

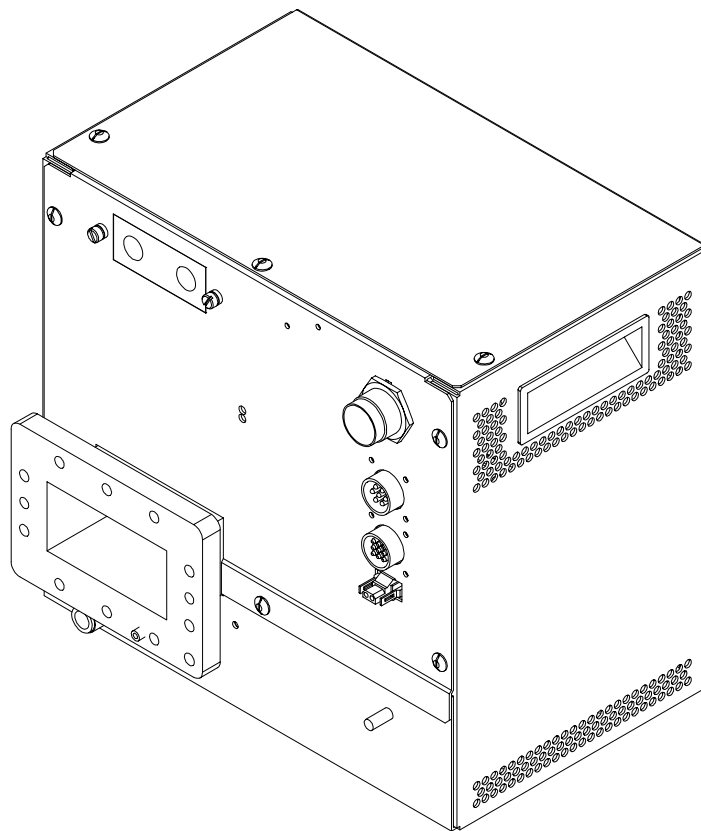
---

# Product User Manual



## Model GA4004 6kW Magnetron Head

---



Document # 930060, Rev. 1



Gerling Applied Engineering, Inc.  
P.O. Box 580816 ♦ Modesto, CA 95358  
[www.2450mhz.com](http://www.2450mhz.com)

---

REVISION HISTORY			
REV.	DESCRIPTION	DATE	APPROVAL
1	RELEASE	30MAR05	JFG

## WARRANTY

Products manufactured and sold by Gerling Applied Engineering, Inc. (“GAE”) are warranted to be free of defects in materials and workmanship under normal use and service for a period of twelve (12) months from the date of original shipment. GAE’s obligation under this warranty is limited to repairing or replacing, at GAE’s option, all non-consumable component parts. Consumable parts are specifically excluded from this warranty and may include, but are not be limited to, magnetrons, fuses, lamps, seals, o-rings, v-belts, and fluids. All warranty repairs are to be done at GAE’s facility or as otherwise authorized by GAE. All shipping charges for warranty repair or replacement are the purchaser’s responsibility unless otherwise agreed to by GAE.

This warranty supercedes all other warranties, expressed or implied. No warranty is given covering the product for any particular purpose other than as covered by the applicable product specifications. GAE assumes no liability in any event for incidental or consequential damages, financial losses, penalties or other losses incurred in conjunction with the use of GAE products.

## DOCUMENT CONVENTIONS



**NOTE:** Means the reader should take note. Notes contain helpful information, suggestions, or references to other sections, chapters, or documents.



**CAUTION:** Means the reader should be careful. You are doing something that might result in equipment damage or loss of data.



**WARNING:** Means danger. A situation exists that could cause bodily injury or death. All personnel must be aware of the hazards involved with high voltage electrical circuitry and high power microwave devices.



## **WARNING**

*All magnetron heads manufactured by GAE, Inc. are capable of producing a microwave field that is potentially hazardous to operating personnel. They must never be connected or operated in a manner that allows a field in excess of 10 milliwatts per square centimeter to be generated in an area accessible to operating personnel. Contact GAE, Inc. for technical support prior to installation and/or operation of these units if there is any question or concern about microwave leakage.*

*All waveguide flange and electrical cable connections throughout the system must be secure prior to operation. Never operate the microwave generator without a properly rated absorbing load attached. To ensure safe operation and prevent microwave leakage, the equipment must be periodically inspected and maintained as required or recommended.*

## TABLE OF CONTENTS

---

<b>EQUIPMENT DESCRIPTION .....</b>	<b>5</b>
General Specifications	5
Mating Connectors (supplied with GA4004)	6
<b>INSTALLATION .....</b>	<b>9</b>
Preliminary Inspection	9
Waveguide Configuration	9
Flange Connections	9
Flange Alignment Pins	10
Water Flow Requirements	10
Water Fitting Connections	10
Power Supply Connections	11
Chassis Ground Connection	12
<b>MAINTENANCE AND CALIBRATION .....</b>	<b>14</b>
Magnetron Removal and Replacement	14
Reflected Power Interface Calibration	15

## EQUIPMENT DESCRIPTION

The GA4004 Magnetron Head is specially designed for use with the GA4107 Switch Mode Power Supply. Together with the line power and control cable set provided with the GA4107, these units make a completely integrated microwave power generation system ideal for laboratory or industrial system applications. The compact design of the GA4004 make it suitable for applications where available space is limited.

Serviceability of the GA4004 was a primary consideration in its design. Removal and replacement of the internal magnetron can be done using standard tools. The GA4004 is designed to use a customized version of the standard YJ1600 water-cooled magnetron. Inside the GA4004 enclosure are the magnetron filament transformer, cooling fans and optional circuitry for detection of reflected microwave power.

A stainless steel enclosure provides rugged durability while multiple safety interlocks meet compliance requirements. Convenient mounting holes facilitate bench-top use or integration into process systems. The simplicity of the GA4004 also facilitates integration with other switch mode magnetron power supplies. Optional features include alternate flange configurations and arc detection.

Model GA4004QD features the popular Q-D (quick-disconnect) style waveguide flange that uses a convenient quick-release clamp (GAE model GA8401) for waveguide connections.

### General Specifications

Output Power (max)	6 kW
Magnetron	Modified YJ1600 (GAE # 911647)
Anode Voltage	-7.2 kVDC
Filament Voltage Supply	Controlled 230 VAC
Output Waveguide	WR340
Output Flange	GA4004: UG584/U GA4004QD: Quick-disconnect round
Frequency	2450 MHz +/- 30 MHz
Cooling	Water: 1.0 gpm nominal (0.5 gpm min.) flow @ 35 °C max. inlet temp (dew point min. inlet temp), 70 psi max. inlet pressure Air: Provided by internal fans
Interlocks	Waveguide flange, Access cover, Magnetron over-temperature

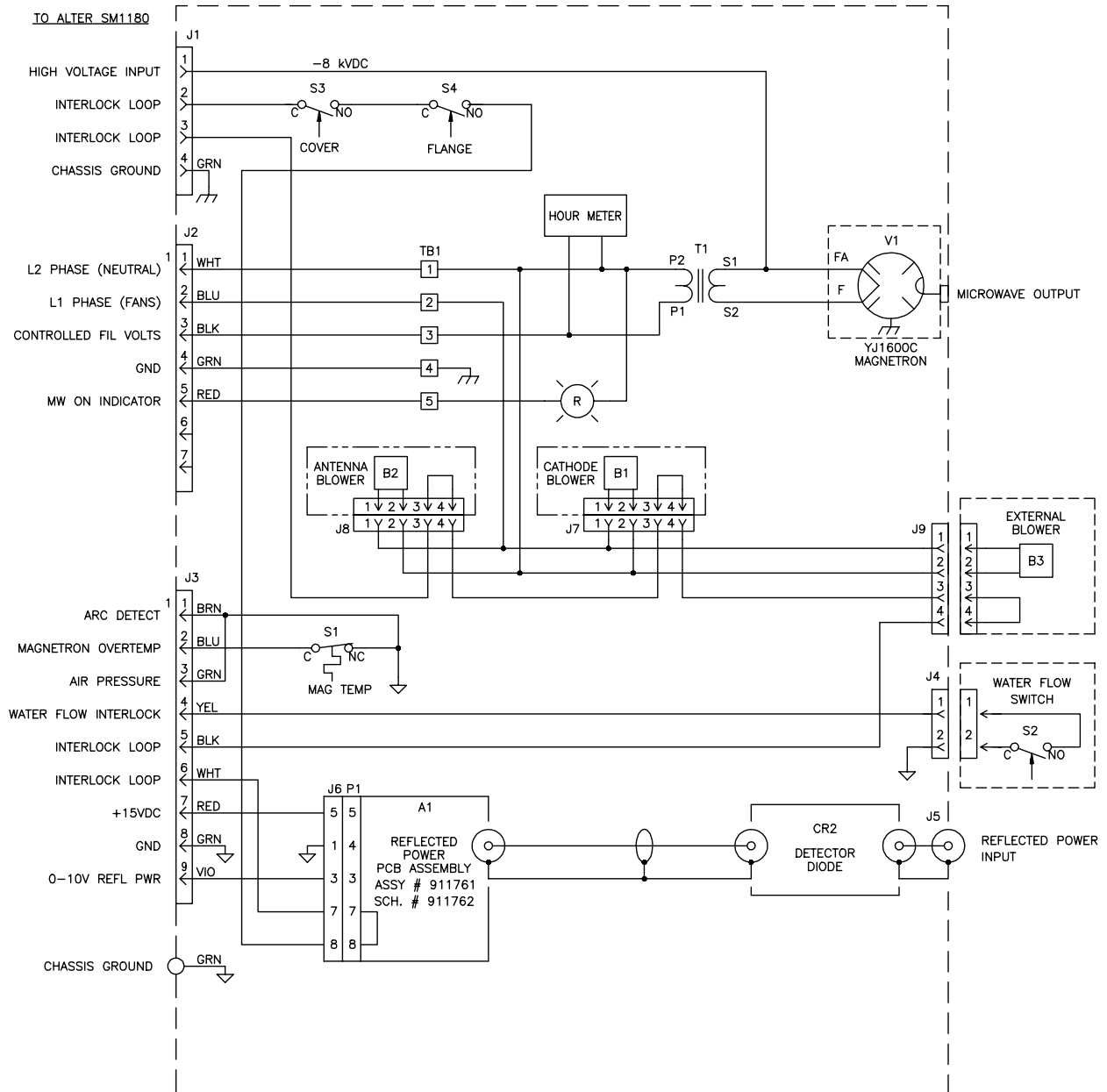
---

Model GA4004 – 6kW Magnetron Head

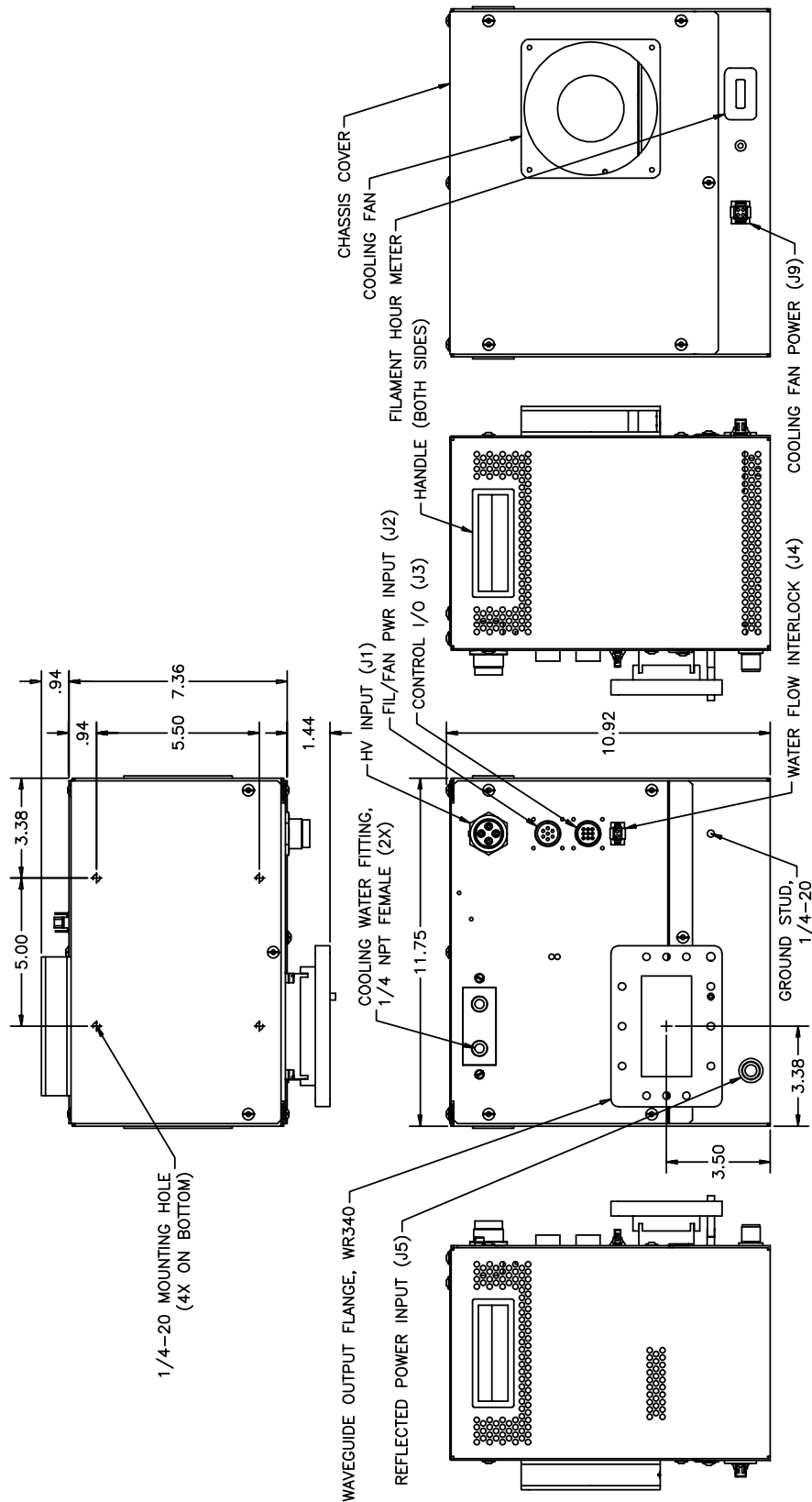
**Mating Connectors (supplied with GA4004)**

High Voltage	4-conductor “LGH” Series AMP # 863022-1
Fan & Filament Power	7-conductor “CPC” series Shell: AMP # 211399-1 Contact: AMP # 66360-4
Control I/O	9-conductor “CPC” series Shell: AMP # 211766-1 Contact: AMP # 66360-4
Water Flow Interlock	2-pin female “MR” style Shell: AMP # 1-640507-0 Contact: AMP # 640545-2
Reflected Power Input	Type N female

**Schematic Diagram**



Outline Drawing





## INSTALLATION

### **Preliminary Inspection**

Upon arrival at the installation site the GA4004 magnetron head should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the packaging material or the magnetron head itself should be noted and reported immediately to the shipping company in accordance with standard claims procedures. The following components are included:

- a) GA4004 Magnetron Head
- b) Mating connector set
- c) Product User Manual (this document)

### **Waveguide Configuration**

The GA4004 magnetron head can be connected to and used with any common waveguide component having a compatible flange (see below). Mounting can be in any convenient position and orientation. Ideally, the magnetron head should be connected directly to an isolator (or 3-port circulator and dummy load) to ensure adequate protection of the magnetron from reverse power. Figure 1 illustrates a typical waveguide configuration.

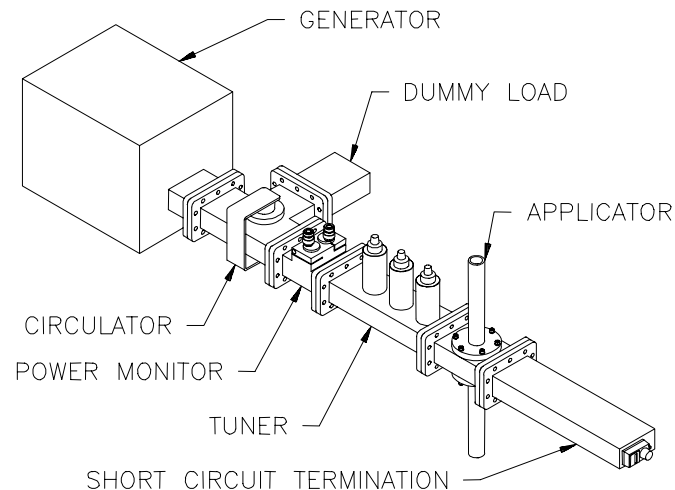


Figure 1, Typical waveguide configuration for process heating.

### **Flange Connections**

The waveguide flange of the magnetron head must be properly connected to another waveguide component or series of components that provide an adequate load for the microwave power being generated. Bolts and nuts must be installed at all flange bolt holes prior to operation.

---

Model GA4004 – 6kW Magnetron Head

Model GA4004QD is configured with a flange designed for used with the GA8401 Quick-Release clamp when connected to another similarly designed flange.

**Flange Alignment Pins**

Each waveguide flange connection that uses a quick-release clamp requires two alignment pins for proper alignment of the adjacent waveguide sections. All GAE waveguide components include one alignment pin for each flange designed for use with quick-release clamps. Alignment pins can be installed into either of two threaded holes centered above and below the waveguide broadwalls. For obvious reasons, the pins must not be installed such that they are opposite each other on mating flanges.



**Microwave Leakage** – Regulatory limits for microwave leakage relate to standards for human safety and interference with other electronic devices. Standards for human safety as adopted by OSHA, the International Electrotechnical Commission (IEC) and other regulatory agencies limit leakage to 5 mW/cm<sup>2</sup> measured at 5 cm from the leakage source under normal operating conditions, and 10 mW/cm<sup>2</sup> at 5 cm from the source under abnormal operating conditions. The U.S. Federal Communications Commission (FCC) has established regulations limiting the emission of energy at frequencies outside the ISM bands. All GAE waveguide components meets these requirements when properly connected to another waveguide component.

**Water Flow Requirements**

A source of water must be connected to the GA4004 that provides an adequate rate of flow. The nominal water flow rate is 1.0 gpm. However, the flow rate must be maintained such that the outlet water temperature does not exceed 150 °F. The minimum allowable flow rate depends on the level of incident microwave power and the inlet water temperature.



**CAUTION:** *The minimum inlet temperature of the cooling water must be above the ambient dew point temperature. Allowing the cooling water inlet temperature to drop below the ambient dew point can allow moisture condensation inside the microwave generator and/or waveguide circulator and cause equipment damage.*

**Water Fitting Connections**

Standard 1/4 NPT female fittings are provided at the front of the GA4004 enclosure. The source of water can be connected to either fitting. It is recommended that a thread sealant such as Teflon pipe

---

Model GA4004 – 6kW Magnetron Head

thread tape be used to ensure a leak-free connection. Care should be taken to prevent debris from falling into the fitting holes.

Since there may be other waveguide components in the system that require cooling water, it may be possible to run all of the water cooling connections in series. In this case, it is recommended that the magnetron head be connected last in the series. Caution should also be exercised to ensure that the resulting water flow rate is adequate for all components.

### **Power Supply Connections**

All electrical power required for operation of the magnetron head is provided by the model GA4107 power supply. All cable connections are located at one side of the magnetron head. The following describes the basic purpose of each cable required for operation.

#### J1 – High Voltage

Pin 1 – -8 kVDC

This voltage is delivered to the magnetron cathode.

Pins 2 and 4 – Interlock Loop

These two pins must be connected together externally for the interlock loop to be closed.

Pin 4 – Chassis ground

#### J2 – Filament and Fan Power

Pin 1 – L2 input for filament and fan power (230 VAC)

This signal is the L2 phase of the power line supplying power to the filament and fan.

Pin 2 – L1 input for fan power (230 VAC)

This signal is the *uncontrolled* L1 phase of the power line and supplies power to the fan.

Pin 3 – Controlled filament power (controlled 230 VAC)

This signal is the *controlled* L1 phase of the power line and supplies voltage to the filament transformer primary.

Pin 4 – Chassis ground

Pin 5 – “Microwave On” indicator (230 VAC)

This signal is on when high voltage is being delivered.

Pins 6 and 7 – No connection

#### J3 – Control Signal Input/Output

Pin 1 – Arc detect interlock (ground)

This function is unused and the pin is permanently connected to ground, except when the arc detect option is installed.

Model GA4004 – 6kW Magnetron Head

Pin 2 – Microwave over-temperature (ground)

This pin is connected to ground through the magnetron thermal switch that senses magnetron temperature. The thermal switch is Normally Closed and opens upon sensing a magnetron overtemp condition.

Pin 3 – Air pressure interlock (ground)

This function is unused and the pin is permanently connected to ground.

Pin 4 – Water flow interlock (ground)

This pin is connected to ground through connector J4 (see below) which is connected to an external water flow switch. The flow switch is Normally Open and closes when the water flow rate exceeds the minimum required for magnetron cooling.

Pins 5 and 6 – Interlock Loop

These two pins are connected together internally through several devices having dry contacts that ensure proper connection and/or operation.

Pin 7 – +15 VDC Power Supply

This voltage supplies power to the reflected power interface circuit.

Pin 8 – Chassis ground

Pin 9 – Reflected power signal (0-10 VDC)

This signal is proportional to the microwave input power signal connected to J5 (see below).

J4 – Water flow interlock switch

Pins 1 and 2 – Water flow interlock switch

These pins are connected together through an external water flow switch. The flow switch function should be Normally Open and must be closed only when the water flow rate exceeds the minimum required for magnetron cooling.

J5 – Reflected power input (optional)

This connector receives a low level microwave signal from a waveguide directional coupler or other similar detector that is proportional to reflected power in the waveguide. The maximum allowable input signal level is 100 mW.

**Chassis Ground Connection**

The chassis of GA4004 magnetron head must be connected directly to the chassis of the magnetron power supply. Connection to the magnetron head chassis is at the ground stud located at the

front near the electrical connectors. The recommended wire is 12 AWG, UL1007 (or equivalent) with green or green/yellow insulation.



**WARNING:** Failure to provide an adequate ground connection between the magnetron head and power supply chassis can expose the operator to high voltage and result in severe injury or death.

## **MAINTENANCE AND CALIBRATION**

---

The GA4004 magnetron head is designed to be maintenance free with the exception of magnetron replacement. The magnetron is considered a consumable component and has a life expectancy of 3000 to 5000 hours depending on operating conditions and usage. No calibration is necessary.

Although the GA4004 magnetron head is a very rugged and stable device, it can be subject to damage due to improper operating conditions or mishandling. If damage occurs, the magnetron head should be returned to GAE for repair. Contact GAE for information on repair services.

### ***Magnetron Removal and Replacement***

1. Turn off the microwave power supply and disconnect line power.
2. Disconnect the source of cooling water, both supply and drain.
3. Disconnect the fan power cord from connector J9 located on the chassis rear panel.
4. Remove the eight cover screws and remove the CHASSIS COVER.
5. Loosen the four captive screws that secure the CATHODE BLOWER to the MAGNETRON. Lift up the blower/duct assembly and disconnect the power cord from the blower.
6. Disconnect the two filament transformer secondary leads and high voltage lead from the magnetron filament leads that are supported by the FILAMENT LEAD SUPPORT BLOCK.
7. Loosen the two panel screws that secure the COOLING WATER CONNECTION BLOCK to the chassis front panel.
8. Remove the five screws securing the FRONT PANEL to the chassis. Carefully pull the top edge of front panel slightly away from the chassis until the panel is resting at an angle approximately as shown.
9. Carefully lay the magnetron on one side. While supporting the magnetron with one hand, insert a 7/32" Allen key through the holes in the chassis bottom and loosen the four CAPTIVE NUTS that secure the MAGNETRON to the waveguide launch section.
10. After loosening all CAPTIVE NUTS, carefully pull the MAGNETRON away from the launch section.

11. Remove the fasteners that secure the FILAMENT LEAD SUPPORT BLOCK to the magnetron and remove the block.
12. Loosen the tube compression fittings that connect the WATER FITTING CONNECTION BLOCK to the MAGNETRON and remove the connection block.
13. Reassemble in the reverse order of disassembly.

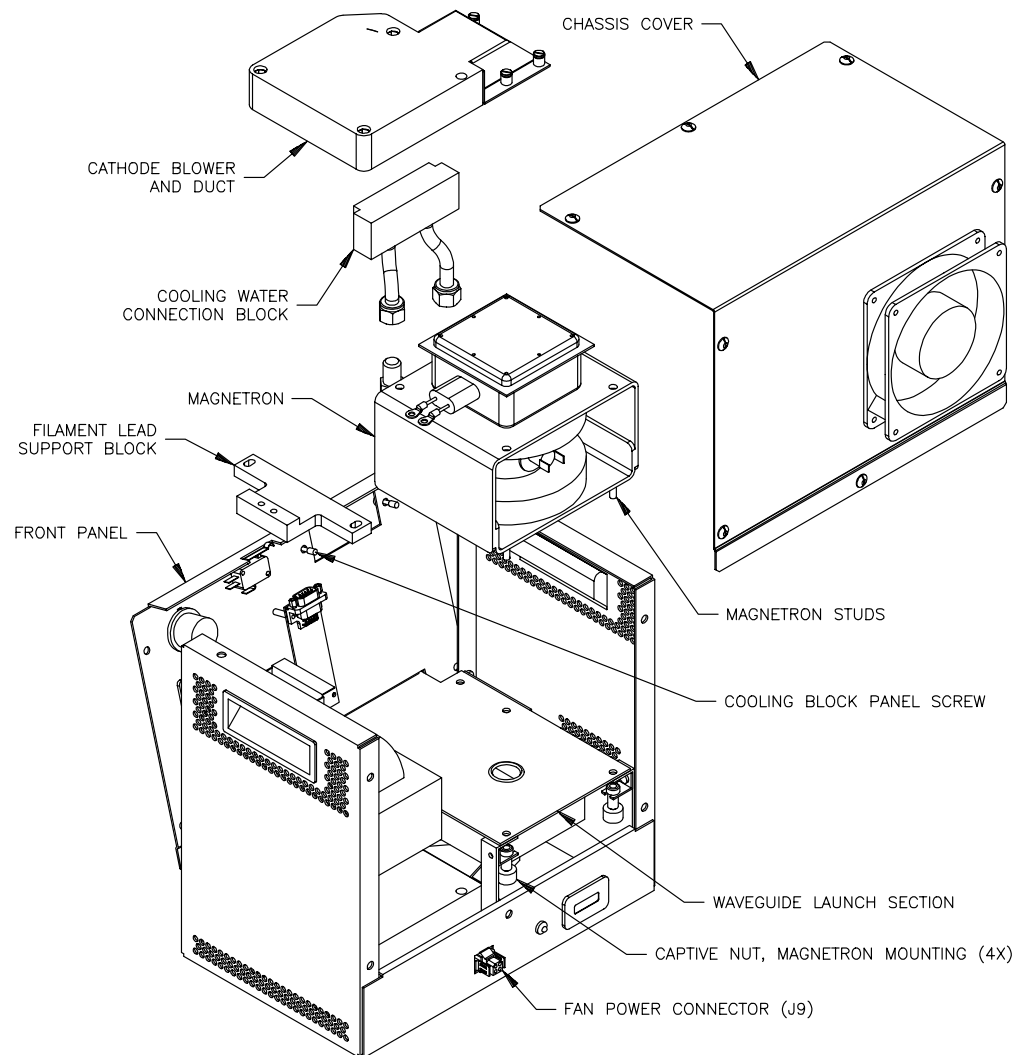


Figure 2, Exploded view for magnetron removal and replacement.

### **Reflected Power Interface Calibration**

The GA4004 magnetron head features an optional reflected power signal interface that consists of a detector diode and signal conditioning circuit. With this interface, the microwave signal from an external waveguide power coupling device is converted to an

---

Model GA4004 – 6kW Magnetron Head

analog 0-10 VDC signal that is proportional to waveguide power. The interface is factory calibrated for a coupling factor of 50 dB.

The interface is designed to be maintenance free and does not require any user maintenance under normal operating conditions. However, calibration may be necessary after a period of time. A calibration period of one year is recommended.

Damage may occur in the event the input signal is allowed to exceed the maximum rating of the detector diode (100mW). In this case, the detector diode may be replaced by the user and the interface recalibrated according to the following procedure. Replacement detectors are available from GAE by ordering part number 040101.

**Required Equipment:**

- Waveguide coupler, WR340 (two couplers required)
- Waveguide dummy load with high return loss rated for 6kW
- HP model 437B power meter with 8481A sensor (or equiv.)
- Digital multimeter (DMM)
- Trimmer potentiometer (“trimpot”) adjustment tool
- Coaxial cable with appropriate style connectors (typically type N male both ends) for connecting the waveguide coupler port to J5 on the GA4004.

**Procedure**

1. Connect the DMM to pins 8 (-) and 9 (+) of connector J3 on the GA4004 front panel.
2. Connect the two waveguide couplers in series to the waveguide output flange of the GA4004. Connect the dummy load to the second coupler.
3. Turn on the microwave generator and allow at least 2 minutes of warm-up time for the output signal to stabilize.
4. Attach the HP power meter sensor to the output port of one of the waveguide couplers. Using the coaxial cable connect the probe output of the second coupler to J5 on the GA4004.
5. Enable microwave power and adjust the microwave generator output power until the reading on the HP meter is 100% of the desired full scale range for input to the interface.



**NOTE:** *Remember to consider the coupling factors of both waveguide couplers when adjusting the microwave power level.*



## Model GA4004 – 6kW Magnetron Head

6. While monitoring the analog output voltage signal with the DMM, adjust trimpot R4 (through small hole in front panel towards bottom) until the output signal is 10.0 +/- 0.1 VDC.
7. While monitoring the HP power meter, adjust the microwave power level such that the input signal to the interface is 20% of the desired full scale range.
8. While monitoring the interface output voltage signal with the DMM, use the trimpot adjustment tool to adjust trimpot R5 (through small hole in front panel towards the top) until the output signal is 2.0 +/- 0.1 VDC.
9. Repeat steps previous three steps until the desired output signal accuracy is attained.
10. Adjust the microwave generator output power until the input signal to the interface is 10% of the desired full scale range. Verify that the output voltage is within the desired accuracy for the desired full scale range. Repeat for incremental power levels of 10% up to full scale.
11. If necessary to meet the desired accuracy, repeat the previous four steps while making small offsetting adjustments to trimpot R5.
12. Turn off microwave power and remove line power from the microwave generator.

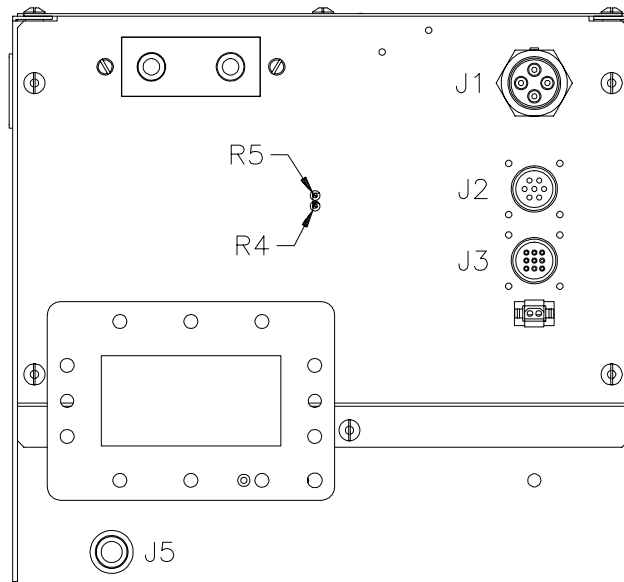


Figure 3, Front panel of GA4004 magnetron head.