POWER MONITOR

PMA1-03

The PMA1-03 is a thru-line microwave power monitor, designed to non-invasively measure and display the power passing through a coaxial line. Battery life is exceptional due to proprietary low power design and auto-shutoff feature.

Features

- Measures Power without System Interference
- Integrated Display
- Low Insertion Loss
- Compact, Portable, and Cordless
- Long Battery Life with Auto-Shutoff
- Rechargeable with Micro-USB
- USB read/writeable (beta)

Electrical Specifications

Parameter[1]	Test Conditions	Min	Typ	Max
Dynamic Range (dBm)	Error <.5 dB, .15-3 GHz	-30		+15
Resolution (dBm)			0.01	
Direct Line Insertion Loss (dB)			0.2	0.4
VSWR			1.15	1.2
Frequency Range (GHz)	Error <1 dB	.070		3
Frequency Calibration (GHz)		0.1		3
Frequency Calibration Step (MHz)			100	
Measurement Rate (per Second)			3	
Battery Life (hours)	Active Mode		100	
(days)	Sleep Mode		30	
Weight (g)			142	
Dimensions (inch)		3.74" x 1.45" x .95"		

[1]Specifications guaranteed when operated in a 50Ω system.

Model Number	Description
PMA1-03S	70 MHz - 3 GHz Inline Power Monitor with SMA Connectors [1]
PMA1-03N	70 MHz - 3 GHz Inline Power Monitor with N Connectors [1]

[1]Default is SMA female-male or N female-female connectors. Consult factory for other connector options.

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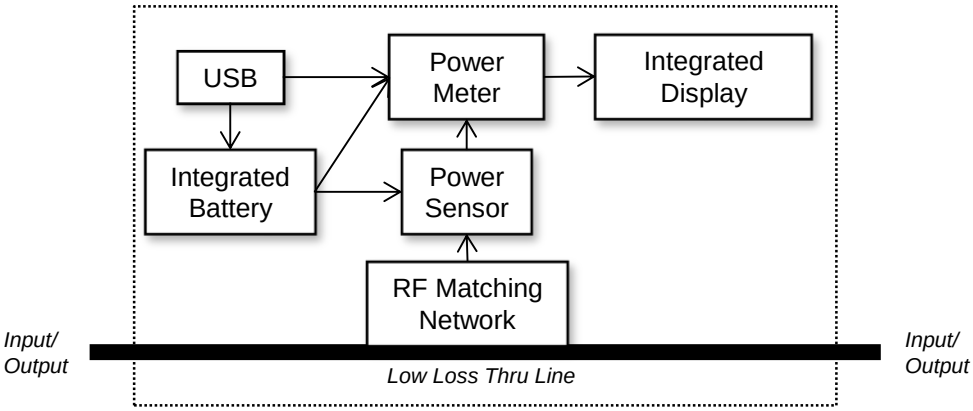
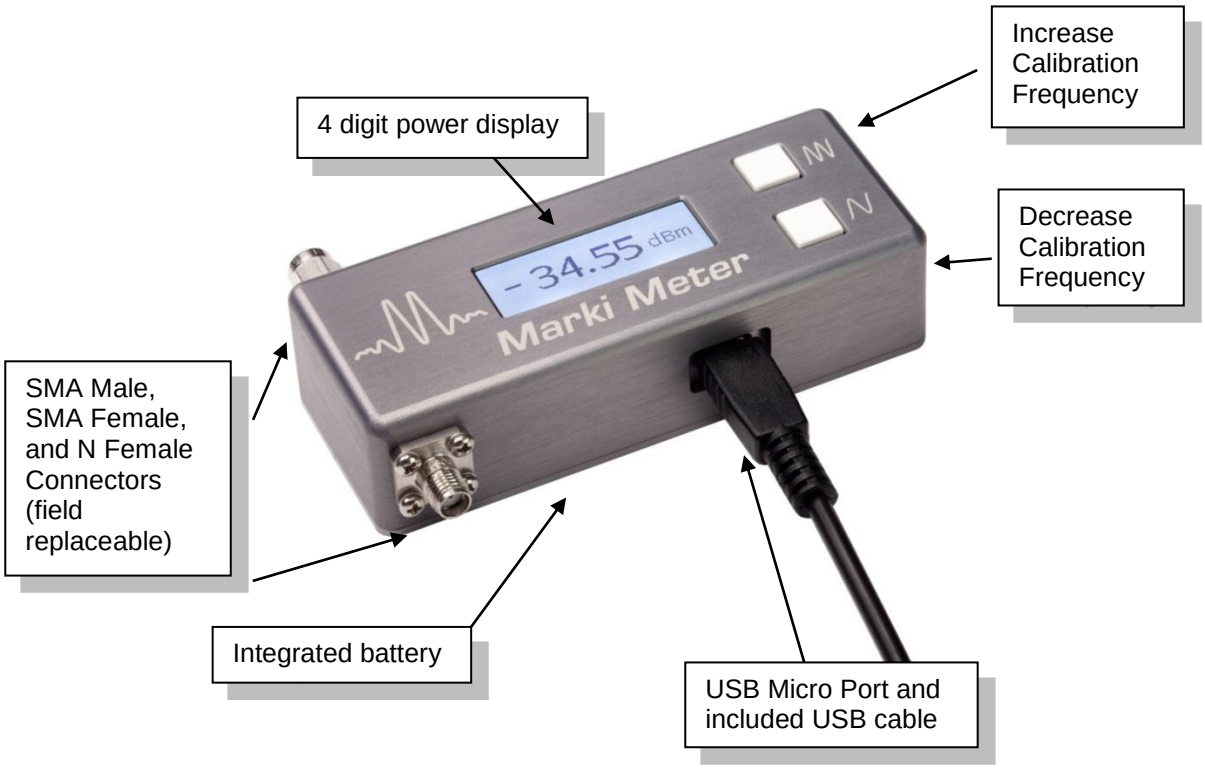
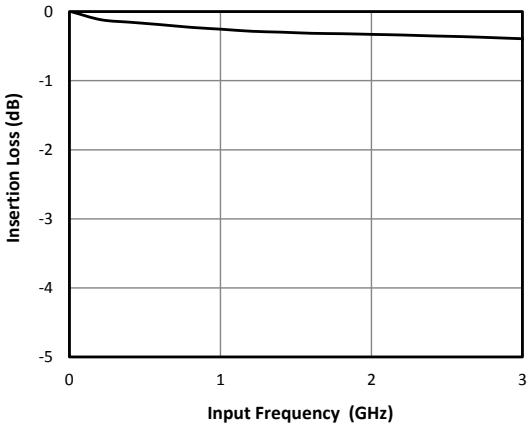
Product Features

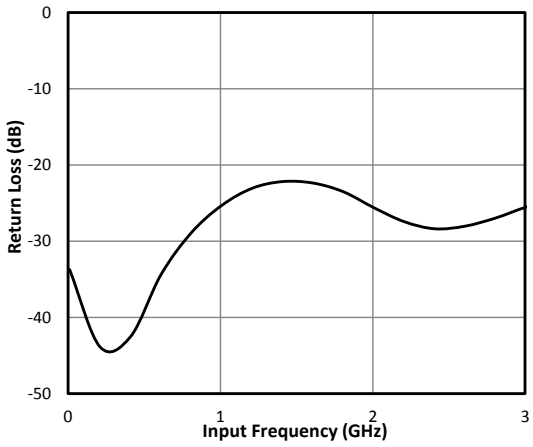


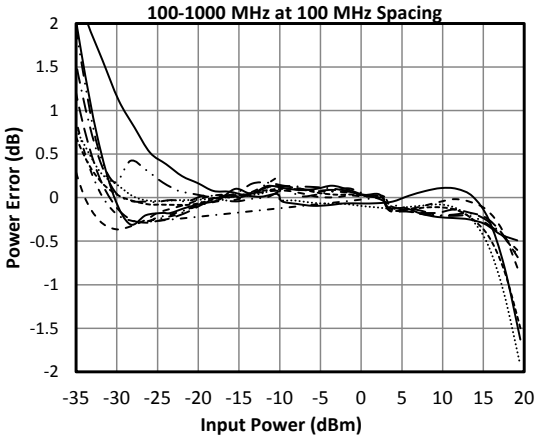
PMA1 Operational Block Diagram

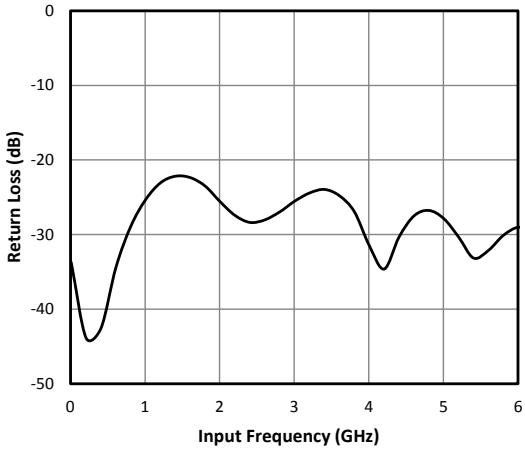


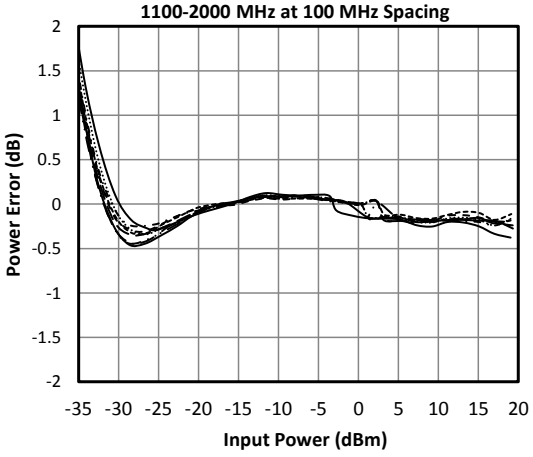
Typical Performance

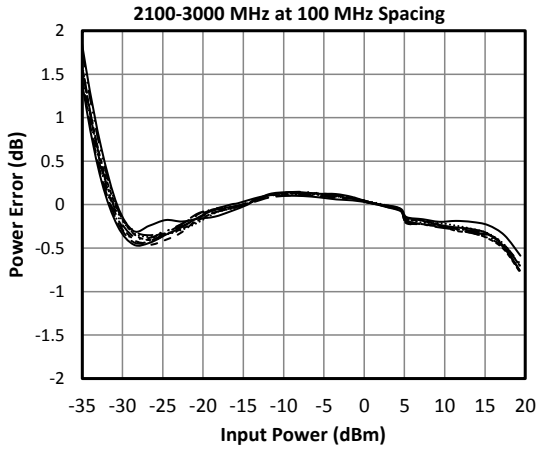












Using the PMA1

Operation

Upon receiving the PMA1, remove the battery pull tabs on the sides of the case. To turn on the PMA1 simply push one of the buttons or plug the device into a powered USB cable. It is recommended that the device be charged for at least 1 hour before it is first used.

Battery Life, Charging, and Sleep Mode

The PMA1 is designed for maximum operation time with minimum charging time. It will operate for at least 40 hours in measurement mode and a month in sleep mode without charging, and will fully charge when plugged into a powered USB port for 3 hours. The user should charge the device at least once a month to maintain maximum battery life, and should return the PMA1 to Marki Microwave for battery replacement service every 3 years.

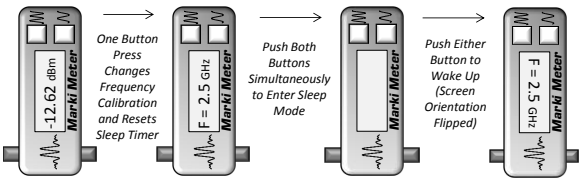


Fig. 1 Device Operation

The device will enter sleep mode after approximately 30 minutes of operation if it is not plugged in and the frequency is not changed. While in sleep mode the RF signal is not affected. Pressing one of the buttons will resume measurement mode without changing the frequency from the sleep state (see Fig. 1). The sleep timer is also reset every time a button is pressed. The backlight will turn on if and only if the device is plugged into a powered USB port (indicating the device is charging) and it will not go to sleep when it is plugged in.

The PMA1 can be put into sleep mode by the user pressing both buttons simultaneously. After being reset the screen orientation will flip to the opposite orientation. This technique can also be employed to extend battery life by keeping the device in a sleep state.

Calibration

To set the frequency calibration, toggle the buttons on the front panel in 100 MHz increments. Note that no additional calibration or 'zeroing' is required since all PMA1 units are calibrated in the factory prior to shipment.

Applications

The primary applications for the PMA1 include non-invasive signal monitoring, system diagnostics, experimental system optimization, and 'on-the-fly' handheld power measurements. Basic operation is demonstrated in Fig. 2A.

Note that the power measurement is **output referred**, with the insertion loss calibrated out. Since the PMA1 is bidirectional either port may be used as the input and the power output will be referred to the opposite port. Finally, note that the PMA1 does not distort the signal on the line beyond a small insertion loss.

To Use as a Power Meter

With a well matched 50 Ω load at one port, the PMA1 can be used as a portable power meter (Fig. 2B). Note that because the PMA1 is output referred, the insertion loss must be added to the reading to determine the input power. Typically the insertion loss will be less than 0.5 dB, depending on frequency.

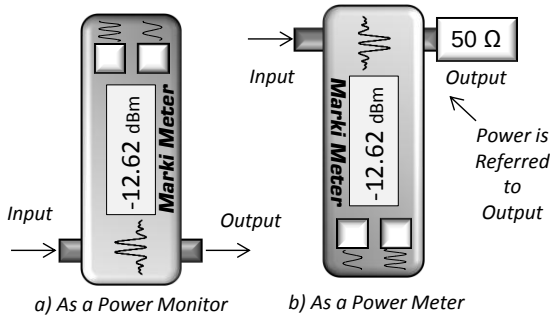


Fig. 2. Use as a power monitor (a) or power meter (b).

Accuracy

As with any power meter, the accuracy of the PMA1 depends on the frequency calibration, source and load impedance, temperature, and the nature of the input signals.

While traditional bench-top power meters are intended to measure power as accurately as possible – often at the expense of size, speed, and cost – the PMA1 has been designed to maximize portability, flexibility, and ease of use while still offering a reliable and repeatable CW power measurement.

Linearity

Linearity, defined as the change in power reading for a 1 dB change in input power, is generally within 0.05 dB or better over the operating range. Linearity for a specific operating frequency at a specific power level can be estimated by the slope of the power error plot at that point. Since the PMA1 has excellent linearity it is well suited to perform ratio measurements. Since it increases (decreases) monotonically with increasing (decreasing) input power, it is also well suited to optimizing system received power, antenna alignment, phase alignments, and similar measurements.

Accuracy with Frequency

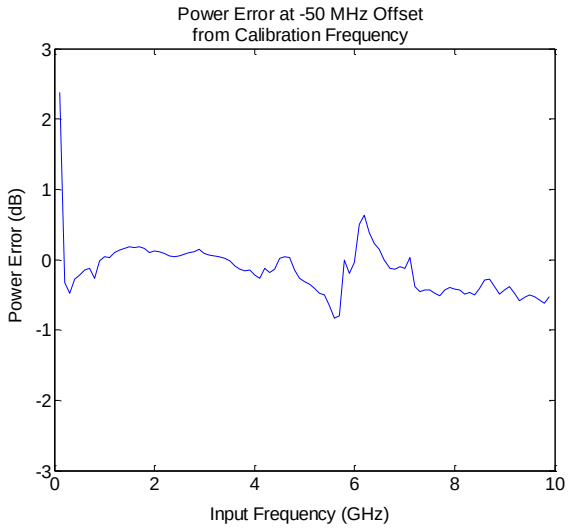


Fig. 3. Error due to mismatch between calibration frequency and input frequency across the measurement range

Frequency calibration with the PMA1 is simple: just use the buttons on the face to change the calibration to the frequency of interest. The frequency calibration is performed in 100 MHz steps starting from 100 MHz to the maximum frequency of the device. If an input frequency does not fall on a 100 MHz step there will be a small discrepancy between the displayed power and the actual power on the line. Fig. 3 gives an

input signal is 50 MHz below the calibration frequency.

Accuracy with Varying Loads

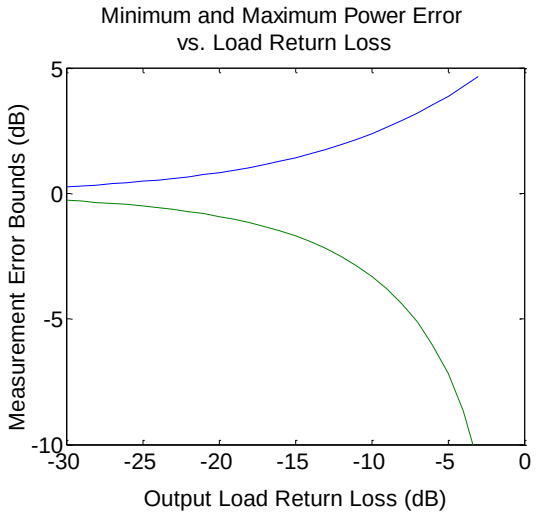


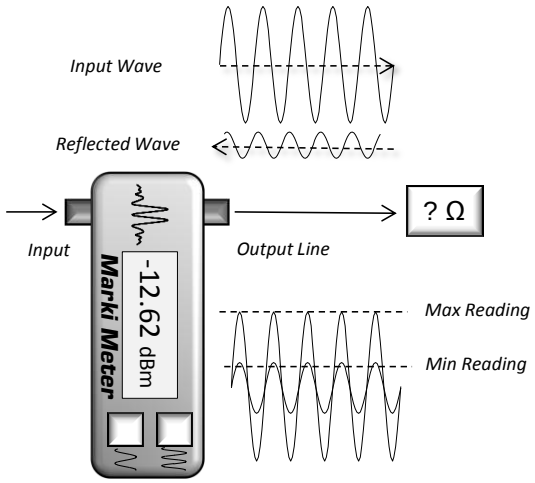
Fig. 4. Range of possible error values for a given output load return loss

The dominant source of error in any power meter is the mismatch uncertainty between the input and the power sensor. For the PMA1 the accuracy depends on both the input load and the output load match to 50 Ω at the frequency of interest. Since the integrated pick off tee is non-directional, any reflected power from the output port will couple back to the power sensor (see Fig. 5). The reflected wave will interfere with the incoming wave and create a standing voltage wave pattern with a ratio of peak to average voltage given by the VSWR at the location of the pick off tee. This means that the linear ratio of the maximum voltage to ideally terminated maximum voltage (V_0) is given by

$$\frac{V_{max}}{V_0} = \frac{2 \cdot VSWR}{VSWR + 1}$$

giving the power error as a function of return loss as shown in Fig. 4.

Note that the power error can be any value within these bounds, depending on the distance between the load and the internal PMA1 power sensor. For this reason it is critical to have a well matched 50 Ω load for accurate measurements. To quickly determine whether a load is matched, disconnect the output and connect it to a known good 50 Ω load. If the reading remains unchanged, the load is well matched to 50 Ω and the reading is accurate. If the reading changes it indicates that the output line is poorly matched.



Power reading indicates peak voltage, which depends on phase of reflected wave.

Fig. 5. Error due to load mismatch

Accuracy with Temperature

The PMA1 is housed in a thick metal enclosure designed to minimize thermal fluctuations. The internal power sensor is designed to have an error of less than ±.5 dB across an operating temperature from -40º to +85º C.

Accuracy with non-CW signals

Although designed for measuring CW signals, the PMA1 may also be used to estimate the power levels of narrowband signals with a constant peak to average power ratio (PAPR), or crest factor. Estimating the power error for a given signal requires careful experimentation to verify repeatability across frequencies. Table 1 gives examples of common signals with different crest factors and example values for their correction factors.

Signal	Power Error (dB)
Sine Wave (CW)	0
GSM Channel (all time slots on)	0.6
CDMA channel (forward link, nine channels on)	3.6
CDMA channel (reverse link)	0.5
PDC channel (all time slots on)	0.6

Table 1. Examples of Power Error Ranges for Various Signals

Measuring the PMA1 Accuracy

To confirm the accuracy of the PMA1, the following procedure should be followed:

1) Locate and turn on a well calibrated power meter. Allow at least 30 minutes to an hour for the power meter to warm up. Experience suggests that power meter error can be as much as 3 dB when warming up, and differences between calibrated laboratory grade power meters are on the order of a few tenths of a dB or more, depending on what adapters are needed for calibration. There is no need to warm up the PMA1.
2) Locate a CW signal generator with a well matched 50 Ω output. If the match of the output is uncertain at the frequency of interest, attach a well matched attenuator of at least 6 dB to the output of the synthesizer (the value of the attenuator need not be precisely known).
3) Calibrate the reference power meter using the internal source immediately prior to making the measurement. Older power meters may need to be zeroed in addition to calibration. The power meter reading will be inaccurate if it is not calibrated shortly before the measurement. No calibration is necessary for the PMA1.

4) Set the synthesizer to a frequency within the range of the PMA1. Locate and set the calibration on the power meter to the desired frequency. The frequency calibration of the PMA1 can be set using the buttons on the front.
5) Attach the PMA1 to the synthesizer and the power meter sensor to the other end of the PMA1. Ensure that all connectors are tightened to their specified torque (5 lb-in for SMA). At this point the difference between the PMA1 reading and the power meter reading is the power error. In the example of Fig. 6 the calculated error would be +.13 dB, which is a typical value under normal operating conditions.

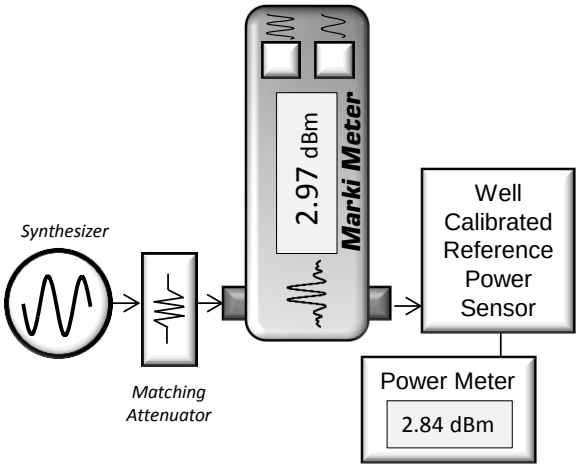


Fig. 6.Experimental Setup to Measure Accuracy

Computer Communication

The PMA1 is capable of computer communication through the micro-USB port in two ways. The first is through the control software that can be downloaded from the Marki Microwave website. The second is with direct serial port control. For a detailed programming guide, please contact the factory.

Communication Methodology

In addition to charging, computer communication with the PMA1 is possible through the USB port. This communication is achieved through the use of the FT232R USB communication chip from Future Technology Devices. This chip allows the PMA1 to communicate with most Windows, Linux, and Mac OS X devices through the use of a virtual COM port. This means that the device will appear as though it was connected through an RS-232 port, and individual characters can be written to and read from the PMA1.

Driver and Software Installation

In many cases the device driver will be installed as soon as the device is plugged in to the USB port on the computer. If not, these drivers may be downloaded here. After the drivers are installed the device should appear as a COM port to the operating system.

To install the software, download the latest version from here. Source code for installation on platforms other than windows is in the installation executable.

Software Operation

Plug the PMA1 into the USB port on your computer. After installing the software to your computer, select “Marki Microwave -> Power Monitor” to start the program. At start up you will see the screen in Fig.7. The PMA1 will show up with a port number (in this case COM20), then the product identification and the serial number.

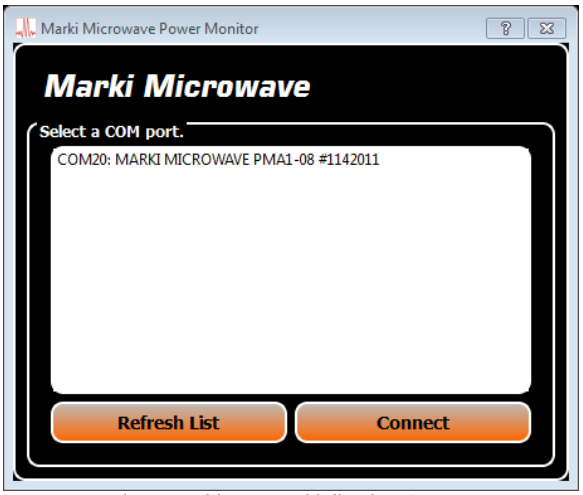


Fig. 7.Marki Meter Initialization Screen

Note: You may have to refresh the device list several times in order for your device to be listed. If the device is not listed there may be a problem with the driver installation. After you select a device and click 'Connect', you should see a screen like in Fig. 8.

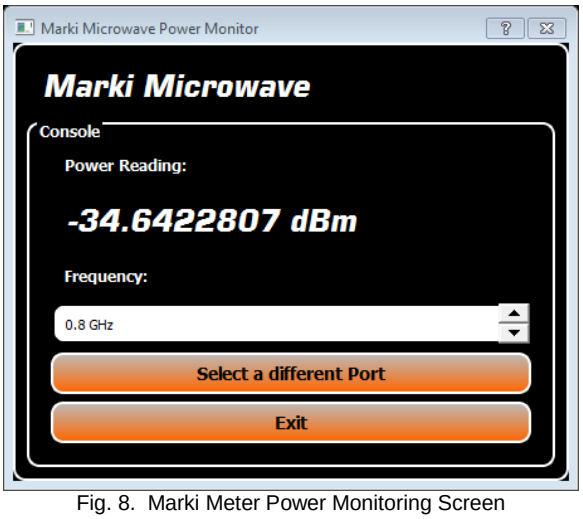


Fig. 8. Marki Meter Power Monitoring Screen

This is the main console for the Marki Meter program. In the center is the power reading continuously updating as long as the device is connected. The currently selected frequency is also shown. Changing the frequency on the screen will cause the device frequency to change and the updated frequency will also be shown on the PMA1 screen. To select a different device click on 'Select a different Port'. Note that connection to the control software does not pre-empt local device control. The frequency can still be changed and will automatically update in the software, and the device can also be reset if necessary.

Warranty

The Marki Meter standard warranty is one year including parts, labor, and recalibration as a part of repair, as well as return shipment within the U.S.A. This warranty covers repairs due to failure during normal operation. Opening the PMA1 by removing the screws on the back voids all warranties. Standard Marki Microwave Terms and Conditions also apply.

Failure Due to Input Power Overload

Estimated power handling of the PMA1 is 20 W with a well matched load capable of sinking this power. It is currently the policy of Marki Microwave to repair or replace a unit that is damaged due to high input power levels so long as the user reports the input power and frequency.

Marki Microwave, Inc.

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