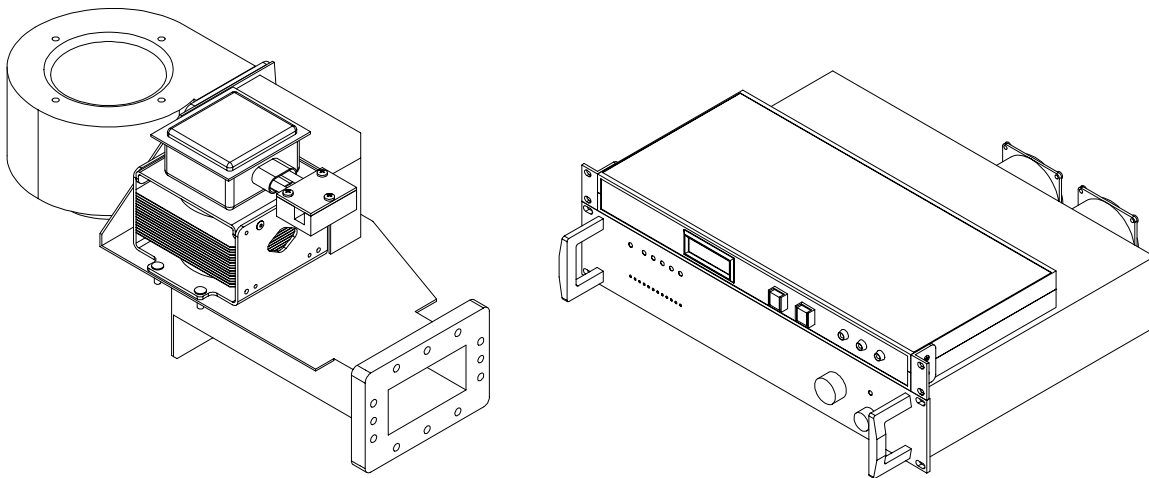

Product User Manual



2 kW Microwave Generator, WR340 (Ceralink)



Document # 930052, Rev. 2



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REVISION HISTORY			
REV.	DESCRIPTION	DATE	APPROVAL
1	PROTOTYPE RELEASE	05MAR04	JFG
2	UPDATES TO REMOTE CONTROL	01MAY04	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 microwave generators 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.

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ATTACHMENTS

<u>Doc Number</u>	<u>Description</u>
911531	Schematic Diagram, 2kW Mw Generator

EQUIPMENT DESCRIPTION

The 2kW Microwave Generator described in this manual was configured as a customized product specifically for Ceralink, Inc. It consists of three separate modules described as follows:

- a) *Magnetron Launch Assembly*, manufactured by Alter Systems (Italy) using a Hitachi 2M130 type magnetron designed to deliver nominally 2 kW microwave power. Included in the assembly is a filament transformer, cooling blower, WR340 output waveguide, and cables for connecting to the high voltage power supply.
- b) *High Voltage Power Supply*, Alter Systems model SM745 designed to operate the Hitachi 2M130 magnetron and its associated filament transformer.
- c) *Control Module*, custom designed and manufactured by GAE for interfacing with and operating the above components. The control module provides the local start/stop control functionality for microwave power as well as an indication of operating status and magnetron anode current.

The power supply and control modules are designed for installation in a standard 19" rack cabinet while the launch assembly can be located at the process applicator (furnace) at a distance of up to 10 feet from the rack cabinet. Cables are provided for connection between the modules as well as line power to the power supply.

Also included with the system are connections for remote control of microwave start/stop functions and output power level. Connections are also provided for external customer-provided interlock devices such as the furnace access door switch, cooling water flow and other safety devices.

General Specifications

Output Power (max)	2 kilowatts average continuous
Frequency	2450 MHz +/- 30 MHz
Magnetron	Hitachi 2M130
Output Waveguide	WR340 (RG113/U)
Output Flange	CPR340 (UG554/U)
Cooling	Forced air by internal fans
Input Line Power	180-265 VAC, 50/60 Hz, single-phase, 23 Amps max. (18 Amps at 230 VAC)
Local Controls	Microwave Start switch (pushbutton) Microwave Stop switch (pushbutton) System Ready indicator (neon lamp) Microwave On indicator (neon lamp)

2kW Microwave Generator, WR340 (Ceralink)

	Fault indicator (neon lamp)
	Anode Current meter (LED digital)
Remote Controls	Microwave Start
	Microwave Stop
	Microwave Power Adjust
	External Interlock
Interlocks	Magnetron over-temperature; External

Components Supplied

<u>Item Description</u>	<u>GAE Part Number</u>
Magnetron Launch Assembly	911533
High Voltage Power Supply	000303 (Alter SM745)
Control Module	911532
Product User Manual	930052 (this document)

INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the system components should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the packaging material or the equipment itself should be noted and reported immediately to the shipping company in accordance with standard claims procedures.

Power Supply and Control Module Installation

The power supply and control modules are designed for use in a clean, dry environment such as a laboratory or cleanroom. Installation can be either on a bench top or in a standard 19" rack enclosure. If installed in a rack then both modules should be supported underneath and not cantilevered off the front panel mounting rails. Adequate clearance must be provided at the rear and sides of the power supply to allow ventilation air to flow freely.

Launch Assembly Installation

The waveguide launch assembly can be connected to and used in any convenient orientation (horizontal or vertical) with any common waveguide component having a compatible flange (see below). Ideally, the launch assembly 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.

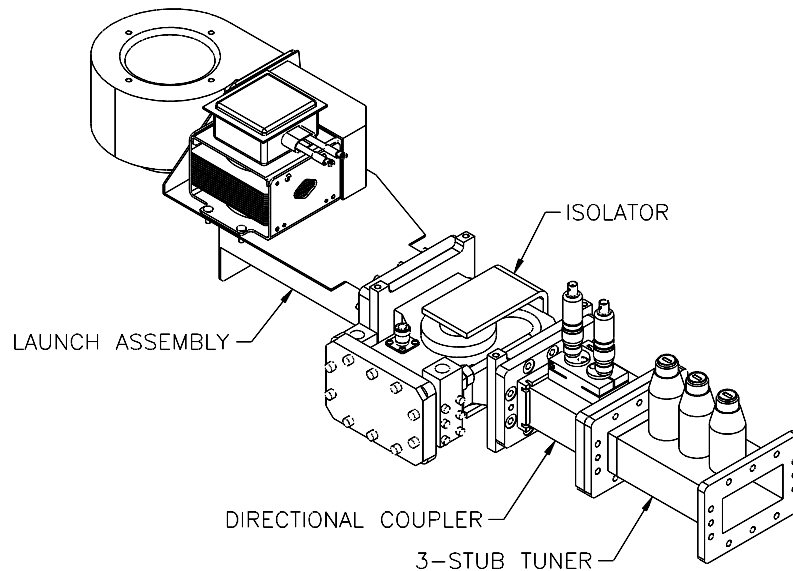


Figure 1. Typical waveguide configuration for process heating.

The launch assembly must be installed inside a protective enclosure to isolate personnel from the exposed high voltage electrical connections. Alternately, covers can be installed over the electrical connection areas such that they cannot be removed without the use of tools. As an added safety measure, cover interlock switches should be utilized to shut off electrical power in the event of cover removal.



WARNING: Failure to provide adequate protection from high voltage electrical connections can expose the operator to high voltage and result in severe injury or death.

Flange Connections

The waveguide flanges 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.



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/cm² measured at 5 cm from the leakage source under normal operating conditions, and 10 mW/cm² 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.

Interconnect Cables

All electrical power required for operation of the magnetron launch assembly and control module is provided by the power supply through a cable harness delivered with the system. Table 1 below lists the cable interconnections between the power supply, control module and launch assembly.

Part Number	Function	Mating Connectors		
		Power Supply	Control Module	Launch Assy
911524-03	Filament/Line Power	J1	J1	-
911525-03	Control I/O	J2	J2	-
n/a	High Voltage	J3	-	V1-FA
911363-10	Chassis Ground	Ground	-	Ground

Line Power Connection

All connections for line power are made to the 3-conductor cable which connects to J1 on the power supply rear panel. Schematic drawing 911531 (see attachments) illustrates the electrical connections. The functions and electrical specifications of each connection are detailed as follows.

Pin 4 – *Chassis Ground (GND)*

Pin 6 – *Line Power Input, Hot Phase (L1)*, connection for one phase of nominal 230 VAC. When using “Delta-connected” line power, either phase can be connected to this pin. When using “Wye-connected” line power, the *hot* phase must be connected to this pin.

Pin 7 – *Line Power Input, Neutral Phase (L2)*, connection for one phase of nominal 230 VAC. When using “Delta-connected” line power, either phase can be connected to this pin. When using “Wye-connected” line power, the *neutral* phase must be connected to this pin.



CAUTION: *The user must provide an external line power circuit protection device such as a fused disconnect or circuit breaker rated no more than 25A. The line power connection wire must be rated no less than the rating of the circuit protection device. Failure to provide proper circuit protection may result in permanent damage to the system.*

Chassis Ground Connection

The launch assembly waveguide must be electrically grounded directly to the chassis of the power supply. The ground connection to the launch assembly may be anywhere on the waveguide, although preferably near the magnetron. Connection to the power supply chassis is at the ground stud located on the rear panel. The recommended wire is 12 AWG, UL 1007 (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.*

Remote Control Connections

All connections for remote control of the microwave generator are made to terminal block TB1 located on the launch assembly. Figure 2 below is a diagram of a recommended electrical circuit configuration. While other configurations are possible, the following interface requirements must be met for safe and reliable operation.

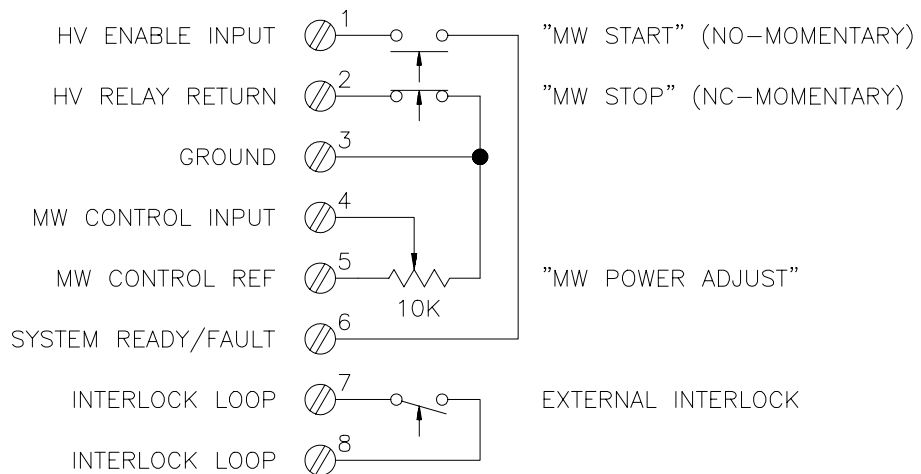


Figure 2. Recommended electrical circuit for remote control.

Pin 1 – HV Enable Input (+24 VDC)

Connecting pin 8 to +24 VDC will enable the magnetron power supply to deliver high voltage to the magnetron head. Microwave power will then be generated according to the setting of the microwave power control potentiometer(s). The recommended device for making this connection is a momentary, normally open dry contact switch or relay. After releasing the switch, this pin will remain at +24 VDC while the system is generating microwave power (“operate” mode) or when a “Fault” condition exists (see pin 6 below).



WARNING: *Serious injury and/or death can result from the use of a non-momentary switching device for enabling high voltage and microwave power. The use of a latching device can allow high voltage to be enabled inadvertently and unknowingly, such as can happen upon resetting an interlock device. It is strongly recommended that a momentary switching device be used for the high voltage enable function.*

Pin 2 – HV Relay Return (Ground)

This pin is provided as a means to connect a momentary, normally closed dry contact “Microwave Stop” switch or relay. This pin must be connected to ground for generation of microwave power, and microwave power will cease to be generated if the connection is opened during operation.

Pin 3 – Chassis Ground



NOTE: *Connection between pins 2 and 3 is required for operation of the microwave generator even if remote control will not*

be used. A jumper wire is factory-installed at this location on the terminal block.

Pin 4 – Microwave Control Voltage Input (0-10 VDC)

The level of microwave power delivered from the magnetron is controlled by varying the voltage present at this pin from 0 to +10 VDC. The use of a precision multi-turn, 10K Ohm potentiometer rated for ½ Watt is recommended for high control resolution and stability. The voltage provided at Pin 5 (see above) may be used as a reference, or a separate voltage source referenced to the same ground point can also be used.



NOTE: Automatic adjustment of microwave power output can be accomplished by delivering an analog voltage signal to pin 4 from a process controller such as a PLC (programmable logic controller) or DAC (data acquisition and control) system. This voltage should be in the 0-10 VDC range and referenced to ground at pin 3.

Pin 5 – Microwave Control Voltage Reference (+10 VDC)

This is a DC voltage generated by the magnetron power supply for use by a remote power control potentiometer for the control input voltage (see Pin 4 above). The maximum allowable current draw from this source is 10 mA. Because of this current limitation, and for maximum operational stability, this voltage should not be used for any other purpose.

Pin 6 – System Ready/Fault

+24 VDC will be present at this pin when the system is either ready to start microwave power (“standby” mode) or currently generating microwave power (“operate” mode). A “Fault” condition exists if the voltage drops to approximately +12 VDC while the voltage present at pin 1 is +24 VDC.

Pins 7 and 8 – Interlock Loop (Ground)

These two pins are part of the interlock chain and must be connected together to satisfy the interlock requirements of the power supply. Pin 8 is connected to ground through the magnetron thermal cutout switch.



NOTE: Connection between pins 7 and 8 is required for operation of the microwave generator even if remote control will not be used. A jumper wire is factory-installed at this location on the terminal block.

OPERATION

The power supply itself provides limited local control functionality, thus necessitating additional controls separately. For this reason, the control module provides additional local controls and indicators that allow convenient and safe operation of the microwave generator system. Certain functions are also available via remote control. The following sections explain the individual operational features at each location.

Power Supply Controls and Indicators

Local controls provided on the power supply front panel include a main power on-off switch and a multi-turn dial for adjustment of microwave output power level. No local controls are provided for turning on and off microwave power (see the following sections).

ON-OFF (rotary switch) This switch turns on and off line power to the entire system. When in the ON position the ON indicator (see below) will illuminate if line power is connected to the system.

POWER LEVEL (multi-turn dial)
This knob adjusts the level of microwave output power. Upon enabling high voltage (see below), microwave power will be delivered according to the setting of this dial. The LED bar graph located below the status indicators (see below) provides an indication of the magnetron anode current which is proportional to microwave output power.

The operating status of the system is indicated by the LED indicators located on the front panel of the power supply and control module. The functions of each indicator on the power supply are as follows:

ON (green) Off: Line power is disconnected and/or main switch on front panel is off.

On: Line power within the rated voltage range is connected and main switch is on.

RACK ALARM (red) Off: No alarm condition
On: A fault condition exists caused by a) internal power supply over-temperature, b) error between input control signal and

	output reference, or c) magnetron anode over-current (permanent fault requiring manual reset).
TUBE OVERTEMP (red)	<u>Off:</u> Normal operation <u>On:</u> Fault from either the magnetron thermal switch or external interlock. This is a temporary fault that will be cleared upon resetting the interlock device(s).
ARC DETECTION (red)	<u>Off:</u> Normal operation <u>On:</u> Arc condition has been detected (temporary fault condition). NOTE: This function is not used in the microwave generator system described in this manual.
OVERVOLT (red)	<u>Off:</u> No alarm condition <u>On:</u> Anode voltage exceeded 5kV for more than 500 ms. This is a permanent alarm requiring manual reset before operation can continue (see below).
LEAKAGE (red)	<u>Off:</u> No alarm condition <u>On:</u> Leakage current caused the anode voltage to drop below 2kV for more than 1 ms. System must be reset before operation can continue (see below).
ENABLE (blue)	<u>Off:</u> High voltage is off <u>On:</u> High voltage is on and microwave power is being generated at the level determined by the <i>Analog Reference Input</i> signal.
Bar Graph (amber)	This 12-lamp bar graph indicates magnetron anode current in milliamperes (mA) which is proportional to microwave output power.

Control Module Controls and Indicators

The control module provides the start-stop control functions for microwave power which are not provided locally by the power supply. These controls are momentary pushbutton switches which energize and de-energize latching circuitry inside the control module.

Indicators provided by the control module are described as follows:

READY (green)	<u>Off:</u> The system is off (or line power is not connected) or one or more interlocks
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	is not satisfied. Microwave power can not be started when this indicator is off. <u>On:</u> The system is ready to begin generating microwave power (“standby” mode) or high voltage has been enabled to generate microwave power (“operate” mode).
MW ON (red)	<u>Off:</u> High voltage has not been enabled to generate microwave power. <u>On:</u> High voltage has been enabled to generate microwave power at the output level as determined by the setting of the microwave output power adjust control(s). When the FAULT indicator is also on, a fault has occurred which has caused the system to shut down. The system must be reset before operation can resume.
FAULT (red)	<u>Off:</u> Normal operation <u>On:</u> When the MW ON indicator is also on, a fault has occurred which has caused the system to shut down. The system must be reset before operation can resume (see the Alarm Fault Reset section).
ANODE CURRENT (digital panel meter)	This meter indicates magnetron anode current in milliamperes (mA) which is proportional to microwave output power.

Basic Operation

After connecting line power, the system can be turned on by turning the rotary switch located on the far right side of the power supply front panel. The presence of line power is indicated on the power supply by illumination of the green ON indicator. The magnetron cooling blower will also be operating.

When all of the interlock conditions are satisfied the TUBE OVERTEMP indicator on the power supply will be off and the READY indicator on the control module will be on. The system is now in the “standby” mode of operation.



NOTE: Power is supplied to the magnetron filament whenever the system is in “standby” mode. Since magnetron life is consumed whenever the filament power is on, it is good practice to turn off the

system during extended periods of non-use in order to conserve magnetron life.

Microwave power may now be enabled by pressing the START pushbutton switch on the control module (or by applying the remote control *HV Enable* input signal). This places the system into “operate” mode as indicated by the power supply ENABLE indicator and control module MW ON indicator. The generator will now deliver microwave power at a level according to the setting of the POWER LEVEL dial or the remote microwave control input signal (see next subsection).

Pressing the STOP pushbutton switch on the control module (or remote “Stop” switch) will immediately disable high voltage and turn off microwave power. The system will then return to “standby” mode and ready to be enabled for microwave power again.

Opening any of the external interlock devices will disable high voltage and turn off microwave power. This will cause a system fault as indicated by the power supply TUBE OVERTEMP indicator and control module indicators. Upon closing the external interlock devices the system will return to “standby” mode as indicated by the associated indicators.

Microwave Power Control

The level of microwave output power can be controlled either locally or remotely. Local control is by the multi-turn dial on the power supply front panel and remote control is by the microwave control input signal.

The power supply POWER LEVEL dial is the primary control and will override the settings of the remote power control input signal *except when the POWER LEVEL dial is set to zero*. For example, if the remote analog control input signal is set to 50% power (5 volts) and the magnetron power supply potentiometer is set to zero then microwave output power will be 50%. If the power supply POWER LEVEL dial is then adjusted to 75% then the microwave output power will be 75% regardless of the remote control signal voltage.

Alarm Fault Reset

A permanent fault condition exists whenever the power supply OVERVOLT, LEAKAGE or in some cases the RACK ALARM indicators are on, or if an interlock device opens while in “Operate” mode. This will be indicated when both the MW ON and FAULT indicators are on (see also the description for pin 6 in the Remote Control Connections section). To reset the system, set the POWER LEVEL dial to zero (or, if used, the remote analog control input signal to 0 Volts) and press the MW STOP switch.

MAINTENANCE AND CALIBRATION

The microwave generator system is designed to be maintenance free with the exception of magnetron replacement. The magnetron is considered a consumable component and has a life expectancy that depends on operating conditions and usage. No calibration is necessary.

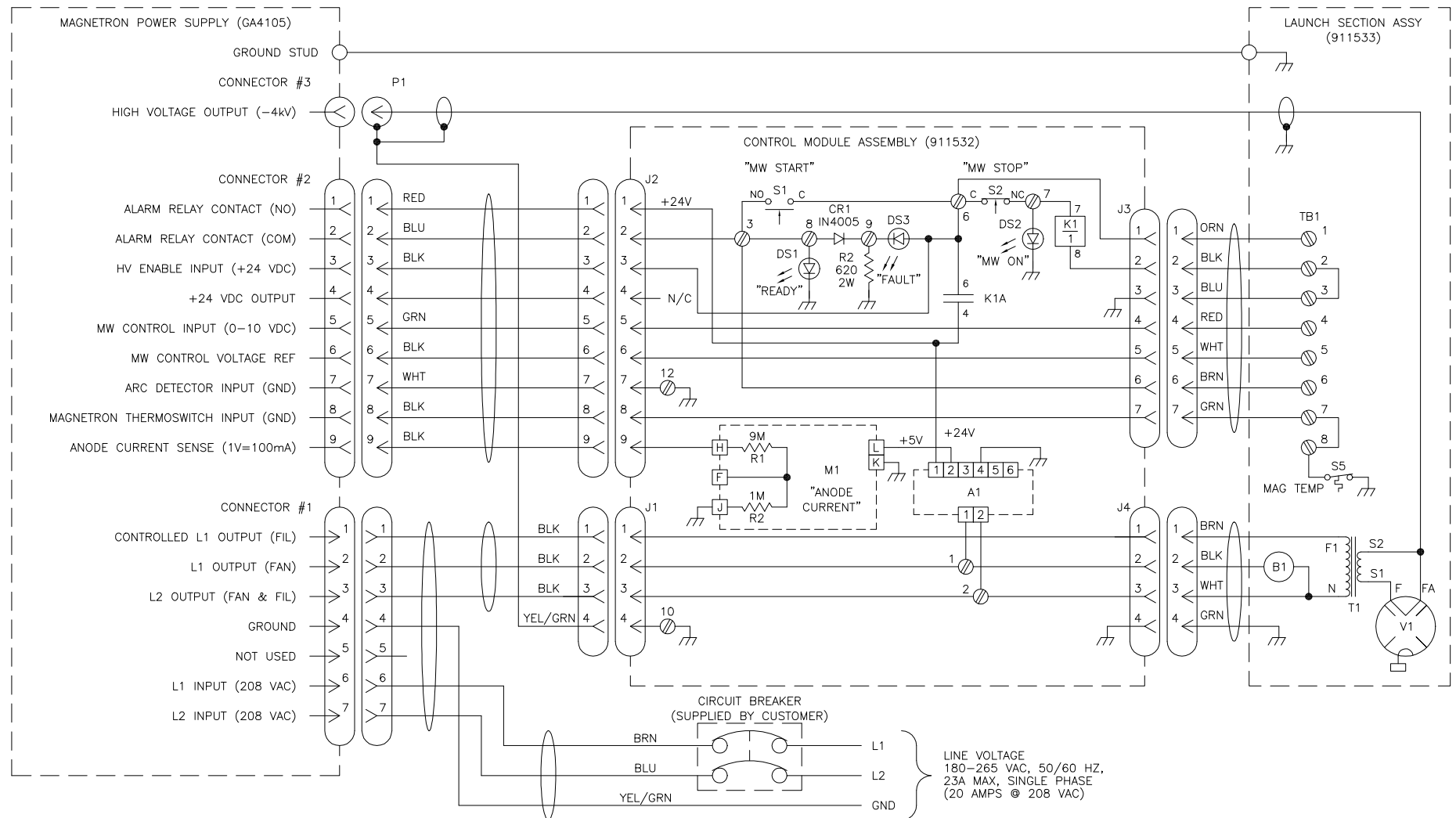
Although the system components are very rugged and stable devices, they can be subject to damage due to improper operating conditions or mishandling. If damage occurs other than to the magnetron itself, the system should be returned to GAE for repair. Contact GAE for information on repair services.

Magnetron Removal and Installation

Removal and replacement of the magnetron can be performed by the user as follows:

1. Turn off the power supply and disconnect all electrical connections from the magnetron launch assembly.
2. Remove the filament lead insulator block and disconnect the wire leads to the magnetron filament terminals and thermal cut-out.
3. Loosen the four locknuts securing the magnetron to the waveguide (two on each side of the magnetron) and carefully lift out the magnetron.
4. Install the new magnetron in the reverse order of removal.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	2	MISC UPDATES	01MAY04	JFG



LINE VOLTAGE
180-265 VAC, 50/60 HZ,
23A MAX, SINGLE PHASE
(20 AMPS @ 208 VAC)

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES (MM) TOLERANCES		CONTRACT NO.	
DECIMALS .XX ±.02	ANGLES ± 1/2 DEG	APPROVAL	DATE
.XXX ±.010		DRAWN JFG	18FEB04
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GAE GERLING APPLIED ENGINEERING, INC. P.O. BOX 580816, MODESTO, CA 95358			
2kW MICROWAVE GENERATOR SCHEMATIC DIAGRAM			
SIZE C	DWG. NO. 911531	REV 2	
SCALE NONE	SHEET 1 OF 1		

DWG. NO. 911531
SHEET 1 OF 2