Product User Manual

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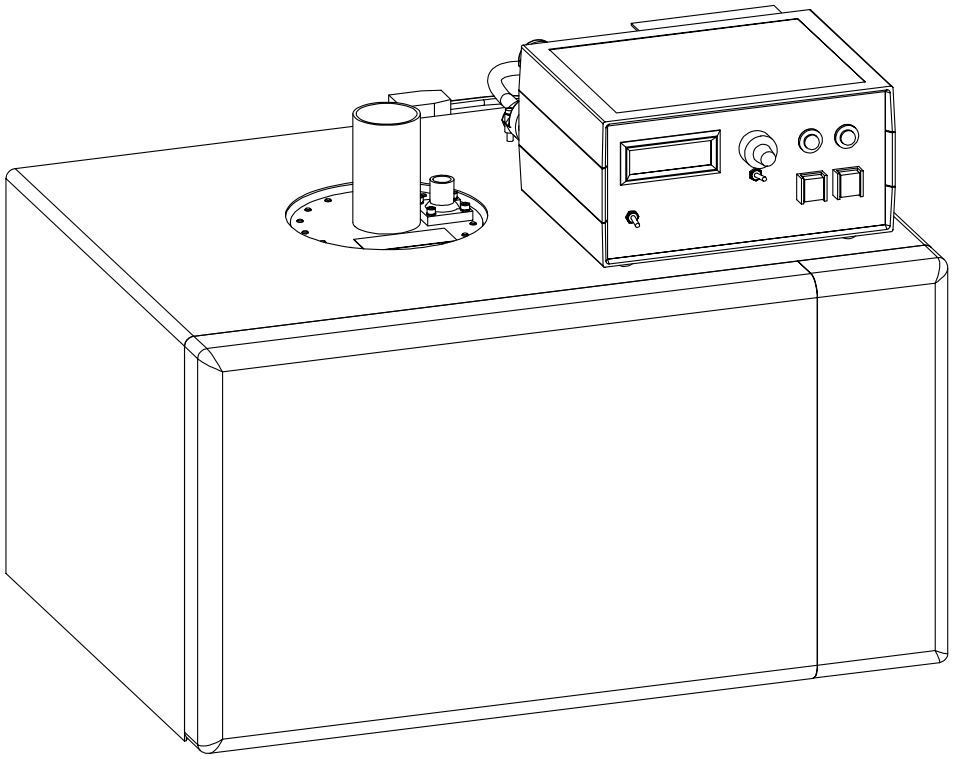
Custom Microwave Oven
Part No. 912315



Document # 930070, Rev. 1

GERLING

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REVISION HISTORY			
REV.	**DESCRIPTION**	**DATE**	**APPROVAL**
1	PROTOTYPE RELEASE	03JAN06	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

The microwave oven described in this manual is capable of producing a microwave field that is potentially hazardous to operating personnel. The unit 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 electrical cable connections must be secure prior to operation. Never operate the microwave oven without a properly rated absorbing load inside the oven cavity. To ensure safe operation and prevent microwave leakage, the equipment must be periodically inspected and maintained as required or recommended.

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EQUIPMENT DESCRIPTION

The microwave oven described in this document was custom designed by GAE, Inc. for Mirari Biosciences, Inc. for use in its process development laboratory. The primary purpose of the custom oven system is to provide a means to remotely control the average microwave power delivered to the oven cavity. The goal is to provide stable delivery of microwave power at variable power levels in a closed loop process control system.

Average microwave power delivered to the oven cavity is controlled by varying the duty cycle on fixed time base. The standard power control time base of a typical commercially available microwave oven is on the order of 20 seconds which is much too long for many laboratory process control applications. The oven defined this specification is modified to shorten the time base to approximately ½ second, thus allowing a small process control time constant and "true" average variable power. Microwave power can also be adjusted remotely via an analog control voltage provided externally. An external interlock device may be connected that will prevent operation whenever the external interlock function is not satisfied.

To facilitate the use of sensors for controlling against a parametric set point, the oven is modified to include a means to mount an infrared sensor and a photomultiplier tube ("PMT").

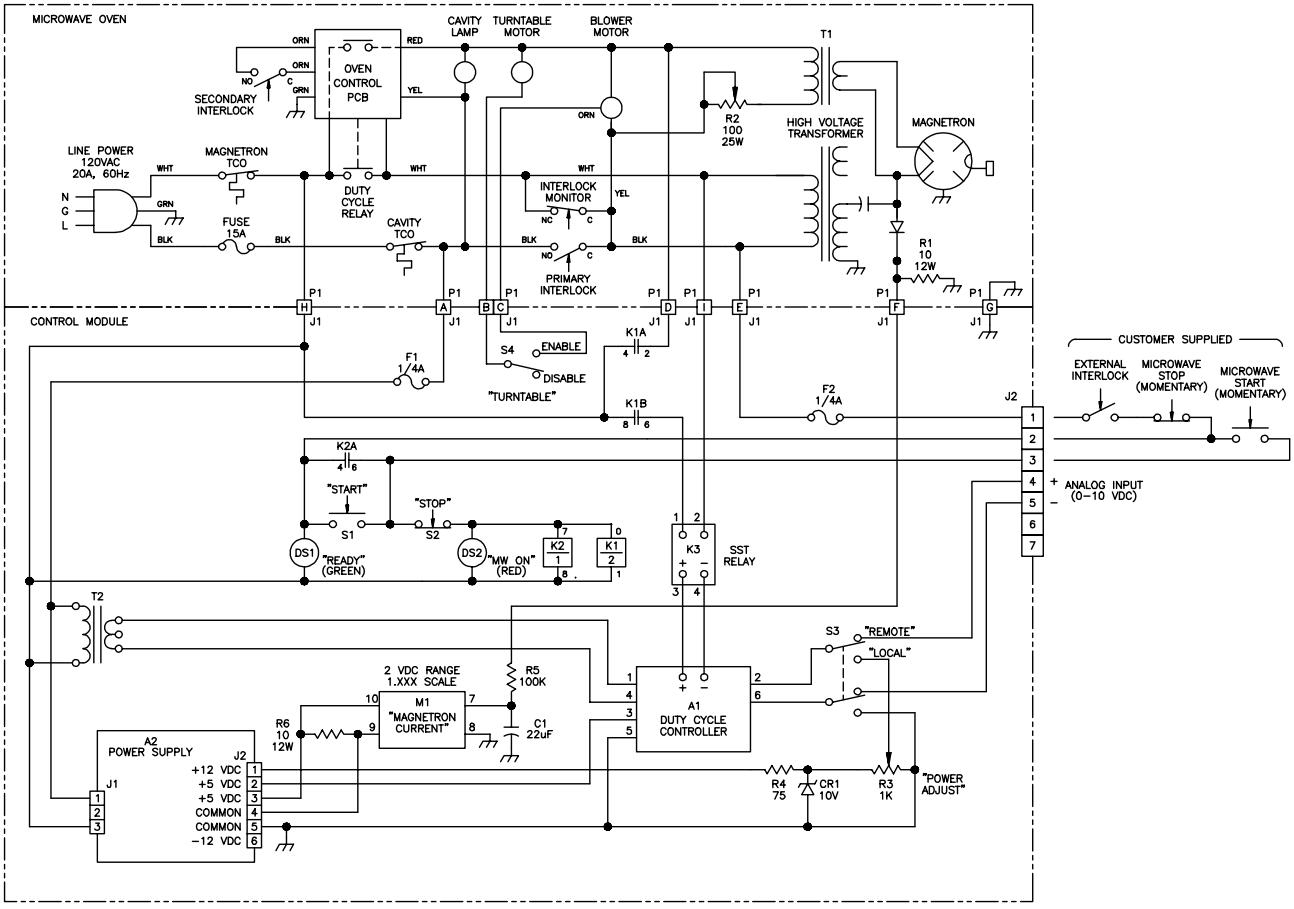
The original controls provided with the microwave oven remain unchanged and can be used separately from the custom controls. All safety related functions of the microwave oven also remain unmodified and fully functional.

General Specifications

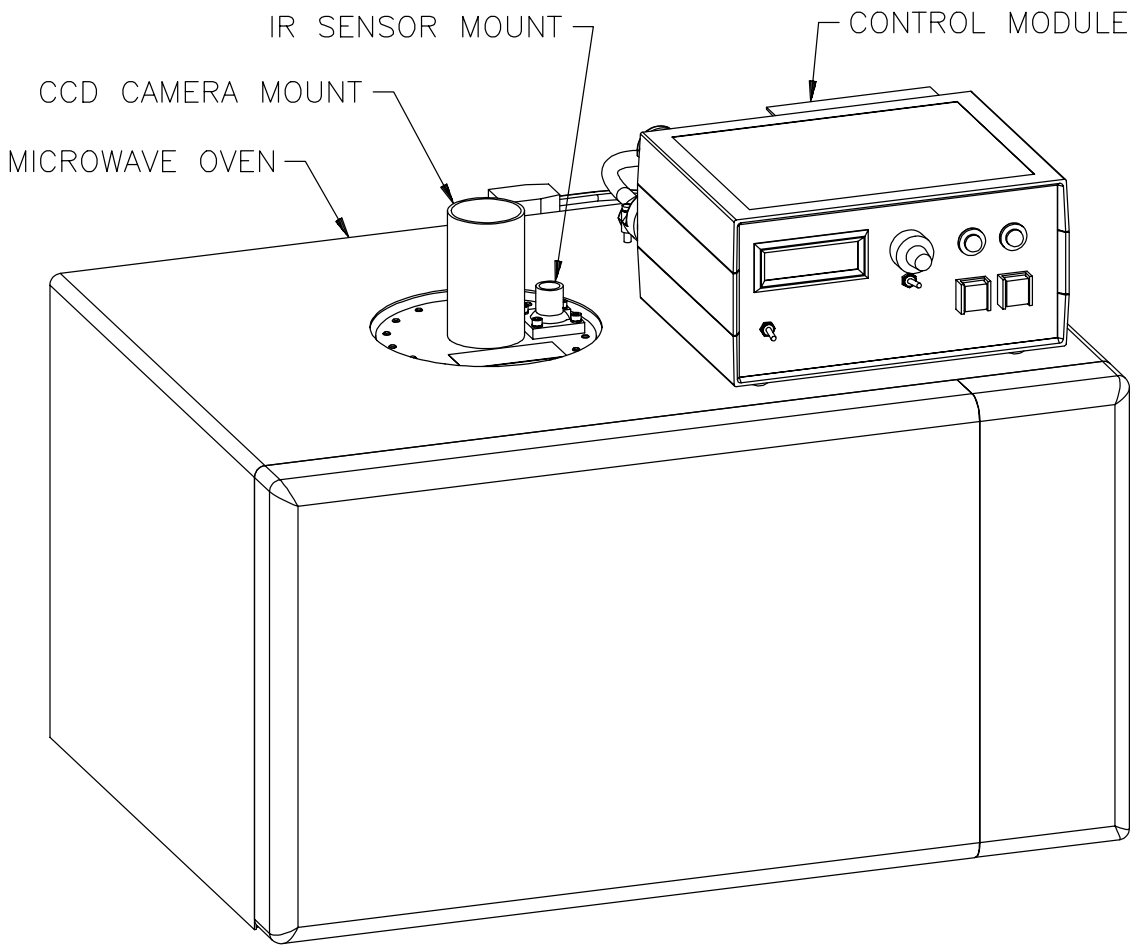
Microwave Oven	GE model JES1246BH
Microwave Power	1000 Watts rated output (per original oven manufacturer's specification)
Power Control	Variable duty cycle from zero to 100% in 4% increments; 417 millisecond time base
Input Power	110-120 VAC, 60 Hz, 15 Amp max.
Turntable	Original oven turntable
Sensor Mounts	(sensors supplied by customer) CCD Camera: Fixed mount centered over turntable for Ikegami model ICD-38 with IK-13VM2812ASW lens IR Sensor: Off-center gimble mount for Raytek model RAYMI-D

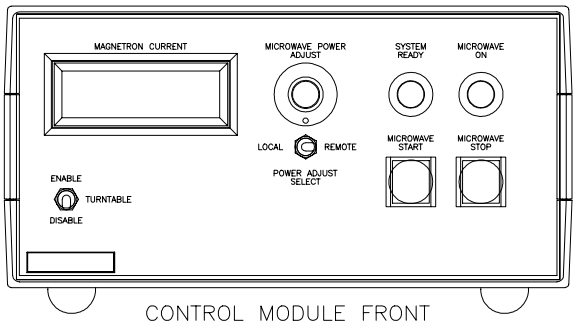
Oven Interlocks	Oven door, Magnetron over-temp (as on original microwave oven)
Remote Interlock	Connections for dry contact switch rated for 120 VAC, 1/4 Amp
Local Controls	Remote/Local Power Adjust (toggle switch) Microwave Start (pushbutton switch) Microwave Stop (pushbutton switch) Turntable enable/disable (toggle switch)
Remote Controls	Input for 0-10 VDC analog signal for average power control Microwave Start (momentary dry switch/relay contact closure) Microwave Stop (momentary dry switch/relay contact opening)

Schematic Diagram

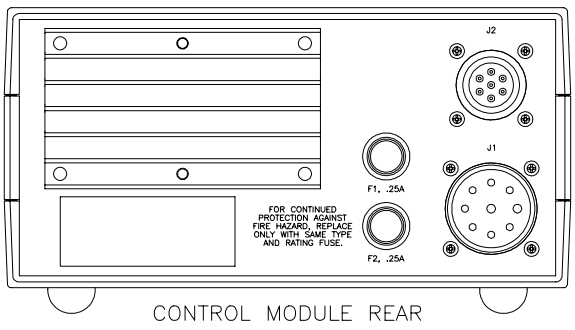


Outline Drawings





CONTROL MODULE FRONT



CONTROL MODULE REAR

INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the custom oven system 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 items are supplied with the system:

1. Customized Microwave Oven, p/n 912354
2. Control Module, p/n 912350
3. Product User Manual (this document)

Mounting Position

The custom oven system is supplied as an integral assembly consisting of the modified microwave oven and control module. It must be mounted upright on a level surface capable of supporting its weight. Sufficient clearance must be provided at the top, sides and rear of the oven to allow adequate ventilation.

Sensor Mount Installation

The microwave oven system is shipped to the customer with the sensor mounts removed to facilitate packaging and protection from damage. Figure 1 illustrates installation of the sensor mount assembly. The IR sensor gimble mount is pre-installed onto the camera sensor mount.

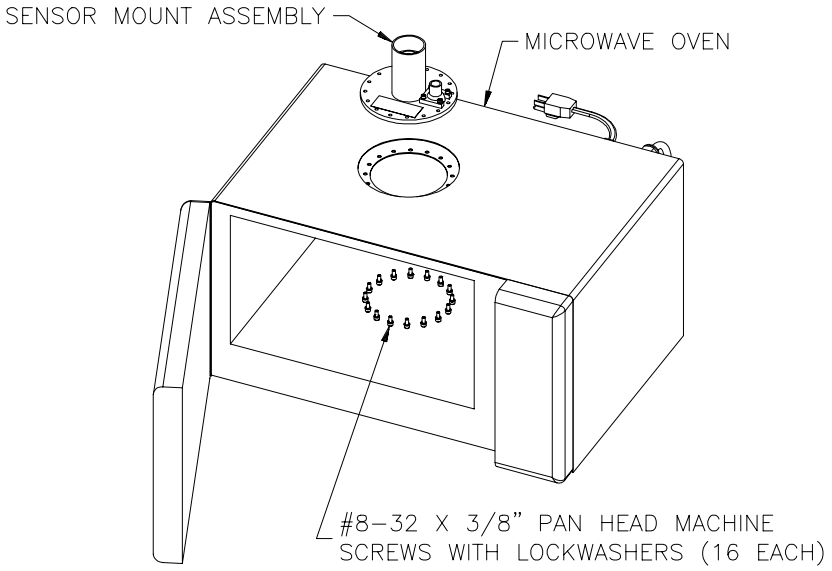


Figure 1, Installation of the sensor mount assembly.

IR Sensor Adjustment

The IR sensor mount is designed to allow adjustment of the sensor aim by rotating the mount in a gimble socket. To adjust the sensor, loosen *but do not remove* the four screws securing the gimble clamp and gently rotate the gimble. Tighten the screws securely to fix the gimble in the desired position.

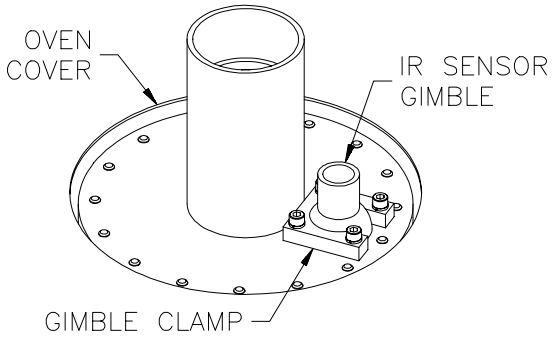


Figure 2, IR sensor gimble mount and clamp.

WARNING: *To ensure adequate protection from microwave leakage, the CCD camera and IR sensor mounts must be properly installed and all screws tightened securely prior to oven operation.*

Control Module Connection

All electrical connections between the oven and control module are made through a 9-conductor cable attached to the rear panel of the oven. Connect this cable to the control module at connector J1 located on the control module rear panel. The control module may be placed on top of the oven or located anywhere the interconnect cable will allow.

Remote Control and Interlock Connections

Remote control and interlock connections are made to the 7-conductor circular plastic connector (J2) located on the rear panel of the control module. Figure 3 illustrates a typical configuration using standard relay or switch devices. The “Stop” device should be normally closed (NC) and the “Start” device should be normally open (NO). Both devices should dry contact momentary operation (non-latching) devices rated for 120 VAC, ¼ Amp.

For remote control of microwave peak power, connect a 0-10 VDC analog signal between contacts 4 and 5 with the positive (+) side connected to contact 4.

In the absence of remote controls or an external interlock device, a jumper wire must be connected between positions 1 and 2 to enable system operation.

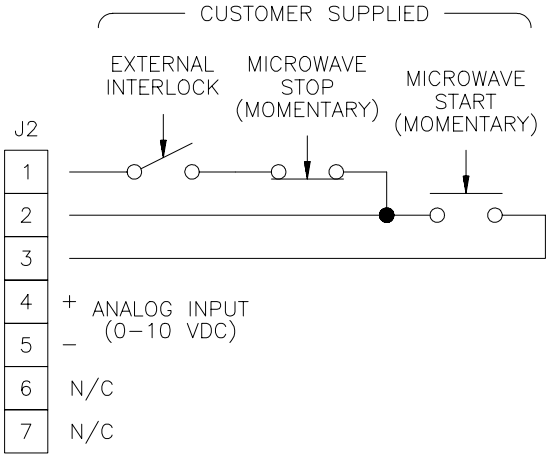


Figure 3, Typical remote control connections.

WARNING: *120 VAC may exit on the remote control circuit while the oven is in operation. The user must employ proper design and exercise caution when installing the remote controls to ensure adequate protection from exposure to live circuits.*

Line Power Connection

Line power is supplied to the system by connecting the oven power cord (located at the rear of the oven) to a standard 120 VAC grounded outlet receptacle. The circuit supplying voltage to the receptacle must be rated for at least 15 Amps of continuous current draw. Although a 15 Amp fuse is provided inside the oven, the line power supply circuit should also be fused or circuit breaker protected.

OPERATION

Basic Oven Operation

The microwave oven can be operated independently of the custom controls by means of the original oven control panel. The custom controls need not be turned on or operating in order to use the oven in this manner. All safety related functions of the original oven remain fully operational.

NOTE: *Operation of the microwave oven independently of the custom controls will not be disabled by opening the external interlock contacts.*

Control Power

Line power is available to the control module whenever line power is supplied to the oven and the oven door is closed. Unplugging the oven from the line power source or opening its door will remove line power from and disable the custom control circuitry altogether.

Standby Mode

Once line power has been supplied to the control circuitry, the **READY** indicator will turn on if the oven door and the external interlock device are both closed. If remote controls are used then the "Stop" contact device must be closed. The system will then be in *Standby* mode and ready to start generating microwave power.

Operate Mode

Once in *Standby* mode, pressing the **START** button on the control module front panel, or closing the "Start" contact device if remote controls are used, will place the system into *Operate* mode. Microwave energy will then be delivered to the oven cavity at power levels determined by the settings of the **POWER ADJUST** dial.

Any of the following actions at any time during operation will stop the generation of microwave power:

1. Pressing the **STOP** button on the control module front panel
2. Opening the oven door
3. Opening the contacts of the external interlock device
4. Opening the remote control "Stop" contact device

Microwave Power Adjustment (Local)

The average microwave power delivered by the oven can be controlled locally using the **POWER ADJUST** dial located on the control module front panel. The **REMOTE / LOCAL** selector switch

must be in the **LOCAL** position to enable power control using the front panel dial. The dial can be adjusted at any time before or during operation. The dial readings when multiplied by ten (x10) provide an approximate indication of average microwave output power.

Remote Microwave Power Adjustment

The average microwave power can also be controlled remotely using a 0-10 VDC analog control signal (see the previous section for connection information). The **REMOTE / LOCAL** selector switch must be in the **REMOTE** position to enable remote power control. The percentage of microwave power generated is approximately equal to ten times (x10) the voltage delivered. Power can be adjusted at any time before or during operation.

Magnetron Current Meter

The digital LED meter on the control module front panel provides a *relative* indication of average magnetron current which correlates to the approximate level of microwave power being generated by the magnetron. The actual microwave power delivered to the oven cavity will depend on factors relating the type, size and location of the power absorbing load placed inside the oven cavity.

This meter reading should never be construed to be an accurate measure of microwave power delivered to and absorbed by the load. However, in conjunction with the calibration procedure outlined in the next section, the meter reading can be used to monitor and verify oven performance.

OVEN POWER CALIBRATION PROCEDURE

The procedure outlined in this section can be used to correlate the **MAGNETRON CURRENT** meter reading with actual microwave power delivered by the oven for a specific load. It is derived from the international standard IEC 60705 (3rd Edition, 1999-04) used worldwide by microwave oven manufacturers for performance measurement.

NOTE: *This procedure utilizes a standardized water load for calibration. As with any microwave oven, the actual power generated may vary with different load types, sizes and locations within the oven cavity. However, the performance variation between two different loads will remain constant as long as both loads remain unchanged.*

The procedure involves heating the water from a starting temperature below ambient temperature to approximately ambient temperature using energy from the microwave oven. This enables a reasonably accurate compensation for heat loss to the container. The procedure may be performed at any microwave power setting as may be required for calibration of normal operation.

Equipment Required

- Cylindrical container made of borosilicate glass (Pyrex®) with outside diameter of approximately 190 mm, height of approximately 90 mm and maximum thickness of 3 mm
- Potable (tap) water, approximately 1000 grams
- Thermocouple probe thermometer capable of accurately measuring the temperature of the water
- IR optopyrometer capable of accurately measuring the temperature of the empty container
- Scale capable of accurately measuring the weight of the container, both empty and filled with water

Initial Conditions

- Line voltage to be within the range per the oven specifications and within +/-1 % of the voltage to be supplied during normal operation.
- Ambient temperature to be 20 °C +/-5 °C.
- The temperature of the microwave oven power supply components to be within +/-5 °C of ambient. This condition can usually be met by not operating the oven for a few hours. External forced air cooling may be used to shorten this time.

Procedure

1. Adjust both Stage 1 and Stage 2 microwave power settings on the control panel to the same desired power level.
2. Set the cycle timer on the control panel as follows:
   Stage 1: 2 seconds (this allows filament warm-up)
   Stage 2: A value (**t**) equal to 52 seconds multiplied by the ratio of full output power to the set output power (i.e. for half power setting the Stage 2 cycle time should be 104 seconds).
3. Adjust the water temperature to 10 °C +/- 1 °C before putting it into the container. Ice chips may be used to lower the temperature, but the ice should be completely melted prior to heating.
4. Accurately measure and record the container mass ($\mathbf{m_c}$) in grams.

Note: Steps 5 through 10 should be done in rapid succession to minimize heat loss and temperature measurement error.

5. Accurately measure and record the initial container temperature ($\mathbf{T_0}$) in degrees Celsius.
6. Accurately measure and record the initial water temperature ($\mathbf{T_1}$) in degrees Celsius.
7. Pour the water into the container and accurately measure and record the filled container weight. Subtract the empty container weight (m_c) to obtain the actual water weight ($\mathbf{m_w}$) in grams.
8. Place the filled container inside the oven cavity, centered on the turntable, and close the oven door.
9. Press the Start button on the control panel to turn on microwave power. During Stage 2, record the reading of the Magnetron Current meter. Allow the system to operate through both cycle stages. The oven will turn off automatically.
10. Upon completion of Stage 2, open the oven door and accurately measure and record the final water temperature ($\mathbf{T_2}$) in degrees Celsius. Gentle stirring will provide a more accurate measurement of average temperature.

Output Power Calculation

Calculate the microwave output power using the following formula:

$$P = [4.187 * m_w (T_2 – T_1) + 0.55 * m_c (T_2 – T_0)]/t$$

The meter reading recorded in step 9 above now corresponds to the calculated output power.

MAINTENANCE

The custom microwave oven is designed to be maintenance free with the exception of magnetron replacement. The magnetron is considered a consumable component and is expected to fail within 1000 to 3000 of operation depending on operating conditions and usage. No calibration is necessary.

In the event of damage due to improper operation or mishandling, the system should be returned to GAE for repair. Contact GAE for information on repair services.

Magnetron Removal and Replacement

The magnetron used in the custom microwave oven is the same as that supplied with the original oven by its manufacturer. Replacement of the magnetron should be done only by technical personnel properly trained for repair of residential and commercial microwave ovens.

