



User Guide

**USB &
Ethernet**

POWER SENSORS



The PWR series covers:

0.009 – 8000 MHz

-60 to +20 dBm

50 and 75 Ω Impedance models

Peak & Average, RMS and CW models



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Chapter 1 – General Information

1.1 Scope of the User Guide

This User Guide provides general introduction, installation instructions and operating information for Mini-Circuits PWR series of USB and Ethernet smart power sensors. For detailed instructions on specific measurement applications using Mini-Circuits measurement applications software see the [Application Measurement guide](#).

1.2 Warranty

See the Mini-Circuits website <http://www.minicircuits.com/support/ordering.html> for warranty information.

1.3 Definitions

Note: A note advises on important information you may need to ensure proper operation of the equipment. There is no risk to either the equipment or the user.

CAUTION

A caution advises about a condition or procedure which can cause damage to the equipment (no danger to users).

WARNING

A warning alerts to a possible risk to the user and steps to avoid it. **DO NOT** proceed until you are sure you understand the warning.



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1.4 General Safety Precautions

Please observe the following safety precautions at all times when using Mini-Circuits smart power sensors.

CAUTION

1. **Note the maximum input power rating in the datasheet and the conditions specified for it. Exceeding these values may damage the power sensor.**
2. **Do not exceed the operational safe power levels for extended periods of time.**

1.5 Introduction

Traditionally, when you wanted to measure signal power from electronic components or circuit boards, you'd have to connect them to a bulky and expensive bench-top power meter. Not anymore. Mini-Circuits PWR power sensors offer a whole new approach, using a quick, simple, USB or Ethernet connection to turn your Windows® PC or laptop into an RF/Microwave power meter.

The PWR series offers a low-cost replacement solution for conventional RF/Microwave power meters, but goes even further by adding portability, easy data storage, advanced data-processing capabilities, and remote operation via Ethernet. Unlike most conventional bench-top instruments, they're self-calibrating and compensate automatically for temperature. They're quick and easy to use, whether you're in the field or helping someone complete a remote test installation over the phone.



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1.6 Service and Calibration

The only user-performed service possible for the PWR models is external cleaning of the case and connectors as needed. Do not use any detergents or spray cleaning solutions to clean the PWR unit. To clean the connectors, use an alcohol solution, and to clean the PWR case, a soft, damp cloth. The recommended calibration cycle for Mini-Circuits PWR series smart power sensors is once a year. Calibration service is available from Mini-Circuits. For details; see Ordering, Pricing & Availability Information link from individual model pages on the website.

1.7 Contact Information

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sales@minicircuits.com
For regional offices and tech support see <http://www.minicircuits.com/contact/offices.html>

1.8 Technical Description

1.8.1 Features of Mini-Circuits power sensors

- ✓ Pocket-sized portability
- ✓ Automatic frequency calibration & temperature compensation
- ✓ Turns a laptop or PC into a low-cost replacement power meter
- ✓ Effective, easy-to-use software
 - User-friendly GUI for any Windows® 32- or 64-bit computer (command-line support for Linux®)
 - Multiple data display and output options, including Excel®
 - Data averaging
 - Relative measurements
 - Scheduled data recording with user defined spec limits
 - Multi-sensor support (up to 24), display options, and management tools
 - Measurement Applications suite to simplify many common test scenarios
 - Remote operation via TCP/IP networks
 - DLL COM objects for both ActiveX, and .NET supporting LabVIEW®, Delphi®, C++, C#, Visual Basic®, and more (see [programming handbook](#) and application note [AN-49-001](#) for details)
 - Download and install in seconds all required software from <https://www.minicircuits.com/softwaredownload/pm.html>.

For specific model features, performance data and graphs, outline drawing, ordering information and environmental specifications, see our catalog at:
<https://www.minicircuits.com/WebStore/PortableTestEquipment.html>



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1.8.2 Intended Applications

Mini-Circuits PWR series smart power sensors are intended for indoor use in:

- Lab and test equipment setups for both manual and automated measurements
- Remote location monitoring
- Automatic, scheduled data collection
- Evaluation of high-power, multi-port devices with built-in virtual couplers/attenuators & other software tools

The models can be used by anyone familiar with the basics of electronics measurements.

1.8.3 Conformity

Mini-Circuits PWR series power sensors conform to all requirements for the following international standards:

RoHS – The models comply with EU directive for Restriction of Hazardous Substances for 6 substances.

USB 2.0 – The models meet the specifications of the Universal Serial Bus Ver. 2.0 communication standard as described by USB-IF.

USB HID – The models meet the requirements for Universal Serial Bus Human Interface Devices according to USB-IF's Device Class Definition for Human Interface Devices firmware rev. 1.11.

TCP/IP – The RC suffix series models' Ethernet communication complies with the specifications of the Transmission Control Protocol (TCP) and Internet Protocol (IP) as defined in RFC 791 and RFC 793.

HTTP – The RC suffix series models' support all requirements for communicating with the Hypertext Transfer Protocol (HTTP) as defined in RFC 1945.

Telnet – The RC suffix series models' support all requirements for communicating with the Telnet protocol, as defined in RFC 854.

1.8.4 Supported software environments

Mini-Circuits PWR series power sensors have been tested in the following operating systems:

32 bit: Windows 10, Windows 8, Windows 7, Windows Vista, Windows XP Windows 98

64 bit: Windows 10, Windows 8, Windows 7, Windows Vista, Linux

The power sensors will work with almost any software environment that supports ActiveX or .Net including: C++, C#, CVI®, Delphi®, LabVIEW® 8 or newer, MATLAB® 7 or newer, Python, Agilent VEE®, Visual Basic®, AutoIT, Visual Studio® 6 or newer, and more

Additionally the HTTP and Telnet protocols can operate from almost any computer with a network connection.

For more information see [Mini-Circuits programming manual](#) on our website.



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1.8.5 Model Selection Guide

Model Name	Frequency Range		Impedance (Ω)	Sensor Type	Input Power		Measurement Speed (ms)	Max DC Current (mA)	Control
	Min	Max			Min (dBm)	Max (dBm)			
PWR-2.5GHS-75	100 kHz	2.5 GHz	75	CW	-30	+20	30	70	USB
PWR-4GHS	9 kHz	4 GHz	50	CW	-30	+20	30	70	USB
PWR-4RMS	50 MHz	4 GHz	50	RMS	-35	+20	30	140	USB
PWR-6GHS	1 MHz	6 GHz	50	CW	-30	+20	30	70	USB
PWR-6LGHS	50 MHz	6 GHz	50	CW	-45	+10	30	110	USB
PWR-6LRMS-RC	50 MHz	6 GHz	50	RMS	-45	+10	30	300	USB & Ethernet
PWR-6RMS-RC	50 MHz	6 GHz	50	RMS	-35	+20	30	300	USB & Ethernet
PWR-8FS	1 MHz	8 GHz	50	CW	-30	+20	10	70	USB
PWR-8GHS	1 MHz	8 GHz	50	CW	-30	+20	30	70	USB
PWR-8GHS-RC	1 MHz	8 GHz	50	CW	-30	+20	30	250	USB & Ethernet
PWR-8P-RC	10 MHz	8 GHz	50	Peak & Avg	-60	+20	0.002	450*	USB & Ethernet

For additional details and ordering information, click on model P/N.

*With Ethernet disabled, increases to 600mA with Ethernet control enabled



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Chapter 2 – Installation and Setup

System requirements for the PWR models are a computer (Pentium II or better) with support for USB HID. To run the GUI program a Windows operating system for either 32 or 64 bits is also required.

The RC models can also be operated remotely over a network with mains power (100-220V) supplied using the included power adaptor.

2.1 Software Setup



If you have had any problems installing the software, we're here to help.

Try following these complete step-by-step instructions. If you still experience problems, give us a call at Mini-Circuits Worldwide Technical support. It's (718) 934-4500 or e-mail apps@minicircuits.com for North America, or go to minicircuits.com/contact/worldwide_tech_support.html for other regional numbers and addresses.

2.1.1 First save all work in progress and close any other programs that may be running.

2.1.2 Next, Insert the *Mini-Circuits* CD into the CD-ROM drive, or download the full CD software from minicircuits.com. If installing from files downloaded from the web - unzip the downloaded files to a temporary folder on your desktop or C: drive, then open the file folder you created and double-click the "Install" icon.

2.1.3 If installation from the CD does not start automatically, run *install.exe* from the <CD drive> root directory.

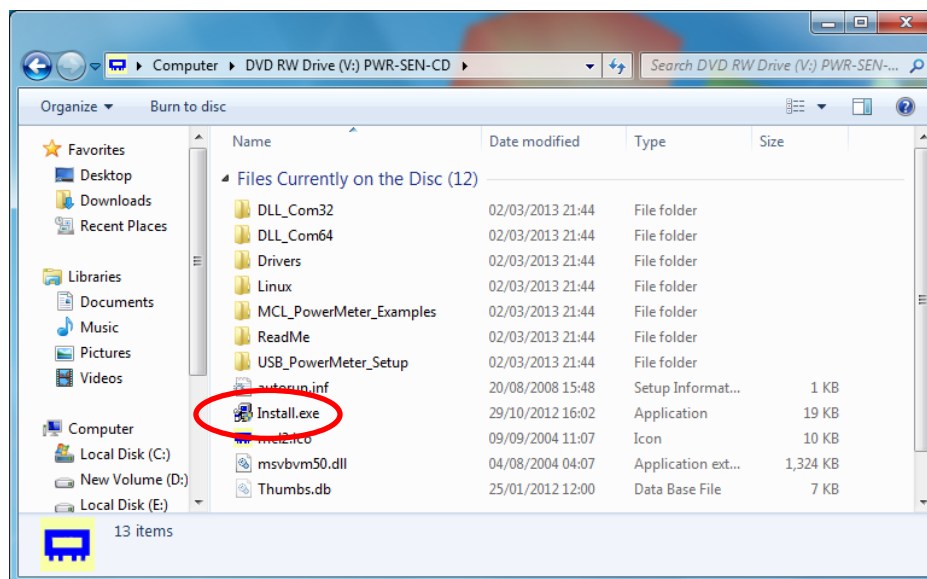


Figure 2.1.3 CD file listing window



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2.2 Installation

2.2.1 **The installer window** should now appear. Click the “Install Now” button.



Figure 2.2.1 Installation window

2.2.2 **The license agreement** should now appear. To proceed, click “I Agree” and the “Continue” button.

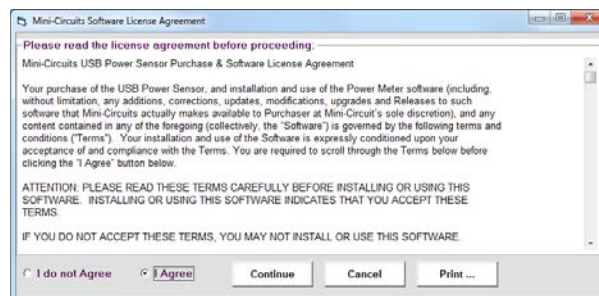


Figure 2.2.2 License agreement

2.2.3 **The installation program will launch.** Click the “OK” button to continue.

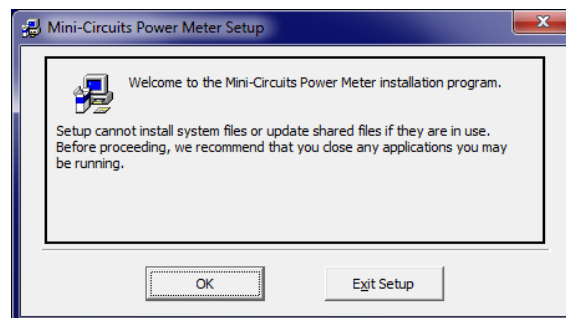


Figure 2.2.3 Installation Program window

2.2.4 The destination directory window will appear. At this point it's a good idea to take a second and confirm the full destination address for the software. In most cases, the default will be your computer's hard drive (C:)\Program Files (x86)\Mini-Circuits Power Meter\. Or Change it then click the large button at the top to continue.

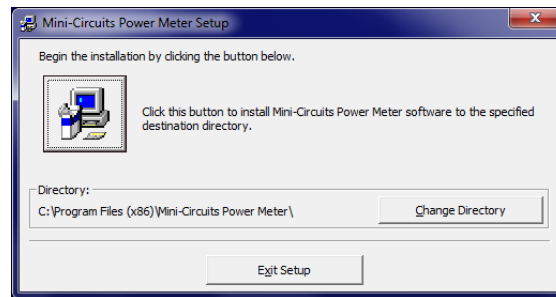


Figure 2.2.4: Destination Directory window

2.2.5 The Program Group window will appear. This window allows you to select the program group under which the link for the smart power meter program in the Start Menu will be created. If you change the Program Group for this software, be sure to record that information together with your destination address. Click on "Continue" to proceed.

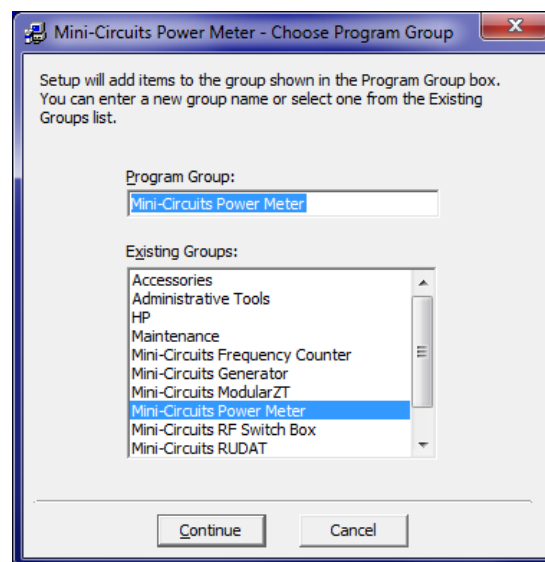


Figure 2.2.5: Program Group Window

2.2.6 In a second or two, your installation will be complete. Click "OK" to close the installer.

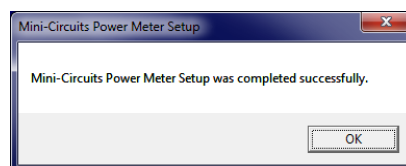


Figure 2.2.6: Installation complete



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2.3 Power Sensor Physical Setup

2.3.1 **For CW and RMS power sensors, align the red dot at** the Power Sensor USB connection with the one on the supplied cable and press in until you hear a 'click'.



Figure 2.3.1: Plug cable into unit

2.3.2 **For Peak power sensors, simply** connect the standard USB cable supplied to the USB port.

CAUTION

1. Note the maximum rating power input in the datasheet and the conditions specified for it. Exceeding these values may damage the power sensor.
2. Do not exceed the operational safe power levels for extended periods of time.

2.3.3 **For USB control,** connect the USB type A plug of the supplied cable to the computer USB port and begin testing. In RC models the RJ45 connector remains unconnected when in USB control.



Figure 2.3.3a: Connections for USB control of a CW or RMS RC model



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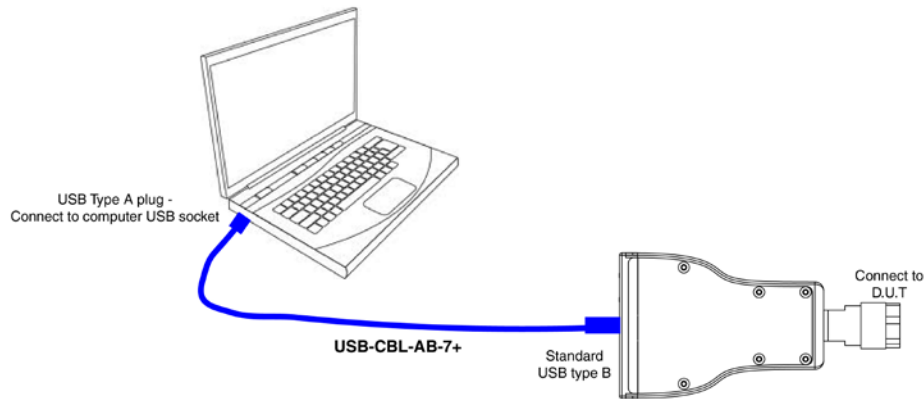


Figure 2.3.3b: Connections for USB control of Peak & Avg power sensor

2.3.4 For Ethernet control using AC/DC adaptor (CW and RMS RC models only)

- Connect the USB type A plug of the 'Y' cable to the provided power adaptor and plug it in to a mains power socket, note the power sensor's power indicator lights up.
- Connect the Ethernet plug to a network port and note power sensor's Ethernet status indicators light up.

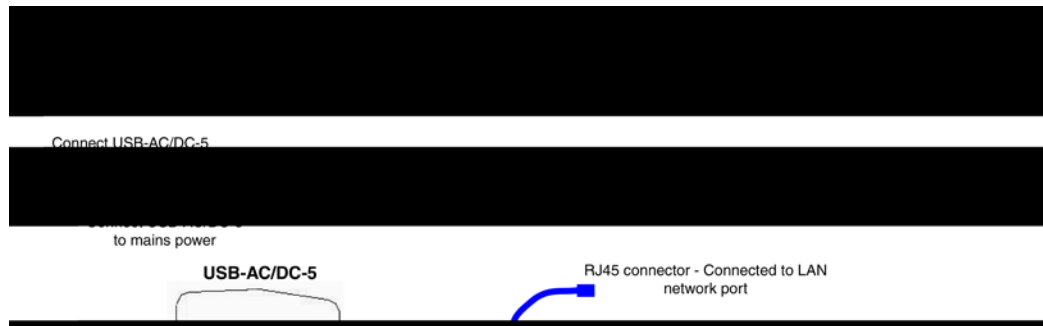


Figure 2.3.4: Connections for Ethernet control with power adaptor

2.3.5 For Ethernet control using AC/DC adaptor (Peak power models only)

- Connect the provided USB cable to the power adaptor and plug it in to a mains power socket, note the power sensor's power indicator lights up.
- Connect the Ethernet plug to a network port and note the indicators at the power sensor's Ethernet port light up.

Note: Before connecting the power sensor for the first time you will need to enable Ethernet control. If Ethernet control is not enabled indicator lights at Ethernet port will not light up.

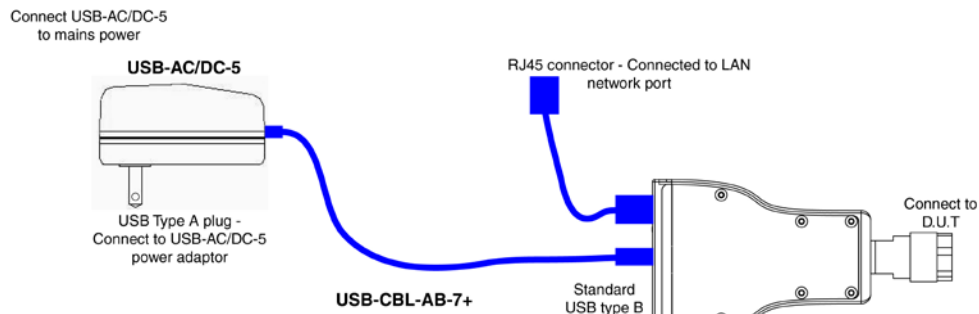


Figure 2.3.5: Connections for Ethernet control of Peak & Avg power sensor

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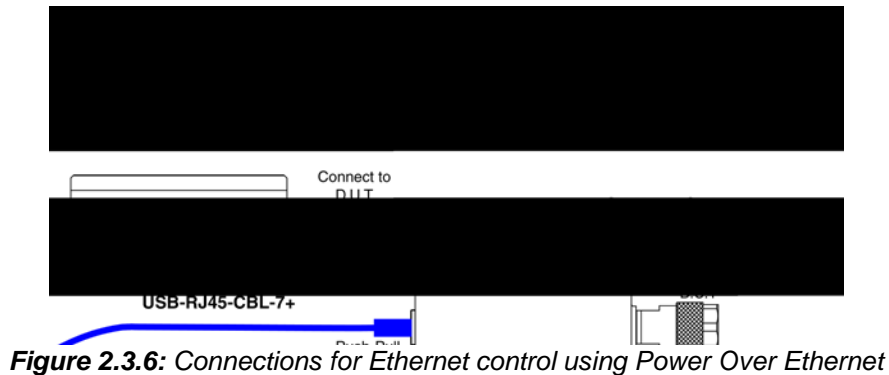
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2.3.6 For Ethernet control using Power Over Ethernet (RC models only)

- Mini-Circuits RC power sensor models do not directly support PoE but an external PoE splitter could be used to enable their use on a PoE network.
- Follow the instructions from the supplier to connect the splitter's PoE interface into an Ethernet port supporting PoE.
- Connect the power sensor's USB connection into the splitter's USB / DC supply port (an adapter may be required), ensuring the sensor's power indicator LED turns on.
- Connect the power sensor's Ethernet connection into the splitter's RJ45 network port, the sensor's Ethernet data indicator LEDs should turn on.



Chapter 3 – Using PWR Smart Power Sensors

3.1 USB Interface

3.1.1 **Go to the Start Menu** and select All Programs>Mini-Circuits USB Power Meter (default), or go to the other destination address you selected earlier. The “Mini-Circuits USB Power Meter” icon should be waiting there for you. Click on it and get started!

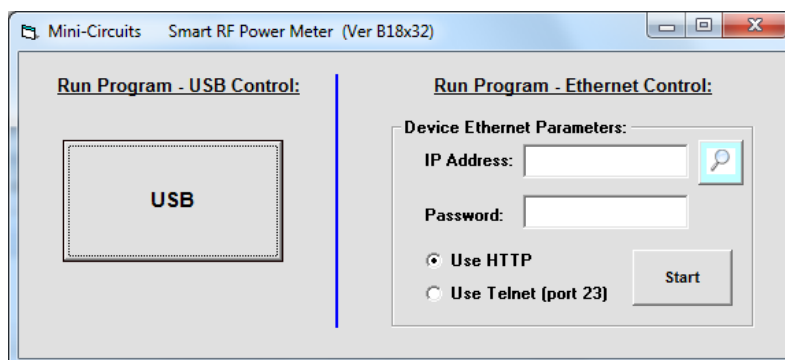


Figure 3.1.1: Power Sensor Startup screen

3.1.2 **The startup allows** you to select the control method you wish to use for the PWR units, USB or Ethernet control. All models support USB control, only models with an ‘RC’ suffix such as PWR-8GHS-RC support Ethernet control. For USB control click on the USB button, for Ethernet control see **section 3.2**

3.1.3 **If a single PWR power sensor is** connected to the computer via USB, the Smart RF Power meter screen will appear, already displaying your unit ready to start measurements.

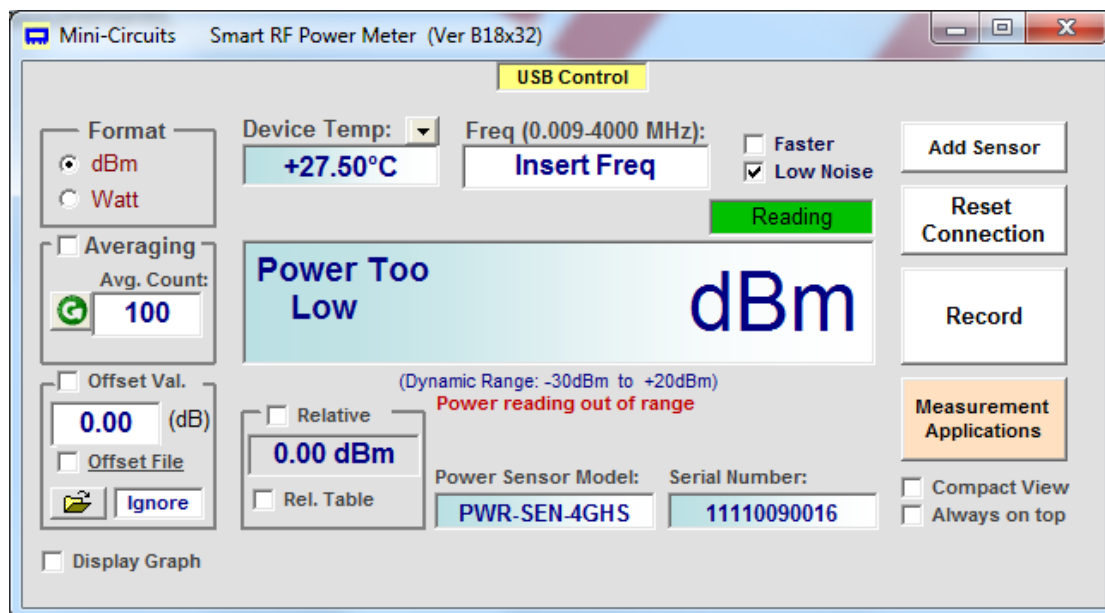


Figure 3.1.3: Main screen



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3.1.4 **If multiple PWR power sensors are** connected to the computer via USB, the initial screen will show a list of S/N for connected units. You can select a single unit, or multiple units you wish to start with – each opening in its own window. The program can handle up to 24 units connected *simultaneously*.

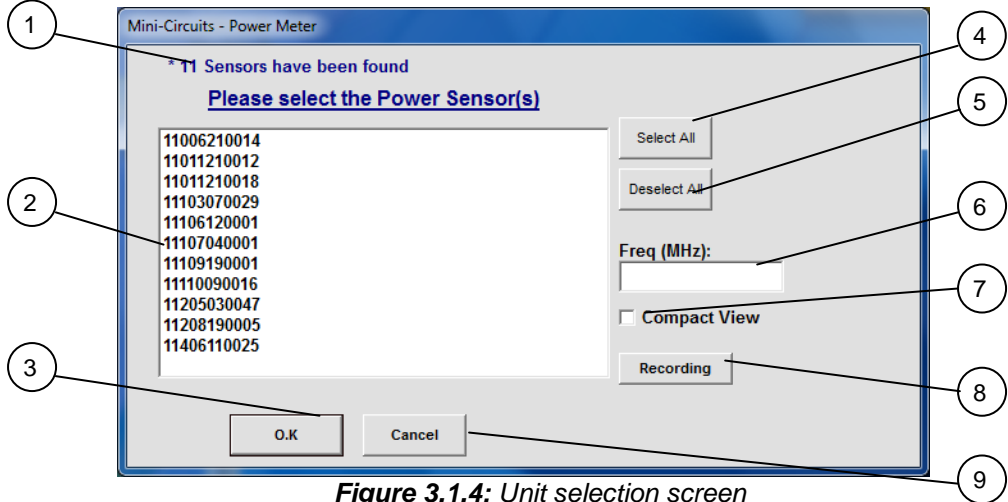


Figure 3.1.4: Unit selection screen

#	Name	Description
1	Number of sensors	Shows total number of power sensors detected
2	Sensor List	List, by serial number of all sensors detected
3	O.K	Proceed with the sensors selected
4	Select All	Marks all sensors listed
5	Deselect all	Cancels selection of all sensors listed
6	Freq	Enter the frequency to be tested for best results. If multiple units are selected all will use the compensation factor suitable for this frequency.
7	Compact View	Open selected power sensors in compact view
8	Recording	Open data recording window to set data recording for one or more of the sensors
9	Cancel	Exit the program

See **section 3.10** for detailed description of operating with multiple units.

3.1.5 **If no PWR power sensors are** connected to the computer via USB or there is a problem with the USB connection selecting USB will cause the following alert will pop-up. Click OK and check the USB connections before clicking the 'reset connection' button.

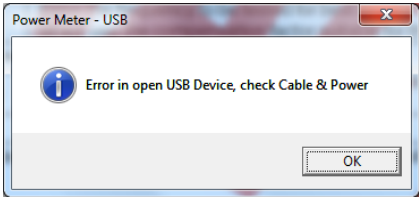


Figure 3.1.5: No USB unit found

3.1.6 **After acknowledging the alert**, the main measurement screen will appear with no unit selected and a 'Not Connected' notice. Click on 'reset connection' to try connecting again, or close the program.

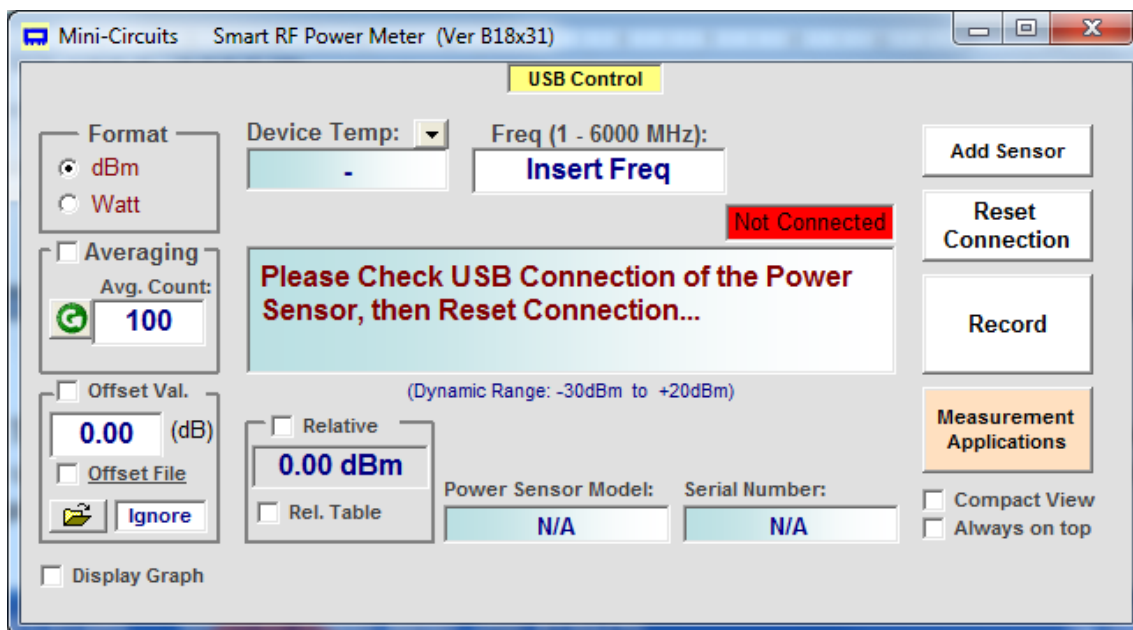


Figure 3.1.6: No USB Unit found

3.1.7 **If there's a faulty D.U.T connection**, no RF power or the power is below the sensors dynamic range a 'Power Too Low' notice will appear.

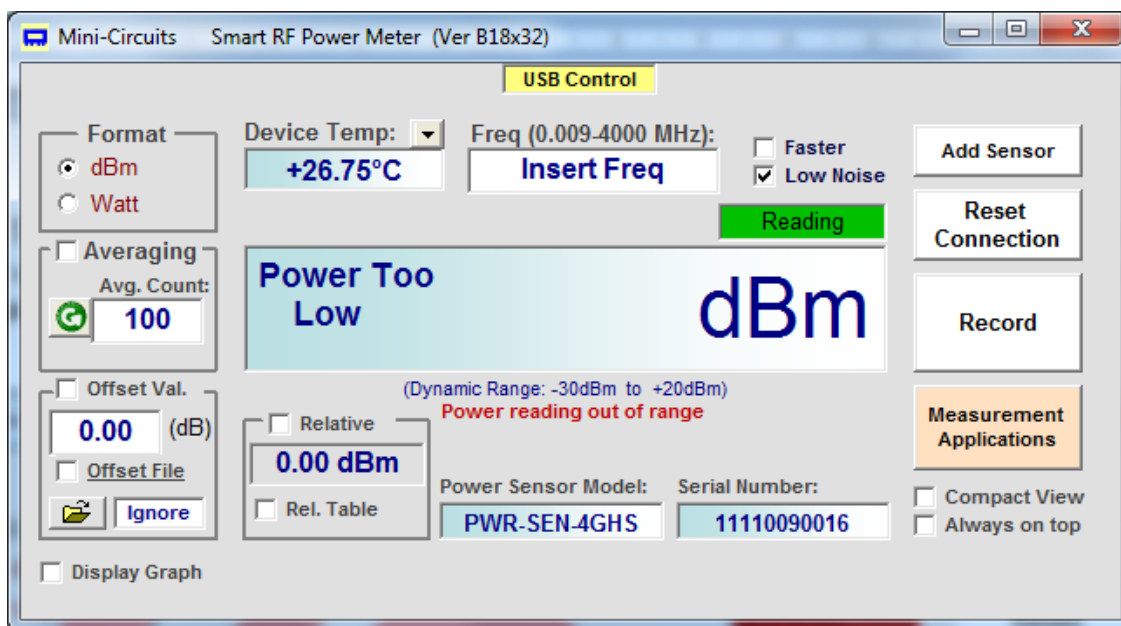


Figure 3.1.7: Power Too Low

3.1.8 **The Ethernet Configuration (RC suffix only) screen can** only be accessed from the USB control main screen. Click on the Ethernet-Config button in the bottom right corner of the screen, and the Ethernet configuration screen will appear.

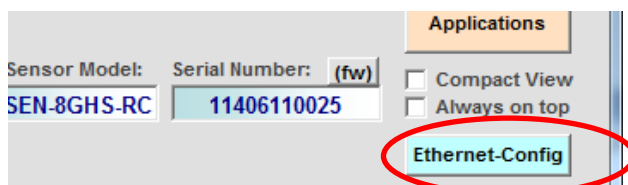


Figure 3.1.8 Ethernet-Config button on USB main screen

3.1.9 **The Ethernet Configuration screen will** open showing the current configuration. **Figure 3.1.9** shows the factory default of the power sensor. If these settings fit your local network, you do not need to access the setup before connecting the power sensor to the network.

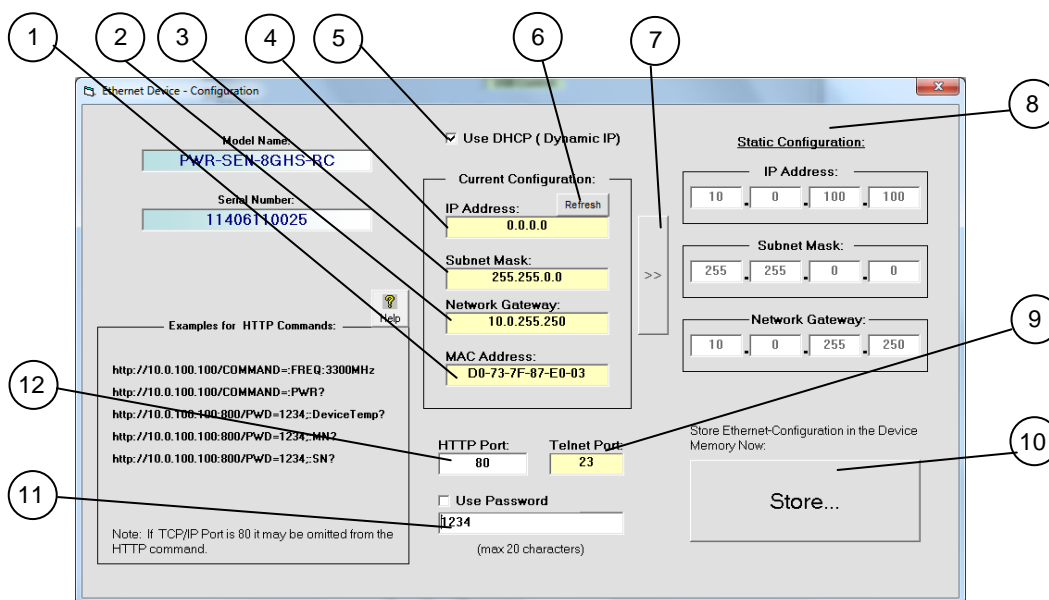


Figure 3.1.9: Ethernet Config. screen (showing factory default state)

Note: If you are using a proxy server for your LAN connections you may need to define a name for the power sensor IP address, or disable the proxy server to connect to the power sensor via Ethernet.

3.1.10 *The Ethernet Configuration settings are:*

#	Name	Description
1	MAC Address	Media Access Control Address – a unique, unchanging identifier for the smart power meter unit.
2	Network Gateway	IP address of the network gateway. When DHCP is selected this is assigned by the server.
3	Subnet Mask	The Network's Subnet Mask. When DHCP is selected this is assigned by the server.
4	IP Address	The IP address of the unit in your Network. When DHCP is selected this is assigned by the server.
5	Use DHCP	When selected the smart power meter will query the server for appropriate parameters with no input from the user and will disregard manually entered IP address, subnet mask and network gateway settings.
6	Refresh	Request IP address, gateway and subnet mask from the server.
7	Copy State	Copies current state of dynamic IP to static IP, not available when DHCP is selected.
8	Static Configuration	When DHCP is not selected the user must specify the values below and will not be changed by the server.
9	Telnet Port	Port to be used for Telnet communication. Cannot be changed by user
10	Store	After you've made all changes you want to click on this button to save the settings.
11	Password	If you want to limit the users able to access the power sensor select "Use Password" and enter the desired password (up to 20 characters).
12	HTTP Port	Specify the port to use for HTTP communication with the network (default 80). Note port address does not get assigned by the server when DHCP is selected. Port 23 is reserved for Telnet communication and cannot be used.

3.1.11 *After making the changes you want, click on "Store"* and the changes will be saved to the smart power meter's memory. See **section 3.2** for working with Ethernet control.

3.1.12 *For Peak and Average power sensors* only, the Ethernet control circuitry needs to be specifically enabled before power sensor can be used via Ethernet by selecting the "Enable Ethernet" option and clicking "Store". Once Ethernet control is enabled you can proceed as described for other RC suffix models.

Note: When Ethernet is enabled the power sensor may draw over 500mA. This may cause issues if attempting to power it from a USB 2.0 port.

The screenshot shows the 'Ethernet Device - Configuration' window. On the left, there's a 'Model Name' field with 'PWR-SEN-8P-RC' and a 'Serial Number' field with '11709100023'. Below these are 'Examples for HTTP Commands' and a 'Help' icon. The main area is divided into 'Current Configuration' and 'Static Configuration'. Under 'Current Configuration', there are fields for IP Address (10.0.5.234), Subnet Mask (255.255.0.0), Network Gateway (10.0.255.250), and MAC Address (D0-73-7F-9B-48-17). There are also fields for HTTP Port (80) and Telnet Port (23). A 'Use Password' checkbox is present with a password field. The 'Static Configuration' section is disabled and shows fields for IP Address, Subnet Mask, and Network Gateway. The 'Enable Ethernet' checkbox is highlighted with a red circle, with a note 'Ethernet - required high current' below it. A 'Store...' button is at the bottom right.

Figure 3.1.12: Ethernet Config. screen for Peak power sensor

3.2 Ethernet Interface (RC suffix models only)

3.2.1 **After starting the GUI (section 3.1) you** can select the control method you wish to use for the PWR, either USB or Ethernet control. All models support USB control, only models with the RC suffix (such as PWR-8GHS-RC) support Ethernet control. To start operation with USB see **section 3.1**. For Ethernet control either type the IP address and port of the power sensor, or click on the search icon.

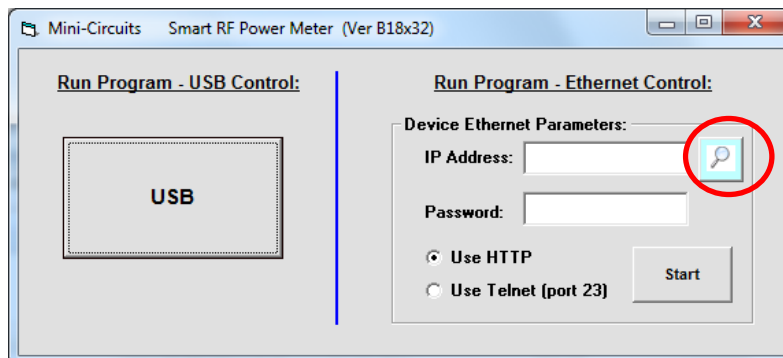


Figure 3.2.1: Power Sensor Startup screen

3.2.2 **After clicking on the search icon** The IP search will pop up with a list of smart power meter IP addresses found and their HTTP ports on the left side of the screen, and full details of each unit on the right. Mark the IP address you wish to use and click select. The search window will close and the IP address and port will be entered in the IP address field of the initial screen automatically.

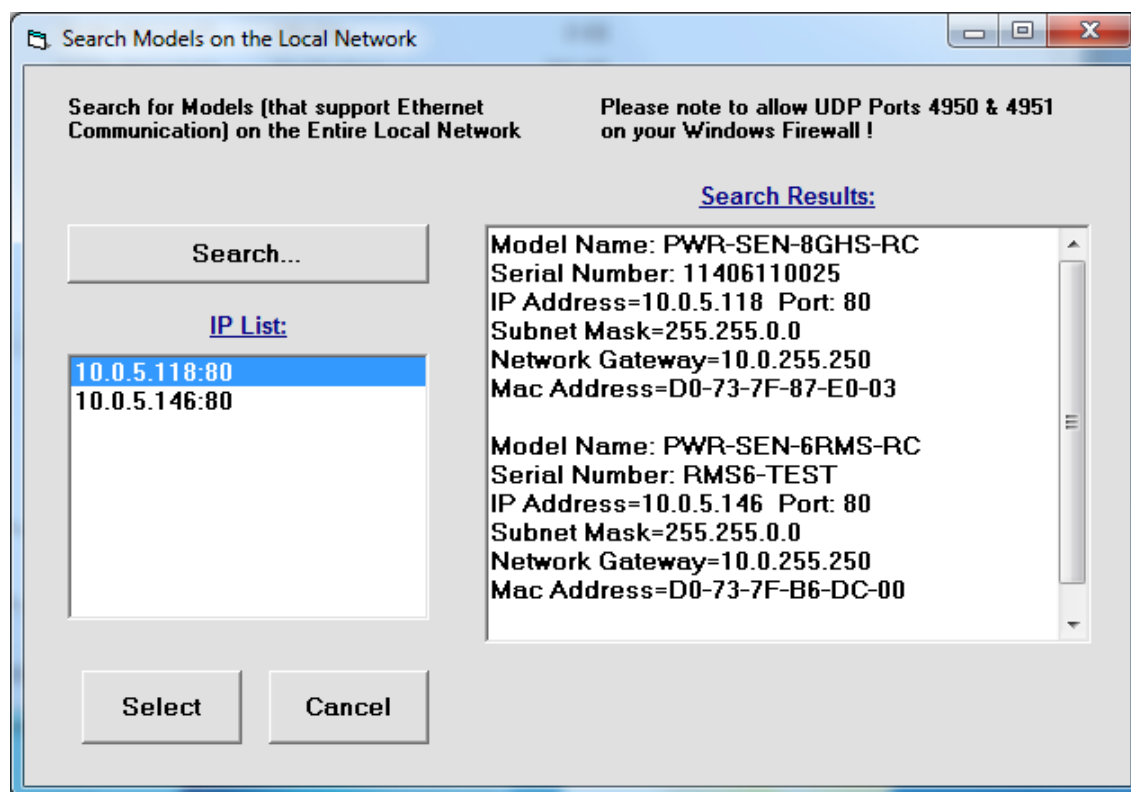


Figure 3.2.2: Ethernet IP search window

Notes:

- 1) To refresh the list of units found click on the Search button.
- 2) The search function uses ports UDP 4950 and UDP 4951 for communication, ensure your firewall allows access to these ports.
- 3) For Peak power sensor models you need to enable Ethernet control before using it for the first time see **section 3.1.12** for details.

3.2.3 After entering the IP address, enter your password if you set one (see **section 3.1.10**), select the communication protocol you wish to use (HTTP or Telnet) and click start, the unit's main screen will open.

Note: changing Ethernet settings is only possible via USB control, see **section 3.1.8** for details.

3.2.4 Telnet or HTTP commands can also be used to control the power sensor without using the GUI. Just type in the command in the address field of your Internet browser, implement a Get/Post HTTP function in your selected application (for HTTP) or establish a Telnet connection (for Telnet). A full list of the commands available and their syntax is available in the PWR models programming handbook.

Note: Depending on the browser used and your network configuration you may need to disable the proxy server for your computer, or add the smart power meter's IP address to the list of addresses in the proxy server.



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3.3 Main Screen

The main screen provides a simple and easy-to-use interface for measuring RF power with the PWR power sensor (See **Fig 3.3**).

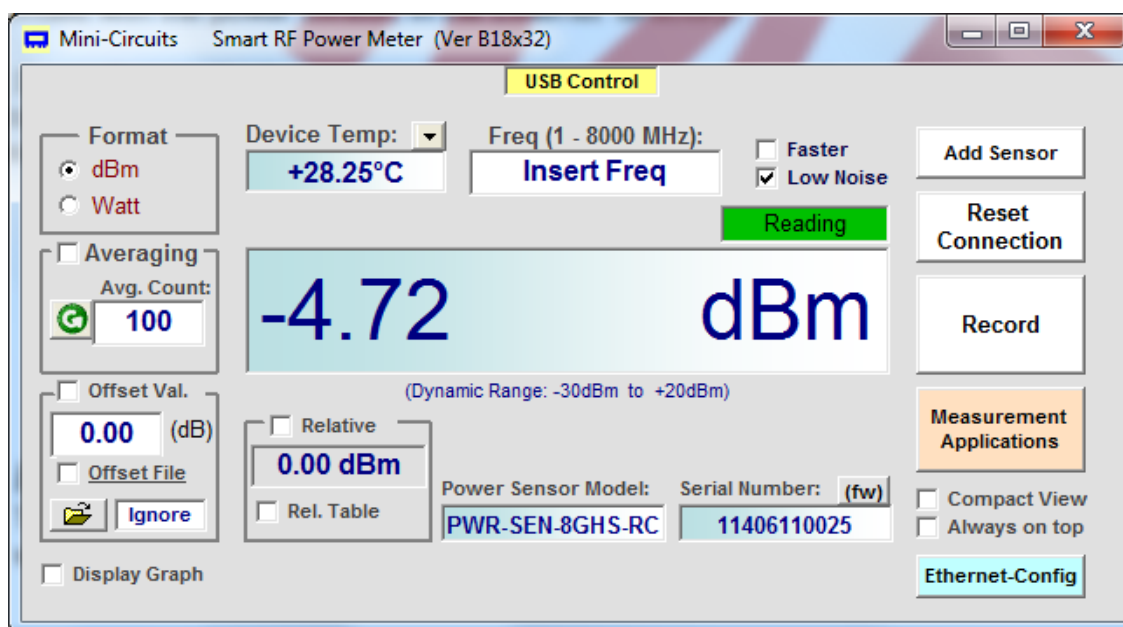


Figure 3.3: PWR Main Screen

3.3.1 Left Side of Screen (Fig. 3.3)

- Format** Select dBm or Watts format to display the data in.
- Averaging** Check the averaging box and enter the number of measurements you wish to average. Individual measurements will be taken at the specified measurement speed (see section 3.3.2). When selected the power sensor will average the power reading over the number of measurements specified in Avg. Count and display the number of measurements averaged. Clicking on the button to the left of the average count window will clear the averaged values and reset the count.
- Offset Val.** This feature allows the user to compensate for Loss or Gain in their DUT setup. A positive value compensates for a Loss, and a negative value for a Gain. Click on the check box, and enter the appropriate value (in dB) in the window below.
- Offset File** Check to get offset values from a saved file. Primarily used for advanced Measurement Applications, see **section 3.6** for details.
- Display Graph** Check to activate real-time graph, see **section 3.4** for details.

3.3.2 Top Center of Screen (Fig. 3.3)

Device Temp.	Displays the power sensor's internal temperature. Click on the drop box to select Celsius or Fahrenheit display format. The PWR smart power sensors compensate automatically for any temperature variation in the 0-50°C (32-122°F) range.
Freq	Displays the power sensor's specified frequency range and allows the user to enter the expected input frequency. For best performance, enter the approximate signal frequency you wish to test.
Meas. Speed	(Not available for peak power sensor models, see section 0) Check the mode in which you wish to operate. "Low Noise" – 100ms typ, "Faster" – 30 ms typ, or (for PWR-8FS only) "Fastest" – 10ms typ.
Connection status	Displays the status of connection to the power sensor: "Reading" – good connection, "Searching" - attempting to reestablish connection, "Not connected" – Power sensor not found.

3.3.3 Bottom Center of Screen (Fig. 3.3)

Relative	Check to save your current reading as a baseline value. From then until unchecked, measurements will show how DUT power varies from that baseline. In dBm format, relative results are given in dBc and in Watt format in %.
Rel. Table	Opens Relative Frequency points Table. When table is filled entries in the table will supersede current reading for relative measurements. See section 3.5 for details.
Model	Displays model name of power sensor currently connected.
Serial Number	Displays serial number of power sensor currently connected.
(fw)	(Not available in all models) opens the Firmware info window to allow upgrading the firmware of the connected sensor. See section 3.8 for details and supported models.

3.3.4 Right Side of Screen (Fig. 3.3)

Add Sensor	Click to work with more than one sensor from the same computer. For more details, see section 3.10 , "Multi-Sensor Setups".
Reset Connection	Click to return to initial control selection screen to reconnect a power sensor to your computer after it was disconnected, change control method or when replacing one sensor with another.
Record	Opens the data record window, for details see section 3.7 .
Measurement Applications	Open advanced measurement applications window. See Measurement Applications Guide for details.
Compact View	Reduce size of window. This option is usually employed for multi-sensor setups. See section 3.9 for details.
Always on Top	Click to keep your power sensor screens on top of other applications.
Ethernet-Config	(Not available in all models) Only in USB control opens the Ethernet configuration window to change the current configuration. See section 3.1.8 for details.



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3.3.5 Peak power specific functions (Fig. 3.3.5)

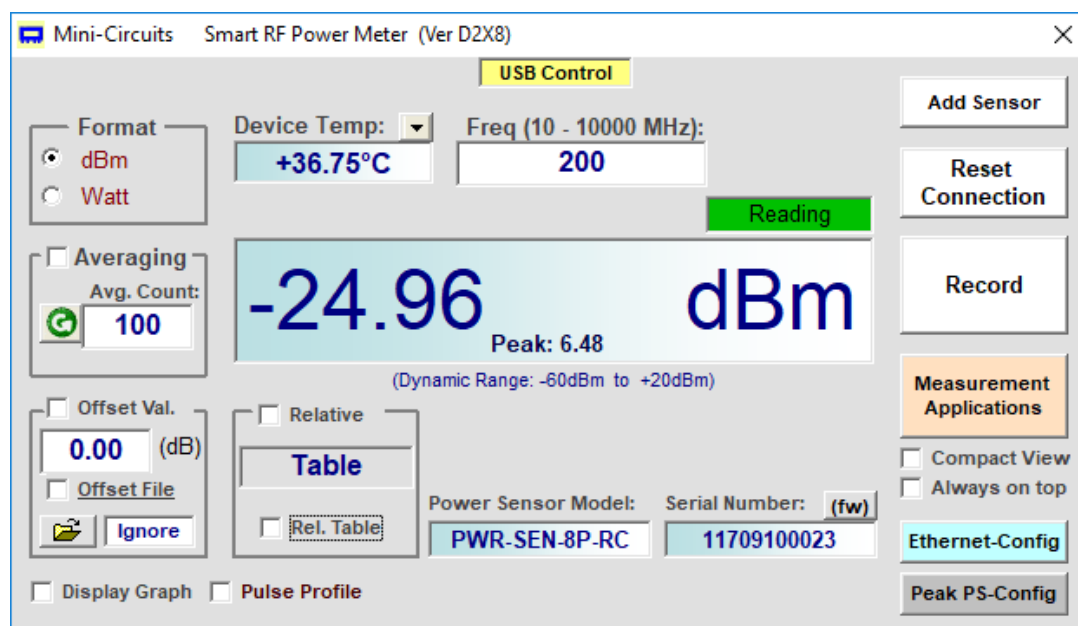


Figure 3.3.5: Peak Power Sensor Main Screen

Measured Power display

Displays the Average power measured over the sample period, similar to the CW power sensors, and below that the peak power. Note: if sample period is not suitable for the signal or zoom track does not lock on pulse power display will not be correct.

Pulse profile

Opens pulse profiling windows to display the pulsed signal and calculated pulse parameters. See **Chapter 3** for details.

Peak PS config

Changes central section of screen to Peak Power Sensor configuration screen to allow setting sample time and trigger mode. See **section 0** for details.



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3.4 Real-Time Graph

Checking the 'Display Graph' box in the lower left corner of the main screen will cause a graph window (Fig. 3.4) showing power over time to appear below the main screen.

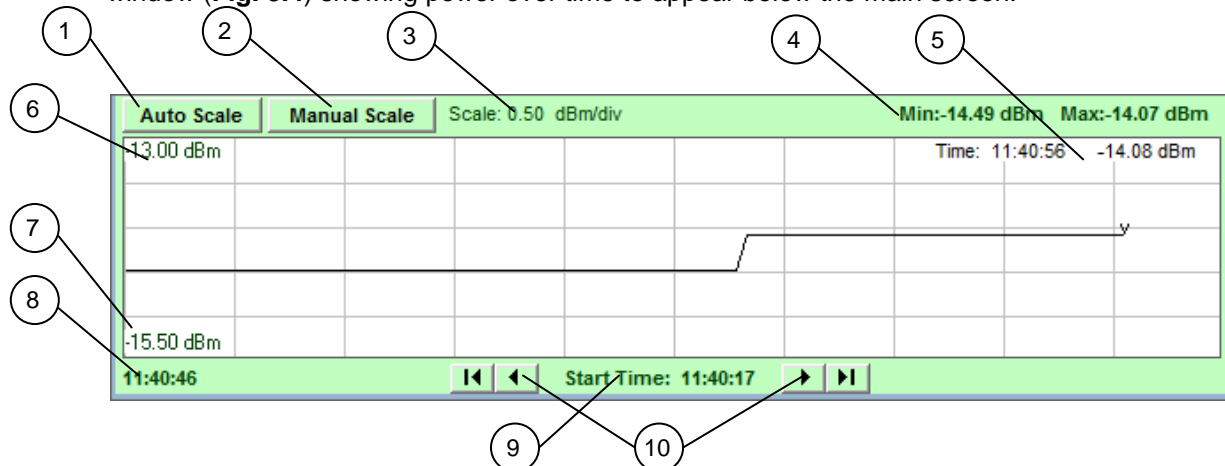


Figure 3.4: Real-Time graph

3.4.1 Real-Time graph indicators and functions (Fig. 3.4)

#	Name	Description
1	Auto Scale	Set Y-axis automatically to best display current data.
2	Manual Scale	Opens a small window to allow setting the Max value and value per div. of the Y-axis. The values shown will be in the same units as those specified in the Main screen format field. Clicking on the button a second time will close the Manual Scale window.
3	Scale	Current value per division of Y-axis
4	Min/Max values	Minimum and Maximum values currently displayed in graph
5	Current reading	Current time and power reading
6	Max scale	Max value of Y-axis
7	Min scale	Min value of Y-axis
8	Time	Start time of currently displayed graph
9	Start Time	Time at which real-time graph was started
10	Arrows	Use arrows to scroll back and forth in graph.

3.5 Relative Frequency Points Table

3.5.1 **Checking the 'Rel. Table' check box** will open the relative frequency points table shown in **Fig 3.5.1**. This table allows specifying multiple points for relative measurements. To add a point to the table enter the relevant frequency and click on 'Add Relative Point' – the current power reading will be added to the table.

Freq (MHz)	Relative Point (dBm)
500	-4.770
1000	-4.680
1500	-4.990
2000	-5.020
2500	-5.060

Figure 3.5.1: Relative Frequency Points Table

3.5.2 **To delete a** point click on the row you wish to delete to select it, then press the 'Delete' key. To delete all values from the table click on the 'Clear Table' button.

3.5.3 **Once you're satisfied** with the entries close the table, the main screen will now show 'TABLE' in relative measurement field. Checking the 'Relative' checkbox will change all measurements into relative measurements referenced to the values in the table. If a frequency not listed in the table is specified for measurement the smart power meter program will calculate the correct reference value based on interpolation of existing data points.

Format: ☒ dB ☐ delta %

Averaging: ☐ Avg. Count: 100

Offset Val.: 0.00 (dB) ☐ Offset File ☐ Ignore

Display Graph: ☐

Device Temp: +26.00°C

Freq (0.009-4000 MHz): 2200

USB Control: ☐ Faster ☒ Low Noise

Reading: -0.326 dB

Relative to Table (Dynamic Range: -30dBm to +20dBm)

Relative: ☒ Table: ☒ Rel. Table: ☒

Power Sensor Model: PWR-SEN-4GHS

Serial Number: 11110090016

Buttons: Add Sensor, Reset Connection, Record, Measurement Applications, Compact View, Always on top

Figure 3.5.3: Measurements relative to table

3.6 Creating and using Offset Files

3.6.1 An offset file is useful for compensating for loss/gain in the system which are not constant over frequency. For example if you need to compensate for the loss of a transmission line between the power sensor and the D.U.T. Measurement Applications #10, Calibrating Thru-Path described in chapter 13 of the [Measurement Applications Guide](#) allows you to measure the gain/loss of the system between the power sensor and the D.U.T and automatically creates an offset file for that system.

3.6.2 Clicking on the folder icon below the 'Offset File' check box will open a browse window. If you have an offset file ready, select it and click OK.

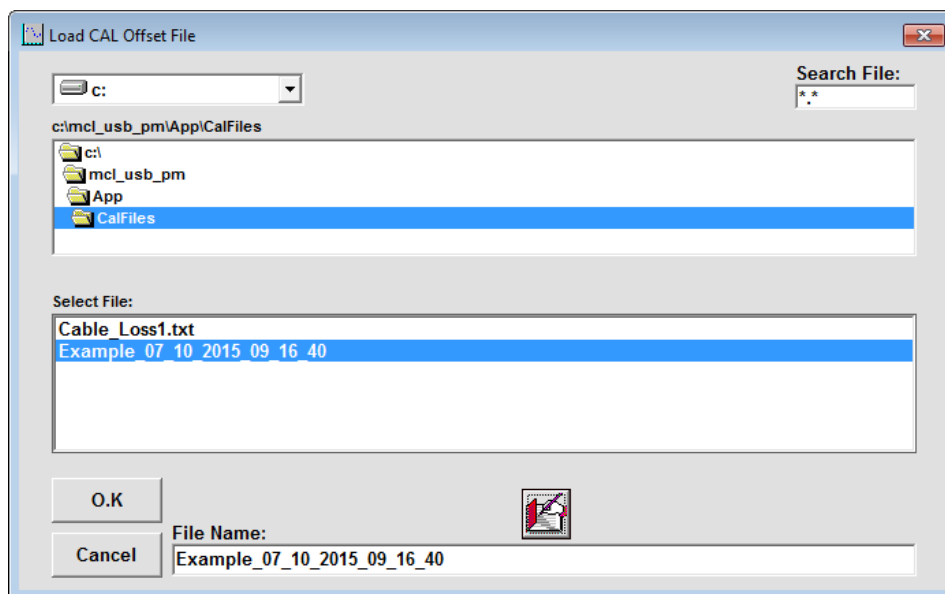


Figure 3.6.2: Offset file browse window

3.6.3 To create an offset file manually click on the edit icon over the file name window and a sample offset file will be created (Fig. 3.6.3). Replace the values in the sample file with the values you need and save the file. There is no requirement for any specific file name or suffix, however as the file is a simple text file saving it with a txt suffix to simplify future editing is recommended.

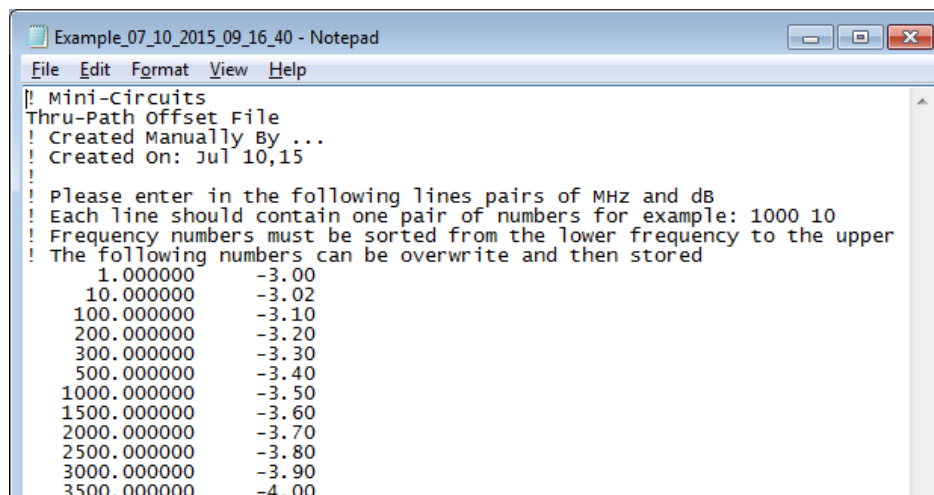


Figure 3.6.3: Offset file browse window

3.6.4 When creating an offset file observe the following rules:

- Any line containing an exclamation mark character (!) will be ignored. This is useful for adding notes to the file, or temporarily skipping certain points in the offset file.
- The first line in the file (other than notes) shall be "Thru-Path Offset File" (Not case sensitive).
- There shall be at least one space character between the frequency value and the loss/gain value and only a single pair of values in a line (Separator character between pairs is line feed carriage return).
- Values will be sorted by frequency from low to high
- All frequencies will be in MHz and Loss/Gain values in dB

Note: When reading frequencies between two sets of values the PWR sensor software will use linear interpolation to calculate the required offset. When reading a frequency outside the range covered by the offset file the closest value will be used. Thus when using the example shown in **Figure 3.6.3** the offset value for 5750 MHz will be -4.45 dB and for all frequencies 6000 MHz or greater will be -4.5 dB.

3.6.5 When the 'Offset File' option is checked an "Offset value: Cal file" notice will appear and the value calculated from the offset file for the frequency tested will be subtracted from the reading. If needed an additional fixed offset can be added by also checking the 'Offset Value' check box.

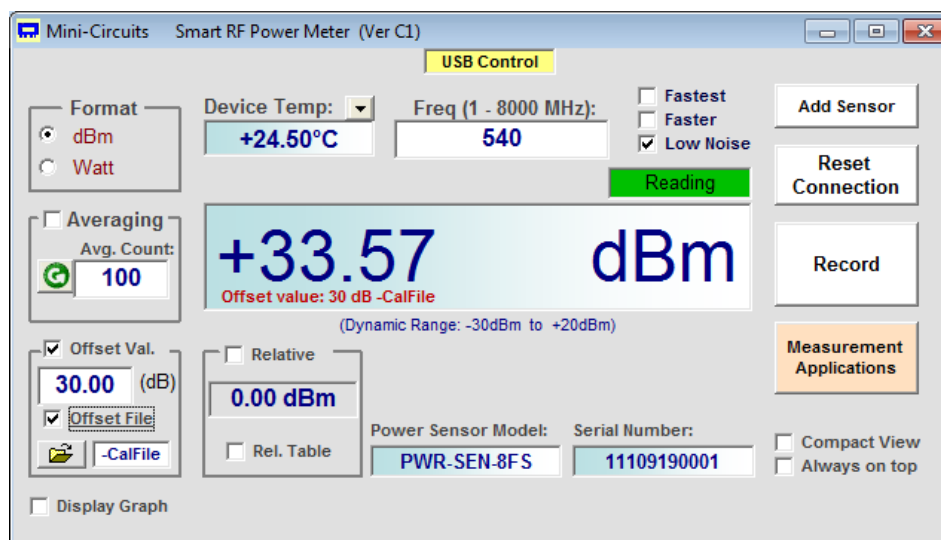


Figure 3.6.5: Offset file browse window

Note: Values in the offset file are subtracted, while values in offset value are added.

3.7 Data Record Window

Get started by clicking the Record button on the right side of the Main Screen. The Power Meter Recording Screen will open, with the serial number of the sensor being recorded at the top:

Power Meter - Recording SN: 11110090016

Start Record At:
Date: 15/09/2014 Time (hh:mm) 00:00

Stop Record At:
Date: 15/09/2014 Time (hh:mm) 00:00

Record Interval (sec): 1 ☐ msec ☐ min ☒ sec ☐ hour

Test Spec Dn (dBm): Test Spec Up (dBm):

Select File: c:\Test_11406110025.txt

Record According to Schedule

Start Recording Now

View Graph

Open Data File

Create Excel File

Browse

Figure 3.7: Data Record Window

3.7.1 Left side of Screen (Fig. 3.7)

Start Record at: Specify date and time at which to start recording, for scheduled tests.

Stop Record at: Specify date and time at which to stop recording, for scheduled tests.

Record Interval Specify the interval at which data points will be recorded, from every 10ms, to 9999 hours. Make sure the measurement speed is less than the record interval.

Test Spec If you enter specification limits in these fields data points which exceed these limits (either above or below) will be marked in the data by an asterisk (*).

Select File Enter the path and file name where you wish to record data, there is no required file name. See section 3.7.4 for data format.

3.7.2 Right side of Screen (Fig. 3.7)

Record According to Schedule Close record window, saving current settings and schedule. Data recording will start according to the schedule specified.

Start Recording Now Close record window, saving current settings. Data recording will start immediately

Browse Open a browse window to select an existing file, or navigate to the desired path.

View Graph Open a graphical presentation of the data stored in the selected file.

Open Data File Open the data file selected (read only presentation).

Create Excel File Export data in selected file to Excel file and open the new Excel file (requires Microsoft Excel to be installed on the local PC)



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3.7.3 View Graph

Clicking on the 'View Graph' button in the data record window (**Fig 3.6**) will open a graphical presentation of the recorded data (**Fig 3.6.3**). Default presentation is of power only, using the same units as the data was recorded in, but user can select to present both power and temperature by checking 'Show temperature graph' or change the power units by clicking on the arrow next to the graph title.

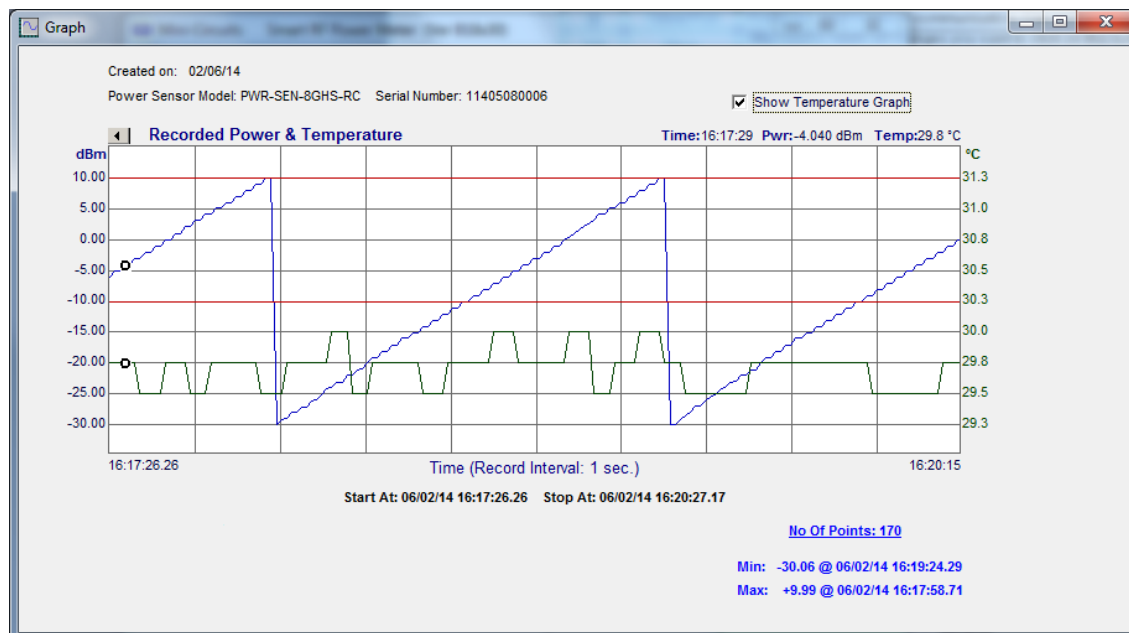


Figure 3.7.3: View Graph Window

3.7.4 Open Data File

Data recorded is saved to a text file in the format shown in **Fig. 3.7.4**

USB Power Meter Record File, Created By Mini-Circuits

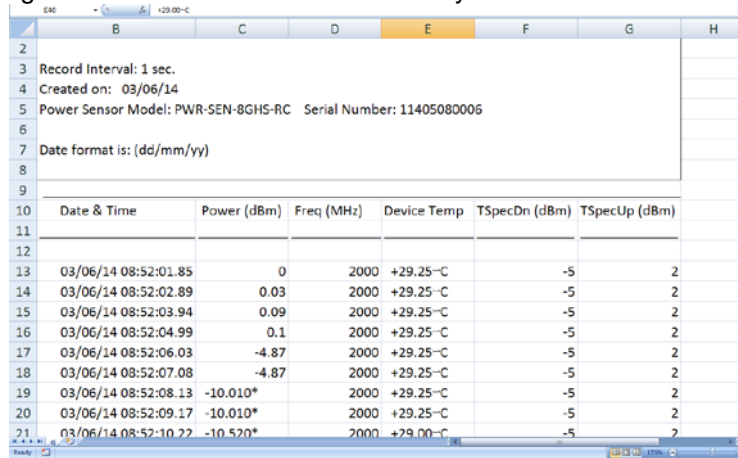
Record Interval: 1 sec.
Created on: 03/06/14
Power Sensor Model: PWR-SEN-8GHS-RC Serial Number: 11405080006
Date format is: (dd/mm/yy)

Date & Time	Power (dBm)	Freq (MHz)	Device Temp	TSpecDn (dBm)	TSpecUp (dBm)
06/03/14 08:52:01.85	0.000	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:02.89	0.030	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:03.94	0.090	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:04.99	0.100	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:06.03	-4.870	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:07.08	-4.870	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:08.13	-10.010*	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:09.17	-10.010*	2000.00	+29.25°C	-5.000	2.000
06/03/14 08:52:10.22	-10.520*	2000.00	+29.25°C	-5.000	2.000

Figure 3.7.4: Data File Window

3.7.5 Create Excel File

When exporting data to an excel file Data will initially be in format shown in Fig 3.6.5



Date & Time	Power (dBm)	Freq (MHz)	Device Temp	TSpecDn (dBm)	TSpecUp (dBm)
03/06/14 08:52:01.85	0	2000	+29.25-C	-5	2
03/06/14 08:52:02.89	0.03	2000	+29.25-C	-5	2
03/06/14 08:52:03.94	0.09	2000	+29.25-C	-5	2
03/06/14 08:52:04.99	0.1	2000	+29.25-C	-5	2
03/06/14 08:52:06.03	-4.87	2000	+29.25-C	-5	2
03/06/14 08:52:07.08	-4.87	2000	+29.25-C	-5	2
03/06/14 08:52:08.13	-10.010*	2000	+29.25-C	-5	2
03/06/14 08:52:09.17	-10.010*	2000	+29.25-C	-5	2
03/06/14 08:52:10.22	-10.520*	2000	+29.00-C	-5	2

Figure 3.7.5: Excel data Window



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3.8 Firmware Update (Supported models only)

3.8.1 **All power sensors are shipped with** the latest available firmware and an update is usually not required. Mini-Circuits occasionally makes firmware update files available as a courtesy to add additional features or correct known issues. Please contact testsolutions@minicircuits.com for details.

3.8.2 Models supporting firmware upgrade:

PWR-8GHS-RC
PWR-6RMS-RC
PWR-6LRMS-RC
PWR-6LGHS
PWR-8P-RC

3.8.3 **The smart RF Power Meter GUI** must be started in USB control (See section 3.1) to allow Firmware upgrade. When in USB control, you will note an **(fw)** indicator over the serial number field in the Power sensor's main screen.

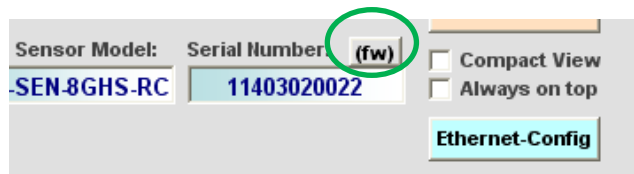


Figure 3.8.3: Firmware indicator on main screen

CAUTION

A power interruption, to either the computer or the power sensor while the firmware is being updated may cause the firmware to be corrupted. It is therefore recommended to only update the firmware while the computer is connected to an Uninterruptible Power Supply (UPS).

3.8.4 **Click on the '(fw)' indicator**, this will cause the firmware - info window to open (See Fig. 3.8.4). The 'Firmware' listed is the version of the firmware installed in your smart power meter. Click on "Update Firmware" to select a new firmware version to install or click 'Exit' to close the firmware – info window.

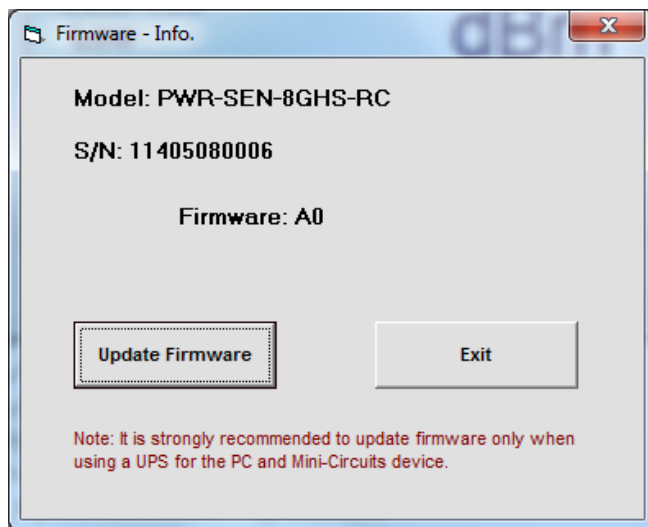


Figure 3.8.4: Firmware Information Window



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3.8.5 A browse window will open to the firmware directory under the path you selected when installing the GUI program (See **Fig. 3.8.5**). Navigate to where you saved your firmware file, select the firmware version you wish to install and click 'O.K'.

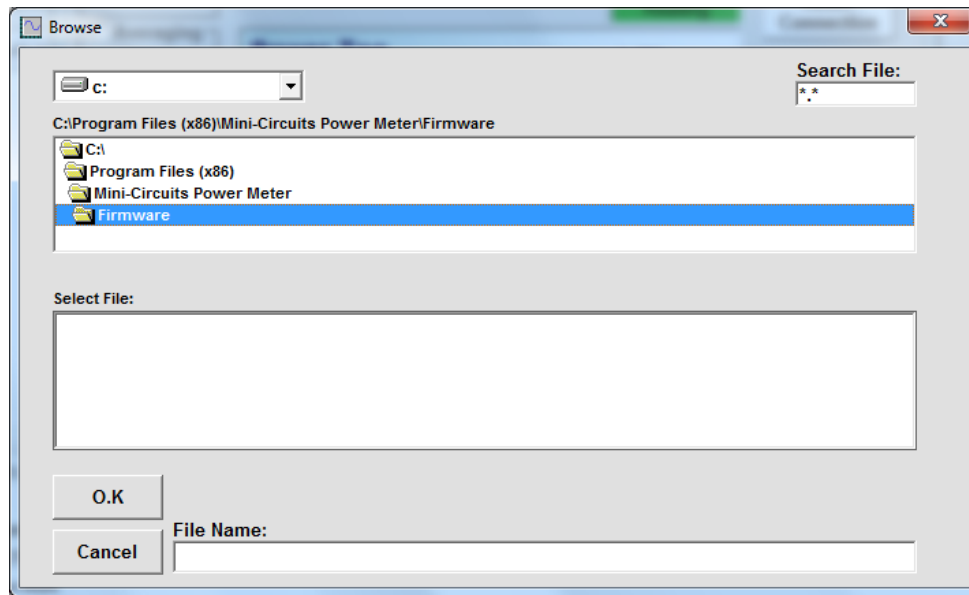


Figure 3.8.5: Firmware - Browse Window

3.8.6 The selected file will be installed in the power sensor. The process will take up to a minute.

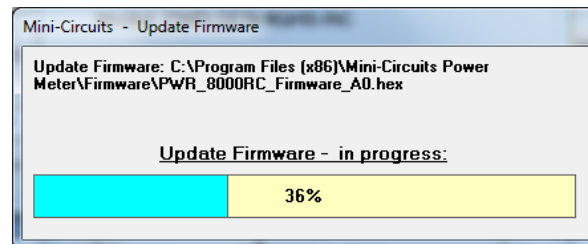


Figure 3.8.6: Firmware - Progress Bar Window

3.8.7 After the firmware has updated an alert will appear. Click 'OK' to shut down the smart power meter program and then restart it normally.

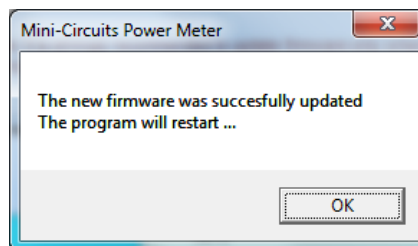


Figure 3.8.7: Firmware - Successful Update

3.9 Compact View

3.9.1 **Checking 'Compact View'** in the bottom right corner of the main screen will cause the screen to shrink to the compact view display.

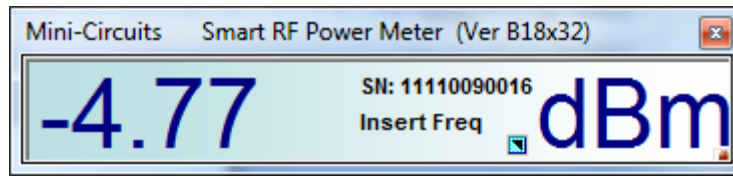


Figure 3.9.1: Compact view window

3.9.2 **Clicking on any spot in the 'Compact View'** screen will cause the program to return to the main screen. In compact view the program displays power measurement, measurement units, Power sensor S/N, and the frequency entered but you must return to main screen to change any parameters.



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3.10 Working with multiple sensors

3.10.1 Starting with multiple power sensors

When the smart power meter detects multiple power sensors on startup, the power sensor selection window will appear. Select the sensors you wish to work with, or click 'Select all' for all sensors.

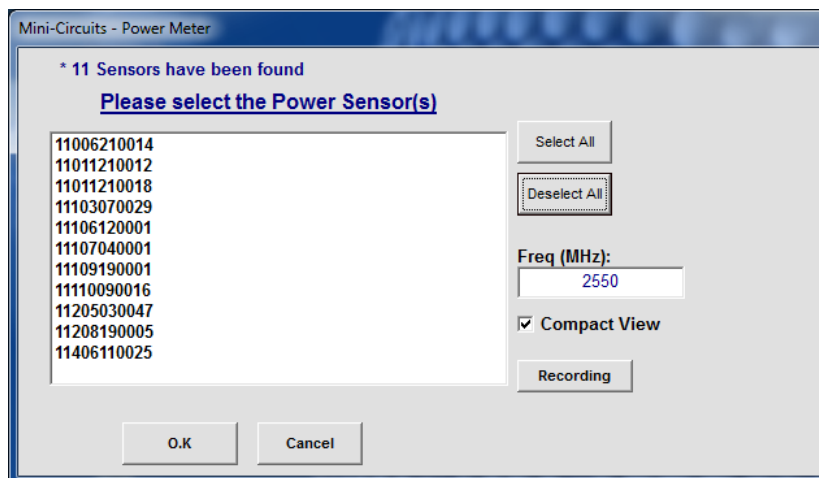


Figure 3.10.1: Power Sensor selection window

3.10.2 Specifying frequency and Compact view

If all the sensors you are working with are testing the same frequency you may enter the frequency in frequency field of the power sensor selection screen, instead of individually for each sensor. When working with many power sensors simultaneously, it is recommended to check the compact view box before starting them so as to have all sensors open initially in compact view and only expand them when you need to modify the settings (See Fig 3.10.2).

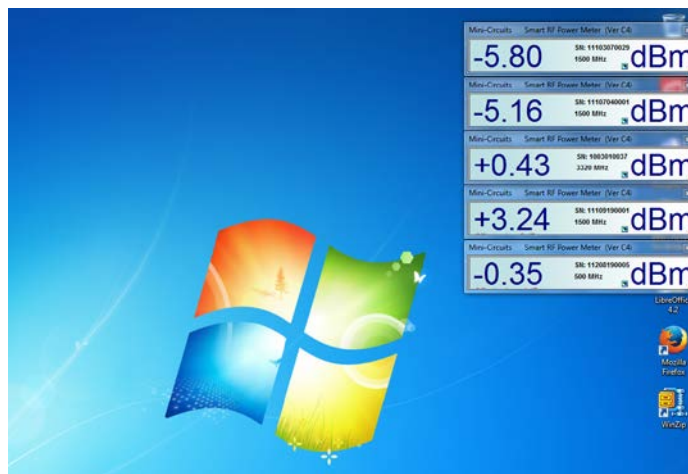


Figure 3.10.2: Multiple power sensor windows

3.10.3 Data recording

Clicking on the 'Recording' button in the bottom right corner of the screen will cause the data recording section of the window to expand below the initial power section selection window (See **Fig 3.10.3**). Recording data settings in this window will apply to all power sensors selected. For description of data recording settings see **section 3.7**.

The screenshot shows the 'Mini-Circuits - Power Meter' window. At the top, it says '* 11 Sensors have been found' and 'Please select the Power Sensor(s)'. Below this is a list of 11 sensor IDs: 11006210014, 11011210012, 11011210018, 11103070029, 11106120001, 11107040001, 11109190001, 11110090016, 11205030047, 11208190005, and 11406110025. To the right of the list are 'Select All' and 'Deselect All' buttons. Below the list is a 'Freq (MHz):' input field and a 'Compact View' checkbox. A 'Recording' button is located at the bottom right of the sensor selection area. Below the sensor selection area are 'O.K.' and 'Cancel' buttons. The 'Recording Data' section is expanded below. It contains several options: 'Start Recording Data immediately' (unchecked), 'Start Recording According Schedule' (unchecked), 'Record Interval (sec):' (set to 1, with radio buttons for msec, sec (checked), min, and hour), 'Test Spec Dn (dBm):' and 'Test Spec Up (dBm):' input fields, 'Start Recording Data at:' and 'Stop Recording Data at:' sections with date and time dropdowns, and a 'Select Format:' section with radio buttons for dBm (selected), W, mW, and uW. There is a 'Base File Name:' input field with a 'Browse' button, and an 'Overwrite existing files' checkbox. At the bottom, a note states: 'Note: for each sensor, recording File Name=BaseFileName_Sensor_SN.txt'.

Figure 3.10.3: Recording Multiple power sensors

Note: File names for multiple power sensor data recording are always in the format of [path]_[model S/N].txt. Thus if the path entered is c:\test the data for power sensor serial number 11405080006 will be saved to file c:\test_11405080006.txt

3.10.4 Add sensor

If you have already started working with a PWR power sensor and wish to start a second sensor you can click on the 'Add sensor' button in the main screen. This will open a second startup screen, as shown in **section 3.1.2**, showing the additional sensors available. If only two sensors are connected via USB when clicking on USB it will automatically open the second sensor, without displaying the power sensor selection screen.

Chapter 4 – Peak Power and Pulse profiling

This chapter explains how to use the peak and average power analysis functions of peak power sensors such as PWR-8P-RC.

4.1 Configuring sample period & Trigger (Peak power only)

Clicking on the 'Peak PS-Config' button in the main screen (Fig 4.1) will cause the central section of the main screen to change to a configuration view. Default settings are sample period of 10 msec, Free mode Trigger in and external output set as video output. Click the 'Peak PS-Config' button to return to measurement mode.

Note: Sample period should be greater than expected cycle of RF signal.

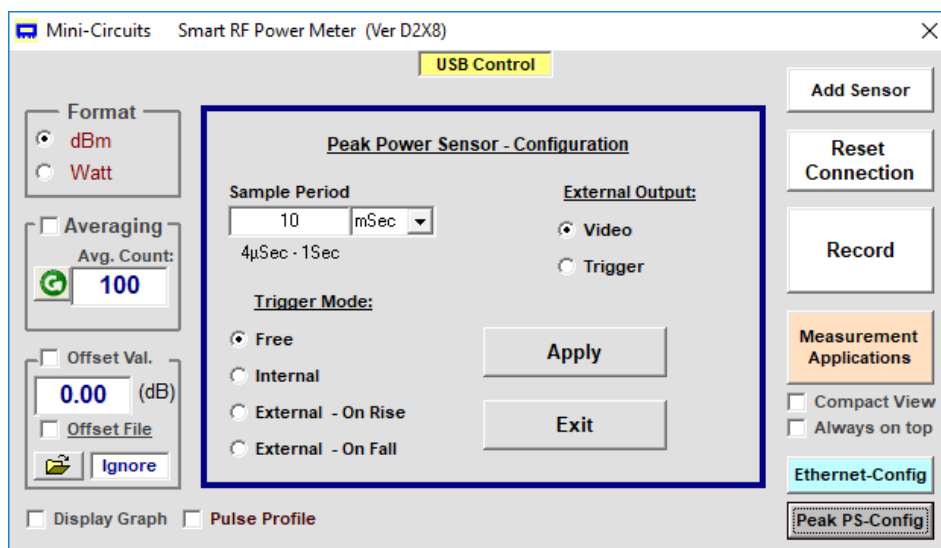


Figure 4.1: Sample Period & Trigger Config. window

4.1.1 Trigger Options (Fig. 4.1)

- Free** No Trigger used.
- Internal** Internal trigger locks on first pulse detected. Detection threshold for Internal trigger is ~5 dB over noise floor.
- External – On Rise** Sample period will start at rising edge of trigger at Trigger Input port of sensor.
- External – On Fall** Sample period will start at falling edge of trigger at Trigger Input port of sensor.

4.1.2 Output Options (Fig. 4.1)

The Peak Power sensor's Trigger/Video Out can be set as either a negative video output, showing the modulating signal of the RF signal (up to 10 MHz bandwidth), or as a TTL trigger with falling edge corresponding to the start of a pulse.

Note: Sample period should be greater than expected cycle of RF signal.

4.2 Pulse Profile Analysis

Select the "Pulse Profile" check box on the main GUI screen to open the pulse profile analysis screens. Three new windows will appear:

- Full pulse profile display - Captures the full sample period of the sensor
- "Zoom on pulse" display - Allows any portion of the signal to be focused on / expanded in a second graphical display
- Calculated parameters display - Summary of the measured and calculated parameters of the signal captured in the "zoom on pulse" display

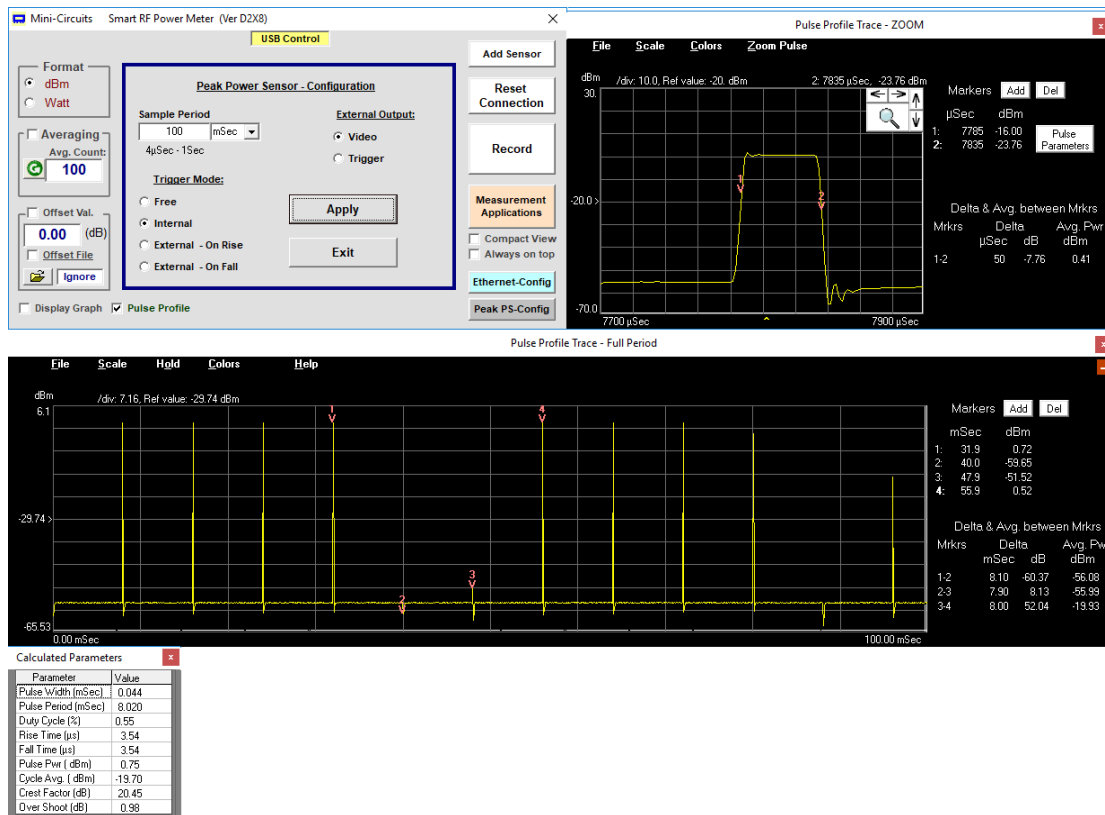


Figure 4.2: Pulse Profiling Windows

4.2.1 Pulse profiling display options (Fig.4.2)

The menus at the top of the pulse profile displays provide the following options:

Screenshot	Select "File" from the menu to save the graph image as a jpg file or copy to the clipboard (either the selected graph or all open windows).
Scale	Select "Auto" to reset the y-axis (power) to display the full signal being measured, or "Manual" to open the configuration window where the max level and dB / div settings can be customized.
Continue / Hold	Click to toggle between continuous live measurements and hold, to freeze the display and all measured parameters.
Colors	Select from a list of alternative color combinations for the background and signal traces.
Help (at full trace)	Accessible on the full pulse profile display. Displays the help file with a summary of all window functions.
Zoom Pulse (at zoom trace)	Accessible on the "zoom on pulse" display. Select "Auto" to center the zoom on the first identified pulse, or "Config" to manually set the zoom display parameters (see section 4.2.4).

4.2.2 Markers for Graphs

To the right of each graph is a Markers table showing up to four markers with the time from the start of the sample period (in μs or ms), and the power level in dBm.

- To add or delete markers click on the **Add** and **Del** buttons at the top of each table.
- To place the marker automatically at the highest signal peak visible in the trace, double click on the marker number.
- To manually place the marker, select the marker by clicking once on the marker number (number will become bold indicating it was selected) and then click in the graph at the location you wish to place the marker, or use the keyboard left and right arrow buttons to adjust the marker location.
- Markers are placed independently in each graph.

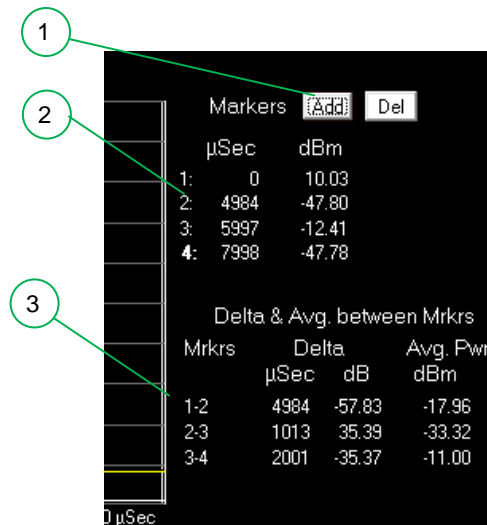


Figure 4.2.2: Marker table

#	Name	Description
1	Add & Del	Add and delete markers. Clicking on Delete will remove the highest numbered marker currently active.
2	Marker list	Shows list of currently active markers, with selected marker in bold. Each marker shows the time from the start of the sample period and power level at that point.
3	Delta & Avg	List of deltas between adjacent markers. List shows delta in time and power, and average power over the period between the two markers.

4.2.3 Zoom Graph Configuration

The zoom display allows any portion of the pulse profile from the main display to be focused on and analyzed more closely. The zoomed section can be configured in a number of ways:

- When the display is first opened, the trace will center on the first pulse detected.
- Any portion of the main pulse profile display (showing the full sample capture period) can be selected for the zoom display by right-clicking in the main display, keeping the right mouse button depressed, and dragging a rectangle around the relevant section. Release the right mouse button to update the zoom display
- The arrow buttons around the magnifying glass icon allow the time span and time delay of the zoomed display to be adjusted in small increments:
 - Left arrow – Decreases the time delay between the start of the full pulse profile display and the start of the zoom display.
 - Right arrow – Increases the time delay between the start of the full pulse profile display and the start of the zoom display.
 - Down arrow – Decreases the time span of the zoomed display around the same center point.
 - Up arrow – Increases the time span of the zoomed display around the same center point.
- Select “Config” from the “Zoom Pulse” menu to manually set the time delay and time span parameters. See **Figure 4.2.4** for details.
- To re-center the zoom display automatically select “Auto” from the “Zoom Pulse” menu or click on the magnifying glass icon.

4.2.4 Zoom on Pulse config window

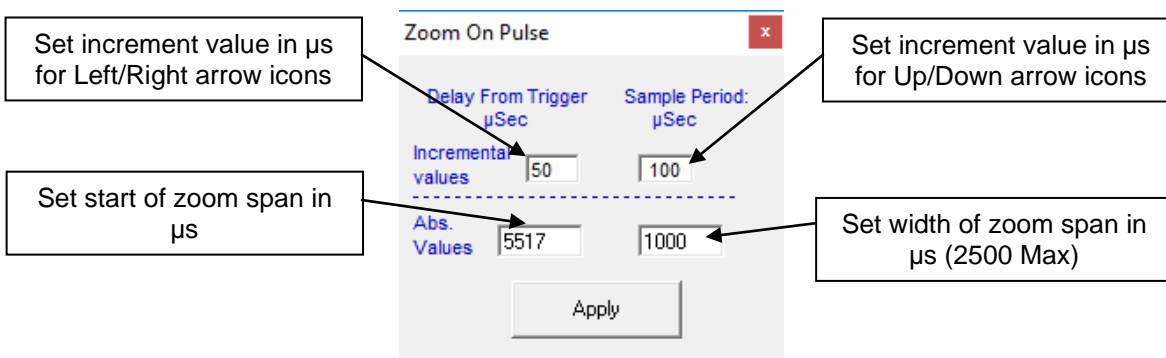


Figure 4.2.4: Zoom on pulse parameters

4.2.5 Calculated parameters

The calculated parameters table provides measured and calculated details of the pulse signal captured in the “zoom on pulse” display. To ensure accurate analysis, the “zoom on pulse” display should be configured to capture one complete pulse period. For extreme duty cycles (as specified in the datasheet) it may be necessary to adjust the zoom configuration manually, or use an external trigger.

Calculated Parameters	
Parameter	Value
Pulse Width (µSec)	16
Pulse Period (µSec)	6013
Duty Cycle (%)	0.26
Rise Time (µs)	3.52
Fall Time (µs)	3.52
Pulse Pwr (dBm)	9.78
Cycle Avg. (dBm)	-15.78
Crest Factor (dB)	25.56
Over Shoot (dB)	0.32

Figure 4.2.5: Calculated parameters

Pulse width	Time from 50% of the pulse rising edge to 50% of the pulse falling edge, calculated in µs.
Pulse Period	Time from 50% of the first pulse rising edge, to 50% of the next pulse rising edge, calculated in µs.
Duty Cycle	Ratio of the pulse width from the pulse period, calculated as a percentage.
Rise Time	Time taken for the pulse rising edge to reach 90% of its final value, from 10% of its final value, calculated in µs.
Fall time	Time taken for the pulse falling edge to reach 10% of its initial value, from 90% of its initial value, calculated in µs.
Pulse Power	Average power of the pulse, measured in dBm. This is an indication of the steady peak power level, averaging out any initial overshoot on the pulse rising edge.
Average Power	Average power for the complete sample period of the “zoom on pulse” display, measured in dBm.
Crest Power	Ratio of the pulse power to average power of the signal (Pulse Power - Average Power), in dB.
Overshoot	Ratio of the peak power to pulse power of the signal (Peak Power - Pulse Power), in dB

Chapter 5 – Revision History

Nov 10, 2014: Created user guide Rev OR.

Dec 12, 2014: Updated legal disclaimer. Rev A

Jun 18, 2015: Updated legal disclaimer. Rev B.

Aug 16, 2015: Added instructions to create offset file manually. Rev C

Dec 22, 2015: Added PWR-6RMS-RC model, updated firmware upgrade instruction. Rev D

May 30, 2016: Added PWR-6LRMS-RC & PWR-6LGHS models, rotated model selection guide and removed unneeded columns. Removed references to only PWR-xxx-RC models supporting firmware upgrade. Updated cover page.

Jan 30, 2018: Added PWR-8P-RC model, and general Peak & Average power sensor functions.



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