Product User Manual

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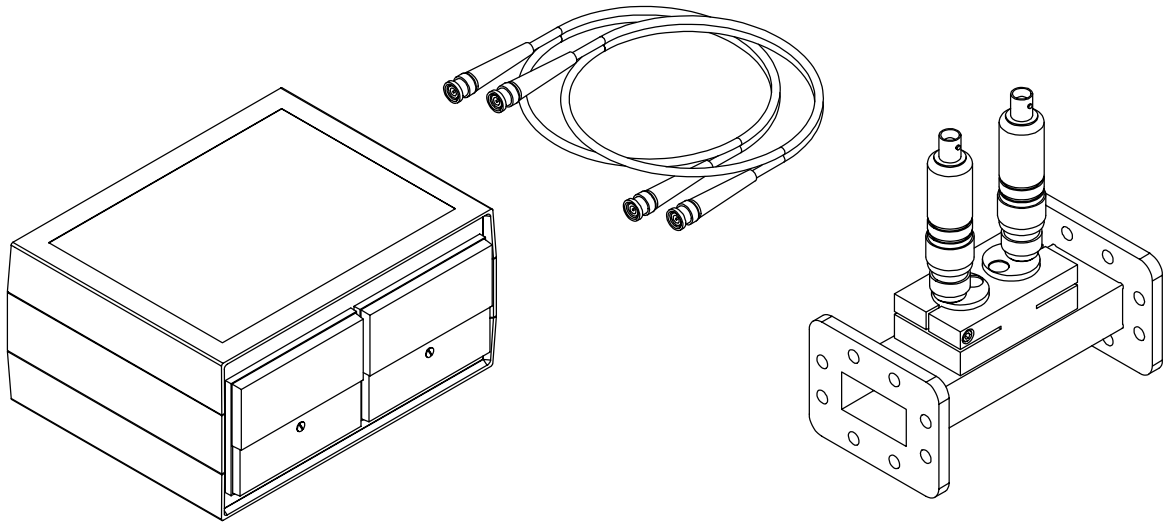
Model GA3008
Dual Microwave Power Monitor, 5.8 GHz



Document # 930042, Rev. 1

GERLING

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REVISION HISTORY			
REV.	**DESCRIPTION**	**DATE**	**APPROVAL**
1	PROTOTYPE RELEASE	15JAN04	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 power monitors manufactured by GAE, Inc. are intended for use with other equipment 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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EQUIPMENT DESCRIPTION

The model GA3008 Dual Microwave Power Monitor is designed for use in high power microwave networks to measure the level of microwave power flowing in the waveguide. These devices are typically used for monitoring power delivered to and reflected from process loads.

The attenuated microwave output signal from the coupler probe is rectified by a crystal detector diode to produce a voltage signal. This signal is delivered to an analog current meter that is calibrated with the specific detector and coupler as a set. Detector diodes characteristically have a high temperature coefficient that causes its transfer function to drift with variation in ambient temperature. Consequently, the user should note that all power monitors using detector diodes are subject to a certain amount of error due to changes in ambient conditions.

Another common characteristic of analog waveguide power monitors is that their calibration is waveform dependent. For example, monitors calibrated for use with a pulsed output microwave generator will give an inaccurate reading when used with low ripple generators. Consequently, all GA300x series monitors are identified with the waveform used for calibration.

General Specifications

Waveguide	WR159
Flange	CPR159F (UG1731/U)
Frequency	5.8 GHz +/- 75 MHz
Power (continuous)	1 kW maximum
Meter Scale (both)	1 kW
Accuracy	+/- 5% of full scale @ 25°C
Coupler Directivity	23 dB minimum
Cables	RG-58/U, BNC male connectors, 6’ long

INSTALLATION

Preliminary Inspection

Upon arrival at the installation site the GA3008 power monitor should be thoroughly inspected for damage or wear caused during shipping. Any visible damage to the packaging material or the power monitor components should be noted and reported immediately to the shipping company in accordance with standard claims procedures. The following components are included:

a) GA3115 dual directional coupler

b) Crystal detector (2x)

c) Meter set

d) BNC cable, 6' long (2x)

e) GA3008 Product User Manual (this document)

Waveguide Configuration

The waveguide coupler can be connected to and used with any common waveguide component having a compatible flange (see below). The mounting position can be in any orientation.

A common configuration is to detect the power flowing to and from the process load. When using a directional coupler, it is important to note that the coupler should not be located between the tuner and the process load. Note the direction of the "FORWARD POWER" arrow and be sure it is oriented in the desired direction for monitoring power. Figure 1 below illustrates a typical waveguide configuration for forward and reverse power monitoring using a directional coupler.

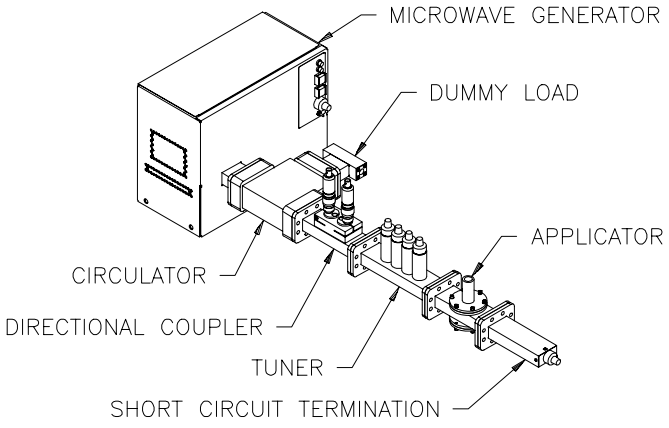

Figure 1. Typical waveguide configuration with directional coupler for forward and reverse power monitoring.

Flange Connections

Both flanges of the waveguide coupler must be properly connected to another waveguide component. Bolts and nuts must be installed at all flange bolt holes on both flanges 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/cm^2 measured at 5 cm from the leakage source under normal operating conditions, and 10 mW/cm^2 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.

Crystal Detector Installation

The crystal detectors mount on the probes of the waveguide coupler by screwing onto the Type N output connectors. Care must be taken to avoid cross-threading the connector or applying excess torque. A finger-tight connection is both adequate and necessary.

NOTE: *Crystal detectors are identified by an "F" or "R" in the serial number. These refer to Forward and Reverse power and designate the respective probe onto which the detectors are to be mounted. Installation onto the wrong probe can yield inaccurate readings.*

Meter Connections

Two BNC jacks are located on the back of the meter set. Connect one end of each BNC cable to these jacks and the other end to the BNC (output) jack on the respective crystal detectors corresponding to Forward or Reverse power. See Figure 2 below for typical connections.

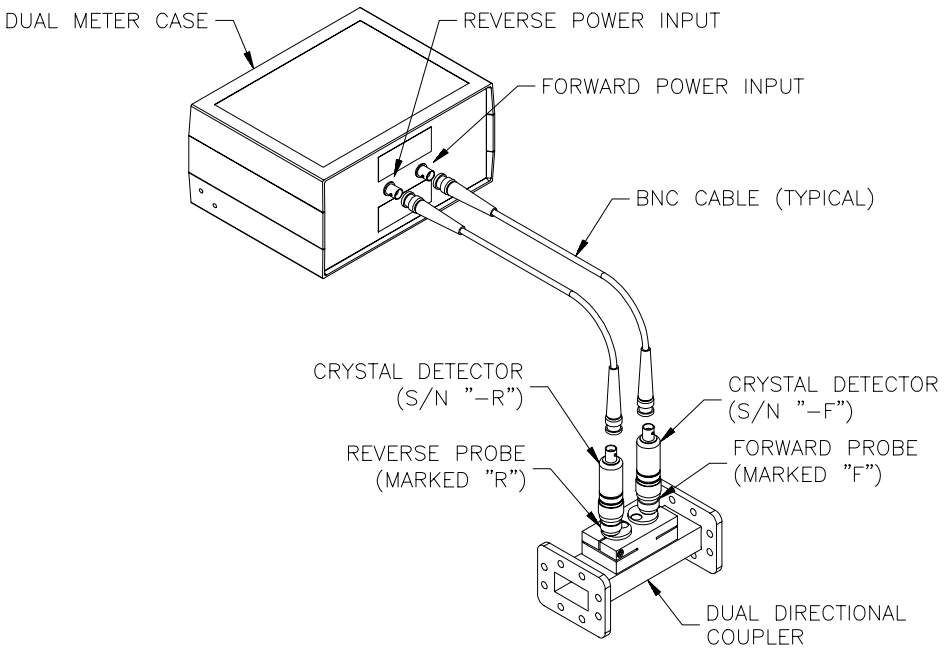

Figure 2. Meter connections to dual directional couplers.

OPERATION

Basic Operation

Once installed, the GA3008 dual power monitor will operate without any need for operator involvement. No adjustments or settings are available or necessary.

Each meter has a calibration label indicating the actual power levels for given meter readings. Although the meter scales were designed based on the average values for a large lot of detectors, the differences between actual values and meter readings may vary due to variations in crystal detector transfer functions.

CAUTION: *Care must be taken to avoid operating the microwave generator at power levels exceeding the rating of the power monitor. Excessive power levels can cause damage to the crystal detector(s) and/or meter set.*

Coupling Factor and Directivity

Directional couplers, by definition, are designed to sample the power propagating in one direction only. The most important parameters relating to their performance are *coupling factor* and *directivity*.

The coupling factor is the attenuation between waveguide power and the output signal as defined by the following equation:

$$\text{Coupling Factor} = 10 \log \frac{\text{Waveguide power}}{\text{Probe output power}}$$

Directivity is the attenuation between output signals derived from sampling the same waveguide power in opposite directions as defined by the following equation:

$$\text{Directivity} = 10 \log \frac{\text{Probe output sensing in normal direction}}{\text{Probe output sensing in reverse direction}}$$

Performance Considerations

Since all directional couplers lack perfect (infinite) directivity, power measurement errors result when power is propagating in both directions. An example of the potential measurement error is shown in Figure 3 for a case in which forward and reverse power are 1500 Watts and 50 Watts, respectively. In this case the maximum possible measurement error for a coupler having 25 dB directivity is approximately +/- 30 Watts, or 2% of the reading. The error will be greater for higher reverse power levels. Note that this chart is only

for a specific case of forward and reverse power and that the curves are different for other power levels.

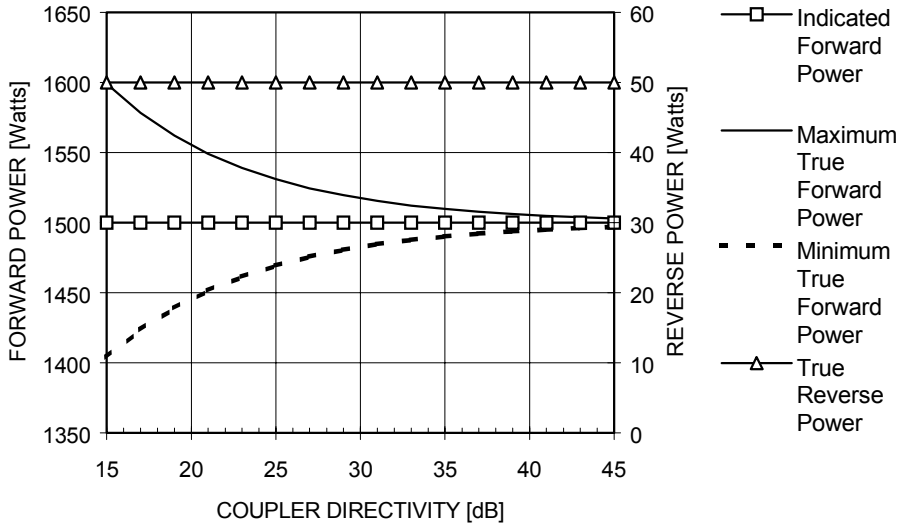

Figure 3. Error limits of true forward power for given indicated forward power and true reverse power.

The above chart is made available to the user by GAE in the form of an MS Excel spreadsheet. Specific values for indicated forward and true reverse power levels can be entered to see the resulting error limits for that case. Contact GAE to obtain a free copy of this spreadsheet.

MAINTENANCE AND CALIBRATION

The GA3008 dual power monitor is designed to be maintenance free and does not require any user maintenance under normal operating conditions. However, calibration of the power monitor may be necessary after a period of time as the meter and crystal detector performance can drift. A calibration period of one year is recommended.

Although the GA3115 dual directional coupler is a very rugged and stable device, even the slightest movement of the probes inside its mounts can change coupling factor and/or directivity. In the event of probe movement, or damage due to excessive power levels or mishandling, the coupler should be repaired and/or recalibrated by GAE. Contact GAE for information on repair and calibration services.

User Calibration

While the waveguide coupler and meter set both require adjustments for calibration, GAE recommends that only the meter set be adjusted by the user. Proper adjustment of the coupler is a tedious procedure involving simultaneous measurement of coupling factor and optimization of directivity. As this procedure is typically beyond the capability and resources of most users, we recommend that couplers be returned to GAE for calibration.

Each meter in the meter set has two adjustment points, one to zero the meter and one to calibrate the scale.

Zero Adjustment

Disconnect the BNC cable at the back of the meter set and adjust the screw on the front of the meter using a small screw driver until the meter pointer is at zero.

Scale Calibration

This procedure requires a separate power measurement device that can be used as a calibration standard. GAE recommends using a previously calibrated digital power meter such as the Hewlett-Packard model 437B power meter with the model 8481A power sensor. The following procedure assumes the use of this meter.

1. Install the coupler in the waveguide setup between the microwave generator and a load having high return loss (such as the GAE model GA1221 Dummy Load).
2. Connect the HP meter and sensor to the coupler probe corresponding to the meter to be calibrated. Set the OFFSET

value to match the coupling factor of the coupler probe as indicated on the coupler body.

3. Operate the microwave generator at a power level near the top end of the meter scale.
4. With the microwave power still on, disconnect the HP power sensor and connect the crystal detector and meter to the same coupler probe.
5. Remove the meter housing cover and adjust the potentiometer inside the meter housing until the meter reads the same as measured in step 3 above.
6. Disconnect the crystal detector and reconnect the HP sensor to verify that the measured microwave power level is the same. Repeat steps 3 thru 6 until both meters read the same.
7. Operate the microwave generator at the lowest power reading on the Meter Scale Calibration label (located on the top of the meter housing cover) as read by the analog power meter.
8. Disconnect the crystal detector and reconnect the HP sensor. Record the reading in the “Actual” column next to the corresponding meter reading.
9. Repeat steps 7 and 8 for all values in the Meter Scale Calibration label.

