LB5900 Series Power Sensor

PMA-12 Software

Operating and Service Guide

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Section I - Introduction & Notices

Notices

SAFETY

A WARNING indicates a potential hazard that could completely damage the product. Do not continue until you fully understand the meaning.

A CAUTION indicates a potential hazard that could partially damage the product. Do not continue until you fully understand the meaning.

A NOTE provides additional pertinent information related to the operation of the product.

CONFORMITY

WEEE Compliant
RoHS Compliant
USB 2.0 Compliant

DISCLAIMER

The information contained in this document is subject to change without notice. There is no guarantee as to the accuracy of the material presented or its application. Any errors of commission or omission will be corrected in subsequent revisions or made available by errata.

WARRANTY

Please refer to the product specification sheet or LadyBug's website for warranty information on the specific product of interest.

DOCUMENT NUMBER

Not Assigned (Reference LB5900 Series Product Manual for the PMA-12 Precision Power Meter Application).

What is covered in this manual

This manual provides information about the installation and operation of the LB5900 series USB power sensors using PMA-12 Precision Power Meter software. The LB5900 series of sensors make True RMS Average - (CW or modulated) measurements.

This manual also contains information regarding product features and support, specifications, compatibility, and some measurement examples. Refer to the specific product's Programming Manual for programmatic remote control information. The Errata and User Update section at the end of this document reflects recent changes in the product.

This manual is divided into three sections.

- Section I covers general information and installation.
- Section II discusses various measurements and how to make them.
- Section III explains the menus, features & functions of PMA-12, and how to access them.

The following additional documentation and support is available from LadyBug Technologies on its website or from technical or sales professionals at the company.

- Detailed Programming Guide
- Programmatic Measurement Examples Guide
- SPI and I2C Interface Users Guide
- Interactive IO Control software
- Programmatic example code
- Drivers and support for LabVIEW & other environments

Overview

The LB5900 Series USB Power Sensor features a compact power sensor body that connects directly to a desktop or laptop computer using a standard USB 2 port. The sensors convert RF and microwave power into fully calibrated and processed digital data. The companion PMA-12 Precision Power Meter Application software provides a front panel display that allows the user to make typical average power measurements as well as advanced triggered, time gated measurements. Specific sensor specifications are detailed in the specific LB5900 series sensor's data sheet. Programmatic information is covered in the LB5900 Programming Guide. The PMA-12 application is the primary subject of this document.

Patented No-Zero No-Cal features eliminate sensor zeroing and meter reference calibration. The sensor features optional Trigger IN/OUT or Recorder OUT connectors in addition to optional RF input connectors. Please refer to the sensor specification sheet for a complete listing of product options.

PowerSensor+™ products address key aspects of general purpose scalar measurements as well as CW, pulse, and other modulated power measurements. PowerSensor+™ products offer benefits in overall cost, accuracy, measurement speed, flexibility and test development time.

Sensors Compatible with PMA-12 Software

All LB5900 Series sensors are compatible with PMA-12 software; however portions of the application are sensitive to the sensor's firmware version and options purchased with the sensor. In some cases, the sensor's firmware may require updating to use the latest version of PMA-12 software. If so, PMA-12 will issue a warning and may close. In this case, it is recommended that the sensor be sent back to LadyBug for updating. Earlier versions of the software are also available. Contact LadyBug sales for further information.

Use of Multiple Sensors

PMA-12 is a multi-threaded software application capable of reliably controlling 12 or more individual LB5900 sensors at one time. Each sensor is controlled by its own sensor window (see Quick Startup).

In addition to multiple individual sensors, a two sensor calculation window with various functions is included. For further information, see the *Derived Measurements* section.

Windows Versions (PMA-12 Software)

PMA-12 and the associated Interactive IO are Windows based software compatible with Windows XP through the latest Windows version in 32 and 64 bit. As of the writing of this document, the software has been fully tested with all versions of Windows 10. PMA-12 and the included Interactive IO utilize the computer systems native USB HID system driver.

Interface Description (Sensor)

LB5900 Series sensors are composite USB devices with both USBTMC and USB HID interfaces plus Optional SPI & I2C interfaces. The USB HID interface will load when a sensor is connected to Windows, LINUX, Apple or other computers with standard USB HID interfaces.

Important Interface Notes

- A connected computer may attempt to load a USBTMC driver. If the user has no intention to use USBTMC, the error should be ignored.

- It is normal for a warning to be shown in Windows Device Manager indicating a driver is missing if USBTMC is not present on the computer. This waring is harmless.
- Sensors with Option SPI (SPI and I2C interfaces) also include fully functioning USB ports. The USB port should not be used when the SPI/I2C port is in use and vice-versa.

LINUX

Linux based computers, like most PC's have native USB HID drivers. When connected, the LB5900 sensor will load this native driver. LadyBug PMA-12 software is Windows based. Please contact LadyBug sales to discuss LINUX support.

Programming Guide Utilization

A complete detailed programming guide is available on LadyBug's site. To make measurements, PMA-12 software uses the commands detailed in the guide. Advanced users of PMA-12 are encouraged to review the guide to gain a complete understanding of the details and measurement nuances. For example, using PMA-12, a user can easily enable a simple offset to include the effect of an attenuator. If the user wishes further information on the DCYC or the GAINx offset commands, it can be located in the programming guide to fully understand how the correction is done by the sensor.

Installation

Insert the flash drive or open the download link from ladybug-tech.com. If the install does not start automatically, click the setup.exe file. Instillation is automatic. During the install process, the installer may request to locate a driver from the internet. PMA-12 uses default system drivers, no additional drivers are required. If asked, this question should be answered with no or ignore. If you plan to test programmatic commands, leave Interactive I/O application selected. Refer to the quick start card for other install details.

VISA-USBTMC Note

If you plan to use VISA IO Libraries with your sensor, no install action is necessary. The sensor is fully compatible and will appear in the Connection Panel / Connection Expert. We recommend installing PMA-12 and our Interactive IO to confirm functionality.

Section II – Making Measurements

Your First Measurement

With the sensor connected, locate PMA-12 in the LadyBug Technologies folder and start the program. After a few seconds the software and sensor will be running and the screen will be similar to the image in Figure 1. Note in the image, there is no signal applied and no settings have been changed.

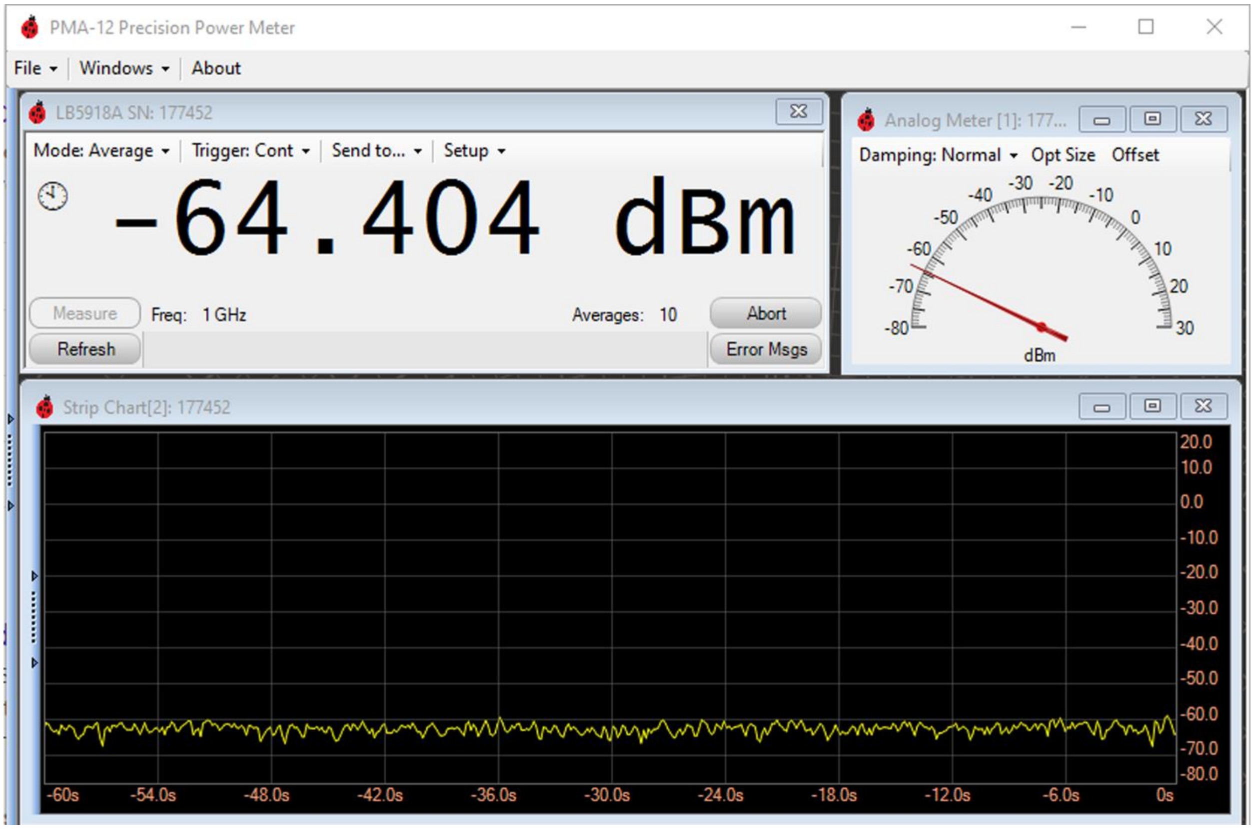


Figure 1 Startup Screen

In this default case, three windows are open; the main Sensor Window; an Analog Meter; a Strip Chart. The Sensor Window is the primary control for the sensor and the measurement, it controls the sensor's parameters including the measurement timing. It is the only control communicating with the sensor. If closed, the connection to the sensor will be terminated, however other windows such as the Strop Chart and Logs remain open and retain the already collected data. The sensor can be re-opened using the details pane (explained later) or by closing and opening the application.

The Analog Meter can be closed if desired. The analog meter simply displays data collected by the main Sensor Window.

The Strip Chart can be very useful because it indicates changes to the signal graphically. The window can be closed if desired. The Strip Chart displays data collected by the Sensor Window.

The Strip Chart and Analog Meter are explained in detail later in this document.

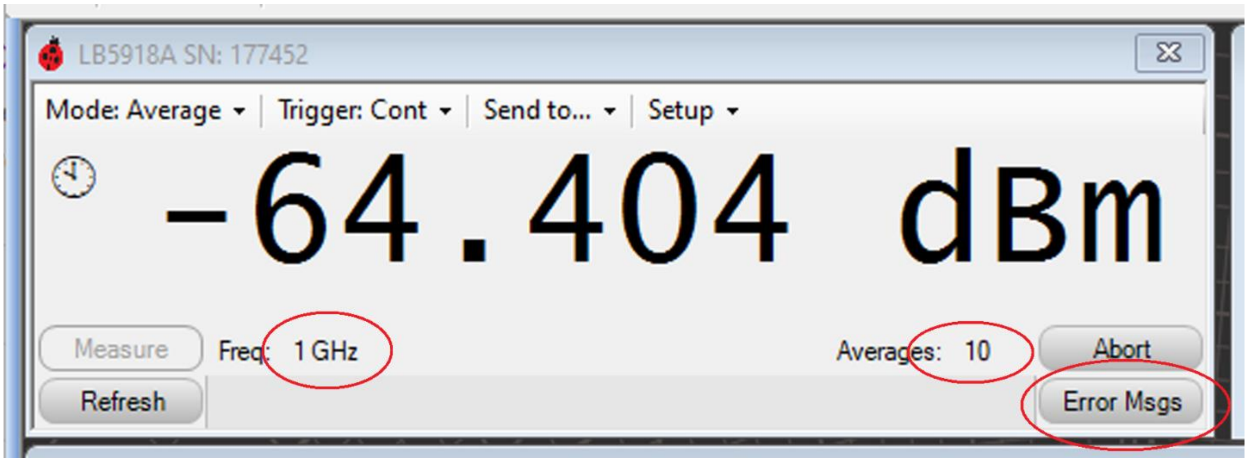


Figure 2 - Sensor Window

As with any power measurement, a few important parameters must be set.

Frequency

In order to achieve very high accuracy, power sensors are calibrated at various frequencies. To make an accurate measurement, set the frequency so the sensor can apply the appropriate calibration data. Click the displayed frequency (1GHz) circled in Figure 2, and set your signal's frequency.

Averages

The power sensor collects readings and averages them together. The number of Averages determines the time data is collected by the sensor prior to making the measurement available. PMA-12 collects these measurements periodically and displays them. They are also provided as a single point on the Strip Chart.

With the default PMA-12 settings, each measurement will take and incorporate about 250ms of measurement time. Some of the reasons for adjusting this are

- Long PRT, if you are working with a signal that has a long time between pulses, such as a radar pulse, you may want to increase the number of averages to include many pulses. Averages can be set to over 1,000.
- Low signal level, if your signal is very low in power, you may want to increase the number of averages to mitigate noise.
- High resolution, if you have sufficient power and a clean signal, you may want to reduce the number of averages to see signal changes more quickly on the strip chart or tabular log (explained later).

Error Reporting

The LB5900 Series power sensors maintain an internal error log. The error system is compliant with IVI SCPI instrument standards. The sensor may issue an error for various reasons including an attempt to set a parameter out of range, communication error, or an interruption during processing a command or query. A typical error that could occur when using PMA-12 is setting a parameter while the sensor is processing a measurement. This accidental, harmless error will be reported by the LED on the sensor indicating RED. Clicking the Error Msgs button (circled in Figure 2) in PMA-12 will request, clear and display the error message(s) form the sensor.

Advanced Measurements & Features

This section explains how to make several types of measurements. It is not intended to cover all of the capabilities or possible uses of the sensor and PMA-12 software. For details on accessing menus and features in this section, refer to *Section III Accessing Menus & Features*. You may wish to browse through these sections to get the look and feel of PMA-12. Reference to the Programming Guide is also encouraged.

Measurement Timing
Note, additional information about measurement timing can be found in the *Trigger Dropdown* area of Section III and the Programming Guide.

An average is made up of processed and calibrated readings. By default, PMA-12 sets the Sensor's rate for each individual reading to 40 per second (Refer to MRATe in the programming guide). With the number of Averages (Figure 2 - Circled in Red) set to 10, each measurement consists of (10 Averages/40 readings per second) or ¼ of a second. This time is often referred to as the capture time. Note: This is the rate the sensor itself makes the measurement, it is not necessarily the rate that PMA-12 displays the measurements.

<u>Measurement Latency</u>
PMA-12 requests measurements from the sensor, and the sensor processes the request as defined above. Because this timing is most likely much faster than it can be visualized, a delay is added between measurement requests. This delay is called *Measurement Latency*, it is located in the *Trigger* dropdown menu.

The type of measurement also affects the rate measurements are displayed. By default, PMA-12 uses the FETCh? query to collect measurements. In this case, the sensor is continuously making measurements and PMA-12 receives the measurement as soon as it requests it. If *Upon Completed Measurement* is selected in the *Display Update Mode* dropdown, the READ? query is used, and the measurement begins when PMA-12 requests the measurement. The interaction between *Measurement Latency* and *Display Update Mode* is explained below and in *Section III*.

<u>Intermediate Results</u>
Figure 3 shows how the sensor makes measurement at initial startup with no changes made. In this mode, the sensor is free running and PMA-12 simply requests a measurement.

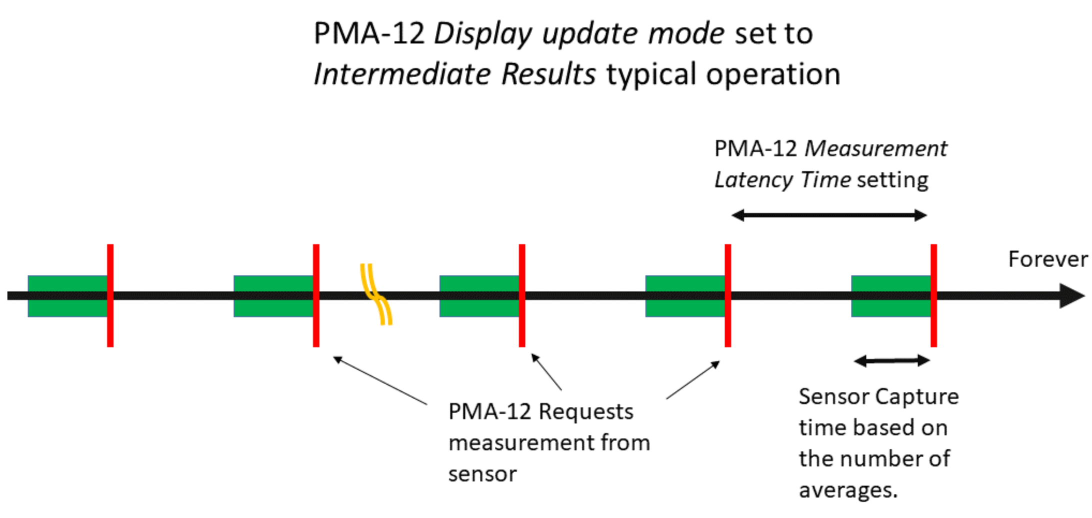


Figure 3 - Default settings Display update mode set to Intermediate results

The sensor immediately returns the last 10 averages (unless the user has changed the default setting). This measurement is very straight forward and makes a "trailing" measurement similar to a thermal sensor, returning the power level that occurred right before the display shows it.

If the user changes the number of averages so that a long period is captured, when the software begins displaying the measurement, all of the averages may not have been collected. In this case an intermediate result is displayed. Refer to Figure 4 for a graphical explanation. This will only affect measurements if the capture time is very long in relationship to the time measurements are displayed. A circular buffer is employed, and once a complete set of averages are collected, and each measurement is composed of the most recent set of averages.

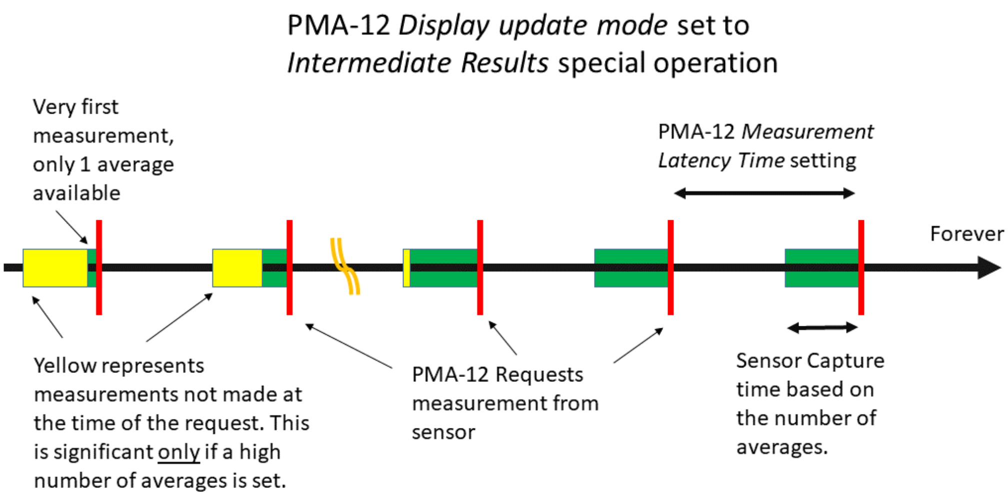


Figure 4 - Explanation of Fetch? and intermediate results with a long capture (high number of averages)

Upon Completed Measurement

When the *Display update mode* is set to *Upon Completed Measurement*, the sensor's Read? query is utilized. This causes the sensor to start a new measurement with fresh readings each time. See Figure 5. This is ideal anytime a measurement start time is important. It is also very useful for triggered measurements which normally define the beginning of a measurement capture.

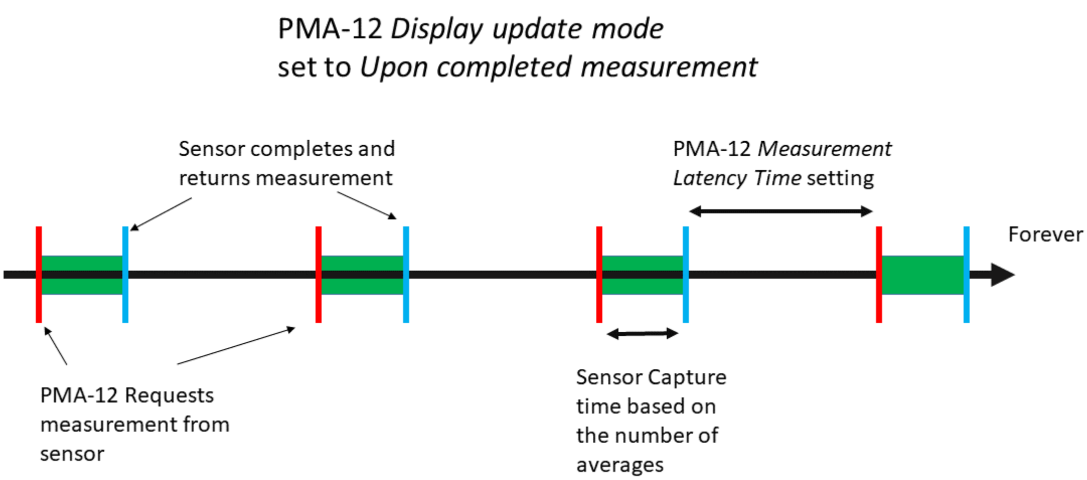


Figure 5 - Read? and if set to Upon completed measurement

Typical users viewing a signal graphically may not notice the timing nuances between *Intermediate results* and *Upon completed measurements* because the measurements are occurring in milliseconds and therefore changing faster than a user can see the data. Understanding the differences is most useful for programmatic users and users employing triggering.

Simulated Sensors

Simulated sensors are available by selecting the *Details Pane* then *Open/Close* then select Simulated Sensor. A simulated sensor is utilized in the *Derived Measurements* section below.

Derived Measurements

PMA-12 can calculate measurements between two sensors. The following measurements can be made using the Derived Measurements window.

- Reflection Coefficient
- VSWR
- Return Loss
- Mismatch Loss
- Gain
- Loss

This example shows a simple gain measurement on a module using an active sensor and a simulated sensor. The simulated sensor is utilized for explanation purposes on that feature as well as the Gain feature. Of course, these same measurements could be accomplished with an actual second sensor.

This example assumes a 20 dB coupler on the input of a module which is terminated into a sensor. The coupler sensor will be the simulated sensor and the terminating sensor is the actual sensor with power applied.

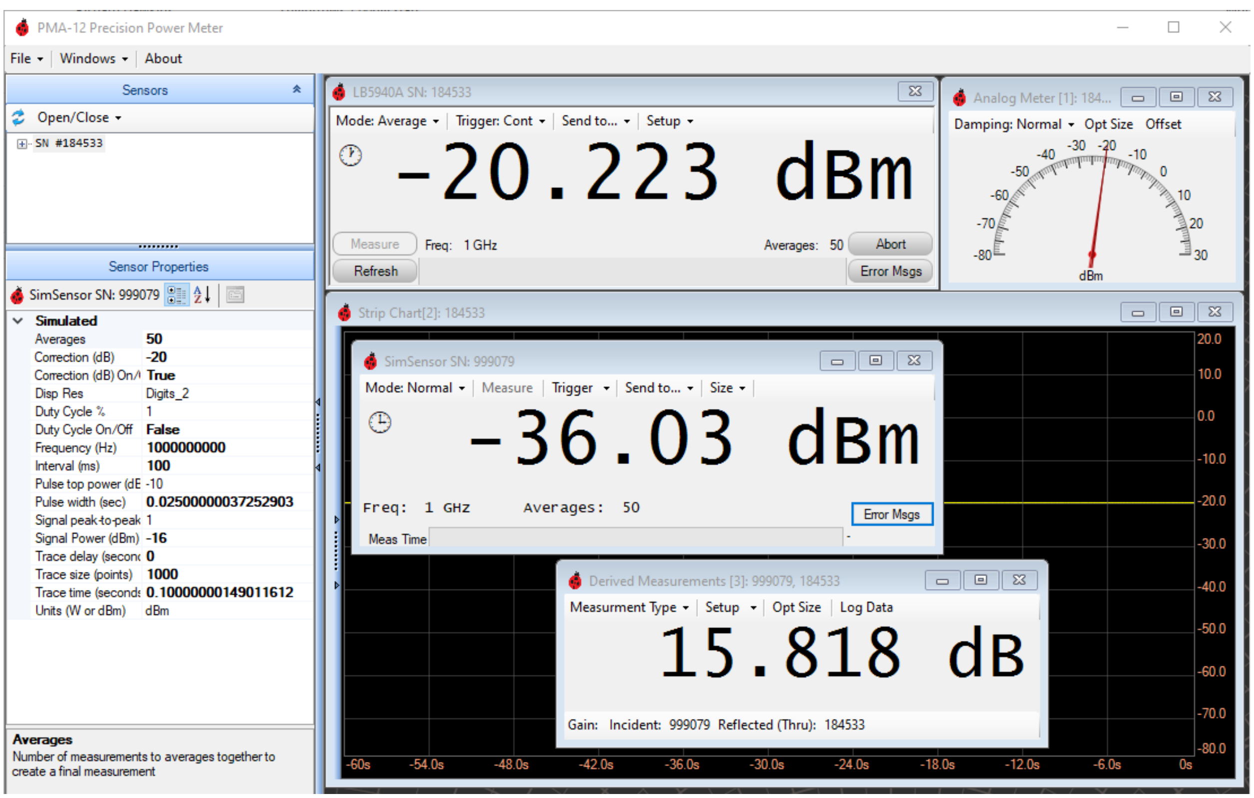


Figure 6 - Derived Measurement and Simulated Sensor

In this simulated example, real power of -20 dBm was applied to an actual LB5940A power sensor which was assigned as the terminating sensor. A simulated sensor was setup and a power level of -56 dBm applied in place of an actual measurement. Setting up this example will show the value of the Derived Measurement and make a real world measurement setup easier. This measurement was done this way:

- Start PMA-12
- Set the frequency
- Apply power to the actual sensor
- Open the simulated sensor
- In Simulated Sensor's Details Pane set the power to -56 dBm and include a 20 dB correction to account for the coupler. Be sure to enable it.
- Open a Derived Measurement window and set
    - Measurement Type to Gain
    - In setup, set the Incident sensor to the simulated sensor and the actual sensor to Thru
- For stability, increase the number of averages to 50 on both sensors.

Note in Figure 3 that the example result indicates shows that the module has a positive gain of 15dB. It would be quite easy to use a real sensor and make this a real world application.

Saving Derived Measurement Data

Derived measurement can be logged by selecting the *Log Data* in the Derived Measurements window. A logger will appear and automatically store data. Once open and data is collected, save the data to a file by first selecting *Pause* the logger window, then select File and then Save, a standard windows file menu will open. The saved file can be opened in Excel or other compatible tool for review.

When paused, data can also be selected and copied to the clip board for pasting in various Windows tools and applications.

Note, data can be stored while paused (default setting), this is selected in the *Options* dropdown of the Derived Measurement Logger window.

Triggered Measurements

LB5900 Series sensors have advanced triggering features. This section covers external triggering in the default *Average Mode* using the READ? query. Refer to the *Trace Measurements* section for triggered measurements made in the trace mode. To make a triggered measurement in Average power mode using PMA-12 software consider the following:

- Capture time
- External triggering
- Single measurement or continuous measurements
- Is a delay or pre-trigger data required

We'll assume the signal is 1GHz with a 150 ms on time and is a repetitive signal with a PRT of 500 ms.

Referring to the *PMA-12 Controls Sensor Window* section then the *Trigger dropdown* we set triggering control to *Single* so that the software does not send commands during setup. Next we set the measurement query to READ? by setting the *Display Update Mode* to *Upon Completed Measurement*. Again in the *Trigger* dropdown, set the *Trigger Source* to External.

Now let's look at the capture time. We'll collect about 100 ms to get a good reading of the power when the signal is on, bear in mind that the video rise time for the sensor in Average mode is about 7ms. PMA-12 sets MRATe (review in the Programming Guide for more info) to double at startup. This equates to 25 ms per average, dividing the desired time of 100 ms by the time per average of 25 ms gives 4. Set the number of averages to 4 in the sensor window.

In this example, external TTL triggering is used, internal triggering is not available in Average mode and will result in a settings conflict error (from the Sensor) if an attempt is made to set the mode. Internal triggering is available in trace mode detailed in that section. Next, in the *Trigger* section of the *Details Pane* set the *Slope* to Positive so that the measurement will be triggered when the input goes high. To account for the sensors video rise time, set *Trig Delay* to 10ms in the *Trigger* section.

Now in the Sensor Window, set the frequency to 1 GHz. Turn on RF Source and the external trigger, then open the *Trigger* dropdown menu and change the trigger to *Continuous*. You may also want to experiment with single manual measurements by setting the trigger back to *Single.* Once this is done, the *Measure* button will highlight. Clicking this button initiates a measurement. Once initiated, the sensor begins waiting for a trigger. When the trigger control is in continuous mode, PMA-12 automatically initiates a measurement based on the *Measurement Latency* time.

Locating Minimum and Maximum Power

PMA-12 can monitor, locate and indicate the lowest and highest power levels automatically. To use the feature, from the Sensor Window, select *Setup* then *Min Hold* or *Max Hold*. The resultant value will be displayed on the lower right hand area of the sensor window as shown in Figure 7.

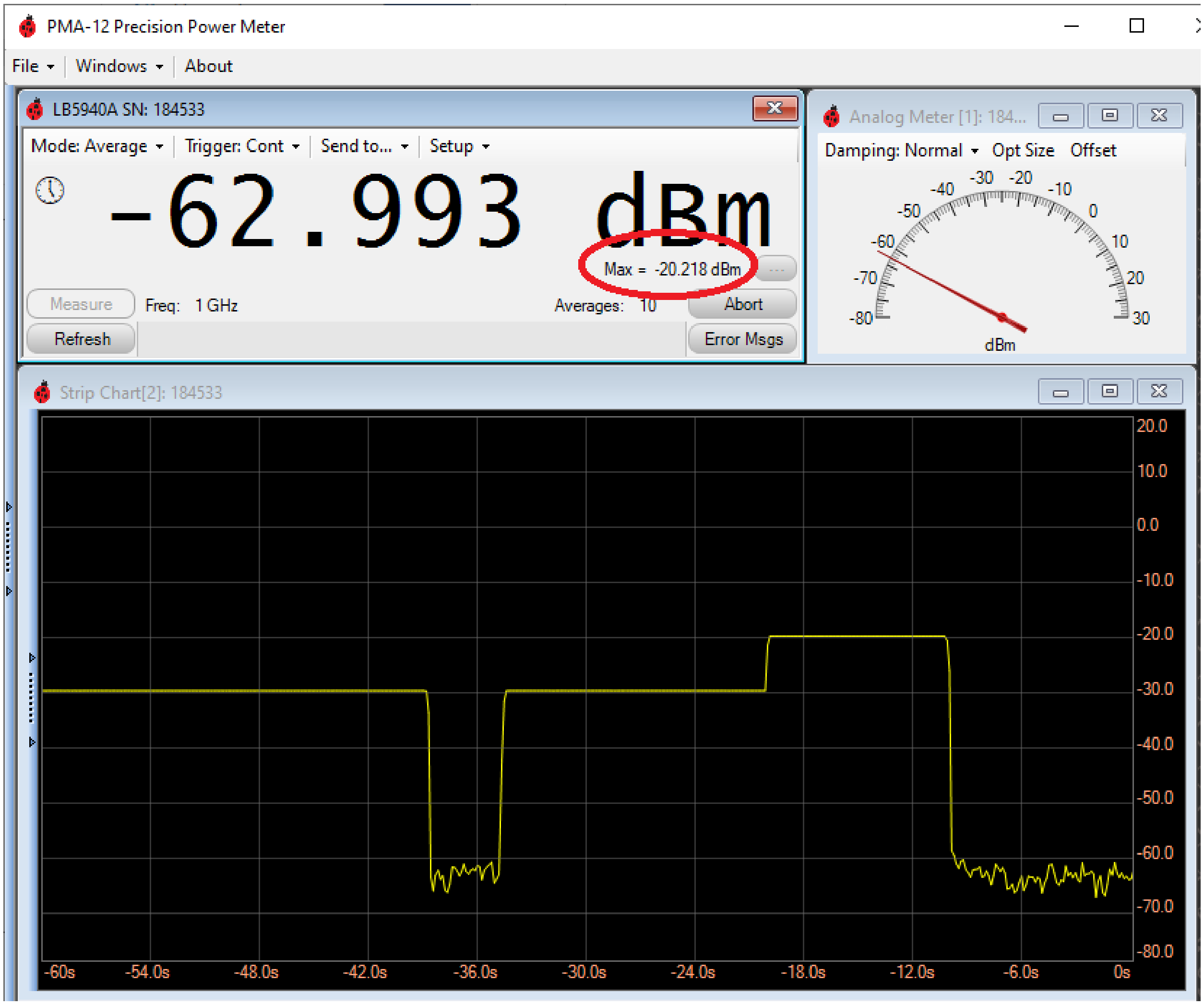


Figure 7 - Max Hold Value

Note the small button to the right of the value. Clicking this will reset measurement to a new starting value in Figure 7.

Displaying Relative Power

Relative Power displays the power between a pre-set level and the current power. The relative value will be displayed on the lower right hand area of the sensor window as shown in Figure 7 but will be labeled Rel. Note clicking the small oval to the right of the value will reset set compare value to the current value.

Frequency Dependent Offsets
LB5900 sensors have 10 internal Frequency Dependent Offset tables (FDO) tables that can hold up to 80 offsets each. These tables allow the measurement to be corrected at various frequencies for various purposes. One example is the use of an attenuator, which often vary slightly over frequency. To make an accurate measurement, you can characterize the attenuator to determine its actual attenuation at the frequencies of interest. Once the actual values are known, they can be placed in one of the LB5900's FDO tables to correct the measurement. Couplers and cables also exhibit a non-flat frequency response and may require the use of an FDO table to achieve the best accuracy.

Once offset data is known, to use an FDO, three things are required.

- Enter the FDO data into one of the tables using the *Setup* dropdown, then *FDO Editor.*
- Select the table in the *Setup* dropdown, *FDO Selection* then select the table.
- Enable the FDO by changing *FDO Enabled* to *True* in *Sense* section of the Details Pane.

The first two are explained in the Sensor Window, Setup dropdown section. The last item, enable, is explained in the Advanced Settings & Detail Pane section.

Note for programmatic users, these 10 tables and the function are located in the sensor itself and can be utilized in ATE test systems as well as PMA-12 software.

Simple Offset Correction
A simple offset correction is a quick way correct for an attenuator, coupler or situation where it is not necessary to include adjustments at different frequencies. Simple offsets are set in dB values in the details pane as shown in the Details Pane section. To use a Simple Offset, open the Details Pane then:

- Place the desired offset value in the *Correction (dB)* field of the Details Pane.
- In the Details Pane, set the *Correction (dB) Enabled* to True.

Note: The correction value will be added to the reading, positive and negative values are allowed. For example. -31.5 dBm will be corrected to -21.5 dB if a 10 dB correction is included; or to -41.5 dBm if a value of -10 dBm is used.

Note for programmatic users, the Simple Offset Correction function and value are located in the sensor itself and can be utilized in ATE test systems as well as PMA-12 software.

Duty Cycle Correction (Pulse Power)
Duty Cycle Correction is provided for users that wish to make pulse power measurements from average power using a known duty cycle. In PMA-12, the feature is controlled from the Details Pane. To use Duty Cycle Offset, open the Details Pane then:

- Set Averaging so that the measurement is stable and representative of many cycles
- Place the known Duty Cycle, as a percentage, in the *Duty Cycle %* field of the Details Pane.
- In the Details Pane, set the *Duty Cycle Enabled* to True.

Note for programmatic users, the Duty Cycle Offset function and settings are located in the sensor itself and can be utilized in ATE test systems as well as PMA-12 software.

75 Ohm Measurements

A simple offset specifically for 75 ohm measurements is provided. A standard MLP (Minimum Loss Pad) is required. MLP's are resistive dividers designed to present 75 ohms to the DUT and 50 ohms to the measurement device, in this case a power sensor. MLP's have a loss of 5.72 dB. This value is pre-programmed into the LB5900 sensor and can quickly and easily be used. To make 75 ohm measurements using PMA-12 and any LB5900 series sensor:

- Acquire and install a MLP (available from LadyBug Technologies)
- Open the Details Pane and change the *MLP Enabled* field to True

When enabled, 5.72 dB will be added to the measurement to correct for the MLP, thereby making accurate 75 ohm measurements.

Offsets and Correction Note

LB5900 sensors offsets and corrections work together in a cumulative way. For example, if an FDO is setup and enabled, and then a simple offset is also engaged at the same time, both offsets will act on the measurement. For example, a 75 ohm MLP offset can be engaged along with a simple offset for an attenuator, and both offsets will combine to make a proper measurement.

Trace measurements

Overview

LB5900 series sensors have two modes of operation. These modes are related to the video detector filters and sensor firmware. In its default state, the sensors operate in Average Mode. Users requiring wider detected video bandwidth can set the sensor to the Normal Mode. Average and Normal modes are sensor settings. Normal mode is referred to as the Trace Mode in PMA-12 and the software includes an easy to use trace display to allow the greatest use of the mode. These modes are described below.

- Average Mode (Not Trace) is the default mode and is designed for high dynamic range general power measurements. In this mode, the detected video filter rise time is about 7 ms. This filter improves the low level measurement range, allowing measurements down to -60dBm or below. The mode provides the best performance for general purposes.

- Normal Mode (used with trace) is designed for users that may need to make a triggered measurement to examine power at a specific point in time or to visualize part of a signal. Programmatic users may have additional uses. The mode includes a rich set of triggering features including the availability of pre-trigger data. The analog detected video filter in this mode is typically 60 kHz with a rise time of about 7 us. PMA-12 provides a trace display so that users can see the power level on a time basis. Like most high quality average power sensors, the LB5900 series sensors utilizes diodes operating in square law. These diodes require analog filtering (such as that used in Average Mode) to reduce noise when making low level measurements. With these filters optimized for speed (Normal Mode) inherent detector noise causes the minimum power level to move up to around -40dBm or so.

Trace mode is entered from the Sensor Window Mode dropdown. PMA-12 configures itself and the sensor for a trace display when the trace mode is entered. Once in Trace mode a trace window with a Control Pane, similar to the Details Pane appears. An image and details of the controls and navigation are shown in Section III under Trace Mode Controls.

9 kHz (L version) note

The Normal Mode detector is not available in LadyBug "L" version sensors (for example LB5908L compared to LB5908A) because the measurement frequency could potentially be less than the video filter frequency.

Triggered Trace Measurements

Though you can view a random time domain trace, nearly all trace mode measurements are triggered. Triggered measurement is triggered when the signal meets the parameters. Refer to Section III for information on accessing the detailed settings.

Internally Triggered Trace Measurements

As a minimum, to make a measurement these must be known and understood.

- Trigger Level – The power level that will cause the trigger to occur
- Trigger Polarity – The slope, or direction (increasing or decreasing) of the signal change
- Hysteresis – The signal level
- Trace Time – The time that the sensor collects data; the data is returned and displayed from left to right on the trace display.

The image below is of a pulse stream with the source set to generate a pulse power of +5 dBm, or off. The pulse width was set at 500us. To make the measurement, only 3 changes from the default trace settings were made. The *Trigger Level* was set to -1dBm, the *Hysteresis* was set to 2dB, then the *Trigger Source* was set to Internal.

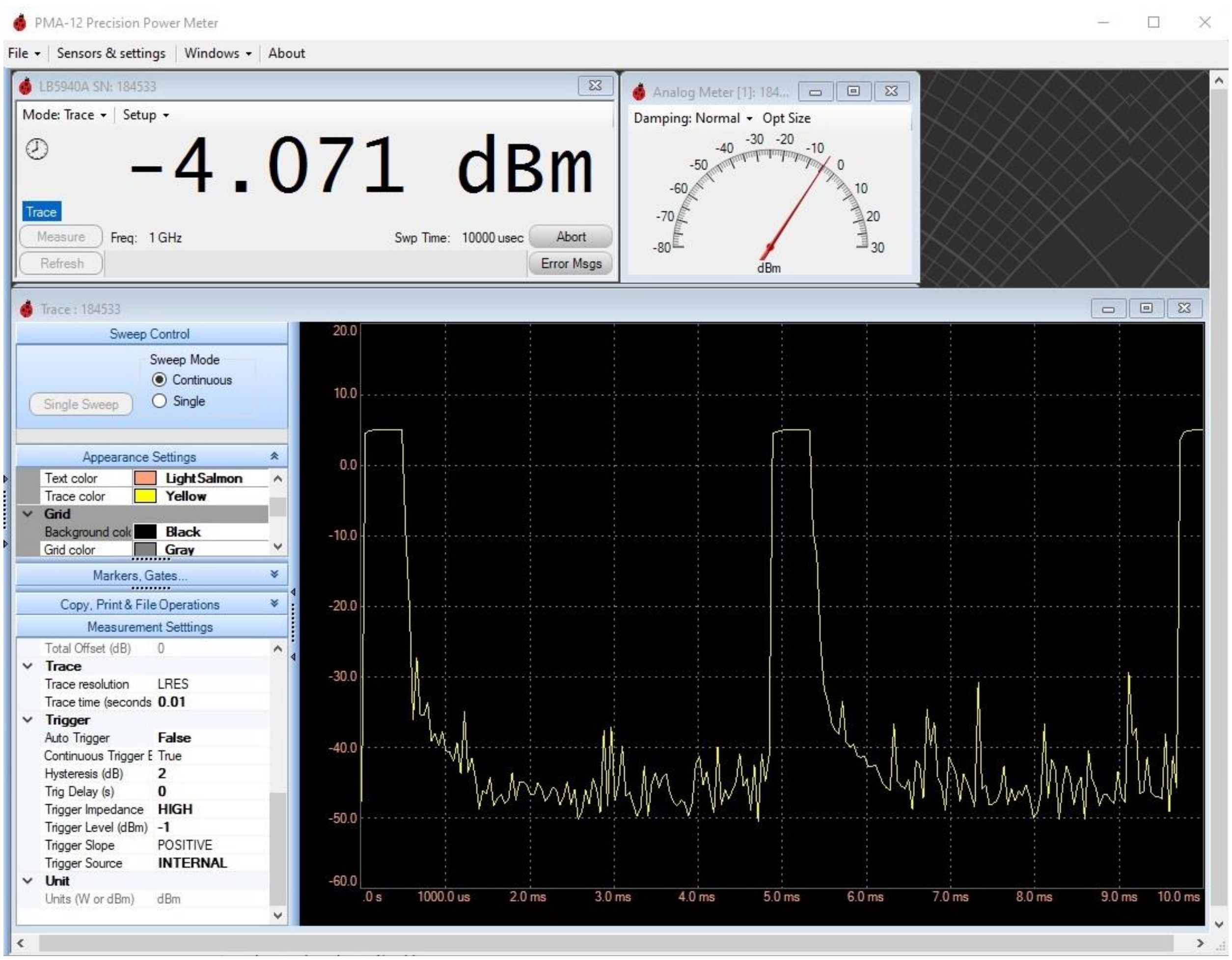


Figure 8 - Triggered Trace Measurement

Referring to Figure 8, note the -4.071 dBm measurement in the Sensor Window. This is the average power of the **trace**, it however may not be the average power of the signal, because there are not an exact number of complete pulses in the trace. To increase the accuracy of this information the *Trace time* can be increased such that there many pulses taken.

The measurement can be refined if additional information is needed. Figure 9 shows the display after a few parameter changes were applied to optimize the measurement. A trigger delay of -1ms was added to view the pre-trigger data; a marker was added at 1.3ms; and a gate has been added to measure the average power of one cycle.

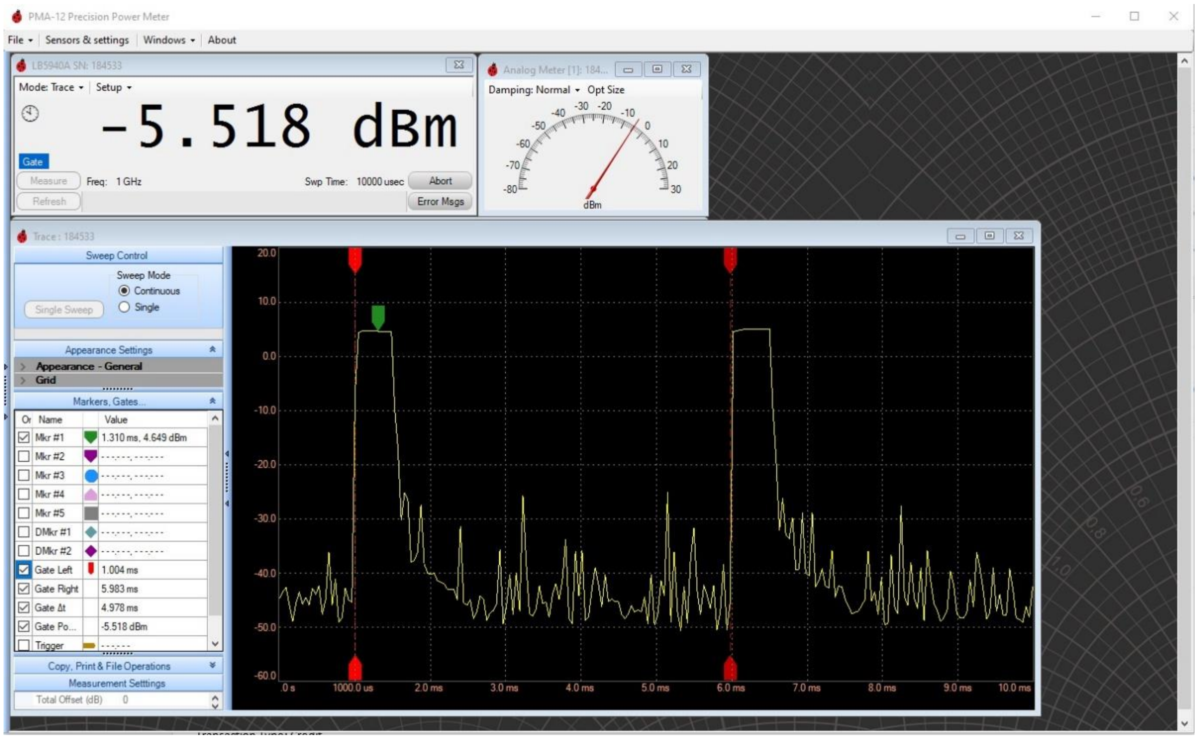


Figure 9 - Triggered Trace Measurement with Gates

In the left pane power at each gate (left and right) is listed as well as the average power between the gates. Additional markers & gates plus other information in a graphical manner can be displayed. For example, trigger level can be displayed along with the signal to aid in optimization.

<u>Externally Triggered measurements</u>

Externally triggered measurement are similar to internally triggered measurement except that the trigger is applied through the SMB connector on the sensor. The trigger is digital, and as such, the level and hysteresis settings are not applicable; however trigger slope, delay and impedance are settings that should be considered for the measurement. Figures 8 and 9 are also representative of the same signal with an external trigger applied and the *Trigger Source* changed to External.

Recorder Out (Analog Output)
The Analog Recorder Output function (Option 001) is a 0 to 1 VDC scalable output that is proportional to the measured RF input power. Note that on LB5900 series sensors Trigger Out shares the connector with Recorder Out. Only one can be used at any one time.

Important note: While in Recorder Out mode, the sensor averaging and other standard operating parameters are forced to parameters required by the Recorder Out functions. The display will show power level however settings in both the Sensor Window and Details Pane are restricted.

PMA-12 can be used to set and control Recorder Out. Recorder Out uses standard SCPI commands and Programmatic users have full control of the feature, refer to the programming guide for further details.

A very useful feature not found on competitive sensors is the ability for Recorder Out to operate with no computer attached (Unattended Mode). Once setup, only power is required for the sensor to supply a calibrated and scalable analog output.

LB5900 series sensor's Recorder Out also include a settable filter with a broad range of adjustability. For example low duty cycle pulses can be filtered into a stable analog level representing the average power.

Recorder Out Level Settings
The level settings for the Recorder Out are located in the *Output* section of the *Details Pane* for the selected sensor. Set up is accomplished by setting the desired power level for 0-Volts output (*Recorder Out Lower*) and the power level that is to result in a 1-Volt Output (*Recorder Out Upper*). These settings are located in the Details Pane. Note power applied below the lower level will result in a 0-Volt output; and power over the higher power will result in a 1-Volt output. **It is important to understand** that the sensor's output levels are dependent upon proper resistive loading. A 1,000 ohm load is required to meet the measurement voltage specifications, a precision resistance is recommend since the value of the load will affect the measurement.

Once the settings are established, the output will be a linear representation of the power between the two levels. The output voltage inside these ranges is a calibrated DC measurement value.

To set up Recorder Out, identify the minimum and maximum power levels (in dBm) that you require. Place these values in the *Recorder Out Lower* and *Recorder Out Upper* settings. Once the values are established, the formula below can be used to determine the output voltage for any given dBm power level.

Vout= (10^(PMEAS/10)-10^(ZeroVoltSet/10))/(10^(OneVoltSet/10)-10^(ZeroVoltSet/10))

The same formula (shown below) can be copied and pasted into excel at cell B4. When pasted into cell B4, the cells listed below will establish the inputs values. All power units are in dBm. Out of range data is not accounted for.

Formula in Cell B4: "=(10^(B3/10)-10^(B2/10))/(10^(B1/10)-10^(B2/10))" (no quotes)

Cell B1 place the dBm power setting to deliver for 1 Volt
Cell B2 place the dBm power setting to deliver 0 Volts
Cell B3 place the desired input power in dBm

It is important to have a clear understand about the levels and set point values. Set points are in dBm, however the DC output voltage scale is linear (not dB). For example, with a setting of -10 dBm for the low value and +10 dBm for high value, 0 dBm is NOT the half way point and will not result in .a 0.5 volt reading. Instead, since -10 dBm equals 0.1 mW and +10 dBm =10mW, the half way point is actually 5.15 mW or 7.12 dBm.

Some Examples:

Power	Recorder Out Low Setting	Recorder Out High Setting	DC Voltage
+10 dBm (10mW)	-10 dBm (0.1mW)	+10 dBm (10mW)	1 Volt
-10 dBm (0.1mW)	-10 dBm (0.1mW)	+10 dBm (10mW)	0 Volts
0 dBm (1mW)	-10 dBm (0.1mW)	+10 dBm (10mW)	0.10 Volts
-24.4 dBm (3.6uW)	-40 dBm (0.1mW)	-20 dBm (10mW)	0.37 Volts

Recorder Out Filter

The digitally applied filter RO Cutoff Freq (Hz) setting is located in the Output section of the Details Pane. For most LB5900 series sensors, the default is 32 Hz and the lowest frequency that can be set is .001 Hz.

Recorder Out Activation

To activate the output, first set the Lower and Upper levels and filter if desired; then set the mode to Recorder Out in the Mode Drop down in the Sensor Window; finally, activate the Recorder Output by selection the Start RO button that appeared when the mode was set. To stop the feature, click the *Halt RO* button in the sensor window, then select *Average* in the *Mode* dropdown.

Grounding and Ground Loops

LB5900 Sensors have solid grounding between the USB shield, USB Common and SMB (Recorder Out) Common connections. It is important to take ground current into consideration between all connected equipment when using Recorder Out. For example, many USB cables exhibit shield and common resistance of greater than an ohm. With 200 ma current draw from the sensor, there could easily be 200mv across the sensor’s USB cable. If the computer and the device monitoring the Recorder signal share common grounding, this current will be driven in a loop and may result in a ground offset voltage on the monitoring device.

Operation with No Computer Attached

As part of the standard Recorder Out Option (Option 001) the output can be operated with no computer attached. The output will be calibrated and scaled in accordance with the settings. Operating the output with no computer attached is controlled by the Unattended Operation controls, however it is not necessary to have Option UOP on the sensor for Recorder Out to function with no computer attached. To use Recorder Out in Unattended mode;

1. Setup the Upper and Lower levels & filter if needed (refer to Recorder Out Activation above)
2. In the *Basic Unattended Operation* section of the *Details Pane* set *UOP Recorder Out Enabled* to True
3. In the *Mode* dropdown from *Sensor Window* select UOP
4. In the *Start UOP* dropdown, select Do Not Save Data

The sensor will activate the Recorder Output. At this point, the sensor can be unplugged from the computer and attached to a 5.0 Volt battery or other power source and the output will function. This mode of operation will continue, through power cycles, until the sensor is reconnected to PMA-12 and UOP halted. These functions can also be performed programmatically.

To disable Recorder Out in Unattended Mode, connect the sensor to a computer running PMA-12, and start the software. The Sensor Window will show a message “UOP in progress . . .”. Select *Halt UOP* from the dropdown menu, then in the *Mode* dropdown, click Average.

Important Output Note

The sensor’s power-up cycle can take many seconds, and during this time the output voltage can fluctuate up to 5 volts.

Unattended Measurements (Unattended Operation)
Option UOP (Unattended Operation) allows the sensor to function with no computer connected. When utilizing UOP, the sensors current measurement setup (frequency & averages) will be utilized and measurements are stored in the sensors non-volatile memory. Unattended operation can also be utilized while the sensor is connected to the computer. In this case, the user can be assured that measurements will not be interrupted while the computer is used for other purposes, even those with high USB activity that could interrupt fast measurements.

UOP can store measurements at up to 1,000 measurements per second. This can take up a significant amount of memory if the sensor is used for a long period of time. To accommodate these applications, UOP has its own latency setting. This setting can be set from 1ms (.001 seconds) to 86,400 seconds (24 hours). A setting of 1 second will place 1 second between each measurement.

A Timer is provided to accommodate applications which do not need to measure for a long period of time. For example, setting this timer to 1 hour will cause the sensor to measure at the set specifications for one hour then go to an idle state. After repowering the sensor will not be in UOP mode but instead be in the normal mode. Data can be retrieved as described below.

Stabilization time
A stabilization time occurs when the sensor is powered on, this time is listed in the sensor's data sheet. Measurements made prior to the completion of the stabilization time are marked with an asterisk in the returned data.

Measurement rate note
If Recorder Out is set to active the measurement and storage rate is forced to 1,000 per second. The latency timer is not utilized in this case.

Setup and measure
To make an unattended measurement take the following steps. Be sure to verify that the clock is set prior to starting the process (refer to *Section III).*

- Set the measurement frequency
- Set the number of averages
- In the *Trigger* dropdown make sure *Display Update Mode* is set to Intermediate Results
- In the *Mode* dropdown, select UOP (a new menu will appear)
- Under the *Manage UOP* tab
    - Set the *UOP Measurement Latency* as needed for example 0.1 seconds
    - If desired, set the *UOP Timer* and click Enable UOP Timer
- In the *Start UOP* dropdown, click Save Data.
- The sensor begins making measurements.
- Disconnect the sensor from the computer and connect it to a 5.0 volt source and it will continue making and storing measurements.

Retrieve UOP Data
Data is stored in the sensor's non-volatile memory, check the data sheet to determine your sensor's memory depth.

Memory is stored in records, each consisting of an index, date, time. Value in dBm, and a flags field. Figure 10 is an image of the Retrieval screen with 5,106 stored measurements. During the period that was used to make these measurements, the sensor was powered a total of 4 times making measurements each time. These times were:

- When UOP was set up and started, a few measurements were made prior to disconnection.
- The sensor was then connected to a portable USB battery for 30 seconds and automatically made measurements.
- The sensor was disconnected from the battery and then reconnected making more measurements automatically.
- The sensor was then reconnected to the computer and began making measurements automatically until the *Halt UOP* button was clicked.

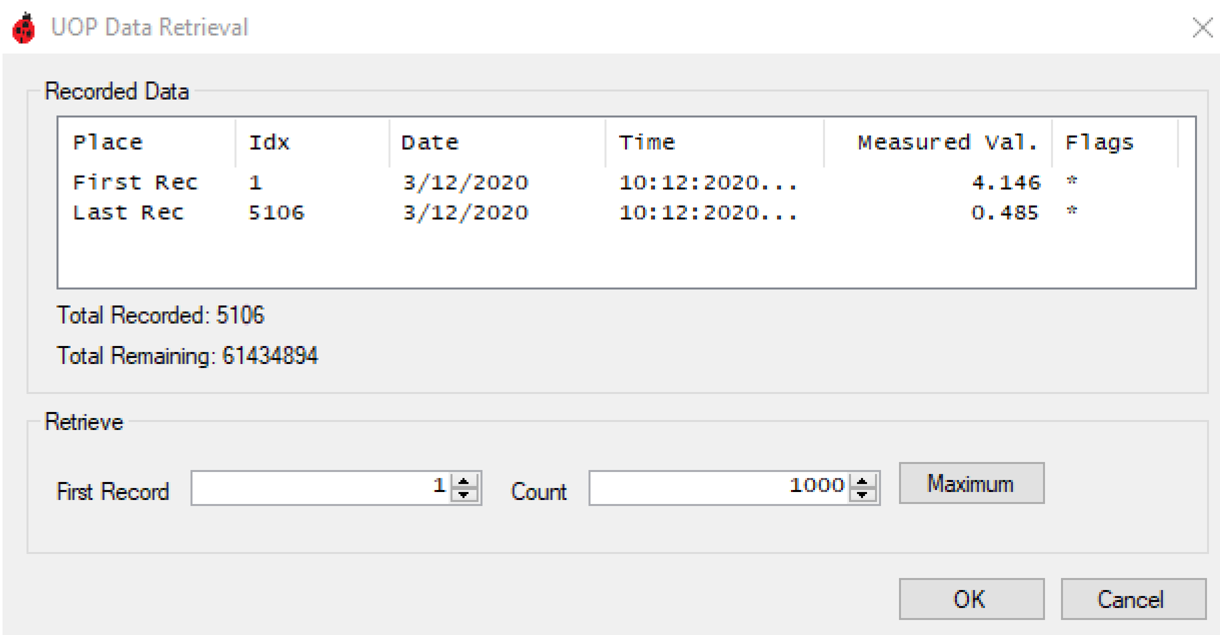


Figure 10 - UOP Data Retrieval

To retrieve data from unattended measurement, refer to Figure 10 and take the following steps.

- Connect to the computer and open the sensor if it does not open automatically. The *UOP In Progress …* screen will appear. The sensor is storing measurements during this time.
- Click *Halt UOP.* The sensor will stop making measurements.
- Click the Manage UOP dropdown then click Retrieve Data and the image in Figure 10 will appear allowing the selection of data.
- Click the *Maximum* button to download all measurements. Alternatively select he first stored measurement (*First Record*) and the number of measurements (*Count*) to select specific measurements to reduce the download time.
- After the UOP Log appears, note that under the File dropdown, the standard PMA-12 analyzation features are available such as Strip Chart and more. Also, the data can be saved for use in EXCEL or other tools.

Section III - Accessing Menus & Features

PMA-12 Controls - Sensor Window

At the top of the Sensor Window are 4 drop down menus that allow control of the measurement. It is important to understand that most of these settings send commands to the sensor making it function differently. A few however change the PMA-12 software settings.

Mode drop down menu

The Mode dropdown controls Presets, Unattended Operation (Optional), Recorder Out (Optional), and the type of measurement, there are two basic measurement types Average and Trace.

Average

The Average mode is the default mode for the sensor. It sets the sensor to collect and average samples into the displayed measurement. The other basic mode Trace, which is discussed later.

Preset Average

The Preset Average is a kind of safety net. If you have set features and functions to unknown conditions and can't seem to get the sensor back to normal, clicking Preset Average will return PMA-12 and the sensor to the startup settings.

User Preset

Load (recall) the User Preset parameters. If you have saved a User Preset, this selection will enable the settings from the preset.

Configure User Preset

This feature allows you to save the current settings as a preset which can be loaded later, saving time during setup for repeated measurements. You can choose to save the settings as a User Preset which can be loaded when requested, or set the current settings so that they will automatically be used at startup. This is ideal when the sensor is used in manufacturing. You can also clear the user presets in this menu.

UOP

If your sensor has the Optional UOP (Unattended Operation) feature clicking this button will place PMA-12 and the sensor in Unattended Mode. Discussed in detail in the Unattended Operation Section.

Recorder Out

If your sensor has the Optional Recorder Out (Analog Output) feature clicking this button will place PMA-12 and the sensor in Recorder Out Mode. Note that many settings, such as the number of averages, are forced into specific settings so that the Recorder Out can function properly. These settings cannot be changed while in Recorder Out Mode. Refer to the Recorder Out Section for additional details.

Trace

If your sensor has Trace Capabilities, selecting this mode will change the PMA-12 display to a time domain display similar to the Strip Chart, but with the sensors maximum sampling rates applied to the measurement. Each sample placed on the display is a fully calibrated un-averaged sample. Note that the sensor's hardware filter rage is changed to +/- 60 kHz. See the Trace Section for further details.

Close Sensor

Closes the sensor window and disconnects the sensor driver.

Trigger drop down menu

The Trigger dropdown controls measurement and display timing as well as internal and external triggering. The important triggering settings are in this dropdown; however when using triggering, it may also be necessary to locate some settings, such as trigger level, in the Details Pane. Accessing these settings is reviewed in the Advanced Settings & Detail Pane section.

Continuous & Single

These two settings control the way that PMA-12 requests measurements from the sensor. PMA-12 uses the LB5900 sensor measurement modes in conjunction with its own timer and controls. Refer to the Programming guide to understand more about the sensor's measurement commands. In the default mode, PMA-12 sets the sensor to free-run by setting INIT:CONT to ON and the sensor's trigger mode to IMMediate which causes it to "free-run". With the sensor free-running, PMA-12 collects measurements each time its (PMA-12's) latency timer times out. The measurement will consist of the previous 10 (default setting) averages.

Changing to Single from the default continuous mode does not change the sensor settings, it simply disables the PMA-12 latency timer and enables use of the green Measure button so that the user can make the measurement manually. See related information in the Display Update Mode section.

Display Update Mode

The display update mode controls the measurement queries that are used. Intermediate results uses the FETCH? query whereas Upon completed measurement uses the READ? query. The difference is that FETCH? is a trailing measurement which reports the average of the past readings, and READ? initiates a new measurement and at completion reports the measurement that occurred after the measurement was requested. Please refer to the programming guide for further details on the measurements.

Intermediate results

In the default *Intermediate results* mode, the FETCH? Query is used to collect the measurements which consist of the previous 10 (default setting) averages. For the special case, such as a high number of averages and a manually triggered measurement, consider the following. If the query is issued and the measurement is not complete, for example only 100 averages have been collected when averages has been set to 500, the calculation will be of the past 100 averages, hence the name intermediate results. However for typical use, there will always be 10 (default setting) averages collected, so the term Intermediate results is more appropriate when the number of averages has been changed and a special measurement is being made.

Upon Completed Measurement

In the *Upon completed measurement* mode, the READ? query is used to collect the measurements. When the READ? Is issued by PMA-12, the sensor starts a new measurement which consist of the specified number of averages (default setting 10) beginning when the request is made. It is common to use READ? with triggered measurements because it defines the beginning of a measurement period. The sensor is inaccessible during the time the measurement is being made, and if a high number of averages is set a measurement might not return for 30 seconds or so. For long measurements it could be necessary to set the time out; refer to Advanced Settings and the Details Pane section.

Clear Display on Start

If the *Clear display on Start*, is set, the display will be cleared when a new measurement is started. This can eliminate confusion when making manual or triggered measurements which could have similar results.

Trigger Source

The LB5900 Series sensor has very flexible triggering capabilities. The selections available in the Trigger Source menu are augmented by the settings in Details Pane discussed later. The Trigger Source menu consists of three settings:

Immediate (default)

When set to Immediate, the sensor re-triggers itself and continuously makes measurement. This is often referred to as free-run mode.

External

When set to External, the sensor will wait until it receives a TTL level trigger at the external trigger input. This is applied through the SMB connector labeled TI for Trigger Input. Trigger polarity can be set in the Details Pane covered later in this document.

Internal

When set to Internal, the sensor will wait until it receives a signal level trigger. Trigger level and polarity can be set in the Details Pane covered later in this document.

Measurement Latency

The Measurement Latency timer determines how often PMA-12 will request a measurement from the sensor. The sensor can make measurements much faster than they can be displayed, therefore a Measurement Latency timer us used to display the measurements clearly and accurately. If logging and storing measurements to a file, Measurement Latency can be set to as low as 5ms.

Send to.. drop down menu

As previously mentioned, the Sensor Window controls the sensor and makes all measurements. Data can be sent from the Sensor Window to various controls for display or storing using the Send to menu.

New

Select New then Logger, Analog Meter, Strip Chart or Derived Measurement. This will create the selected feature and send measurements from the Sensor Window at the selected Measurement Latency to the new Window.

Logger

A tabular log lists Measurement Index, Sensor Serial Number, Date and Time plus the reading. When Paused, Logged data can be saved in user defined files. While paused, data is buffered and can be included if Add Buffered Data is checked in the Logger's Options menu. Multiple sensors can be logged by pausing the log, and selecting the desired active sensors using the Logger Options dropdown then clicking Sensors and selecting from the list of active sensors.

<u>Analog Meter</u>
The Analog Meter can be useful in certain applications. Select New Analog Meter from the Sensor Window to open a new Analog Meter. Meter damping can be applied to make the movement smooth. Click Offset to show any offset that has been setup in the Details Pane for the measurement (it is independent of the meter).

<u>Strip Chart</u>
A Strip Chart is open by default if a single sensor is connected at startup. The strip chart shows the signal level and changes graphically. The chart can be very useful, for example, when determining the amount of averaging required to achieve a clean accurate measurement, the graphical view can be an exceptional tool.

Multiple sensors can be plotted on the chart. To add a data from a second sensor to a strip chart, go to the second sensors Sensor Window and select *Send to* then *Existing*, select the existing chart. Note the two small arrows at the left of the Strip Chart which open a menu with additional settings such as offset and reference level which can be set to look more closely at a specific level. Right click in the chart area to open a menu that allows setting parameters such background, grid and trace colors. Markers can be enabled to indicate measurement point.

From the right click menu, the strip chart can be printed, saved as an image.

The Strip Chart can be saved as a data file. This file can be imported into excel or back into the Strip Chart for plotting against another sensor, file or simply viewing. To plot an existing sensor with saved strip chart data, first open a new unassigned Strip Chart from the main Open/Close menu in the Details Pane (see Advanced Settings & Details Pane). Once the new blank chart is open, right click the plot area and select Open File and open the graph_....txt data file. Then go to the active Sensor Window and select *Send to* then *Existing* and select the chart. The new data will begin plotting at the point the stored data began on the chart.

<u>Derived Measurements</u>
If multiple sensors are open, or if it is desired to compare a simulated sensor, a Derived Measurements Window can be opened. Open the Derived Measurement Window by selecting *New* then *Derived Measurements* from the *Send to* dropdown in a Sensor Window. Once opened, select the Measurement Type dropdown and set the type of measurement you want to make. Then, in the Derived Measurements Window, select the *Setup* dropdown and assign a sensor to function as the Incident and one for Reflection / Through. Once these are properly set, measurements will appear. Data can be logged by selecting the *Log Data* and a logger (previously explained) will appear.

The dropdown controls measurement and display timing as well as internal and external triggering. The important triggering

Existing

The *Send to.. Existing* button shows a check box for any open Logger, Analog Meter, Strip Chart or Derived Measurement windows. Checking the desired box and clicking OK will cause the data to be included in the selected feature as previously explained.

Set Log File, Log Overwrite & Log Append

Measurements can be made much faster than they can be displayed on the screen. The logging features are designed to make fast measurements. To use the log to file feature, first set the log file by clicking the *Set Log File* button from the *Send to..* dropdown menu. Once set, you can begin logging by using the *Log Overwrite* or *Log Append* buttons from the *Send to..* dropdown menu. The overwrite will delete any previous data from the set file or if append is selected, the new data will be added to the file.

Add Comment to File

While the file is being written, the *Add Comment to File* button can be used to write a reference into the file. Each measurement is time stamped and the comment will appear at the time (computer time) when it was made.

Setup drop down menu

The Setup dropdown controls PMA-12 Window size features plus the max and min hold and relative functions. These are PMA-12 features and not sensor settings. Additionally, this menu controls the sensor's FDO tables which are stored and activated in the attached sensor.

Size

When PMA-12 starts, the windows are arranged for general use, in some case window arrangements are locked so that when new windows are opened carnages can be controlled. The *Size* menu contains controls to unlock and change windows to suit a user's specific needs or layout.

Unlock/Lock and Optimize Size

The first selection, *Unlock and Optimize Size,* sets the windows to the preset idealized size settings but in an unlocked stats so that users can resize the windows. Selecting *Lock and Optimize* will return the windows the preset states and lock them.

Lock / Unlock Size

Selecting *Lock* or *Unlock* simply allows control without any pre-set sixe optimization.

Default

Selecting *Default* returns the window sizes to the preset default sizes and locks them.

Min-Max Hold Enabled

PMA-12 features Min and Max features. These features locate the minimum or maximum signal and report it. The measurements are ideal when measuring long term levels extremes, unexpected spikes or losses which can occur in source range changes and various other conditions. Once the measurement is set, the Min-Max Hold Enabled selection turns the feature on and off.

Min Hold / Max Hold

PMA-12 can display either the minimum value or the maximum value. Select the *Min Hold* and the application will continue to report the lowest value since the selection was made. Select the *Max Hold* and the application will continue to report the highest value since the selection was made.

Relative Enabled

The relative measurement feature continuously compares the current value to a set value. When the *Relative Enabled* selection is checked, the current value is set as the compare value. The relative value will be displayed in the lower right hand area of the sensor window.

FDO Editor

LB5900 sensors have several internal Frequency Dependent Offset tables (FDO) tables. These tables are located in the sensor itself, and not in PMA-12. PMA-12 makes using the tables easy. From the *Setup* dropdown, clicking *FDO* Editor then select a table from the left *Tables* column. The table can be renamed using the *Rename* button below the list of tables. To add an offset, which consists of a frequency and an offset, go to the top and either enter a percentage or click the *dB>%* button and the software will calculate the dB value and insert it when the *Enter* button is clicked. Click *Add or Modify*. Note that the FDO table can actually be looked at as a response table. For example, response data for an attenuator can be placed directly into the table and the sensor will subtract positive values (in dB) so that the response is flat. Change the frequency to the next one in your list and add it the same way up to 80 values can be added. Interpolation is used between the points.

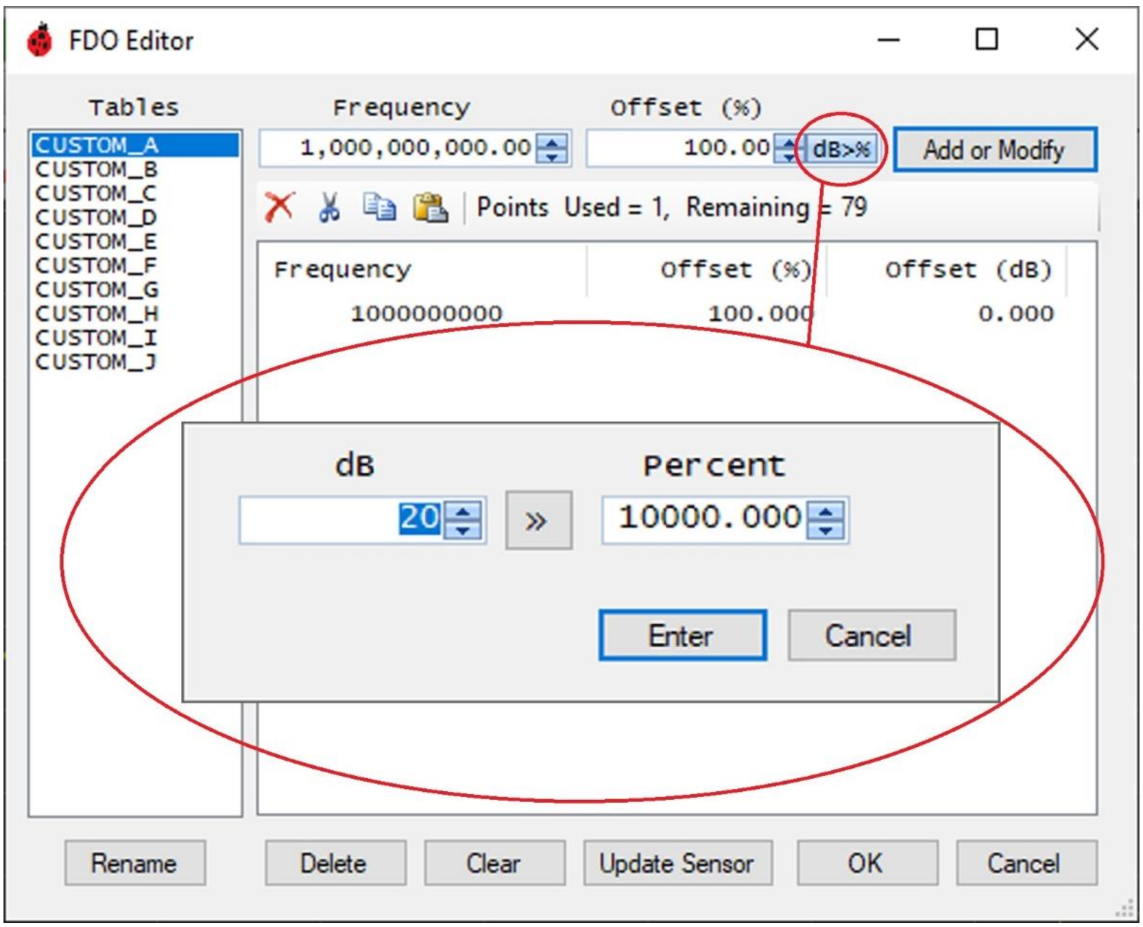


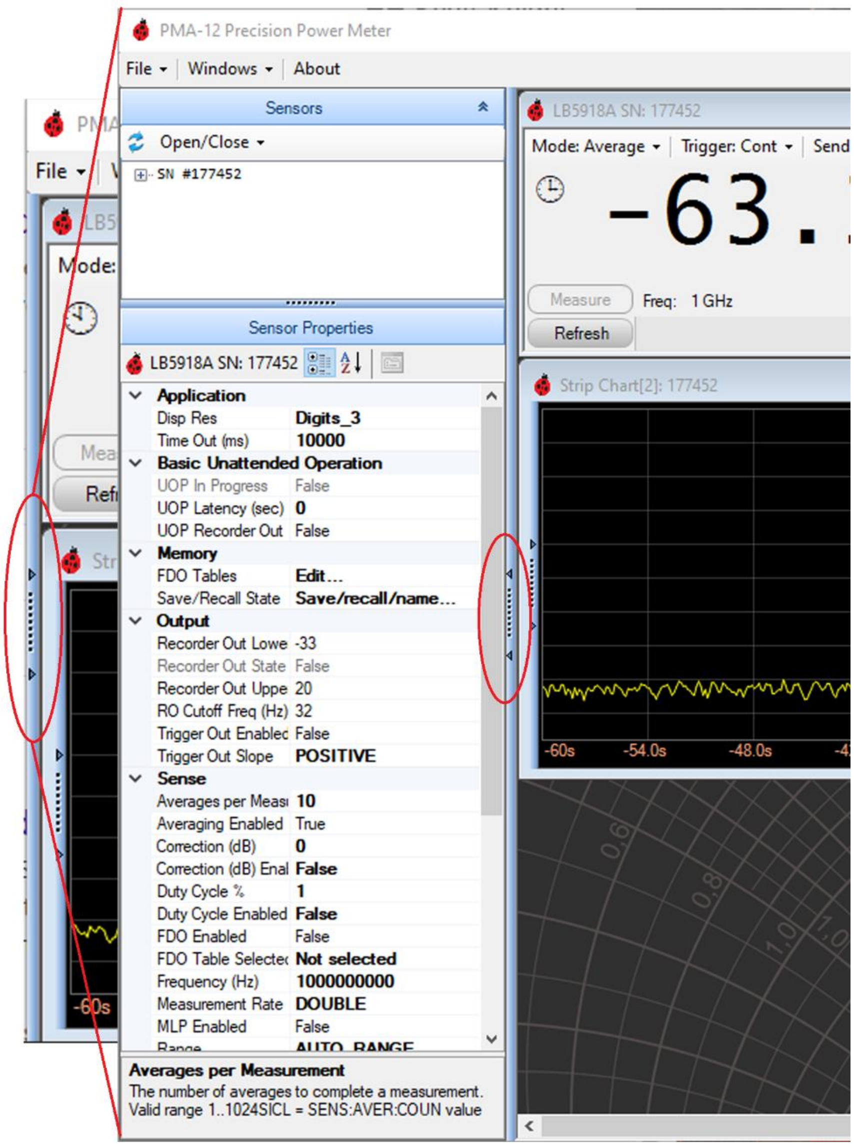
Figure 11-FDO Table Editor

FDO Selection

To select a specific table, from the *Setup* dropdown in the Sensor Window, click *FDO Selection,* a list will appear, select the table from the list.

Advanced Settings & Detail Pane

Settings that are not accessible from the drop down menu's are available in the Details Pane. Many of these settings are used for advanced measurements such as Time Gated Measurements, Frequency Dependent Offsets, Recorder Output and other settings. The Detail Pane is accessed by the two small arrows shown in Figure 11. Note also the two arrows at the right to close the Pane. Some settings are available in both the dropdown menu's and Details Pane. To gain a full understanding of any setting in the Detail Pane not covered in this manual, refer to the Programming Guide.



Trace Mode Controls

Activating trace mode places the sensor in Normal Detector mode, refer to Section II Making Measurements then Trace Measurements for more information. After PMA-12 configures the sensor for Normal Mode, the Trace Display similar to Figure 12 will appear.

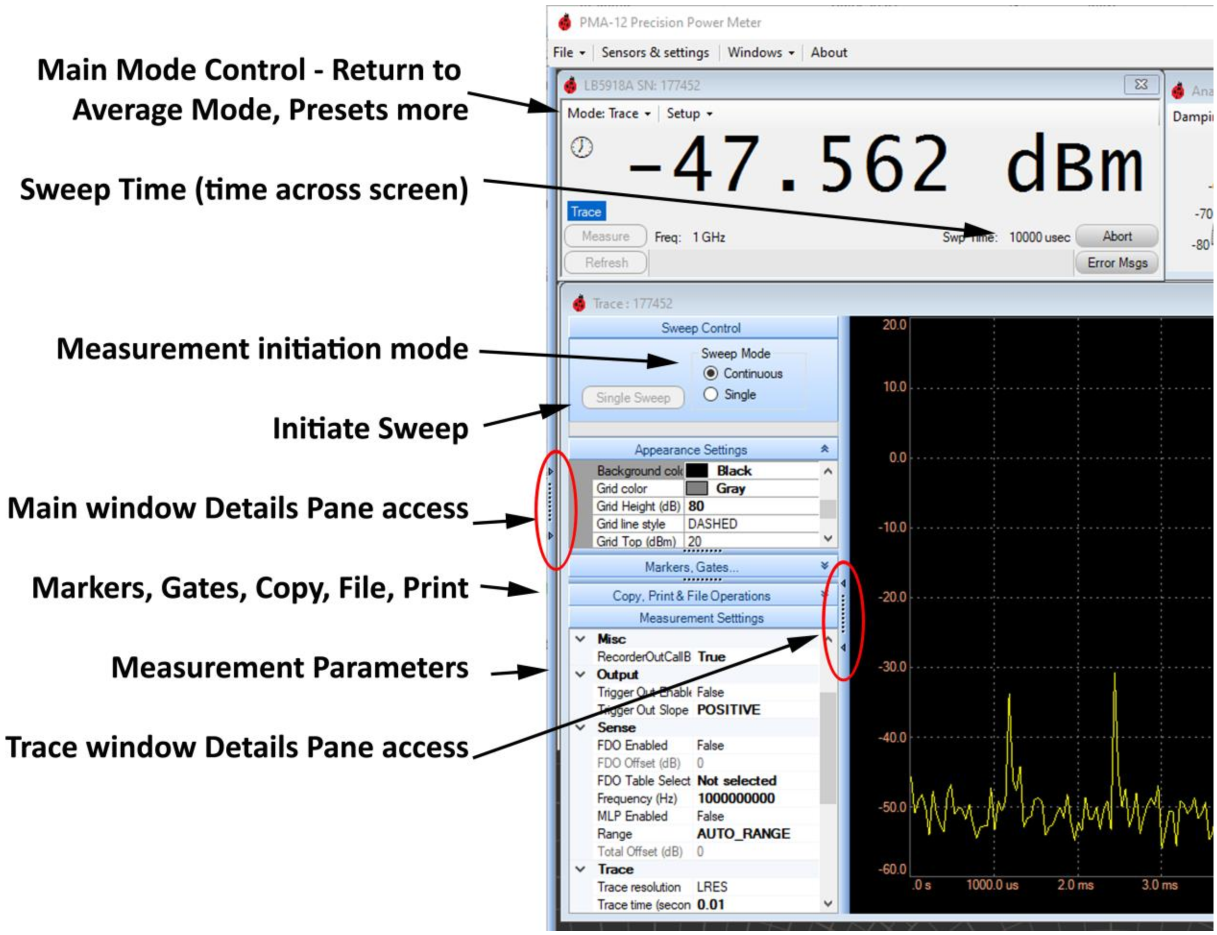


Figure 12 - Trace Mode Controls

To return to Average Mode, select the *Average* from the *Mode* dropdown in the *Sensor Window*. The trace time is controlled by the *Swp Time* listed in the Sensor Window or *Trace time* in the Trace Measurement Details Pane. These two settings affect the same parameter.

Sweep Control (Trace Initiation)

Measurement initiation controls the start of a measurement, when set to *Continuous*, measurements are initiated when the previous measurement is complete (after the trace has been delivered). When set to single, the sensor will wait for manual initiation (clicking the *Single Sweep* button). Note: Initiation is <u>not triggering</u>, triggering can occur only after a measurement has been imitated.

Trace Appearance Settings

Below the Sweep Control in the Trace Detail Pane are settings that can be used to change the appearance of the display and to adjust the numeric scales which can be used to achieve better detail on a particular level or time range.

Markers, Gates…

Markers, Gates, and a Graphical Trigger level are included in the Trace Detail Pane below the Appearance settings. To use any of these features open the *Markers, Gates..* section of the *Trace Controls Pane*, then click the check box for the desired feature. The feature will appear on the screen and can be adjusted using the mouse. In the check box table, *Value* indicates the set point of feature. In some cases, such as Average Gate Power, the data in that Value field may include a returned measurement; markers are another example of this. Clicking the icon for the individual feature allows the shape and color of the icon to be adjusted to suit the user's preference.

Trace Copy, Print & File Operations

The Copy to Clipboard copies the trace as a list of time and power levels. The data can be pasted into Excel or other standard Windows software. Print image prints the char in color; colors can be adjusted if required. Save image to file generates gif format image file of the chart. Save data generates a txt file with the data; this data is identical to the copy to clip board data.

Trace Controls Pane (Measurement Settings)

Measurement settings determine how the sensor makes the trace measurement.

<u>Application - Time Out (ms)</u>

The default time out setting of 10 seconds is adequate for most applications; however for some triggered applications this may need to be changed.

<u>Memory - FDO & Offsets</u>

Offsets, including MLP & FDO tables are covered in the previous sections. Duty Cycle correction is not available in Trace Mode because the entire time period of the waveform may be unknown.

<u>Output (Trigger Out)</u>

Trigger Out is electrically applied through the TO SMB connector on the sensor. If *Trigger Out Enabled* is set to True, a 500ns pulse will be presented at the TO connector when the sensor is triggered. Trigger Out Slope sets the polarity, when set to POSATIVE, the normal state is 0 volts, and a positive 500ns pulse will be delivered. Refer to the programming guide and data sheet for additional information.

<u>Sense</u>

Items in the Sense section have been covered in the previous sections.

<u>Trace</u>

<u>Resolution</u>

Resolution and time settings control the data that will be returned from the sensor. By default Low Resolution is used. Resolution can be set to LRES, MRES, HRES which is the number of points that will be returned from the sensor with each trace. LRES trace returns 230 points, MRES returns 1000 points. HRES returns a high resolution trace with the number of points based on the trace time and fast sampling rage. The USB transfer and processing of a HRES can take a relatively long time to return. For additional information, consult the programming guide. Trace time can be set in the Sensor Window or Trace Controls Pane.

<u>Trace Time</u>

Trace time sets the time that the trace will cover. For example if an anomaly occurs sometime in a 1 ms window, a 2ms triggered trace with a delay could be set to capture the anomaly.

Trigger

To make measurements, the sensor must be initiated, then triggered. See also above Sweep Control. Sweep relates to sensor initiation and triggering relates to control of the measurement after it has been initiated.

Continuous Trigger

After measurement Initiation occurs causing the sensor to leave the idle state, continuous trigger determines when the measurement will be started. Data collection begins after initiation, this allows access to pre-trigger data. To use triggering, *Continuous Trigger* must be set to False.

- If True, *Continuous Trigger* causes the sensor to immediately collect and return a trace after PMA-12 initiates it. In this case *Sweep Control* controls the measurement which is essentially a NON-Triggered measurement.

- If *Continuous Trigger* is set False, the sensor will wait for an internal or external trigger to occur before reporting the trace data (after initiation).

Note: It may be necessary to adjust the USB time-out when making triggered measurements.

Hysteresis (dB)

In the trigger system, hysteresis is included to prevent re-triggering. It is used only with internal triggering because external triggers are digital. Hysteresis is the level below (or above if the slope is negative) the set trigger level, at which the trigger system will allow acceptance of another trigger. Trigger Hysteresis is set in dB, regardless of the reporting units (Watts or dBm).

Trigger Delay - Trg Delay (s)

After initiation occurs, the sensor begins collecting data into a buffer. After a trigger occurs, the sensor continues to collect data until the measurement is complete. The sensor then returns the data, the data returned data will begin at the trigger point plus the trigger delay. If the trigger delay is negative, pre-trigger data will be included. Note: By default, the sensor includes an automatic trigger delay which may or may not be sufficient for your application.

Trigger Impedance

The External Trigger input includes a selectable input load to accommodate different systems. When set to HIGH (default setting) the input impedance is 100k ohms. When set to LOW the input impedance is 50 ohms.

Trigger Slope

If internal or external triggering is active, the sensor detects triggers based on level change. The *Trigger Slope* setting controls the direction of change that will cause a trigger to occur.

- If set to Positive, *Trigger Slope,* the measurement will be triggered when the external trigger input goes from low to high; or when the signal reaches the internal trigger level setting. Re-arming of the trigger circuit occurs when the External input goes low or when the internal level drops below the trigger level less the hysteresis.

- If set to Negative, *Trigger Slope,* the measurement will be triggered when the external trigger input goes from high to low; or when the signal falls below the internal trigger level setting. Re-arming of the trigger circuit occurs when the External input goes high or when the internal level exceeds the trigger level plus the hysteresis.

<u>Trigger Source</u>
Trigger source determines what will cause the measurement to start. Note that the measurement must already have been initiated (see *Sweep Control*). There are three options.

- Immediate - Triggering automatically occurs (triggering per se is not used). In this setting the measurement simply starts with no synchronization other than the initiation.

- External - With this setting, the sensor will wait for an external trigger (after initiation). In this setting, time-out setting should be considered. Initiation can be Single or Continuous (see *Sweep Control*).

- Internal - With this setting, the sensor will wait for an internal trigger (after initiation). In this setting, time-out setting should be considered. Initiation can be Single or Continuous (see *Sweep Control*).

<u>Unit</u>
Unit sets the displayed measurement units. Units can be Watts or dBm. Although Unit is a sensor function and does control the way the sensor returns data, it is important to understand that some of the settings are made in one specific unit regardless of the Unit setting. These are noted in their specific setting. Refer to the programming guide for further information.

<u>System</u>
Sensor Clock
Sensors with Option UOP (Unattended Operation) can take advantage of the sensors internal clock. The clock is set to the host computers by selecting *Set* then System. The sensor must not be in the UOP mode, set to Average Mode first.