applied; regulated DC cathode and collector voltages are then applied to their respective EIK electrodes.

In the OPERATE mode anode voltage will be present at the ANODE DIVIDER terminal and the EIK will be conducting nominal cathode current (RF capable conditions).

However, if utilizing the regulated anode terminal, cathode current is not supplied to the EIK until "RF ON" applies anode high voltage.

Internal (system) and external (cooling, safety) interlocks must be satisfied for high voltage operation.

All front panel controls (except for "MAIN POWER") and indicators may be implemented through the RS-422/RS-485 serial communication connector.

## 4.0 SPECIFICATIONS

### 4.1 EIK Output

Cathode Voltage (wrt body):	-3.0 to -12.0 kVDC. (field adjustable)
Collector Voltage (wrt body):	virtual ground or approx. 25% of Cathode Voltage (fixed, field selectable)
Anode Voltage (wrt cathode):	+0.8 kV. to +6.0 kV. (field adjustable)
Divided Anode Voltage (wrt cathode):	factory selected resistive voltage divider
Cathode Current:	125 mA. (maximum)
Body Current:	20 mA. (maximum)
Filament Warm-up Period:	1 to 300 s. (factory adjustable)

### 4.2 Prime Power

Voltage:	209 to 231 Vac.
Phasing:	1 (no neutral required)
Frequency:	48 to 62 Hz.
Current:	10.0 ADC (steady state operating)
Fusing:	20 A. (surge)

### 4.3 External Signals

Interlocks:	switch closure
Remote communication:	RS-422/RS-485 (DB-9)

### 4.4 Mechanical

Power Supply Unit:	approx. 17" wide x 9" high x 28" deep (19" rack) approx. 80 pounds
Remote Connector Unit:	approx. 10" wide x 10" high x 10" deep approx. 12 pounds

## **4.5 Cooling**

Power Supply Unit:

Self-contained air-cooling

Remote Connector Unit:

No cooling required

## **4.6 Environmental**

The power supply and Remote Connector Units are designed for laboratory condition operation and standard truck shipment transportation.

## 5.0 PROTECTIVE MEASURES

EIK sub-system installations must provide protection to personnel as described below. In addition, to protect the EIK and its associated power supplies, the installation and operating precautions must be observed and absolute ratings must not be exceeded.

### 5.1 Personnel

#### 5.1.1 High Voltage

**Caution;** voltages required for the operation of EIKs, can be dangerous and potentially fatal to personnel. Equipment should be designed with protective interlock circuits on access panels to prevent accidental contact with high voltage. Some EIK collector designs operate at depressed voltage potential. Forced air-cooled systems must accommodate these depressed voltages with insulated and shielded ducting. Liquid-cooled depressed voltage collectors use plastic coolant tubing for electrical isolation; but, all metal components in the cooling system must be grounded to prevent charge transfer through the coolant (see *CPI Product Safety Advisory MMSB001 Revision B*).

#### 5.1.2 Microwave Radiation

**Caution;** prevent the exposure of personnel to millimeter wave radiation from any EIK equipment waveguide circuits. EIKs have specified RF load requirements to prevent oscillation; never operate with unterminated waveguides.

EIK millimeter wave waveguide circuits employ high power density RF that may radiate from any waveguide flange gaps. Refer to “*American National Standard Safe Levels of Microwave Radiation*” (ANSI C95.1 published by IEEE, 345 East 47<sup>th</sup> Street, New York, NY, 10017) for safe radiation levels.



## 5.2 Equipment

### 5.2.1 Grounding

Ensure that all components of the EIK sub-system are suitably grounded. While every effort has been made to ensure adequate electrode spacings within the EIK and its CW power supply, occasional electrical breakdowns are possible. Arc currents can be very large in value and induce undesirable voltage drops in marginal ground leads. Do not rely on ground connections through removable connectors.

The EIK leads are not ground shielded and therefore personnel barriers should be utilized.

### 5.2.2 Approved Operation

**Caution;** never operate the EIK sub-system with any of the connectors not connected; irreparable damage may result.

The prime power applied to J1 must be within voltage ratings and fused to prevent a fire hazard; see the specification section for fuse ratings.

Servicing, maintenance or repairs must be performed by high voltage qualified personnel.

### 5.2.3 Interlock System

**Caution;** interlocks should be incorporated into the CW power supply to prevent or remove any high voltage or safety hazard if any of the EIK sub-system absolute ratings are exceeded. Do not rely on electrical interlocks for human safety.

A cooling system interlock must be used to prevent possible damage to the EIK under inadequate cooling conditions (use "EIK OVER TEMP" interlock).

## **6.0 INSTALLATION INSTRUCTIONS**

### **6.1 Equipment List**

The EIK CW power supply is shipped with:

- a rack mountable Power Supply Unit
- a remote connection and mounting (with connecting cable) Unit
- an installation and operating instructions manual

### **6.2 Unpacking**

Remove and identify all items listed on the equipment list from the shipping container. Retain all packing material for future EIK CW power supply transportation.

**Caution;** the rack mounted power supply weighs approximately 80 pounds and may require two person lifting.

### **6.3 Mounting**

The Power Supply Unit is designed to be mounted into a standard 19" rack. It is recommended that additional support of the module (side rails) be used due to the weight of the unit. During operation, the power supply may assume any orientation that maintains air-cooling to the rear inlet and outlet ports.

The EIK may be mounted in any orientation within the Remote Connector Unit lead lengths.

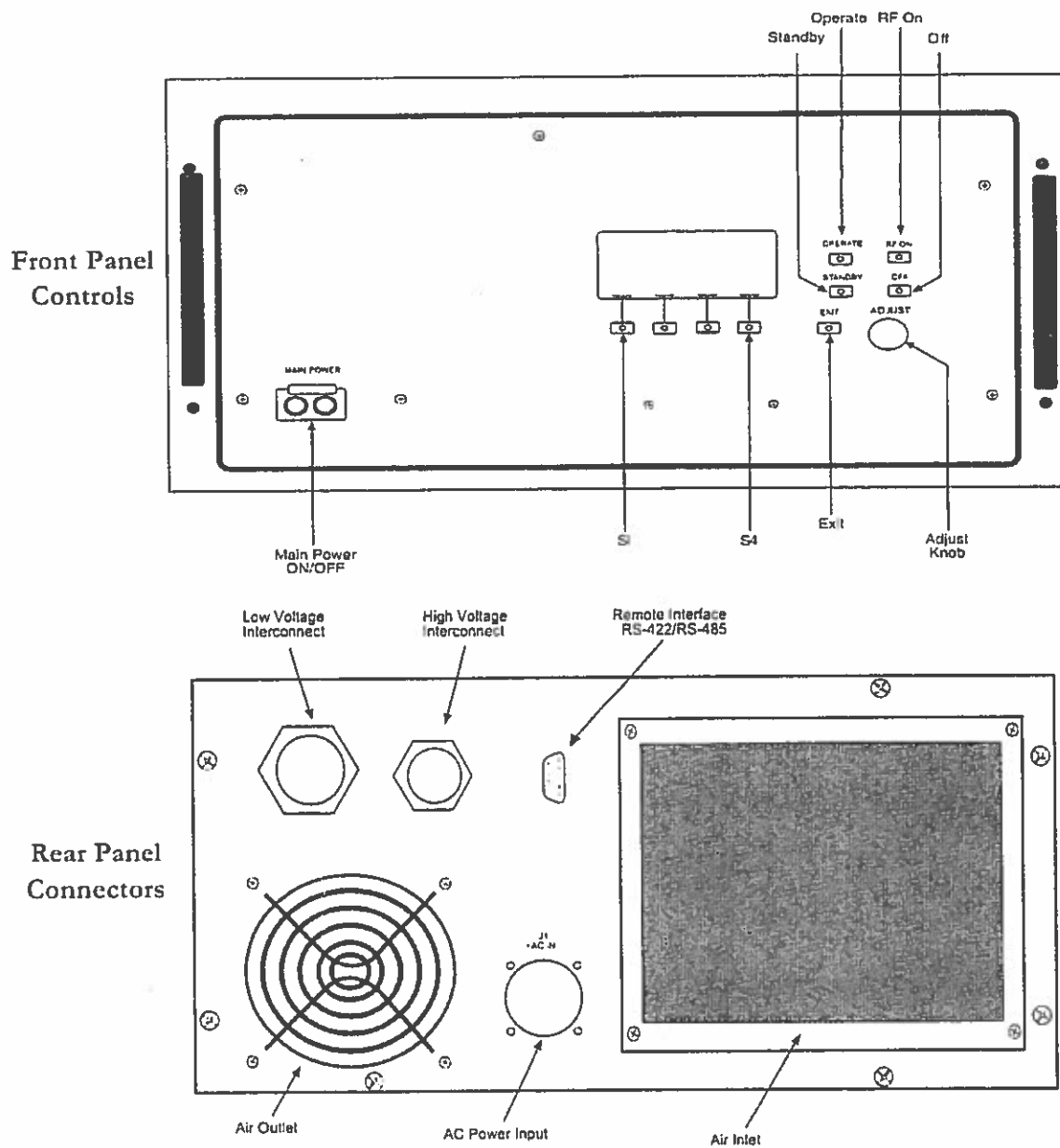


Figure 1 - Front and Rear Views

## 6.4 Cooling

EIKs and their CW power supplies are conduction, air or liquid-cooled. All applications must use exhaust side flow interlocks to prevent or remove operation if the cooling system is compromised. Interlocking capability is available on either the Remote Connector Unit ("EIK OVER TEMP") or directly at J2.

See the specification sections of both the EIK and the CW power supply manuals for the minimum cooling requirements.

Liquid-cooled EIKs must use clean deionized coolant. The specified flow rate is for water and must be increased for lower heat capacity fluids. Depressed voltage collectors must use and maintain a deionized coolant with a minimum of 1 M $\Omega$  cm resistivity.

**Caution;** all metal components of the liquid-cooling system (except the EIK collector) must be grounded to prevent charge accumulation (potentially collector-to-body voltage) through the coolant, posing an operator hazard. See the *CPI Product Safety Advisory MMSB001 Revision B* (available from CPI Canada).

## **6.5 Connections**

### **6.5.1 Grounding**

Ground both the Power Supply Unit and the Remote Connection Unit to safety grounds at the rear grounding studs.

**Caution;** do not rely on electrical connectors to fulfill grounding connections.

### **6.5.2 Prime Power Connection**

Prime power is applied to J4 (if used or a line cord) using the following pin assignments:

- Pin A - 220  $\pm$ 5% Vac, 48 – 62 Hz, 1 phase (wrt to pin C) (or neutral)
- Pin B - no connection
- Pin C - 220  $\pm$ 5% Vac, 48 – 62 Hz, 1 phase (wrt to pin A)
- Pin D - ground

User supplied prime power must be externally fused for product protection. See the specification section for operating / fusing current requirements.

### 6.5.3 EIK Electrical Connections

The electrical lead connections to the EIK are colour coded as follows:

YELLOW	- HEATER (-ve)
WHITE	- CATHODE & HEATER (+ve)
RED	- ANODE
BLUE	- COLLECTOR
BROWN	- BODY (may be BLACK in some applications)

High voltage leads should be kept away from ground planes to reduce the possibility of corona. Keep the leads as short as possible. Restrict personnel access to unshielded leads.

High voltage connections to the EIK are made through flying leads, which may be connected to the binding posts of the Remote Connector Unit. Refer to the applicable EIK Final Test Results for correct collector voltage connection (either virtual ground or 25 % voltage depression) and anode connection (either Divided Anode or Regulated Anode). Within the Remote Connection Unit, dress and secure low voltage leads away from the high voltage terminals.

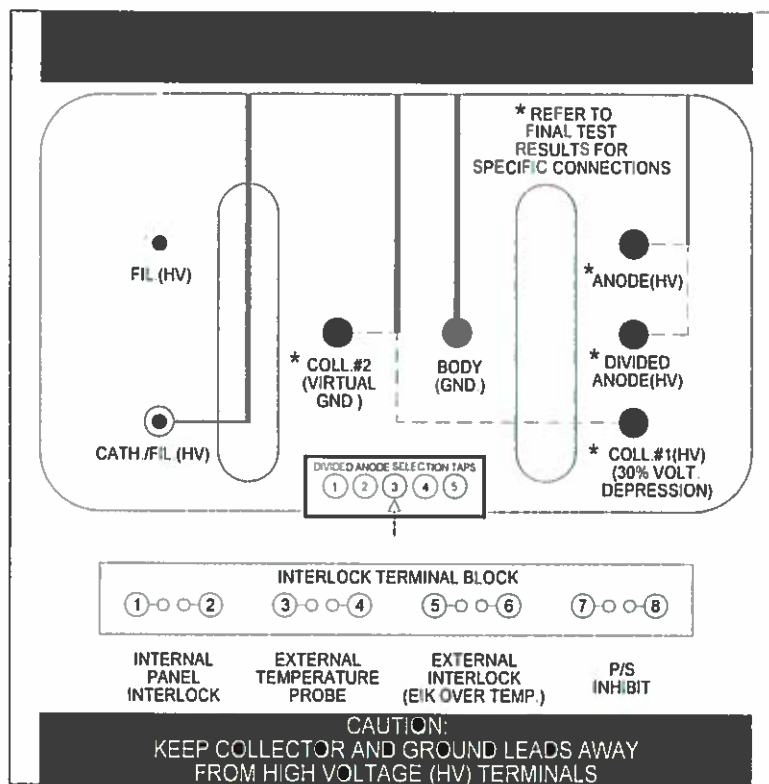


Figure 2 - Remote Connection Unit Terminals

#### **6.5.4 Remote Connector Unit**

The Remote Connector Unit is connected to the Power supply Unit through plugs P2 and P3 connected to jacks J2 and J3.

**Caution;** high voltage connector J3 is an air exclusion type connector which requires repeated “wiggling” while turning the locking ring. Inadequate tightening may result in unrepairable damage due to an arc internal to the connector.

**Caution;** keep the high voltage connectors covered when not in use.

If the user makes direct connections to J3, take appropriate safety precautions with personnel shielding.

#### **6.5.5 Control and Monitoring**

EIK interlock functions are available at J2 and within the Remote Connection Unit. A cooling system interlock must be employed to protect the EIK from operation with inadequate cooling (see Figure 2 – Remote Unit Connections).

All control and monitoring functions may be implemented through the RS-422/RS485 connector on the rear of the Power Supply Unit.

## 7.0 OPERATING INSTRUCTIONS

### 7.1 Safety Precautions

**Caution:** EIKs produce millimeter wave radiation, which can be dangerous to personnel. Before operating an EIK CW system, ensure that appropriate waveguide connections are in place.

**Caution:** never apply prime power to the CW power supply with any of the connections open; irreparable damage may result and an operator hazard may exist.

Follow all instructions presented in the installation section prior to applying prime power.

The CW power supply incorporates protection to the EIK through the use of trips and limits preset at the factory. The user is responsible for incorporating prime power fusing, personnel safety and cooling interlocks.



## 7.2 Operation

### 7.2.1 Stand-By Mode

Apply AC power by turning on “MAIN POWER” switch / breaker. The internal cooling fan should be heard running. After several identification messages on the front panel display, MENU 1 will appear.

Menu 1

Ef	0.00v	If	0.00A
Eb	0.01k	ea	°5.402K
Ek	°-13.53k	Iw	0.0mA
Ea*	[HTR TD: 5]		MORE

The fourth line will display [HTR TD \*\*\*] which indicates the remaining number of seconds of heater (filament) warm-up high voltage delay. When the heater warm-up delay has expired, the message [Stdy / rdy] will be displayed. No high voltage operation is possible until “STAND-BY / READY” is displayed.

Menu 1

Ef	0.00v	If	0.00A
Eb	0.01k	ea	°5.402K
Ek	°-13.53k	Iw	0.0mA
Ea*	[Stby / rdy]		MORE

If the external cooling interlock is not satisfied, the lower display will indicate “EIK OVER TEMP”.

\*Ea in the lower display is only displayed when in calibrate / adjust mode.

While in STAND-BY mode, a small square next to Ea (anode voltage) and Ek (cathode voltage) indicates that the preselected operating value is displayed.

**Caution;** do not leave the EIK operating in STANDBY mode for extended periods of time. Operation of the heater (filament) without high voltage for periods greater than 1 hour may create poor high voltage application conditions and potentially producing cathode damage.

### 7.2.2 OPERATE Mode

Pressing the “OPERATE” button will turn on the cathode and collector voltages to their preselected values. The display will now indicate the measured values of  $E_b$  (collector voltage) and  $E_k$  (cathode voltage). If utilizing the DIVIDED ANODE voltage terminal, the EIK will now be conducting nominal cathode current and be RF capable. However, if utilizing the REGULATED ANODE terminal, with only cathode voltage applied, no significant  $I_k$  (cathode current) or  $I_w$  (body current) will be conducted by the EIK.

### 7.2.3 RF ON Mode

Pressing the “RF ON” button will turn on the (REGULATED) anode voltage to the preselected value. The EIK will now be operating at preselected voltages and current.

### 7.2.4 Shut Down Sequence

Press the “(RF) OFF” button to turn off the (REGULATED) anode voltage. Press the “STANDBY” button to turn off the cathode voltage.

Alternatively, pressing the “STANDBY” button only will properly sequence off both voltages.

**Caution;** do not leave the EIK operating in STANDBY mode for extended periods of time. Operation of the heater (filament) without high voltage for periods greater than 1 hour may create poor high voltage application conditions and potentially producing cathode damage.

### 7.2.5 Calibrate / Adjust Mode

**Caution;** operation of the EIK at voltages other than those found on the EIK Final Test sheet may result in permanent EIK damage or out of specification performance.

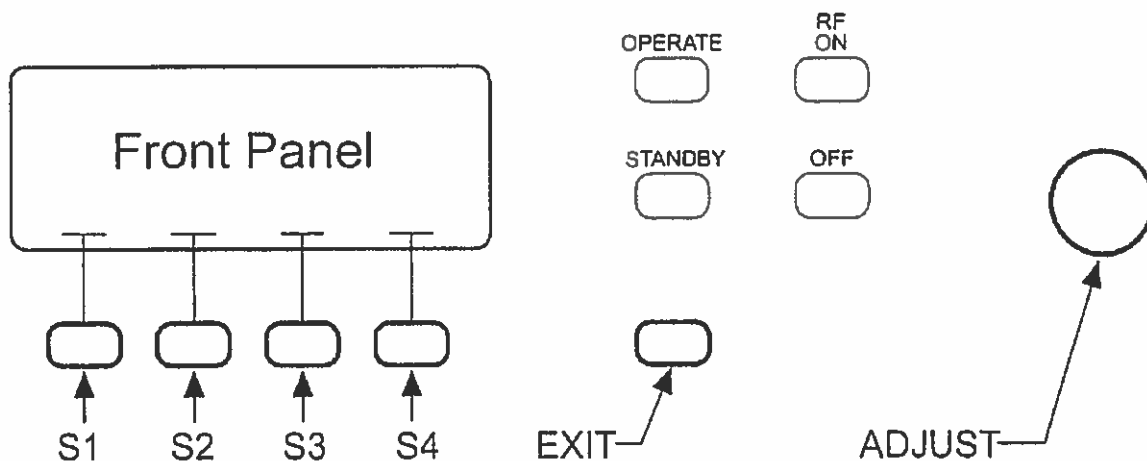
**Note;** if the password is blank in this manual, voltage adjustments for the operation of the integrated EIK are not recommended. Consult CPI Canada for further recommendations.

To enable changes to either  $E_k$  (cathode voltage) or  $E_a$  (REGULATED anode voltage) a password is required. Press S2 in Menu 4 (no displayed function). Rotate the ADJUST knob alternatively clockwise and then counter clockwise until the numbers 35451 are entered. Then rotate the ADJUST knob once more in the opposite direction to enter into the Calibrate / Adjust mode.

**Note;** calibrations should not be required after factory commissioning. Consult CPI Canada for further recommendations.

## 7.3 Display and Menu System

The front panel displays information on EIK CW Power Supply parameters and system status. Data is displayed in pages that can be accessed through a system of menus. Four soft keys, the exit key and the adjust knob allow navigation within the menu system.



### 7.3.1 Soft Keys S1 – S4

The current function of each soft key is displayed in the screen row directly above each key.

- S1 Entry to Setup screens 1 – 4 from Menu 3  
Entry to Warnings screens 1 – 6 from Menu 4
- S2 Entry to Faults screen from Menu 4
- S4 Entry to next level down; from the lowest level, returns to the top

### 7.3.2 Exit Key

Returns to the top level from within a menu sequence.

### 7.3.3 Adjust Knob

This knob is used to:

- Set Ek or Ea
- Scroll through lists of menu items
- Select parameter values to change

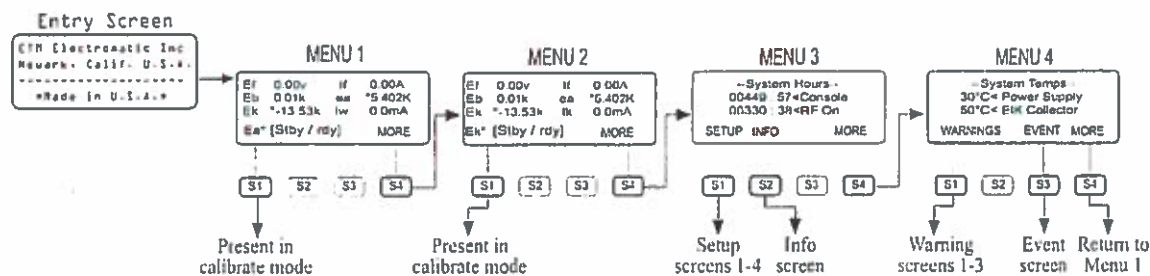


Figure 3 - Menu System

### 7.3.4 Menu 1 and Menu 2

This screen displays key EIK parameters:

- Ef Filament (heater) Voltage
- If Filament (heater) Current
- Eb Collector Voltage
- Ea Anode Voltage
- Ek Cathode Voltage
- Iw Body Current
- Ik Cathode Current

S1 enables adjustment of Ek or Ea (REGULATED) if the CW EIK Power Supply is in the CALIBRATE / ADJUST mode. In the STANDBY mode, Ea and Ek values are approximate preselection values. When the cathode and anode voltages are applied, measured values are displayed.

### 7.3.5 Menu 3

Menu 3 shows console (If) hours and RF ON (Ik) hours.

S1 (SETUP) key is described in a subsequent section.

S2 (INFO) key displays the following information:

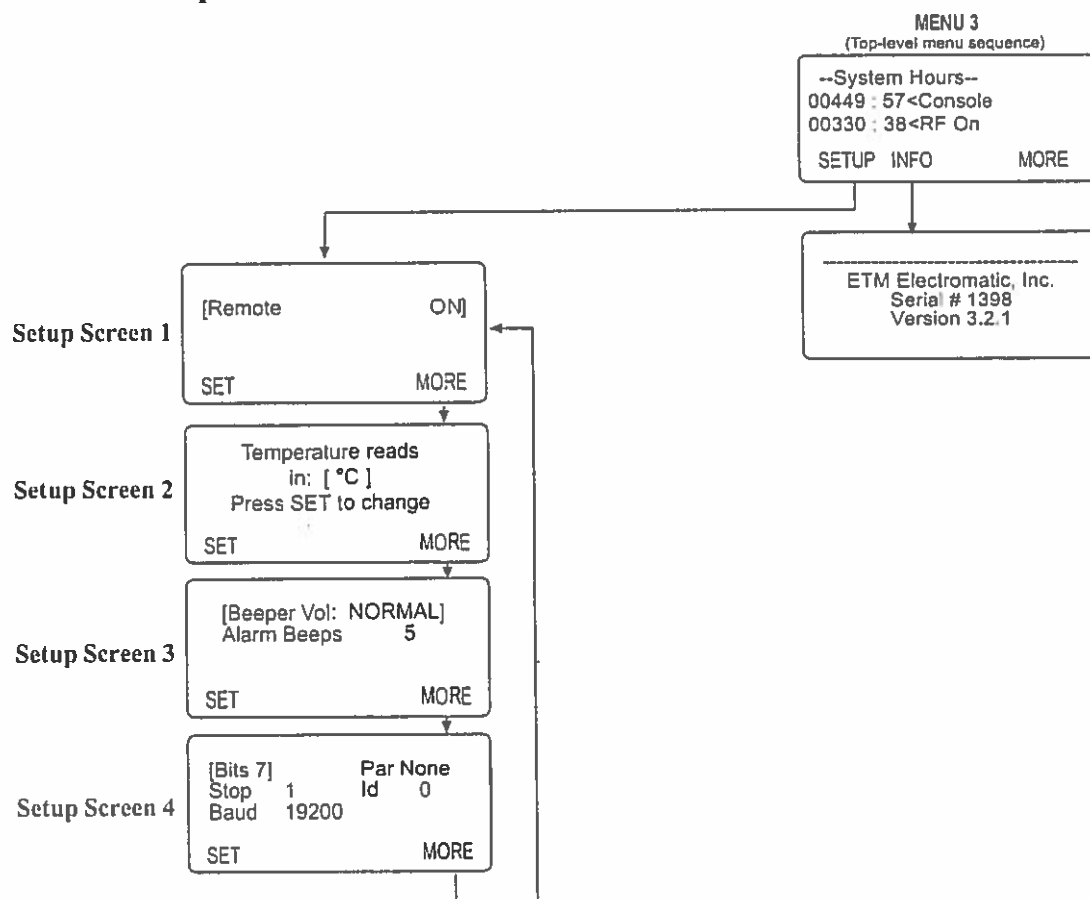
- Model Number
- Serial Number
- Firmware Version

### 7.3.6 Menu 4

This screen displays internal power supply and EIK (if used) temperatures. The system will shutdown if the internal power supply temperature exceeds 65 °C.

S1 (WARNINGS) key accesses the Warnings screens (subsequent section).

### 7.3.7 Setup Screens



**Figure 4 - Setup Screens**

Figure 4 illustrates the SETUP screen menu sequence.

Entry into this screen is from the top-level screen Menu 2 (EXIT to reach top level and then MORE until Menu 2)

```
-- System Hours --  
00129:22<Console  
00091:23<RF On  
SETUP INFO HELP MORE
```

### Menu 3

Press S1 (SETUP) on Menu 2 repeatedly to cycle through the setup screens.

Press EXIT key to return to Menu 3.

Parameters or values are stored when you press MORE or EXIT.

Setup Screen 1 - Remote:

- When Remote is OFF, a remote device may monitor the status of the EIK Power Supply but not control any operational functions. With Remote ON, the remote device has full control of the EIK Power Supply. Pressing (RF) OFF or STANDBY cancels the Remote ON function.
- Turn the ADJUST knob until square brackets enclose the desired function. S1 will now SET Remote with arrows to allow changes
- Press S1 (SET) again to toggle Remote function ON and OFF.

Setup Screen 2 - Temperature Units:

- Press S1 to SET units to °F or °C

Setup Screen 3 – Beeper Volume and Count:

- Turn the ADJUST knob until square brackets enclose Beeper Volume. S1 will now SET Beeper Volume with arrows to allow changes.
- Turn ADJUST knob to select OFF, SOFT, NORMAL and LOUD.
- Press S1 SET to store.
  
- Turn the ADJUST knob until square brackets enclose Alarm Beeps. S1 will now SET Alarm Beeps with arrows to allow changes
- Turn ADJUST knob to select 0, 1, 2, 3, 4 or 5.
- Press S1 SET to store.

Setup Screen 4 – Computer Interface

- Details in subsequent section.

### 7.3.8 Warnings Screens

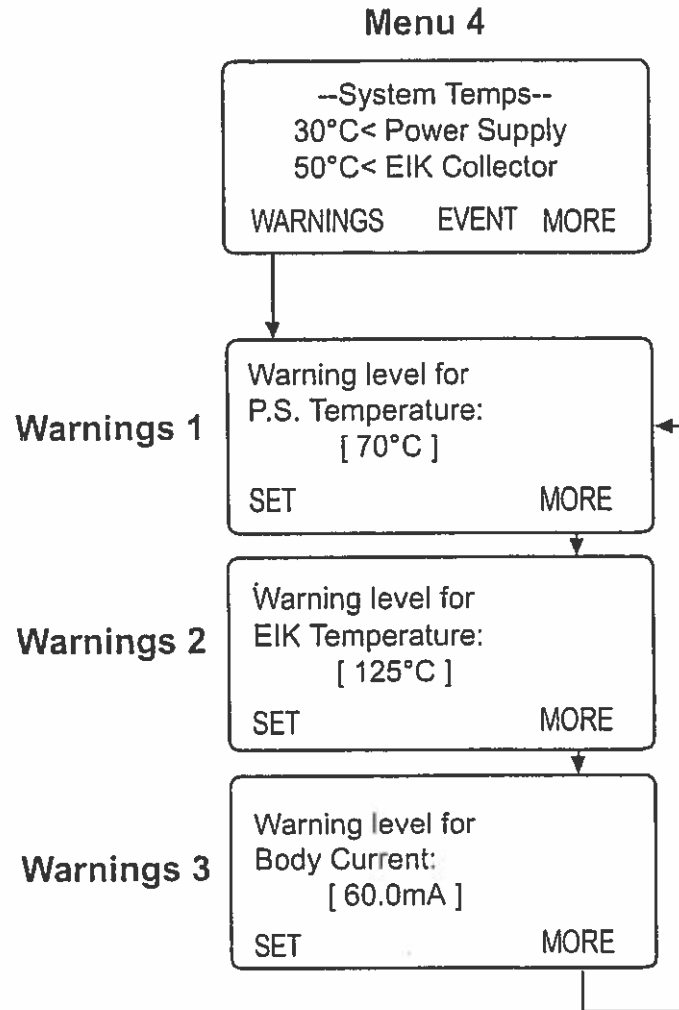
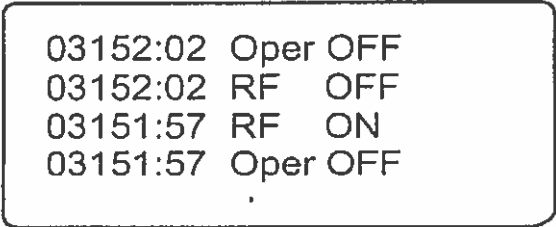


Figure 5 - Warnings Screens

- If not already at the top menu level, press EXIT key and then MORE until Menu 4 appears. Press S1 (WARNINGS) and the MORE until desired limit appears.
- Press S1 (SET) to change square brackets to arrows, which will allow changes.
- Turn the ADJUST knob to set the desired values.
- Pressing S1 (SET) again will store the value.

### **7.3.9 System Events Screen**



```
03152:02 Oper OFF
03152:02 RF  OFF
03151:57 RF  ON
03151:57 Oper OFF
```

### **Events Screen**

This screen is accessed from Menu 4 by pressing the S3 (EVENTS) key. The display shows the last four system events along with their console hours. The latest (top) event will be flashing. The ADJUST knob can be turned to scroll through the last 100 events.



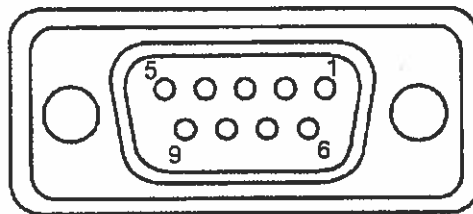
## 7.4 Computer Interface

### 7.4.1 Interface Capabilities

The computer interface can be used to implement all front panel control and monitoring functions except for calibration.

### 7.4.2 Implementation

A subminiature DB-9 connector on the rear panel of the EIK CW Power Supply supports half-duplex RS-422 or RS-485 serial communication with an external computer.



Pin Number	RS-422	RS-485
1	N.C.	N.C.
2		*
3	R+	R+/T+
4	T+	*
5	GND	GND
6	T-	*
7	R <sub>L</sub> **	R <sub>L</sub> **
8		*
9	R-	R-/T-

\*For 2-wire RS-485 operation, jumper pins 2 and 4 (R+ to T+) and pins 6 and 8 (R- to T-)

\*\*To terminate the receiver with 120 Ohms, jumper pin 9 (R-) to pin 7 (R<sub>L</sub>). This termination is not usually needed at 19,200 baud or below.

### 7.4.3 Serial Communication Configuration

[Bits 7]	Par	none
Stop 1	Id	1
Baud	9600.0	
SET	MORE	

#### Setup Screen 4

- From the top-level menu, select SETUP in Menu 3. Press MORE until Setup screen 4 appears.
- Turn the ADJUST knob until square brackets appear around the desired parameter.
- Press S1 (SET) to change to arrows, which will allow changes.
- Turn the ADJUST knob to change values.
- Press S1 (SET) to store the value.
- Data Bits 7 or 8, normally 8
- Stop Bits 1 or 2, normally 1
- Parity odd, even or none, normally none
- ID between 1 and 99, chose unique equipment number
- Baud Rate choices: 19,200, 9600, 7200, 4800, 3600, 2400, 2000, 1800, 1200, 600, 300, 150, 134.5

#### 7.4.4 Software Command Format

Command blocks are formatted as follows:

STX	>	0	1	b	R	D	E	K	ETX	0	1	CR
Prefix		Address		blank	Command				Suffix	Checksum		Terminator

All characters are 8-bit ASCII.

The address must match the value in the setup screen.

The checksum is the hexadecimal sum of all ASCII character values following the STX character up to and including the ETX character; divided by 256d (100h).

Example message exchange:

HOST:

STX	>	0	1	b	R	D	S	T	A	T	ETX	0	1	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL:

ACK	STX	>	0	1	b	S	T	A	T	U	S	=	2	2	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	----

- Command block begins with PREFIX and ends with TERMINATOR
- Command begins with SPACE and ends with SUFFIX
- Checksum is used to test for transmission errors
- ASCII character ">" is a delimiter
- STX=02d (02h)
- NAK=21d (15h)
- ETX=03d (03h)
- SPACE=32d (20h)
- ACK=06d (06h)

#### 7.4.5 Read Status Command (RDSTAT)

LOCAL replies to RDSTAT:

STATUS =	DESCRIPTION
0	No status to report, no command given
1	Last command was successful
10	Last command failed, invalid command
11	Last command failed, data was unparseable
20	Last command failed, data was beyond high limit
21	Last command failed, data was beyond low limit
22	Last command failed, data was out of range
23	Last command failed, data was wrong polarity
50	Remote mode not enabled
60	Not allowed

### 7.4.6 Read Fault Command (RDFLT)

LOCAL replies to RDFLT:

FLT =	DESCRIPTION
7	System fault
8	Heater fault
9	Low line voltage
10	Cathode over-voltage
11	Body over-current
12	Cathode under-voltage
15	Collector under-voltage
16	Inverter fault
17	Interlock open
18	Tube arc
19	EIK over-temperature (h)
20	Cabinet over-temperature (h)
26	Panel open
29	External inhibit
30	Anode over-voltage
49	EIK over-temperature (s)
50	Cabinet over-temperature (s)
62	Anode over-limit (s)
64	Anode not set (s)

(h) = hardware

(s) = software

#### 7.4.7 Basic Command Set

HOST COMMAND	LOCAL RESPONSE	MEANING
PWR-ON	CR	Turn power on
PWR-OFF	CR	Turn power off
XMIT-ON	CR	Transmit
XMIT-OFF	CR	Stop transmitting
RESET	CR	Clear system faults
RDS/N	s/n =	Read unit serial number
RDSTAT	Status =	Refer to Status Code
RDFLT	Status =	Refer to Fault Code
RDCONHR	ConHr =	Read console hours
RDCONMN	ConMn =	Read console minutes
RDRFHR	RfHr =	Read RF (Ik) ON hours
RDRFMN	RfMn =	Read RF (Ik) ON minutes
RDEK	Ek =	Read cathode voltage
RDEB	Eb =	Read collector voltage
RDEF	Ef =	Read filament voltage
RDIF	If =	Read filament current
IDIW	Iw =	Read body current
RDTMPEIKF	EIKF =	Read EIK temp. in °F
RDTMPEIKC	EIKC =	Read EIK temp. in °C
RDTMPPSF	PSF =	Read P/S temp. in °F
RDTMPPSC	PSC =	Read P/S temp. in °C
RDEIKOTF	EIKOTF =	Read EIK over-temp. warning level in °F
SEIKOTF	none	Set EIK over-temp. warning level in °F
RDEIKOTC	EIKOTC =	Read EIK over-temp. warning level in °C
SEIKOTC	none	Set EIK over-temp. warning level in °C
RDPSOTF	PSOTF =	Read P/S over-temp. warning level in °F
SPSOTF	none	Set P/S over-temp. warning level in °F
RDPSOTC	TC =	Read EIK over-temp. warning level in °C
SPSOTC	none	Set EIK over-temp. warning level in °C
IDIWOC	IwOC =	Read body current in mA
SIWOC	none	Set body over-current in mA
RDLOGIC	Sys =	Refer to Logic code
RDHTDREM	HTD =	Read remaining heater warm-up delay

## 7.4.8 Read Logic Command (RDLOGIC)

LOCAL replies to RDLOGIC:

ASCII	MSD			LSD
1	Standby / ready	External inhibit	HTD OK	HV ON
2	RF OFF / ready	External interlock	Unused	Transmit ON
4	Unused	Unused	Unused	Remote mode
8	Unused	Power ON	Unused	Fault

Example: logic code 07hex

- HV ON
- Transmit ON
- Remote mode

## 7.4.9 Example of Successful Message

Example 1:

HOST: turn high voltage ON

STX	>	0	1	b	P	O	W	-	O	N	ETX	0	2	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: successful command

CR

*Twenty - years of service  
Sander  
service awards @ Carl. gov*

#### 7.4.10 Examples of Messages with Errors

##### Example 2:

HOST: incorrect checksum

STX	>	0	1	b	P	O	W	-	O	N	ETX	9	9	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: replies with command and NAK

NAK	STX	>	0	1	b	P	O	W	-	O	N	ETX	9	9	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

##### Example 3:

HOST: missing prefix

>	0	1	b	P	O	W	-	O	N	ETX	9	9	CR
---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: no response is missing prefix, address or suffix

##### Example 4:

HOST: sends message to node 8 (wrong node)

STX	>	0	8	b	P	O	W	-	O	N	ETX	9	9	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: no response

##### Example 5:

HOST: sends unknown command

STX	>	0	1	b	P	W	)	~	O	N	ETX	9	9	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: replies

ACK	STX	>	0	1	b	S	T	A	T	U	S	=	1	0	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	----



**Example 6:**

HOST: address delimiter is missing

STX	0	1	b	P	O	W	-	O	N	ETX	9	9	CR
-----	---	---	---	---	---	---	---	---	---	-----	---	---	----

LOCAL: no response

**Example 7:**

HOST: sends message with no address

STX					P	O	W	-	O	N	ETX	9	9	CR
-----	--	--	--	--	---	---	---	---	---	---	-----	---	---	----

LOCAL: no response

## 8.0 TROUBLE SHOOTING

This section is designed to help you in troubleshooting problems that occur while operating the power supply in the field. The emphasis here is on procedures that do not involve removing the power supply from its installation.

You can also call CPI Canada at 905-877-0161 to get technical assistance for any operational issues.

The EIK CW Power Supply has two levels of protection: faults and warnings.

### 8.1.1 Hardware Fault Detection

Fault detection circuitry protects the EIK and the power supply from damage if a failure is imminent. Dedicated hardware (factory set) will shut down the EIK power supply immediately if certain system parameters exceed critical levels.

When a fault occurs, the EIK CW Power Supply continuously generates an audible alarm and displays a message on the front panel display. You may be able to clear a fault if it is caused by external conditions.

#### EXTERNAL FAULTS

MESSAGE	HARDWARE TRIP POINT	POSSIBLE CAUSE / RECOMENDATION
Input Line O/voltage	AC voltage input >10 % high	Check line voltage under load conditions
Input Line U/voltage	AC voltage input < 15 % low	
Body O/Current	Body current > set point	Check RF drive level
EIK Over Temp.	Temp. > 120 °C	Check air intake and exhaust ports and ambient air temperature
Cabinet Over Temp.	Temp. > 65 °C	

### INTERNAL FAULTS

MESSAGE	CAUSE
Cath U/Voltage	Ek below minimum fault level
Cath O/Voltage	Ek above maximum fault level
*Fil U/Voltage	Ef below minimum fault level
*Fil O/Voltage	Ef above maximum fault level
*Fil O/Current	If above maximum fault level
Coll U/Voltage	Eb below minimum fault level
Inverter Fault	High voltage power inverter failure
Tube Arc	High voltage arc occurrence

### MICROCONTROLLER FAULTS

MESSAGE	RECOMMENDATION
Database Corrupt	<ol style="list-style-type: none"> <li>1. Turn off main breaker</li> <li>2. Wait 10 seconds</li> <li>3. Turn breaker back on</li> <li>4. If prompted to press OK, all data may be erased, consult CPI</li> </ol>
Communication Failure	
Cannot Restore	
CU line voltage too low	

#### 8.1.2 Software Warnings

A software monitoring system warns of possible concerns, but allows the equipment to continue operating. An audible reminder alarm sounds every 30 seconds and a message appears on the front panel display. The parameter values, that trigger the warning alarms, can be set by the user. See Warnings Screens section for details.

## 9.0 SHIPPING INSTRUCTIONS

### 9.1 General

**Caution;** the EIK CW power supply weighs approximately 80 pounds and may require two person lifting.

If it is required to return the EIK CW power supply to the manufacturer or ship it to another destination by conventional carrier:

- disconnect and remove the EIK (follow EIK shipping instructions if it is also being shipped)
- disconnect the remote connection unit, the prime power and grounding connections
- insert the power supply into a plastic bag to prevent possible moisture penetration
- pack the EIK CW Power Supply into the factory shipping container using the retained packing material
- also pack the remote connection unit with suitable cushioning materials
- if the EIK will be left attached to the remote connection unit, then ensure that a complete container magnetic shielding system is in place
- identify the container as required by the carrier

If the original containers are not available, contact CPI for replacement containers or for special shipping instructions:

Canada Microwave Division  
Communications & Power Industries  
45 River Drive  
Georgetown, Ontario  
Canada, L7G 2J4  
905-877-0161  
905-877-5327 (FAX)  
[marketing@cmp.cpii.com](mailto:marketing@cmp.cpii.com)

## **10.0 APPENDIX**





Communications & Power Industries

## OPERATING HAZARDS

**READ THIS SHEET AND TAKE ALL  
APPROPRIATE SAFETY PRECAUTIONS**

**PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO MICROWAVE TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. CPI PROVIDES INFORMATION ON ITS' PRODUCTS AND ASSOCIATED HAZARDS, BUT IT ASSUMES NO RESPONSIBILITY FOR AFTER-SALE OPERATING AND SAFETY PRACTICES. TUBE FAILURES MAY OCCUR; TAKE APPROPRIATE ACTION THROUGH REDUNDANCY OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM THE CONSEQUENCES OF TUBE FAILURE.**

**ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO MICROWAVE 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.**

### OPERATING INSTRUCTIONS

This sheet, the Test Performance Sheet and the Operating Instructions can help you to operate this tube safely and efficiently. PLEASE READ THEM. The Test Performance Sheet is a record of individual product test conditions and test results from the factory. Special operating considerations and precautions will be found in the Operating Instructions. Uninformed or careless operation of this tube can result in poor performance, damage to the tube or other property, serious bodily injury and, possibly, death.

Address written questions regarding tube operation to the Marketing Manager, at the address at the bottom of this sheet.

### WARNING - SERIOUS HAZARDS EXIST IN THE OPERATION OF MICROWAVE TUBES

The operation of microwave tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel.

- a. **HIGH VOLTAGE** - Normal operating voltages can be deadly.
- b. **RF RADIATION** - Exposure to rf radiation can cause serious bodily injury resulting in blindness or death. **Cardiac pacemakers may be affected.**
- c. **X-RAY RADIATION** - High voltage tubes can produce dangerous, possibly fatal, X-rays
- d. **BERYLLIUM OXIDE POISONING** - The dust or fumes from beryllium oxide (BeO) ceramics used in some microwave tubes are highly toxic and can cause serious injury or death if inhaled or entering an open wound.
- e. **CORROSIVE AND POISONOUS COMPOUNDS** - If a dielectric gas is used in the external waveguide or around

the high voltage bushing portions of some microwave tubes, highly toxic or corrosive compounds may be produced by either rf voltage breakdown or high voltage DC breakdown.

- f. **FC-75 TOXIC VAPOUR AND FLUID** - Decomposition products of FC-75 coolant are highly toxic and can cause serious injury or death.
- g. **IMPLOSION HAZARD** - Ceramic windows in microwave tubes can shatter on impact or crack in use, possibly resulting in injury from flying particles or from beryllium oxide (BeO) dust or fumes where BeO is used.
- h. **HOT COOLANT AND/OR STEAM** - For liquid cooled collectors the electron collector and water used to cool it reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.
- i. **HOT SURFACES** - Surfaces of air cooled collectors and other parts of tubes reach temperatures of several hundred degrees celsius and can cause serious burns if touched.

Additional specific information about microwave tube hazards:

### HIGH VOLTAGE

Most microwave tubes operate at voltages high enough to kill through electrical shock. Design equipment utilizing these tubes to prevent personnel from coming in contact with high voltages. Securely attach prominent hazard warnings. Personnel must always break the primary circuits of the power supply and discharge high voltage capacitors when direct access to the tube is required.

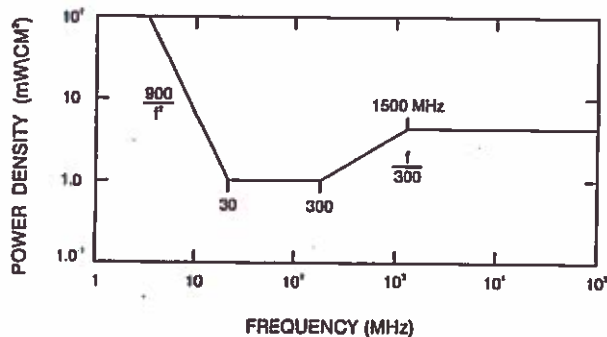
### RADIO FREQUENCY (RF) RADIATION

**EXPOSURE OF PERSONNEL TO RF RADIATION SHOULD BE MINIMIZED. PERSONNEL SHOULD NOT BE PERMITTED IN THE VICINITY OF OPEN, ENERGIZED WAVEGUIDES OR ENERGIZED ANTENNAS.** It is generally accepted that exposure to high levels of rf radiation can result in severe bodily injury, including blindness. **Cardiac pacemakers may be affected.**

The effect of prolonged exposure to low-level rf radiation continues to be a subject of investigation and controversy. Although an absolute safe exposure limit is not defined, it is generally agreed among official standard-setting groups in the U.S. that prolonged exposure of personnel to rf radiation at frequencies of 10 MHz - 300 GHz should be limited to average power densities as represented in the profile on the other side of this sheet.

It is also generally agreed that exposure should be reduced in working areas where temperatures are above normal. This practice has been adopted as a guideline by several U.S. Government agencies, including the Occupational Safety and Health Administration (OSHA), as the standard of protection





### RADIATION PROTECTION GUIDE AS AVERAGED OVER 0.1 HOUR PERIOD

**ALL INPUT AND OUTPUT RF CONNECTIONS, WAVEGUIDE FLANGES AND GASKETS MUST BE RF LEAK-PROOF. PROPERLY MATCHED RF ENERGY ABSORBING LOAD ATTACHED NEVER LOOK INTO OR EXPOSE ANY PART OF THE BODY TO AN ANTENNA OR OPEN WAVEGUIDE WHILE THE TUBE IS ENERGIZED. MONITOR THE TUBE AND RF SYSTEM FOR RADIATION LEAKAGE AT REGULAR INTERVALS AND AFTER SERVICING.**

### X-RAY RADIATION

As voltages increase beyond 15 kilovolts, metal-body tubes are capable of producing progressively more dangerous X-ray radiation. Provide adequate X-ray shielding on all sides of these tubes, particularly the cathode and collector ends, as well as the modulator and pulse transformer tanks. Check X-ray levels. NEVER OPERATE HIGH VOLTAGE TUBES WITHOUT ADEQUATE X-RAY SHIELDING IN PLACE. MONITOR THE TUBE AFTER SERVICING AND AT REGULAR INTERVALS FOR POSSIBLE CHANGES IN X-RAY LEVELS DUE TO AGING.

### DANGER - BERYLLIUM OXIDE, LEAD AND COBALT

Some microwave tubes contain Beryllium Oxide (BeO) ceramics: usually the output waveguide window or around the cathode. Lead is another material used in microwave tubes, usually as an X-ray shield around the collector area of high power microwave tubes. Cobalt is a constituent in samarium cobalt magnets used in certain microwave tubes.

Do not perform any operations on parts containing BeO, lead or cobalt which produce dust or fumes; for example, sand or grit blasting, grinding, cutting or acid cleaning.

**CHRONIC EXPOSURE TO THE HIGHLY TOXIC DUST AND FUMES OF BERYLLIUM OXIDE, LEAD AND COBALT CAN RESULT IN SERIOUS LONG-TERM HEALTH EFFECTS.**

### BERYLLIUM OXIDE WINDOWS

If a broken window is suspected, carefully remove the tube from its waveguide and seal the output flange of the tube with tape. Because BeO warning labels may be obliterated or removed, we urge you to contact CPI, before performing any work on ceramics in any CPI microwave tube. Some tubes have BeO ceramics internal to the vacuum envelope. Take precautions to protect personnel working in the disposal or salvage of tubes containing BeO and lead. All such personnel should be made aware of the hazards involved and the necessity for great care and attention to safety precautions.

### CORROSIVE AND POISONOUS COMPOUNDS

External output waveguides and cathode high voltage bushings of microwave tubes are sometimes operated in

voltage breakdown. If breakdown does occur, the gas may decompose and combine with impurities, such as air or water vapour, to form highly toxic and corrosive compounds. Examples are Freon gas which may form LETHAL PHOSGENE, and sulfur hexafluoride (SF<sub>6</sub>) gas which may form highly toxic and corrosive sulfur or fluorine compounds such as BERYLLIUM FLUORIDE. When breakdown does occur in the presence of these gases, VENTILATE THE AREA TO OUTSIDE AIR, AVOID BREATHING ANY FUMES OR TOUCHING ANY LIQUIDS WHICH DEVELOP, TAKE PRECAUTIONS APPROPRIATE FOR BERYLLIUM COMPOUNDS AND FOR OTHER HIGHLY TOXIC AND CORROSIVE SUBSTANCES before permitting personnel to perform any work on or near the tube. If a coolant other than pure water is utilized, follow the precautions supplied by the coolant manufacturer.

### DANGER -FC-75 TOXIC VAPOUR AND FLUID HAZARD

Decomposition products of FC-75 are highly toxic. Decomposition may occur through exposure to temperatures above 200 °C, to liquid fluorine or alkali metals (lithium, potassium or sodium) or to ionizing radiation. Known thermal decomposition products include perfluoroisobutylene (PFIB; {CF<sub>3</sub>})<sub>2</sub>C=CF<sub>2</sub> which is highly toxic in small concentrations. If FC-75 has been exposed to temperatures above 200 °C through fire, electric heating, prolonged electric arcs, or has been exposed to alkali metals or strong ionizing radiation, strictly avoid breathing any resulting fumes or vapours, thoroughly ventilate the area, and strictly avoid contact with the FC-75. Under such conditions, promptly replace the FC-75 and handle and dispose of the contaminated FC-75 as a toxic waste.

### IMPLOSION HAZARD

Due to the internal vacuum in microwave tubes, the glass or ceramic output window can shatter inward (implode) if struck with a hard object or subjected to mechanical shock. Flying debris could result in bodily injury, including cuts and puncture wounds and, if made of BERYLLIUM OXIDE ceramic, produce highly toxic dust or fumes. DO NOT BREATHE SUCH DUST OR FUMES.

### HOT COOLANT AND/OR STEAM

High temperatures occur in the electron collector portion of microwave tubes during operation. Coolant channels used for cooling also reach high temperatures (100 °C or above), and the hot coolant is under pressure (typically as high as 100 psi). Some collectors are cooled by boiling the coolant and forming steam.

A rupture of the coolant channel or the coolant or steam line or other contact with hot portions of this tube could scald or burn. Carefully check that all fittings and connections are secure and monitor backpressure for changes in cooling system performance. Replace Any defective fittings and tighten any loose fittings or connections. If backpressure is increasing above normal operating values, shut the system down and clear the restriction.

### HOT SURFACES

The electron collector portion of microwave tubes is often air-cooled or conduction cooled. The air cooled external surface normally operates at a high temperature (typically 200 °C to 300 °C). Other portions of the tube may also reach high temperatures, especially the cathode insulator and the cathode/heater surfaces. All hot surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to prevent and avoid any bodily contact with these surfaces both during and for a reasonable cool-down





## LIMITED WARRANTY

### MICROWAVE TUBES, EQUIPMENT AND COMPONENTS

Communications & Power Industries Canada Inc. ("CPI") warrants its Microwave Tubes, Equipment and Components ("Products") in accordance with the CPI Warranty General Provisions on the reverse side and the following. In case of conflict with CPI Warranty General Provisions, the following shall govern:

#### WARRANTY

CPI warrants the Products it manufactures to be free from defects in material and workmanship and to be in substantial compliance with operational features of CPI's published specifications at the time of sale. CPI's warranty shall begin on date of shipment and continue for the period of time specified on CPI's quotation or as agreed in writing by CPI, per the agreed Warranty Code.

#### WARRANTY CODES AND MAXIMUM WARRANTY PERIODS

Warranty Code	Pro-rata and Maximum Periods	
	Maximum Hours of Filament or Heater Operation	Maximum Months
WU	Unlimited	*
B	100	6
E	200	12
G	500	12
K	1000	12
L	2000	12
S	5000	12
V	7500	18
W	7500	24

\* As specified in CPI's quotation.

When one of these Warranty Codes is stated in CPI's quotation, or otherwise stated in writing by CPI to the Customer, the price includes the warranty coverage specified. Warranties other than as specified above may be purchased for an additional charge. For CPI Tube Products, if no period of time is stated, then the warranty is limited to thirty (30) days from date of shipment. CPI Equipment and passive Components (including power supplies, X-Ray Products, electromagnets, solenoids, filters, loads, circulators, couplers, waveguide windows, diplexers, and other passive devices) if no other period of time is stated are warranted for unlimited hours of operation during not more than a twelve (12) month period following their date of shipment from CPI.

#### REMEDIES/ADJUSTMENTS

If CPI's examination confirms that a Product has failed from causes covered by this warranty through no fault of Customer within the applicable maximum hours of filament or heater operation or the maximum number of months after shipment specified above, whichever first occurs, CPI will at CPI's option either: (1) repair or replace the Product at no cost to Customer or (2) make an equitable adjustment on the price paid for the Product.

For CPI Tube Products the equitable adjustment will be calculated as follows:

- (a) either refund a pro-rata portion of the original purchase price of Customer, or  
(b) apply such pro-rata amount as a credit on a replacement order for a new Product. Any such refund or credit shall be determined as follows:

Adjustment = (Applicable Selling Price) multiplied by

$$\frac{(\text{Maximum Warranted Hours} - \text{Total Operating Hours at Failure})}{\text{Maximum Warranted Hours}}$$

#### WARRANTY CONDITIONS

- Repairs and adjustments must be made (or directed in writing) by authorized CPI personnel only. Unauthorized repairs or adjustments will void the warranty.
- The Customer must give CPI written notice of Product failure prior to the end of the Product warranty period. CPI shall determine probable hours of Product usage when no accurate records can be found.

3. The Product must have been used under normal operating conditions within the respective CPI-specified ratings and in accordance with CPI operating instructions. CPI shall make the sole final determination as to whether failure occurred in normal operation (under warranty) or whether the Product was subjected to other than normal operation (excluded from warranty).

4. The Customer must return the failed Product and a completed Warranty Claim Form within 45 days following its written notice of failure.

5. The warranty period remaining on the date CPI received notice of failure shall apply to the repaired or replaced Product from the date of reshipment to Customer. No new warranty period shall apply except on paid replacements.

6. Customer shall be responsible for and shall immediately file claims against the carrier in cases of loss or damage to Products during either the initial shipment to Customer or the Customer's return to CPI for repair or replacement.

7. CPI shall have no warranty obligation other than as specified by the Warranty Code on CPI's quotation, or otherwise to the Customer in writing. If "No Warranty" is specified, CPI makes no express or implied warranties, and disclaims MERCHANTABILITY and FITNESS for any particular purpose, use or application, and Customer releases CPI from any warranty liability whatsoever.

8. Subject to the WARRANTY REPLACEMENT AND ADJUSTMENT provisions of CPI Standard Terms and Conditions of Sale (paragraph 10), the following WARRANTY RETURN PROCEDURES apply:

- Before initiating return procedures, determine that the Product is itself at fault. Please call the local CPI Field Office or Communications & Power Industries Canada Inc. for assistance in determining the problem and in obtaining satisfactory performance from the Product. This may save shipping time and expense and may minimize equipment downtime.
- If examining the Product at your facility confirms that the Product is at fault: (1) Contact Communications & Power Industries Canada Inc. for instructions on return of the Product. Communications & Power Industries Canada Inc. Customer Service, will issue to the Customer a Return Material Authorization (RMA) Number. The Customer must identify to CPI the Product type and serial number of the Product and a description of the circumstances giving rise to the warranty claim. If the Product is being returned from outside Canada, the Customer will be provided special instructions regarding customs and ship to information. The Customer must follow these instructions when returning the Product against the RMA, otherwise, costly duty and brokerage charges may be incurred and charged to the Customer. (2) Ship the Product prepaid, whether in or out of warranty. Products repaired by CPI under a valid warranty claim will be returned to the Customer with return transportation prepaid by CPI. Products repaired out of warranty will be returned at the Customer's expense. (3) Return the Product along with a fully complete Warranty Claim Form via a means of transportation acceptable to CPI to minimize the possibility of shipping damage. CPI reserves the right to reject any warranty claim on any Product returned without a Warranty Claim Form, any Product that has been altered, or that has been shipped by an unacceptable means of transportation. Return Products in their original container, or if unavailable contact Communications & Power Industries Canada Inc. for instructions, and unless an alternate ship to address is provided along with the RMA number, ship to:

Communications & Power Industries Canada Inc.  
45 River Drive  
Georgetown, Ontario, L7G 2J4 Canada  
Attn: Returned Products/Customer Service  
Tel: (905) 877-0161

# WARRANTY

## (General Provisions)

CPI Products, Software and Services are warranted in accordance with these general warranty provisions, as well as the supplemental warranty terms and conditions on the reverse side applicable to specific individual Products.

### 1. General Warranty Statement

CPI warrants products, parts and accessories manufactured and sold by CPI ("Products") and firmware and software media furnished by CPI in or for use with Products ("Software") to be free from defects in material and workmanship and in substantial compliance with operational features of published CPI specifications at the time of sale. CPI makes no warranty that the operation of any Software will be uninterrupted or error free. Warranty for services provided by CPI in connection with Products ("Services") shall be as stated in CPI terms and conditions of service for specific Products.

### 2. Warranty Periods

CPI's warranty shall begin and continue for the period(s) specified on the reverse side, or as stated on CPI's quotation, or as agreed in writing by CPI, under the conditions below and on the reverse side.

### 3. Warranty Remedies

Buyer's sole and exclusive remedy under warranty shall be repair or, at CPI's option, replacement of defective Products, parts, accessories or Software. CPI shall determine whether Product or Software malfunctions require repair or replacement under warranty. If in CPI's opinion such repair or replacement is not feasible, or if such remedy fails of its essential purpose, CPI may refund or credit a portion of any sums paid by Buyer for the Product, Software or Service. In-warranty repair or replacement parts are warranted only for the unexpired portion of the original warranty period.

### 4. General Exclusions from Coverage

CPI's warranties shall not apply to the extent that malfunction is caused in CPI's reasonable opinion by (1) accident, abuse, alteration, misuse or neglect, (2) failure to use Products under normal operating conditions or environment, or within CPI specified ratings, or according to any operating instructions provided by CPI, (3) lack of routine care or maintenance as indicated in any CPI operating or maintenance instructions, (4) failure to use or take any proper precautions under the circumstances, (5) user modification of any Product or Software, or (6) latent defects discovered after expiration of the applicable warranty period. Additional exclusions from coverage may apply to individual Products, Software or Services.

### 5. Other Supplies Warranties

Warranties given by other suppliers of equipment, accessories, components or computer software not owned by CPI but incorporated by CPI on or into Products are passed on to Buyer, shall be subject to all exclusions and limitations on CPI warranty liability, and shall apply exclusively to the equipment, accessories, components or computer software of which they are a part. CPI shall not have any warranty liability with respect to warranties provided by such other suppliers, nor shall CPI have any liability for failure of such supplier to perform under its warranty.

### 6. Exclusion of Implied Warranties

*This limited warranty is expressly in lieu of and EXCLUDES all other express or implied warranties including but not limited to warranties of MERCHANTABILITY and of FITNESS for a particular purpose, use, or application.*

### 7. Limitations on Damages and Liability

CPI'S TOTAL LIABILITY IN DAMAGES OR OTHERWISE SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY CPI FOR THE UNIT OF PRODUCT, SERVICE OR SOFTWARE FURNISHED OR TO BE FURNISHED RESULTING IN THE LOSS OR DAMAGE CLAIMED. IN NO EVENT SHALL CPI BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, INDIRECT, PUNITIVE OR SPECIAL LOSS OR DAMAGES OF ANY KIND, SUCH AS, BUT NOT LIMITED TO, LOST BUSINESS REVENUE, LOST PROFITS OR COSTS OF DOWNTIME RESULTING FROM CPI'S PRODUCTS, SERVICES OR SOFTWARE, HOWEVER CAUSED, WHETHER BASED ON CONTRACT, TORT (INCLUDING NEGLIGENCE) OR ANY OTHER LEGAL THEORY. Liability to third parties for bodily injury, including death, resulting from CPI's performance or Products shall be determined in accordance with applicable law. Patent infringement liability shall be determined solely in accordance with the "Patents and Other Intellectual Property Rights" provision of CPI standard terms and conditions of sale. NO claims, regardless of form, arising out of, or in any way connected with Products, Software or Services furnished by CPI, may be brought by Buyer more than one (1) year after the cause of action has accrued or CPI's performance has been completed or terminated, whichever is earlier.



## WARRANTY CLAIM FORM FOR MICROWAVE TUBES, EQUIPMENT AND COMPONENTS

PROPER COMPLETION OF THIS FORM IS VITALLY IMPORTANT TO THE  
PROMPT AND EFFICIENT HANDLING OF PRODUCT WARRANTY CLAIMS.

I. This claim form, properly completed, must accompany any returned Product and be received by Communications & Power Industries Canada Inc. ("CPI") prior to expiration of the adjustment period. Compliance with this requirement assures the user of the most prompt and thorough service possible. A Product returned within the adjustment period, but without the completed Warranty Claim Form, will be treated as out of warranty.

II. Complete the following information regarding the Product being returned:

A. Product Type: CPI Part No. \_\_\_\_\_ Serial No. \_\_\_\_\_  
Customer Part No. \_\_\_\_\_

B. Customer Purchase Order No. \_\_\_\_\_  
Date of Purchase Order \_\_\_\_\_

C. Control Specification Number \_\_\_\_\_ Dated \_\_\_\_\_  
(Check one) Document of CPI ☐ your Company ☐

D. Contract Warranty (either CPI Warranty code or specification paragraph)

\_\_\_\_\_

Filament Hours \_\_\_\_\_ Warranty Adjustment Began \_\_\_\_\_  
Adjustment Time \_\_\_\_\_ (months) Expires \_\_\_\_\_

III. Claim is made against warranty based on the following:

A. Specification(s) not met by the Product (list by specification and paragraph number):

\_\_\_\_\_  
\_\_\_\_\_

SC3802 (01/03)

**PLEASE FILL IN FOR FAILED PRODUCT**

Place an "X" in the appropriate box to show what variance from normal was seen at the time of tube failure.

Product Serial No.	Date Instld	Date Failed	Filament Hours	Radiate Hours	Filament Current		Beam Current		Helix or Body Current		Hi Voltage Arcs		W/G Arcs		Coolant Flow		Mech. Problems		Electro- Magnet Current	
Type No.					Lo	Hi	Lo	Hi	Nm	Hi	No	Y	No	Y	Nm	Lo	No	Y	Nm	Lo

\*It is necessary to have the Product serial number rather than the system serial number.

B. Describe the circumstances and/or sequence of events under which the Product failed. Include remarks relating to installation problems, system anomalies, etc. \_\_\_\_\_

IV. System used in \_\_\_\_\_  
Serial No. \_\_\_\_\_

V. Purchaser's Name \_\_\_\_\_  
Address \_\_\_\_\_

Claim made by: \_\_\_\_\_

Person to contact for additional information:

Name \_\_\_\_\_

Telephone \_\_\_\_\_

VI. Repair or Replacement to be sent to:

Name \_\_\_\_\_

Address \_\_\_\_\_

(Signature) \_\_\_\_\_

(Date) \_\_\_\_\_

Return completed form promptly, with Product, to:

Communications & Power Industries Canada Inc.  
45 River Drive  
Georgetown, ON  
Canada, L7G 2J4  
Attn: Returned Products/Customer Service

Telephone: (905) 877-0161  
FAX: (905) 877-5327