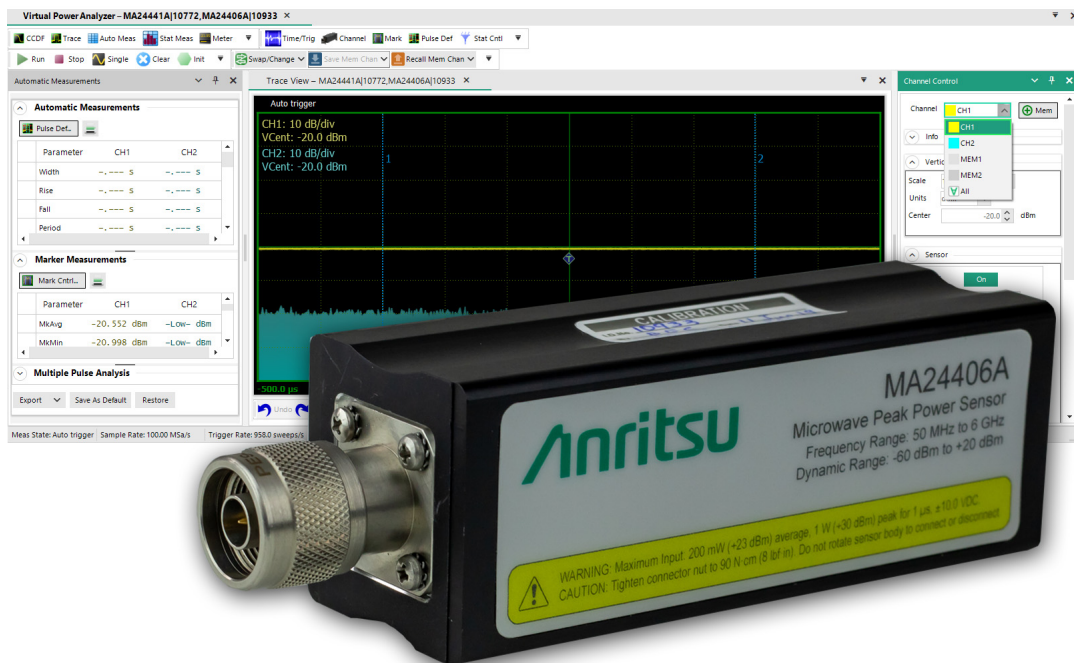


## User Guide

# MA244xxA Microwave USB Peak Power Sensors



# Anritsu

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# Chapter 1 — General Information

## 1-1 Introduction

The MA244xxA microwave USB peak power sensors (MA244xxA peak power sensors) are designed to provide accurate peak-power measurements from 50 MHz to 6 GHz, 18 GHz, and 40 GHz with up to 80 dB of dynamic range and 195 MHz of video bandwidth. The sensors provide real-time processing and a unique parallel processing methodology that performs the multi-step process of RF power measurement. While conventional power meters and USB sensors perform steps serially resulting in long re-arm times and missed data, Anritsu's MA244xxA Peak Power Sensors capture, display, and measure every pulse, glitch, and detail with virtually no gaps in data and with zero latency.

### Before You Begin

Read the Anritsu *Power Meters, Power Sensors, and Power Analyzer Product Information, Compliance, and Safety Guide* (PN: 10100-00066) for important safety, legal, and regulatory notices before operating the equipment.

### Additional Documentation

**Table 1-1.** Related Manuals

Document Part Number	Description
10100-00066	Important Product Information, Compliance, and Safety Notices
11410-01127	Microwave USB Peak Power Sensors Technical Data Sheet
10585-00034	Programming Manual

For additional information and literature covering your product, visit the product page of your instrument and select the Library tab: <https://www.anritsu.com/en-us/test-measurement/products/ma24400a>

## 1-2 Manual Organization

This User Manual provides the information needed to install, operate, and maintain the MA244xxA Peak Power Sensors.

The manual is organized into these seven chapters:

**Chapter 1, “General Information”** presents summary descriptions of the sensors and their principal features, accessories, and options. Also included are specifications for the instrument.

**Chapter 2, “Overview”** describes the basic operation of the Microwave Peak Power Sensors and the Power Analyzer Software.

**Chapter 3, “Operation”** describes, in detail, the Graphical User Interface (GUI) of the Power Analyzer Software and the MA244xxA Peak Power Sensors.

**Chapter 4, “Measurements”** provides definitions for key terms used in this manual and on the GUI displays, as well as methodologies used to calculate automated pulse, marker, and statistical measurements.

## 1-3 Instrument Description

This modular product line offers speed and accuracy in a USB form-factor. The new line includes 6, 18, and 40 GHz models and measures wideband modulated signals.

The MA244xxA Peak Power Sensors are the latest series of products from Anritsu that turn your PC or laptop using a standard USB 2.0 port into a state-of-the-art peak power analyzer without the need for any other instruments. Power measurements from the MA244xxA Peak Power Sensors can be displayed on your computer or can be integrated into a test system with a set of user-defined software functions.

The MA244xxA Peak Power Sensors include the models MA24406A, MA24408A, MA24418A, MA24440A, MA24419A, and MA24441A. Collectively, they cover a frequency range of 50 MHz to 40 GHz and offer broadband measurements with rise times as fast as 3 ns, time resolution of 100 ps, and video bandwidths up to 195 MHz.

The MA244xxA Peak Power Sensors enable rapid-pulse integrity determinations. Effective sampling rate is up to one hundred times faster than conventional power sensors. This makes finer waveform details visible. The sensors perform automatic capture of pulse power, overshoot, droop, edge delay, skew timing, and edge transition times.

The MA244xxA Peak Power Sensors have exceptional trigger stability of less than 100 ps trigger jitter regardless of the trigger source. The MX244xxA yields greater waveform detail because a stable trigger point yields a stable waveform. Using dedicated trigger circuitry rather than software-based, triggering provides precise time-stamping of relative trigger-to-sample delay. This precision permits the use of random interleaved sampling (RIS) for repetitive waveforms. This results in an effective sampling rate of 10 GS/s, which permits accurate, direct-measurement of fast timing events without requiring interpolation between samples.

Real-time processing offers new possibilities for power integrity measurements because every pulse is analyzed and none are discarded. Trace acquisition, averaging, and envelope times are drastically reduced, resulting in simultaneous analysis of average, peak, and minimum power values.

The MA244xxA Peak Power Sensors are supported by the MA244xxA Peak Power Analyzer, a Windows-based software package that provides control and readout of the sensors. It is an easy-to-use program that provides both time and statistical domain views of power waveforms with variable peak hold and persistence views. It supports power measurements using automated pulse and statistical measurements, power level, and timing markers. The GUI application is easily configured with dockable or floating windows and measurement tables that can be edited to show only the measurements of interest.

The MA244xxA Peak Power Sensors are ideal for manufacturing, design, research, and service in commercial and military applications such as telecommunications, avionics, RADAR, and medical systems. They are the instrument of choice for fast, accurate, and highly-reliable RF power measurements, equally suitable for product development, compliance testing, and site-monitoring applications.

## 1-4 Architecture

The sensor functions as an ultra-fast, calibrated, power-measurement tool, which acquires and computes the instantaneous, average, and peak RF power of a modulated, wideband RF signal. The internal A/D converter samples the detected RF signal at up to 100 megasamples/second (MSa/s), and a digital signal processor carries out the work of forming the digital samples into a correctly scaled and calibrated trace on the display.

Figure 1-1 shows a block diagram of the peak power sensor.

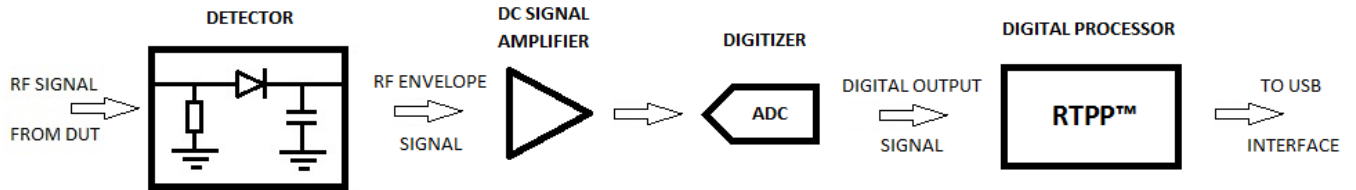


Figure 1-1. MA244xxA Peak Power Sensors Block Diagram

The first and most critical stage of a peak power sensor is the detector, which removes the RF carrier signal and outputs the amplitude of the modulating signal. The width of the detector’s video bandwidth dictates the sensor’s ability to track the power envelope of the RF signal. The image on the left of Figure 1-2 shows how a detector with insufficient bandwidth is unable to track the signal’s envelope effectively, affecting the accuracy of the power measurement.

The image on the right shows sufficient video bandwidth to track the envelope accurately. The fast detectors used in peak-power sensors are by their nature non-linear, so shaping procedures within the digital processor must be used to linearize their response. When measuring instantaneous peak power, a high-sample rate is important to ensure that no information is lost. The MA244xxA Peak Power Sensors have a sample rate of 100 MS/s, enabling capture and analysis of power versus time waveforms at a very high resolution.

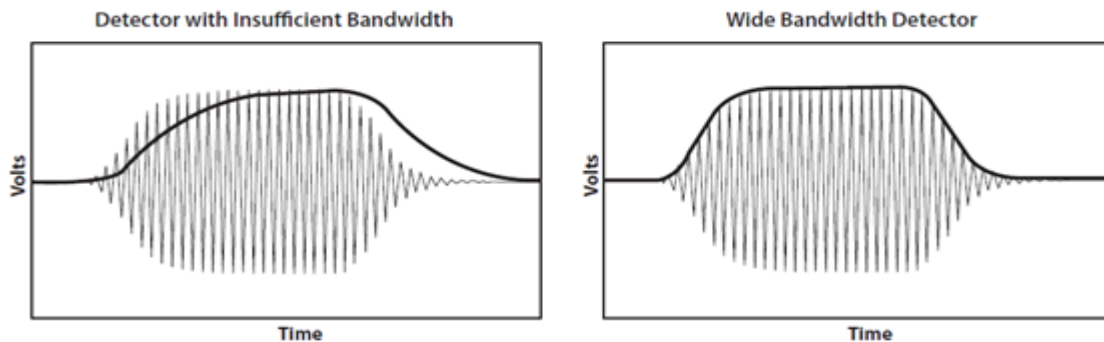


Figure 1-2. Comparison of Bandwidth Detectors

## 1-5 Instrument Care and Preventive Maintenance

Instrument care and preventive maintenance consist of proper operation in a suitable environment, occasional cleaning of the instrument, and inspecting and cleaning the RF connectors and all accessories before use. Clean the instrument with a soft, lint-free cloth dampened with water or water and a mild cleaning solution.

**Caution** To avoid damaging the display or case, do not use solvents or abrasive cleaners.

### Connector Care

Clean the RF connectors and center pins with a cotton swab dampened with denatured alcohol. Visually inspect the connectors. The fingers of the N(f) connectors and the pins of the N(m) connectors should be unbroken and uniform in appearance. If you are unsure whether the connectors are undamaged, gauge the connectors to confirm that the dimensions are correct. Visually inspect the test port cable(s). The test port cable should be uniform in appearance and not stretched, kinked, dented, or broken.

To prevent damage to your instrument, do not use pliers or a plain wrench to tighten the Type-N connectors. The recommended torque is 12 lbf · in (1.35 N · m). The recommended torque for K connectors (2.92 mm) is 8 lbf · in (0.9 N · m). Inadequate torque settings can affect measurement accuracy. Over-tightening connectors can damage the cable, the connector, the instrument, or all of these items.

Visually inspect connectors for general wear, cleanliness, and for damage such as bent pins or connector rings. Repair or replace damaged connectors immediately. Dirty connectors can limit the accuracy of your measurements. Damaged connectors can harm the instrument. Connection of cables carrying an electrostatic potential, excess power, or excess voltage can damage the connector, the instrument, or both.

### Connecting Procedure

1. Carefully align the connectors. The male connector center pin must slip concentrically into the contact fingers of the female connector.
2. Align and push connectors straight together. Do not twist or screw them together. A slight resistance can usually be felt as the center conductors mate.
3. To tighten, turn the connector nut, not the connector body. Major damage can occur to the center conductor and to the outer conductor if the connector body is twisted.
4. If you use a torque wrench, initially tighten by hand so that approximately 1/8 turn or 45 degrees of rotation remains for the final tightening with the torque wrench.

Relieve any side pressure on the connection (such as from long or heavy cables) in order to assure consistent torque. Use an open-end wrench to keep the connector body from turning while tightening with the torque wrench.

Do not over-torque the connector.

### Disconnecting Procedure

1. If a wrench is needed, use an open-end wrench to keep the connector body from turning while loosening with a second wrench.
2. Complete the disconnection by hand, turning only the connector nut.
3. Pull the connectors straight apart without twisting or bending.



### ESD Caution

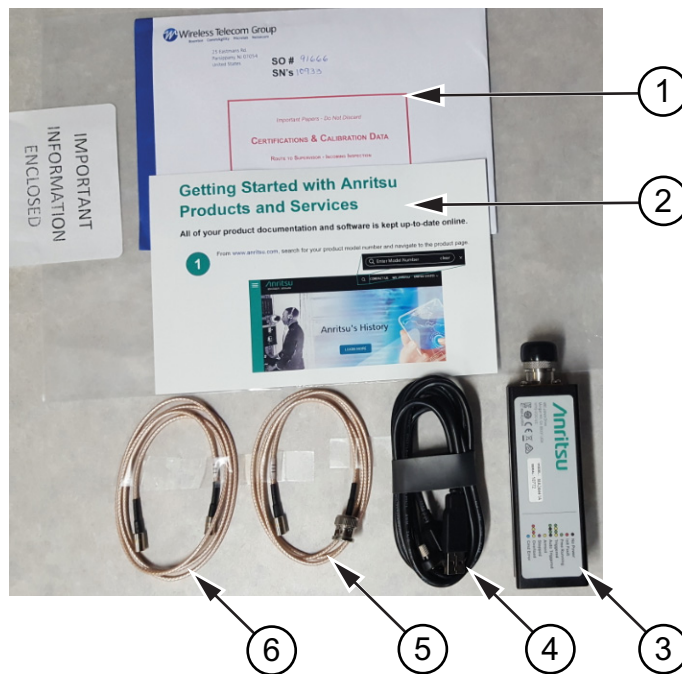
The MA244xxA power sensors, like other high performance instruments, are susceptible to electrostatic discharge (ESD) damage. Coaxial cables and antennas often build up a static charge, which (if allowed to discharge by connecting directly to the instrument without discharging the static charge) may damage the MA244xxA input circuitry. Instrument operators must be aware of the potential for ESD damage and take all necessary precautions.

Operators should exercise practices outlined within industry standards such as JEDEC-625 (EIA-625), MIL-HDBK-263, and MIL-STD-1686, which pertain to ESD and ESDS devices, equipment, and practices. Because these apply to the MA244xxA power sensors, it is recommended that any static charges that may be present be dissipated before making connection. It is important to remember that the operator may also carry a static charge that can cause damage. Following the practices outlined in the above standards will ensure a safe environment for both personnel and equipment.

## 1-6 Unpacking

**Caution** Follow all ESD procedures when handling the MA244xxA Peak Power Sensors.

The MA244xxA Peak Power Sensors are shipped complete and are ready to use upon receipt. Verify the items in your power sensor package as shown in Figure 1-3. If any of the items are missing or damaged, refer to contact Anritsu Customer Service.



1. Calibration Certificate	4. USB Type-A Cable (6 ft)
2. Information Card	5. External Trigger Multi-I/O Cable (SMB to BNC)
3. MA244xxA Power Sensor	6. Trigger Sync Cable (SMB to SMB)

**Figure 1-3.** MA244xxA Peak Power Sensors Kit

### 1-7 Contacting Anritsu for Sales and Service

Customers having questions or equipment problems should visit this website and select the services in your region: <http://www.anritsu.com/contact-us>.



# Chapter 2 — Overview

This chapter provides MA244xxA Peak Power Sensors user interface and operational overview. For a detailed functional description, see [Chapter 3, “Operation.”](#)

## 2-1 Installing MA244xxA Software

This section describes the installation and use of the MA244xxA USB peak power sensors software.

<b>Caution</b>	Do not connect the MA244xxA peak power sensors to your PC until you have installed the MA244xxA Peak Power Analyzer software.
----------------	---

### System Requirements

- Processor: 1.3 GHz or higher, recommended
- RAM: 512 MB (1 GB or more, recommended)
- Operating System:
  - Microsoft® Windows® 10
  - Microsoft® Windows® 8 (32-bit and 64-bit)
  - Microsoft® Windows® 7 (32-bit and 64-bit)
- Hard-disk free space: 1.0 GB free space to install or run
- Display resolution: 800x600 (1280x1024 or higher, recommended)
- Interface: USB 2.0 high-speed

### Installation Procedure

MA244xxA provides a PC user interface for making peak power measurements.

To install the MA244xxA peak power analyzers software:

1. Download the latest MA244xxA USB peak power sensors software from the Anritsu Website:  
<https://www.anritsu.com/en-us/test-measurement/support/downloads/software/dwl19784>
2. Click **Download**.
3. Select **Run** to start the installation.
4. Click through the installation screens. The installation creates a folder on the users PC that is located here: C:\Program Files (x86)\MA244xxA peak power analyzer. Open the folder to launch

AnritsuPowerAnalyzer.exe. Once launched, the MA244xxA PC User Interface will appear as shown in Figure 2-1.

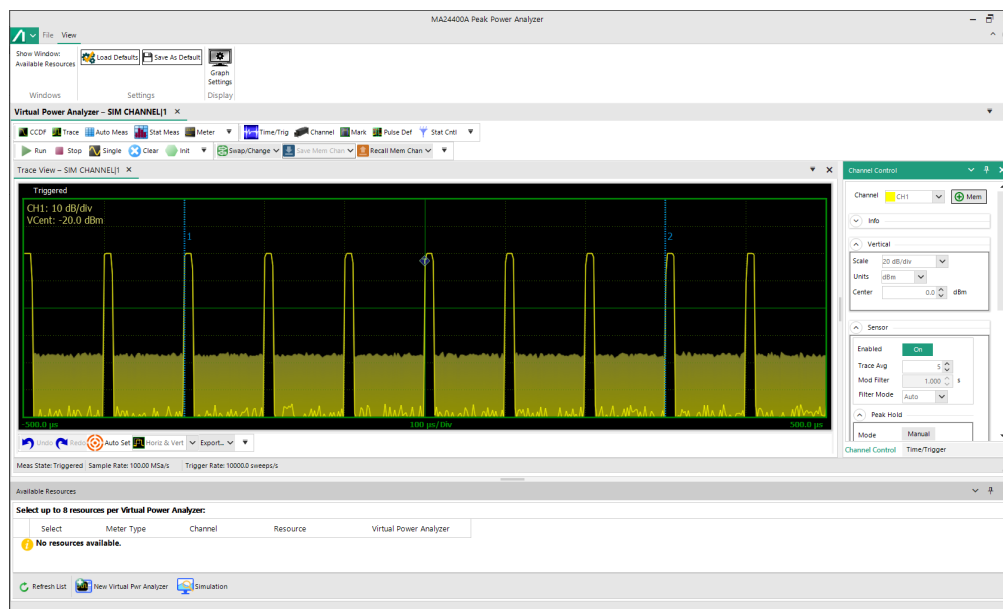


Figure 2-1. MA244xxA PC Interface Display

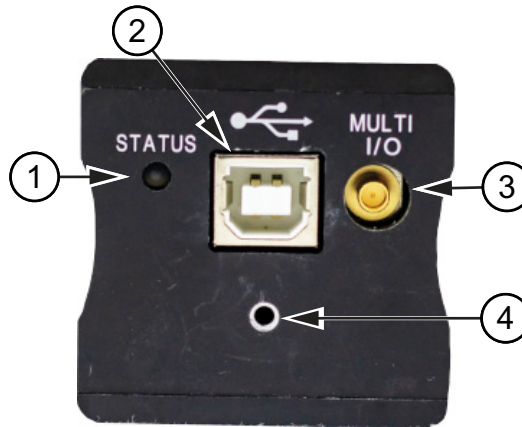
## 2-2 MA244xxA Input Power Requirements

The MA244xxA Peak Power Sensors require 2.5 Watts at 5 Volts, this is supplied via a USB port. Therefore, power sensor MUST be connected to a USB 2.0 compatible port that is able to supply 500 mA.

## 2-3 Connecting the MA244xxA Peak Power Sensors

The connector panel of the MA244xxA Peak Power Sensors is shown in [Figure 2-2](#). The USB Type B receptacle is used to connect the MA244xxA Peak Power Sensors to the host computer. The MULTI I/O is an SMB plug provides a trigger input, a status output, or a trigger-synchronizing interconnection when multiple MA244xxA Peak Power Sensors are used.

**Note** The MA244xxA Peak Power Analyzer software must be installed prior to connecting the sensor.



1. STATUS indicator. See [“Status LED Codes” on page 2-5](#).
2. USB Type B receptacle
3. MULTI I/O SMB plug
4. Captive Screw. See [Figure 2-3 on page 2-3](#).

**Figure 2-2.** Rear Panel

### Procedure

1. Connect the power sensor to your PC with the supplied USB cable. The cable should be secured (hand-tight only) to the sensor using the captive screw on the USB plug. See [Figure 2-3](#).



**Figure 2-3.** Captive Screw for the USB Cable

The MA244xxA Peak Power Sensors front label provides information on the maximum input power levels. Do not exceed the specified Dynamic Range RF input power as specified on the front label. See [Figure 2-4](#) for location of this information.

**Caution** Use the connecting and disconnecting procedures described in [“Instrument Care and Preventive Maintenance”](#) on page 1-4.

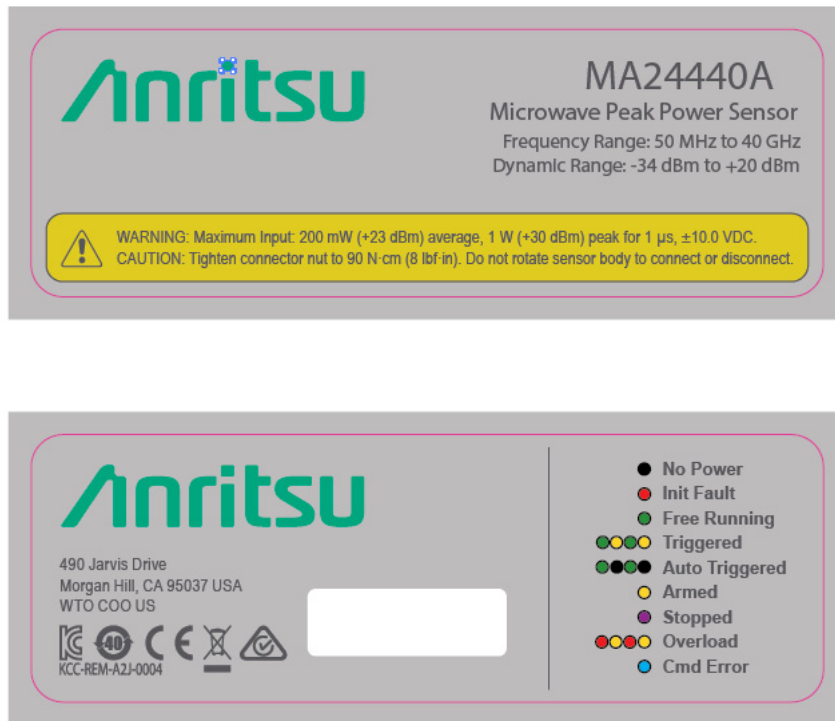


**Figure 2-4.** MA24406A With N-Type Connector

2. Connect the MA244xxA peak power sensors to the RF source to be measured. All MA244xxA peak power sensors models are equipped with either a precision Type-N male RF connector (for applications up to 20 GHz) or a precision 2.92 mm male RF connector (for applications up to 40 GHz).
3. Up to eight sensors can be connected to the MA244xxA peak power sensors. See [“Multichannel Operation”](#) on page 3-29 for connection schemes for multichannel situations.
4. Start the MA244xxA peak power analyzer. Refer to [“Starting the MA244xxA Peak Power Analyzer”](#).

## 2-4 Status LED Codes

The rear panel STATUS LED color and flash pattern display the sensor’s status as indicated on the side panel label shown in [Figure 2-5](#).



**Figure 2-5.** Information Labels on the MA244xxA Peak Power Sensors

The information label descriptions of the various status LED flash patterns are shown in [Table 2-1](#).

**Table 2-1.** LED Status Indicators






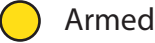


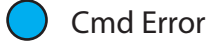
Icon	Description
 No Power	<b>No Power:</b> No input power detected.
 Init Fault	<b>Init Fault:</b> Initialize meter setting failed.
 Free Running	<b>Free Running:</b> Generating horizontal sweeps asynchronously, without regard to trigger conditions.
 Triggered	<b>Triggered:</b> Indicates a preset triggered condition has occurred.

Table 2-1. LED Status Indicators

Icon	Description
 Auto Triggered	<b>Auto Triggered:</b> Automatically generates a trace if no trigger edges are detected for a period of time.
 Armed	<b>Armed:</b> Meter is armed and waiting for trigger event.
 Stopped	<b>Stopped:</b> Measurement Stopped.
 Overload	<b>Overload:</b> Input power is too high. Reduce input power.
 Cmd Error	<b>Cmd Error:</b> Command Error return. Measurement is not valid.

## 2-5 Starting the MA244xxA Peak Power Analyzer

After you have installed the MA244xxA software and connected the power sensor to the PC, you are ready to make measurements using the MA244xxA Peak Power Analyzer.

To start making measurements:

1. Start the MA244xxA Peak Power Analyzer by double-clicking the desktop icon. The splash screen that welcomes you to the application is shown in [Figure 2-6](#).



Figure 2-6. MA244xxA Peak Power Analyzer Desktop Icon



If no sensors are connected, the MA244xxA Peak Power Analyzer displays the No resources available message as shown in Figure 2-7. If this is the case, close the analyzer, connect one or more sensors and restart the analyzer.

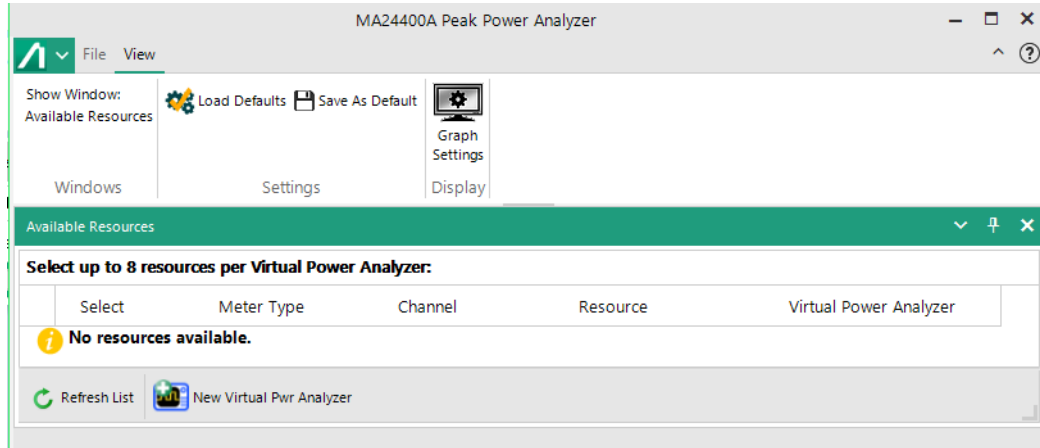


Figure 2-7. No Resources Available

With a sensor connected, the Available Resources 1 window shows a list of the connected devices

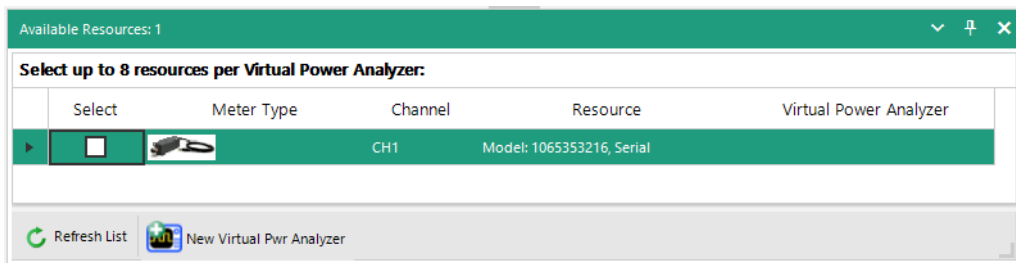


Figure 2-8. Available Resources Box

2. In the Available Resources window, check select boxes for one or more connected sensors.

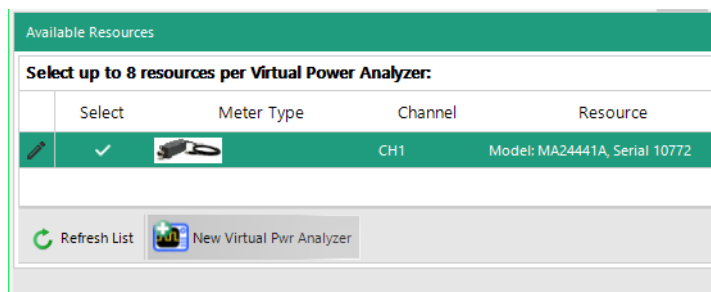


Figure 2-9. Selecting a Sensor from the Available Resources List

- Click New Virtual Pwr Analyzer. This launches a new Virtual Power Analyzer instance containing trace and control panels, and adds the Virtual Power Analyzer name to the Available Resource entries.

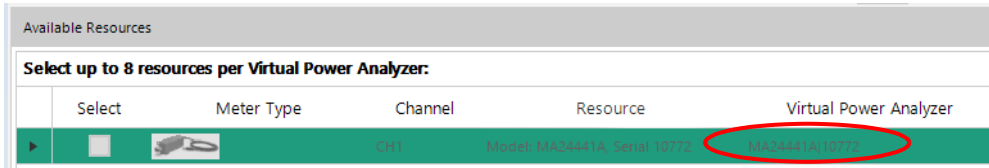


Figure 2-10. Assigned Devices

- If you have an RF signal connected to the USB sensor, the measured signal's waveform appears in the trace window.

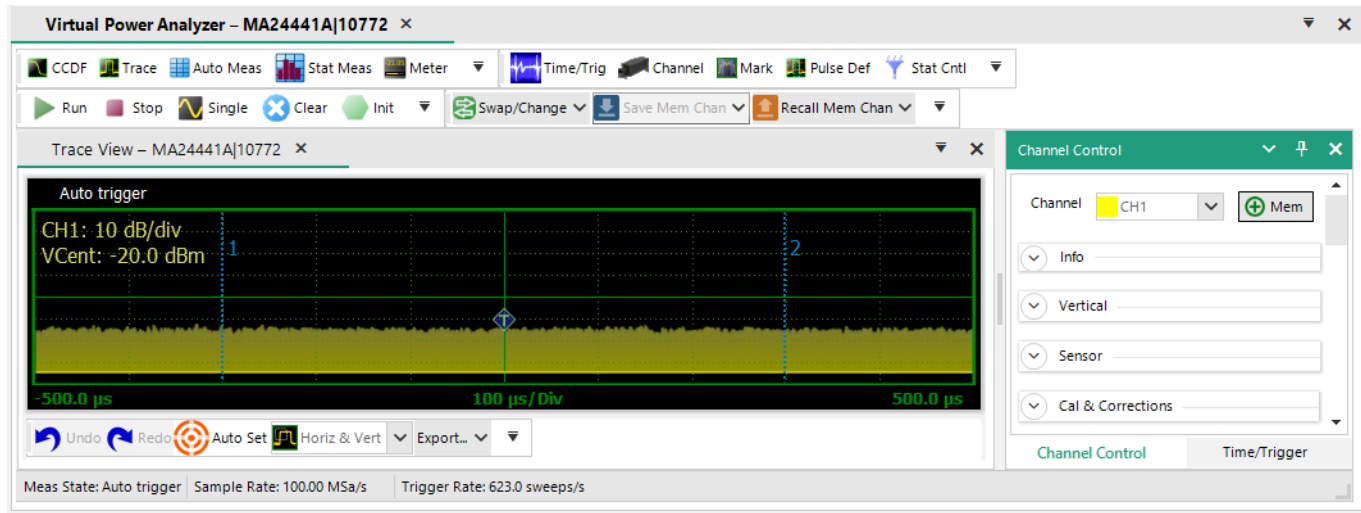


Figure 2-11. Initial View of the Virtual Power Analyzer

A Virtual Power Analyzer is analogous to a bench-top RF power analyzer with one or more sensors connected. Time and trigger controls are typically common to all sensors within a MA244xxA Peak Power Analyzer, while channel-specific controls are available for most other settings. This offers users the familiar, multi-channel approach common to power meters and oscilloscopes.

When independent control of timebase-related settings is desired, you may open multiple MA244xxA Peak Power Analyzer windows, each with their own sets of controls.

## 2-6 MA244xxA Peak Power Analyzer Basics

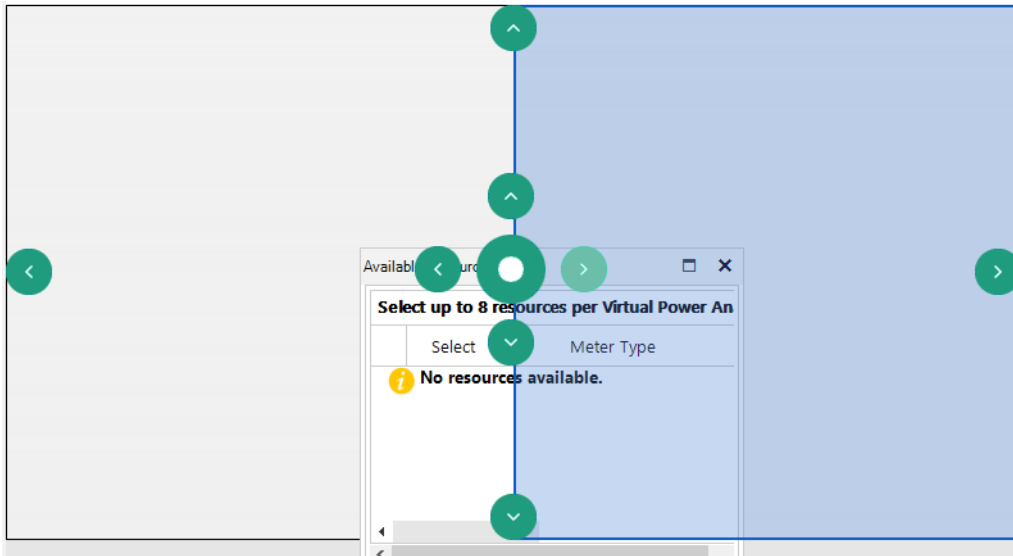
### Dockable Windows

The MA244xxA Peak Power Analyzer uses dockable windows that allow you to arrange the various windows into the configuration of your choice. Drag a docked window by clicking its title bar to move the window to a different docked position or undock it.

To dock tool windows:

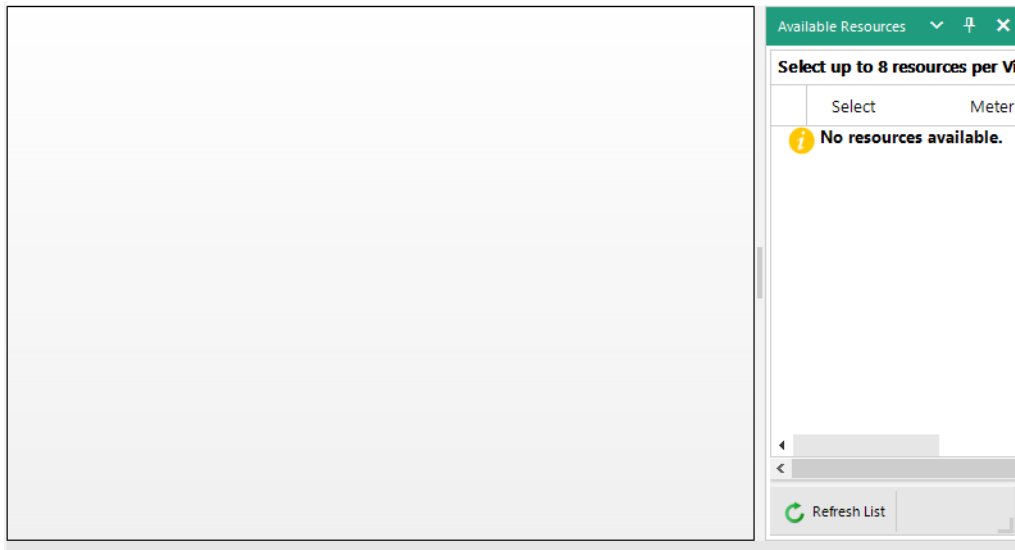
- Click and hold the title bar of the tool window you want to dock.
- Start dragging the window.  
Guide arrows appear pointing toward the four sides of the main window.

- When the tool window you are dragging reaches the location where you want to dock it, move the pointer over the corresponding portion of the guide diamond. The designated area is shaded blue.



**Figure 2-12.** Docking a Window

- To dock the window in the position indicated, release the mouse button.



**Figure 2-13.** Docking a Window to the Right-side of the Main Window

**Note** Each of the tool windows may be positioned by dragging in any direction within the main window. [Figure 2-12 on page 2-9](#) is one example; but you can rearrange tool windows as you prefer to see them within the main software window or onto the desktop; [Figure 2-14](#) shows this.

- Docked windows can be overlapped. Resize and reposition each tool window by selecting individual tabs.

- Docked windows can also be moved partially or completely out of the MA244xxA Peak Power Analyzer main window.

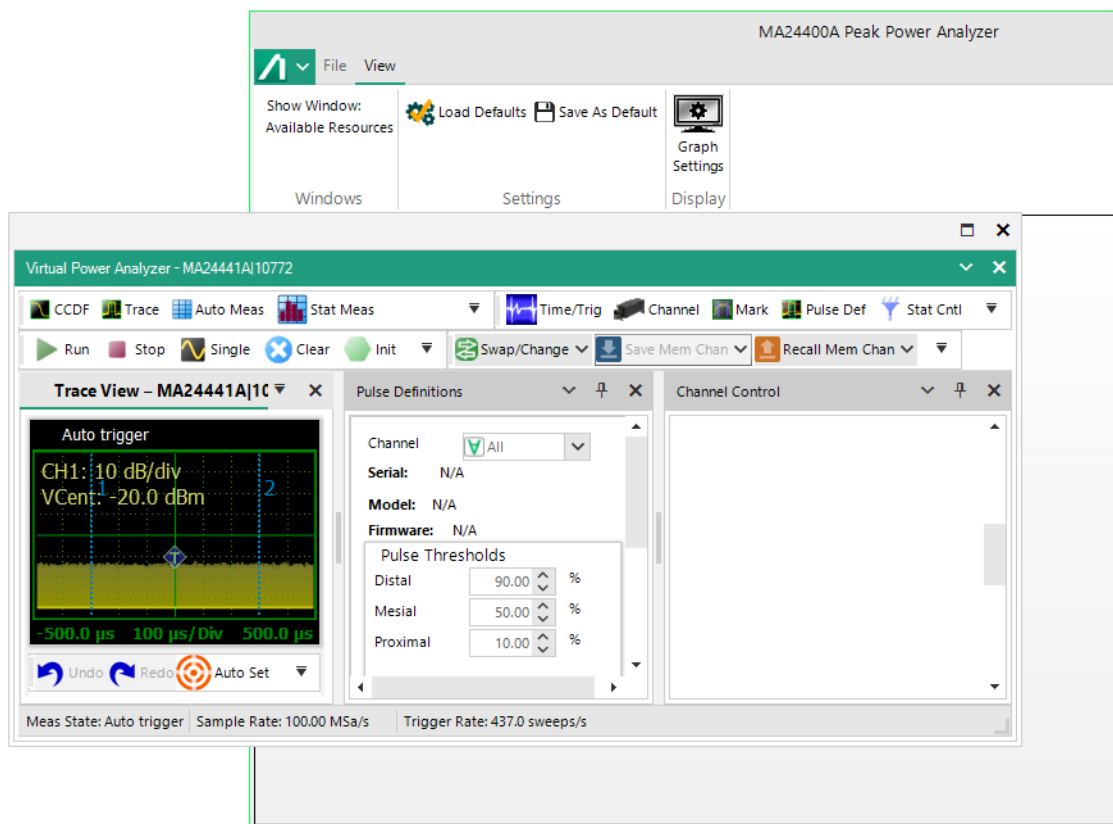


Figure 2-14. Partial Window Repositioning

### Available Resources Window

Sensors can be selected from the Available Resources window. A description for each connected resource indicates the hardware version, model, and channel information. Users can select up to eight resources per Virtual Power Analyzer instance. After selecting sensors, click **New Virtual Pwr Analyzer** and a new Virtual Power Analyzer instance opens for those sensors with default configurations suitable for pulse measurements.

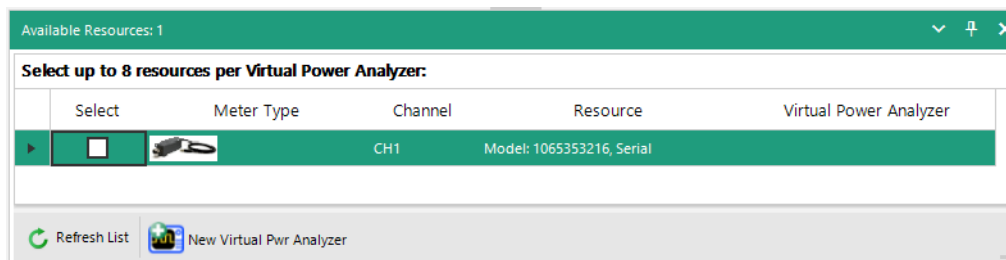
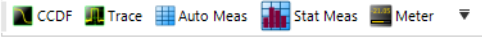
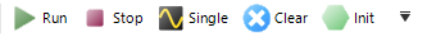

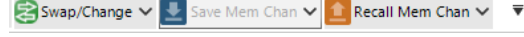


Figure 2-15. Selecting a Sensor Using the Available Resources Box

### Virtual Power Analyzer Main Toolbar

Each Virtual Power Analyzer window displays a main toolbar at the top of its window which hosts shortcuts to commonly used functions and measurement modes. The main toolbar is subdivided into smaller toolbars by function. The order of tools in each toolbar may be customized or the groups may be dragged and dropped as needed to provide more usable arrangements.

Toolbar	Tool	Description
<b>Measurement Control</b> 	CCDF	Opens the CCDF window (Complementary Cumulative Distribution Function)
	Trace	Opens the trace window
	Auto Meas	Opens the auto measurement window
	Statistical Meas	Opens the stat measurement window
	Meter	Opens the meter view
<b>Acquisition Control</b> 	Run	Starts a capture
	Stop	Stops a capture
	Single	Performs a single sweep
	Clear	Clears measurement buffer
	Init	Initializes meter settings
<b>Control Windows</b> 	Time/Trig	Views time and trigger settings
	Channel	Views channel controls
	Mark	Opens marker control form
	Pulse Def	Opens pulse definition editor
	Stat Cntl	Opens stat mode control editor
<b>Memory Channel</b> 	Swap/Change	Swaps the USB power meter for a channel
	Save Mem Channel	Saves (archives) a memory channel
	Recall Mem Channel	Loads an archived memory channel

**Figure 2-16.** Toolbars

With each of these tools is associated a dialog. These are described in [Chapter 3](#) in more detail. When several are open simultaneously you can switch between them using the shortcuts at the bottom of the dialog.

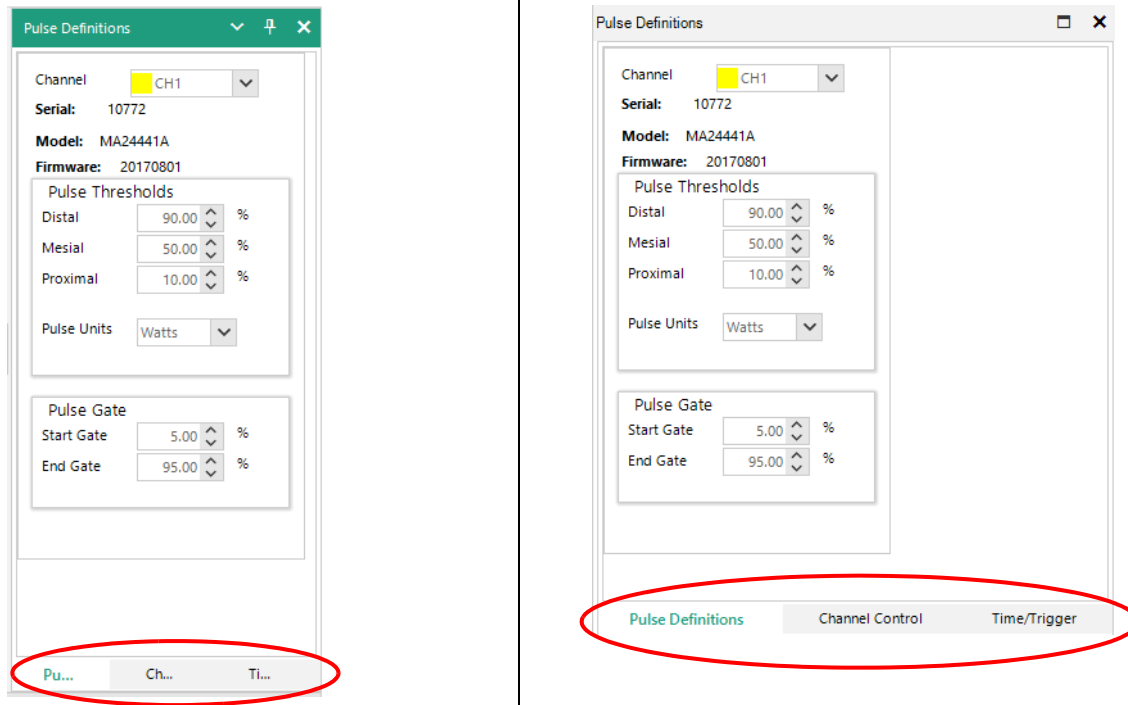


Figure 2-17. Toolbar Shortcuts: Left View is Docked; Right View is Undocked.

## Trace View Window

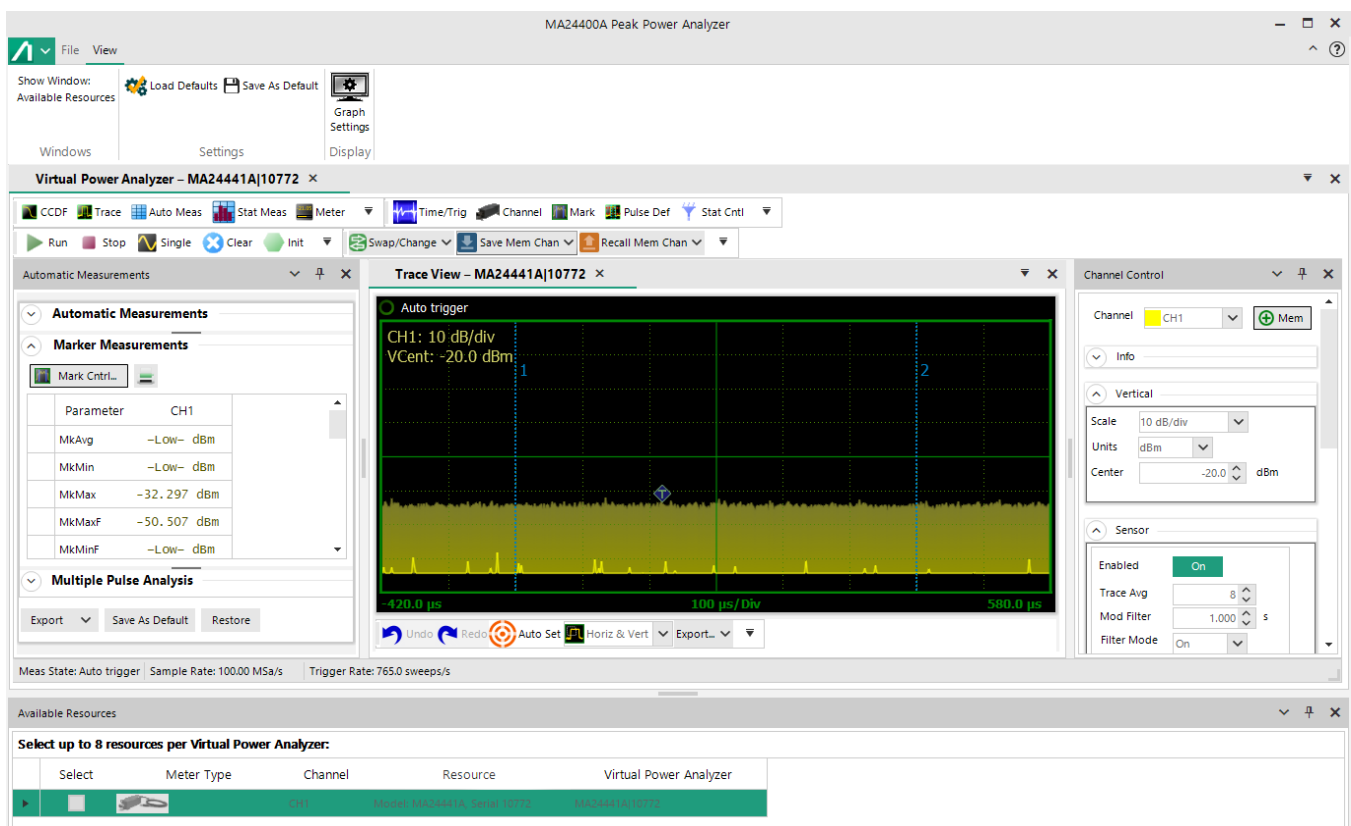
To display a pulse measurement, select the Trace button from the Measurement toolbar. This is the default view for a Virtual Power Analyzer instance.

The Channel and Time/Trig(ger) settings are related to pulse measurement can be selected from the Control toolbar and can be applied to the measurement as shown in [Figure 2-18](#).



**Figure 2-18.** The Trace, Channel, and Time/Trigger Buttons

A Virtual Power Analyzer instance, in a configuration suitable for pulse measurements, is shown in [Figure 2-19](#). This shows a large trace window, automatic measurements, and a tabbed control box for time and channel settings.



**Figure 2-19.** Main Application Window of the MA244xxA Peak Power Analyzer

The Virtual Power Analyzer allows you to directly enter numeric values for most settings in the Channel Control and Time/Trigger windows. For many of the controls, additional methods such as increment/decrement or preset buttons are available.

## Virtual Power Analyzer Lower Toolbar

### Trace Pan and Zoom

The mouse can be used to select a zoom area to view detail in an area of interest on the displayed waveform. The highlighted dragged rectangular area indicates the minimum area that will be shown when the zoom operation completes.

Horizontal pan or zoom adjusts the timebase (within preset values) and the trigger delay to highlight an area of interest without vertical rescaling.

Directly pan or zoom to waveform areas of interest by selecting any option from the lower toolbar of the trace window. Available options for zoom/pan control are: Horizontal & Vertical, Horizontal, Pan and None.

Clicking the Trace View display, dragging a zoom box, and releasing the mouse button results in the trace being expanded to show the area outlined by the zoom indicators.

### AutoSet

The Auto Set button tries to configure level scaling, trigger level, and timing for a best-fit display based upon amplitude and timing of the applied signal. All other parameters are set to defaults. If the Auto Set process fails, all settings are left untouched.

You can undo or redo an action with the undo and redo buttons.

### Trace Data Export

Any trace window can be exported and saved or printed as a PDF or CSV document by selecting PDF or CSV from the Export drop-down menu. An exported trace file can easily be imported into a spreadsheet or other report file or documentation.

## Channel Control Window

Select the Channel button of the Trigger group and a dockable sidebar appears, on the right-hand side of the main application window. This allows you to change all the related settings that control one or more sensor channels. The Channel Control is defined by these parameters.

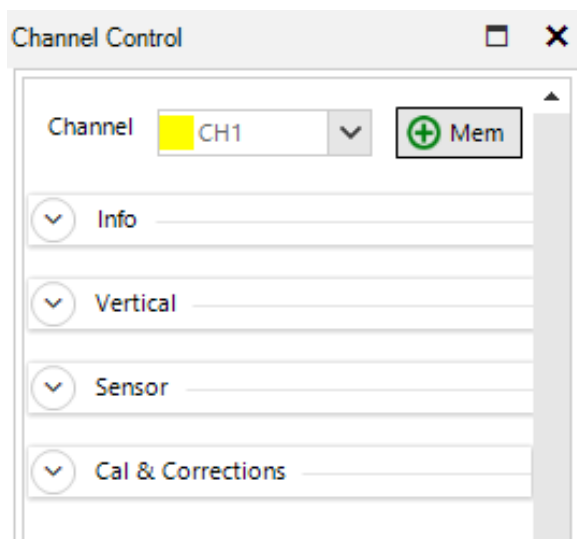


Figure 2-20. Channel Control Dialog

### Channel

Select one channel to update from the drop-down list or select All channels (available only with multiple channels) to simultaneously update all measurement channels (up to 8) for most settings.

### Memory Pull-down

You can select the stored memory channels.



**Info Group**

- Serial: Displays the serial number of the sensor.
- Model: Displays the model number of the sensor.
- Firmware: Displays the date of the firmware version.
- FPGA: Displays the FPGA version.
- Mark Control: Brings up the Mark Control dialog.
- Pulse Definition: Brings up the Pulse Definition dialog.

**Vertical Group**

- Scale: Sets vertical amplitude scaling and centering of the displayed waveform. These settings affect only the Trace display.
- Units: Selects dBm, Watts, or Volts measurement units. Selection affects displayed text, measurements, and trace.
- Center: The center frequency for the display.

**Sensor Group**

- Sensor Enabled: Enable or disable individual connected sensors.
- Trace Avg: Sets number of acquired sweeps averaged together for displayed trace in pulse/triggered modes. Useful for noisy signals.
- Mod Filter: Sets the modulation filter integration time.
- Filter Mode: Sets manual or automatic filter integration time window for measurements in modulated (non-triggered) acquisition modes.
- Video BW: Selects sensor video bandwidth, high or low.
- Frequency: Sets measurement frequency for the applied RF signal.

**Peak Hold Group**

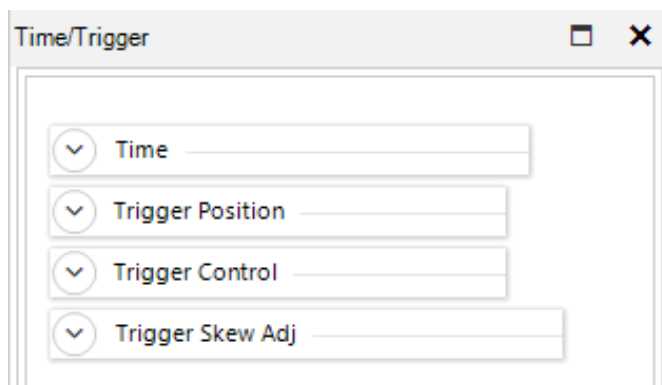
- Mode: Sets the mode of the sensor to either manual or tracking.
- Decay Count: Sets peak hold duration (# of sweeps).

**Cal&Corrections Group**

- Offset: Compensates reading for external gain/loss.
- Zero and Fixed Cal : Performs sensor zeroing or fixed calibration by selecting each specific button.
- Clear User Cal: Clears any user calibration for the sensor selected (refer to [“Channel” on page 2-14](#)).
- Fixed Cal: Performs a calibration at 0 dBm at the currently set frequency.

## Time / Trigger Settings Window

Click the Time/Trig button of the Trigger group to customize all related settings for both timebase and trigger of a pulse signal. Refer [“Time/Trigger Control Window” on page 3-5](#) for details.



**Figure 2-21.** Time and Trigger Dialog

### Time

**Timebase:** Acquisition time in seconds per division. The power sensors use a fixed grid of 10 divisions for the sweep extents. Settings are in a 1-2-5 sequence. Consult series specifications for timebase range.

**Trigger:** Delay The trigger delay can be adjusted by manually entering a numerical value into the field or using the up-down arrow keys. Refer to [“Time Control” on page 3-6](#).

### Trigger Position

The trigger position can be changed by entering numerical values into the Divisions field, clicking the scroll arrows, dragging the slide control, or by clicking the L/M/R (Left/Middle/Right) indicators. Refer to [“Trigger Position Control” on page 3-7](#).

### Trigger Control

**Source:** Several trigger modes are available for each trigger source under **Trigger Control** section. Multiple trigger sources are available under the drop-down list including both **Internal** and **External** selection.

**Mode:** Select Normal, Auto, AutoLevel or Free run.

**Level:** Sets trigger level when trigger source is INT and trigger mode is Auto or Normal.

**Slope:** Selects rising- or falling-edge triggering.

**Holdoff:** Sets trigger holdoff time.

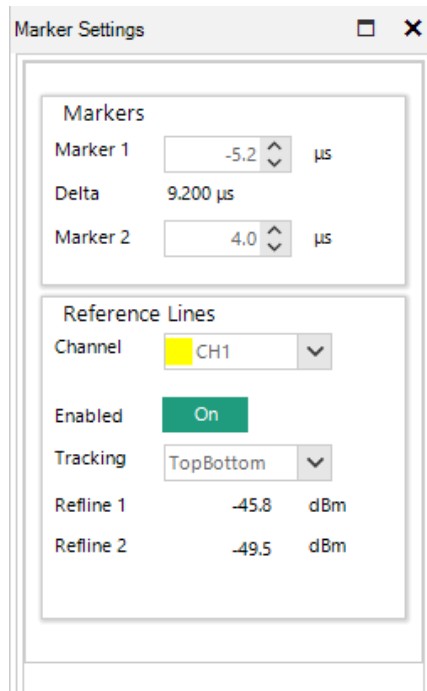
**Holdoff Mode :** Selects between Normal or Gap.

#### Trigger Skew

**Adjustment:** Adjusts the skew for internal trigger with primary trigger output, and also external and secondary triggers. Skew adjustments allow you to calibrate out-trigger delay between sensors so that you can measure the propagation delay of the DUT from input to output. Manual skew adjustments can be made by entering the skew value in the numeric entry field. The button to the right of each skew adjustment is the Auto-Skew, which allows automatic adjustment of the skew. Refer to [“Trigger Skew Adj\(ust\)” on page 3-9](#).

## Marker Settings Window

Click Mark of the Control Windows toolbar to control settings for time markers and reference lines of a pulse signal. refer to “[Marker Settings Window](#)” on page 3-20.



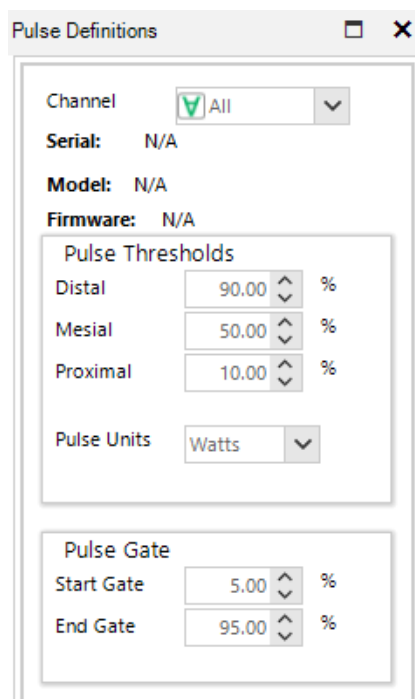
**Figure 2-22.** Marker Settings Window

**Markers:** Change both Marker 1 and Marker 2 time positions by using either arrow keys or entering numerical values into the fields. It also displays the time delta value between the two markers. You may also drag the markers in the active window and their values will be reflected in this window.

**Reference Lines:** Referred to as Horizontal Markers. They can be enabled by selecting the On/Off button for each individual channel. After they are enabled, users may select several options for automatic amplitude tracking from the Tracking drop-down list: Off, Markers, TopBottom, DistalMesial and DistalProximal. Two reference lines can be set by using up/down arrow keys. Horizontal markers are useful to determine the difference with regard to loss.

## Pulse Definitions Window

Click Pulse Def of the Trigger group to access settings for the pulse definitions. Refer to “[Pulse Definitions Window](#)” on page 3-19.



**Figure 2-23.** Pulse Definitions Menu

**Channel:** The channel to which the definitions will be applied.

**Serial:** The serial number of the unit. (Not applicable when all channels are selected.)

**Model:** The model number of the unit. (Not applicable when all channels are selected.)

**Firmware:** The version number of the installed firmware on the unit. (Not applicable when all channels are selected.)

### Pulse Thresholds:

Pulse definition settings allow you to define distal, mesial, and proximal values for pulse thresholds. You may change the pulse unit between watts and volts.

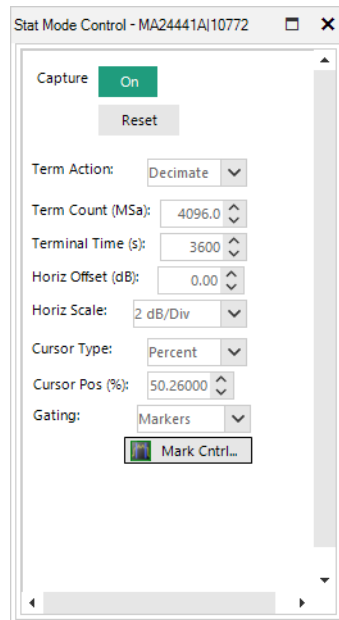
### Pulse Gate

Pulse Start and End Gates can be changed both numerically and by using the up/down arrow keys. It is not necessary that the two of them total to 100%.

[Chapter 4, “Measurements”](#) contains a detailed description of the Pulse Threshold level and the pulse measurement process.

## Stat Mode Control Window

Click **Stat Cntl** of the Trigger group to access settings for the pulse definitions. Refer to “[Statistical Mode Control Window](#)” on page 3-23.



**Figure 2-24.** Pulse Definitions Menu

**Capture:** Set to On to capture the stat mode.

**Reset:** Click to reset all the parameters.

**Term Action:** The action to take upon termination: Decimate, Restart, and Stop.

**Term Count (Msa):** Type or use the arrow buttons to enter a sample limit.

**Terminal Time (s):** The time in seconds for the sample period to end.

**Horiz Offset (dB):** Use the up-down arrow buttons to modify the amount of offset.

**Horiz Scale:** Choose the scale from six fixed values from 0.1dB to 5.0dB.

**Cursor Type:** Choose between percent (%) and power.

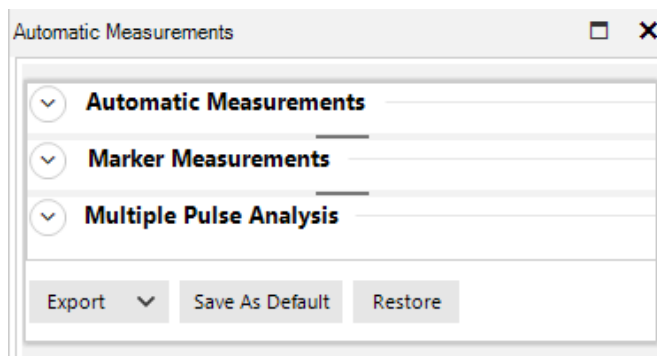
**Cursor Pos (%):** The position of the cursor in Type units.

**Gating:** Choose between Freerun and Markers.

**Mark Cntrl:** Opens the Marker Settings dialog.

## Automatic Measurements Window

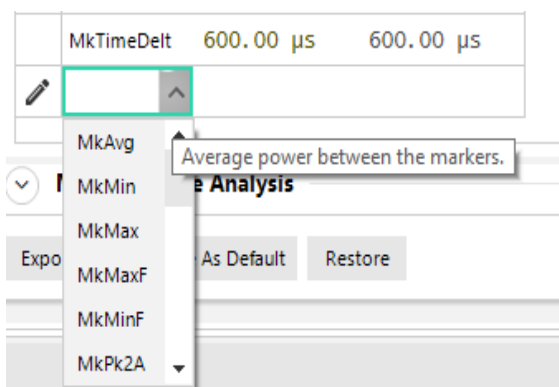
Select the Auto Meas button to display three tabulated fields with lists of parameters for Multiple Pulse Measurements, Automatic Measurements, and Marker Measurements. [Figure 2-22](#) is an example screenshot for Automatic Measurements displayed for a typical pulse measurement. Refer to “[Automatic Measurements Display](#)” on [page 3-15](#)



**Figure 2-25.** Automatic Measurements Window: Collapsed View

All parameters are customizable and may be edited or deleted from these lists. A part of or the whole table may be copied and pasted into a spreadsheet. Adding screenshots from the Export>PDF you make any custom report file along. Export>CSV exports all the parameters from these lists to a CSV file.

To add a row to any table click on the table icon or [Click here to add a new row](#). You may select from any of the parameters in the drop-down list. Generally, this feature is used to replace any row that was deleted.



**Figure 2-26.** Selecting Automatic Parameters

Click **Restore** to restore all the factory default values to the parameter in the lists.

### Customize Field Parameters

All field parameters under automatic measurement are customizable. They can be edited or deleted from the list by selecting individual parameters with the right mouse button. Right-click a parameter to access its Edit pop-up.

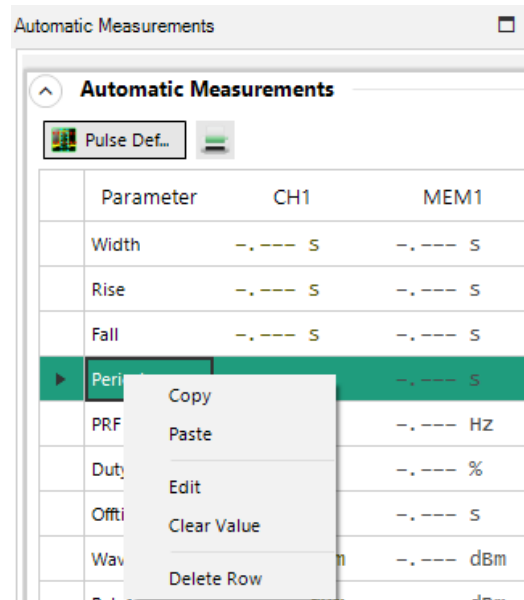


Figure 2-27. Pulse Measurement Pop-up

### Export or Copy Field Parameters

The whole or partial automatic table or field can be copied and pasted into any spreadsheet or document. Control+click those rows needed to make a custom report, and include screenshots captured by the application.

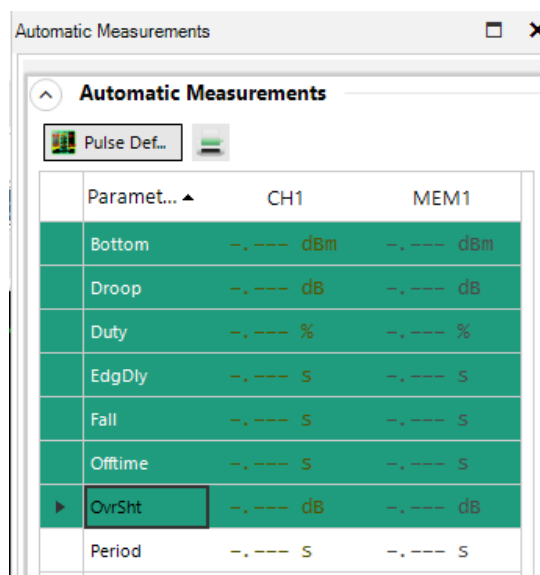


Figure 2-28. Select Multiple Parameters and Right-click to Copy

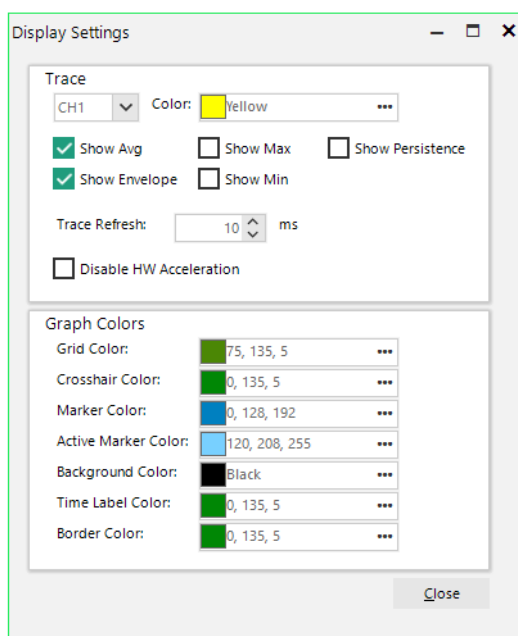
## Display (Graph) Settings Window

Select Graph Settings from the window toolbar to customize data and trace colors for each measurement channel, and enable or disable trace display features such as Average, Envelope, Maximum, Minimum, and Persistence.



**Figure 2-29.** Graph Setting Icon

It is also possible to adjust marker color, background, grid colors, and more under Graph Colors section of the display settings.



**Figure 2-30.** Display Settings



### CCDF View Window

For statistical measurements, select the CCDF (Complementary Cumulative Distribution Function) icon from menu bar to view a CCDF graph. The sidebar on the CCDF screen allows adjustment of horizontal scale, horizontal offset, cursor type, cursor position, and dB offset. You can also enable/disable capture or reset the statistical data acquisition.

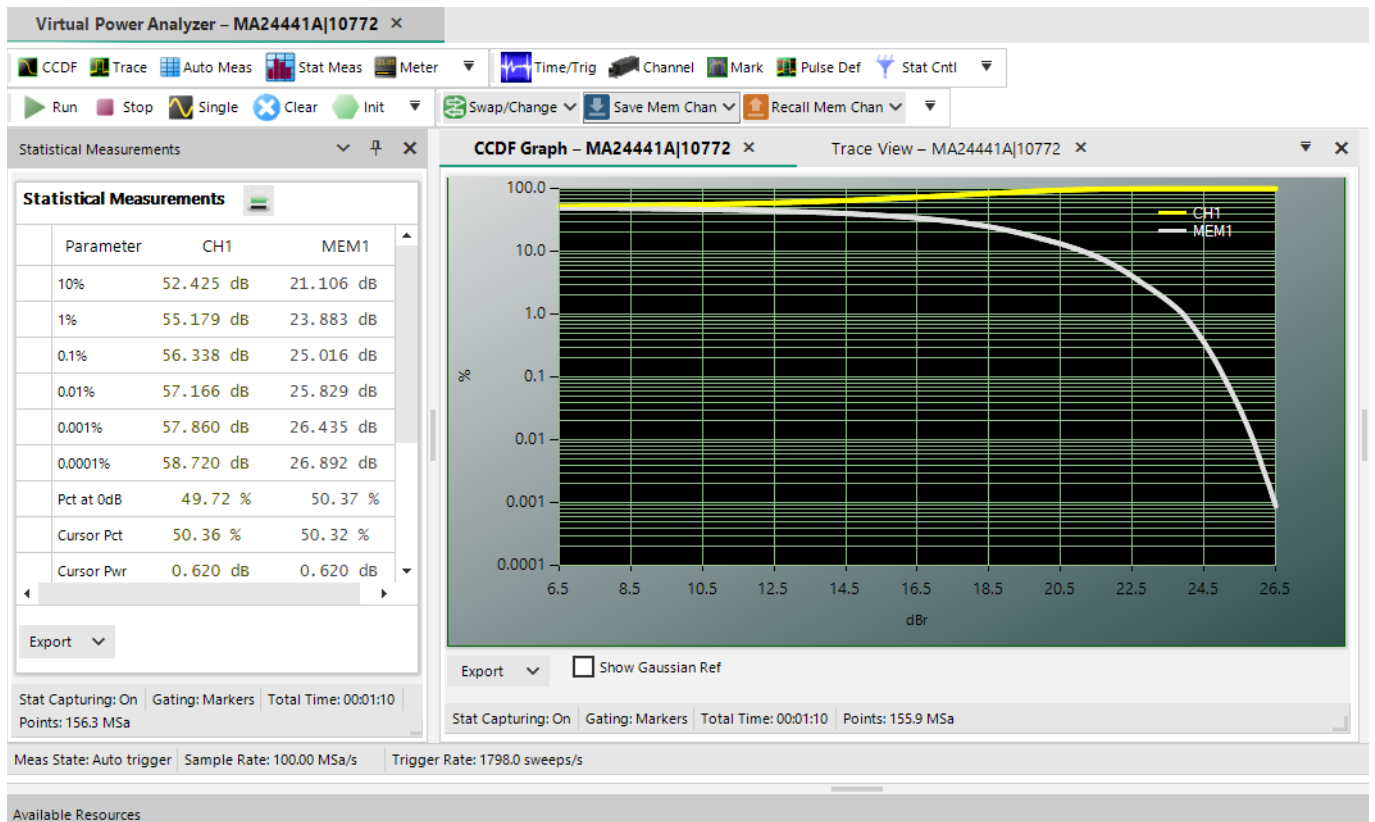
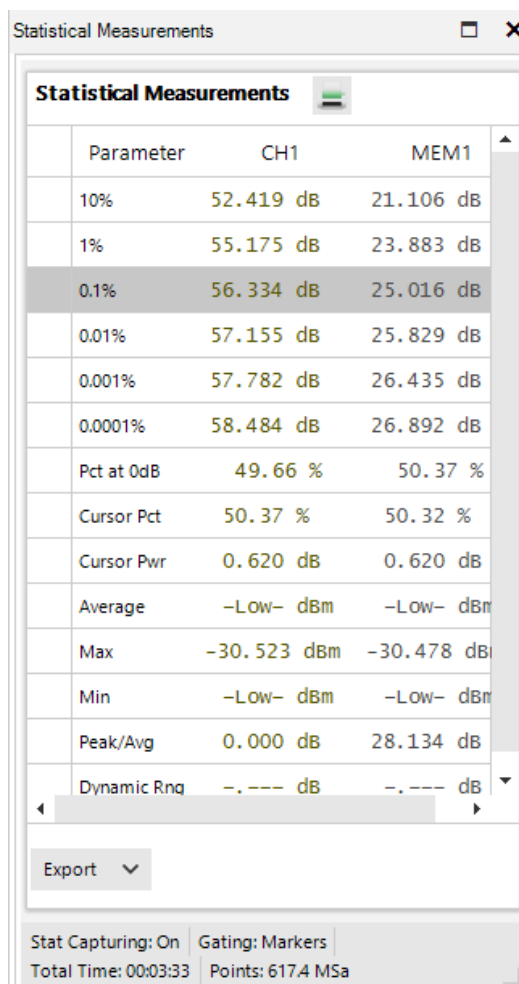


Figure 2-31. CCDF Graph

## Statistical Measurements Window

Click the Stat Meas button to display a tabulated list of statistical measurements. Figure 2-32 is an example parameters text display for statistical measurements.



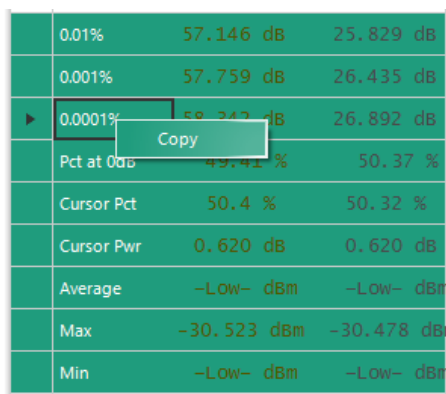
Parameter	CH1	MEM1
10%	52.419 dB	21.106 dB
1%	55.175 dB	23.883 dB
0.1%	56.334 dB	25.016 dB
0.01%	57.155 dB	25.829 dB
0.001%	57.782 dB	26.435 dB
0.0001%	58.484 dB	26.892 dB
Pct at 0dB	49.66 %	50.37 %
Cursor Pct	50.37 %	50.32 %
Cursor Pwr	0.620 dB	0.620 dB
Average	-Low- dBm	-Low- dBm
Max	-30.523 dBm	-30.478 dBm
Min	-Low- dBm	-Low- dBm
Peak/Avg	0.000 dB	28.134 dB
Dynamic Rng	-.--- dB	-.--- dB

Export ▾

Stat Capturing: On Gating: Markers  
Total Time: 00:03:33 Points: 617.4 MSa

**Figure 2-32.** Statistical Measurements Window

This data can also be exported by holding Shift and pressing the up or down arrow keys until all the rows needed are selected. Right-click on any of the selected rows and click Copy.



0.01%	57.146 dB	25.829 dB
0.001%	57.759 dB	26.435 dB
0.0001%	58.342 dB	26.892 dB
Pct at 0dB	49.41 %	50.37 %
Cursor Pct	50.4 %	50.32 %
Cursor Pwr	0.620 dB	0.620 dB
Average	-Low- dBm	-Low- dBm
Max	-30.523 dBm	-30.478 dBm
Min	-Low- dBm	-Low- dBm

Copy

**Figure 2-33.** Exporting Data

# Chapter 3 — Operation

## 3-1 Introduction

This chapter provides procedures for using the MA244xxA Peak Power Analyzer to operate the MA244xxA Peak Power Sensors. All the display windows that control the sensors are illustrated and accompanied by instructions for each control in the window.

The MA244xxA Peak Power Analyzer is a Windows-based software program that provides immediate RF power measurements from MA244xxA Peak Power Sensors without the need for programming on your Windows OS-based computer. RF power measurements from the power sensor can be displayed on your computer or can be integrated into a test system using an Application Program Interface (API).

<b>Note</b>	This section of the manual requires that the MA244xxA Peak Power Analyzer is installed on a computer using the instructions provided in <a href="#">Chapter 2, “Overview”</a> .
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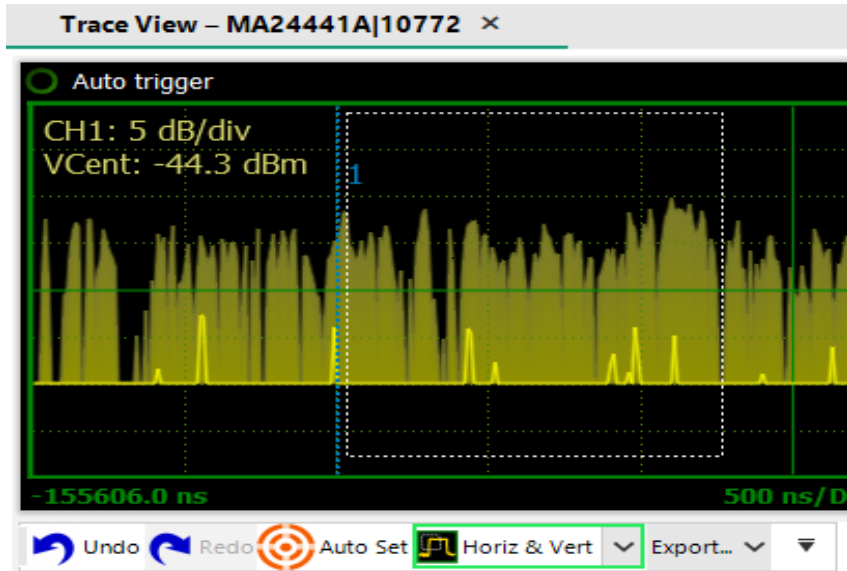
## 3-2 The Trace View Display

The Trace View shown in [Figure 3-1, “Horizontal and Vertical Zoom on a Trace”](#) is the default view when a Virtual Power Analyzer is first opened. It displays a trace of power versus time. The readout in the upper left corner shows the channel number of the trace, the vertical scale factor, and the vertical center. In [Figure 3-1](#), CH1 is displayed with a vertical scale of 10 dB/div (division) and a vertical center of  $-20$  dBm.

- The horizontal scale of the trace in the Trace View window is shown at the bottom of the grid. At the center of the horizontal axis is the horizontal scale factor. Numbers at the right and left ends of the horizontal axis show the trace start and end times relative to the trigger.
- The two vertical blue lines labeled 1 and 2 are markers used for measurements of the displayed signals. Refer to [“Marker Settings Window” on page 3-20](#).
- The bar at the bottom of the Trace View window provides useful tools that can be used to optimize the trace display and archive the trace(s):
  - The Export button is used to export any trace window as a PDF or CSV document. These exported trace files can be used for a report or document.
  - The Undo and Redo buttons work in conjunction with the display expansion (zoom) function to remove (Undo) and restore (Redo) changes in display scaling.
  - Autoset provides an automatic setup of the trace display scaling that optimizes the trace view in the Trace View window.
  - The pull-down menu selects the zoom mode from these options:
    - Horiz(ontal) & Vert(ical), refer to [“Trace Zoom: Horizontal and Vertical”](#)
    - Horizontal, refer to [“Trace Zoom: Horizontal Only” on page 3-2](#)
    - Pan allows you to click and drag the trace either horizontally or vertically. You may also drag the trace symbol to adjust the position of the trace.
    - None prevents all zoom and pan actions.

### Trace Zoom: Horizontal and Vertical

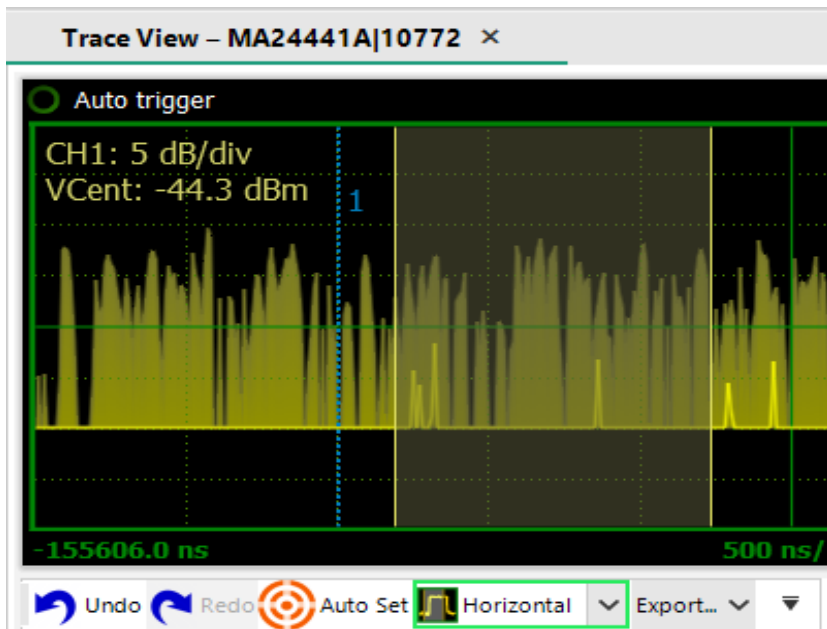
The analyzer trace-zoom feature lets you drag a rectangular box (as shown in [Figure 3-1](#)) around the trace to zoom onto a special area of the displayed waveform. The rectangular area indicates the area that is enlarged when the mouse button is released. The zoom area is constrained to the preset timebase settings and trigger vernier limits. Note in [Figure 3-1](#) that the zoom horizontal scale changes from 10  $\mu\text{s}/\text{div}$  to 1  $\mu\text{s}/\text{div}$  (the nearest available fixed timebase setting). Vertical scaling is similarly constrained.



**Figure 3-1.** Horizontal and Vertical Zoom on a Trace

### Trace Zoom: Horizontal Only

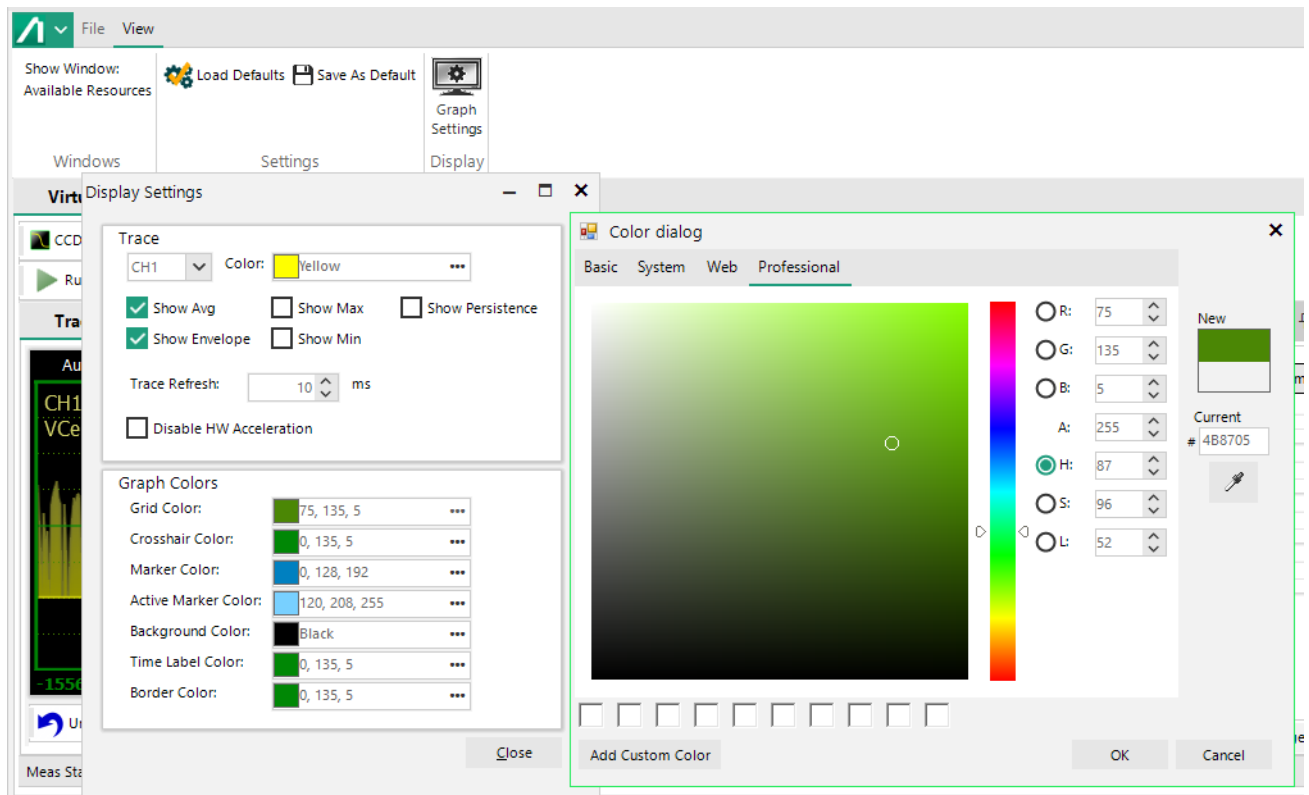
Horizontal-only display expansion (zoom) is accomplished by clicking on the trace view and dragging the mouse horizontally. A shaded box outlines the area to be expanded. Releasing the mouse button rescales the trace.



**Figure 3-2.** Horizontal Zoom

### Formatting Trace View Display Settings

In the upper left-hand corner, click **View** (next to **File**) and then click the **Graph Settings** icon. This opens the **Display Settings** popup as shown in [Figure 3-3](#).



**Figure 3-3.** The Display Settings Popup

The **Display Settings** popup is used to configure the **Graph View**. The elements to be displayed can be chosen and their colors may be selected, along with the background color.

The upper section of the **Display Settings**, labeled **Trace**, controls the configuration of the selected trace. There can be a maximum of eight traces. The configuration of each trace includes the trace color, the choice of five viewable trace attributes, and the trace refresh time. Trace attributes include graphical view of the average value, envelope, maximums, minimums, and persistence (trace history). The defaults are **Show Avg** and **Show Envelope**. Each of the selected elements is overlaid on the trace.

**Note**

The sensor acquires all three traces (average, min and max) when required for a trace. These are used for several of the marker measurements, such as interval, peak-to-average, and others. The sensor also tracks Min and Max (highest maximum trace and lowest minimum trace points) as well as MinF and MaxF (minimum and maximum filtered) which are the highest and lowest points on the average trace. The former measurements are useful for looking at modulation, while the latter are most useful for seeing systematic peaks and dips (for example, ringing) of a repetitive waveform with the noise reduced.

A check box for **Disable HW Acceleration** can be checked if the computer does not have a monitor or graphics card or if it is operated remotely using **Remote Desktop**.

**Note**

This change takes effect the next time a trace window is opened.

The lower section of the Display Settings popup provides controls for color choices for trace grid, border, and background. Markers, axis label, and crosshair color selections are also included. Color choices are made by clicking on the ellipsis symbol (...) adjacent to each element. This brings up the Color Dialog palette used to set the desired color for the element

## The Main Toolbar

The MA244xxA Peak Power Analyzer always displays the Main Toolbar at the top of the main program window and contains shortcuts to commonly used functions and measurements. The Main Toolbar can be customized as discussed below. [Figure 3-4](#) shows the Main Toolbar:



**Figure 3-4.** The Main Toolbar

The Main toolbar contains three sections. The group of shortcuts on the left, including CCDF, Trace, Auto Meas (Measurement) and Stat Meas (Statistical Measurement) comprise the Measurement Windows toolbar and bring up trace display or measurement panels. The middle group with Time/Trig (Trigger), Channel, Mark, Pulse Def (Definitions) and Stat Cntl (Statistical Control) are the Control Windows toolbar. They cause setup and control windows to be displayed. The right-most group including Run, Stop, Single, Clear, and Init (Initialize) are the Acquisition Control toolbar and affect the state of the acquisition.

Any of the toolbars may be separated from the Main Toolbar and re-positioned by clicking on the ellipsis symbol at the left end of any of the groups and dragging the toolbar.

The drop-down menu bar on the right of each section allows you to edit the tools bar by adding or removing any of the items under the Items tab. The toolbars tab allows you to show or hide the toolbars.

### The Acquisition Control Toolbar

The buttons on this toolbar control the state of the acquisition:

- Run: Starts the measurement acquisition and allows it to run continuously until stopped.
- Stop: Stops the measurement acquisition.
- Single: Starts a single measurement acquisition and then stops.
- Clear: Erases the acquired data trace. Useful when clearing single or averaged acquisitions.
- Init: Initializes or resets all settings for the active Virtual Power Meter to default values.

### The Measurement Control Toolbar

The buttons on this toolbar create Trace View and CCDF Graph displays as well as the automated power measurement and statistical Measurement tabular display windows:

- CCDF: This button turns on the complementary cumulative distribution function (CCDF) display. If the CCDF display is already opened but hidden behind the Trace View display, clicking this button brings the CCDF trace to the foreground. Refer to [“Statistical CCDF Graph Display” on page 3-22](#).
- Trace: This button turns on the Trace View trace that displays power versus time. Refer to [“The Trace View Display” on page 3-1](#).
- Auto Meas: This button opens Automatic Measurement windows showing the automatic Pulse and Marker Measurements tables. Refer to [“Automatic Measurements Display” on page 3-15](#).
- Stat Meas: This button opens the Statistical Measurements window displaying the measurements associated with the CCDF Graph. Refer to [“Statistical Measurements Display” on page 3-24](#)

### The Control Windows Toolbar

The buttons on this toolbar control the setup windows for the acquisition, and measurement functions.

- Time/Trig: This button displays the Time/Trigger control windows. Refer to [“Time/Trigger Control Window” on page 3-5](#).
- Channel: This button brings up the Channel Control Window, allowing control of the vertical range and offset as well as sensor-related settings. Refer to [“Channel Control Window” on page 3-10](#).
- Mark: This button causes the Marker Settings window to be displayed. Marker and reference lines can be controlled from here. Refer to [“Marker Settings Window” on page 3-20](#).
- Pulse Def: This button displays the Pulse Definitions window controlling the pulse measurement thresholds, units, and gating. Refer to [“Pulse Definitions Window” on page 3-19](#).
- Stat Cntl: This button brings up the Stat Mode Control window with scaling and population control for the CCDF display. Refer to [“Statistical Mode Control Window” on page 3-23](#).

### Memory Channel Toolbar

The Memory Channel is a reference trace that appears on the Trace View when Mem+ is enabled. The Memory Channel toolbar contains Swap/Change, Save Mem(ory) Chan(nel), and Upload Mem(ory) Chan(nel) options, and these control the sensor connection source and the saving and recalling Mem(ory) traces.

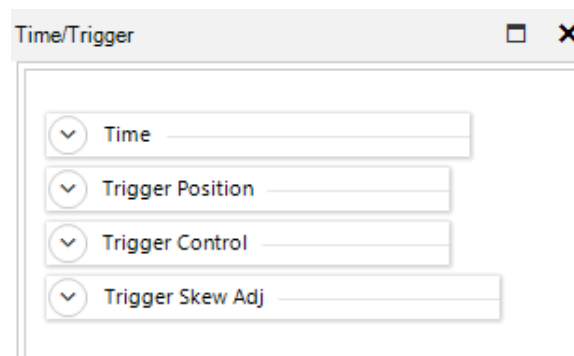
Swap/Change: Allows you to change sensors for a particular session if more than one are connected.

Save Mem Chan: Saves the current memory channel archive to a user-selected folder on the computer.

Recall Mem Chan: Recalls a stored memory channel archive to the Memory Channel Trace on the Trace View.

### Time/Trigger Control Window

Pressing the Time/Trig button icon the Control Windows toolbar brings up the Time/Trigger control window.

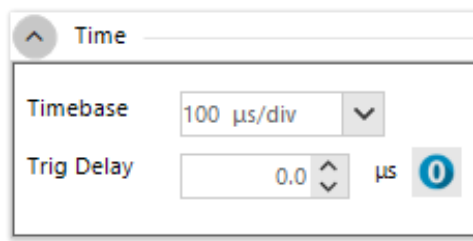


**Figure 3-5.** The Time/Trigger Control Window

This window has these sections: Time (time base and delay), Trigger Position, Trigger Control, and Trigger Skew Adj (Adjust). Any of these sections can be opened or collapsed by clicking the up/down arrow buttons to the left of the section title.

### Time Control

These settings affect the horizontal scaling of the acquired waveform.



**Figure 3-6.** Time Control Settings

**Timebase:** Controls the timebase or horizontal scale of the acquisition and is noted on the horizontal axis label of the Trace View. The **Timebase** pull-down menu permits selection of fixed timebase ranges from 5 ns/div to 50 ms/div (sensor series dependent) in a 1-2-5 progression.

Click the  icon to reset the trigger delay to zero seconds.

**Trig(ger) Delay:** This setting can be adjusted either manually, by entering a numerical value into the field, or by using the up-down arrow keys.

The trigger delay time is set in seconds with respect to the trigger. Positive values mean that the trace display shows a time interval after the trigger event. This positions the trigger event to the left of the trigger point on the display, and is useful for viewing events during a pulse, or some fixed-delay time after the rising edge trigger. Negative trigger delay means that the trace display shows a time interval before the trigger event, and is useful for looking at events preceding the trigger edge.

Pressing the '0' button to the right of the trigger delay entry field resets the trigger delay to zero.

The range of trigger delay times is dependent on the timebase setting and is summarized in [Table 3-1](#). Note the range also depends upon the trigger position.

**Table 3-1.** Trigger Delay Summary

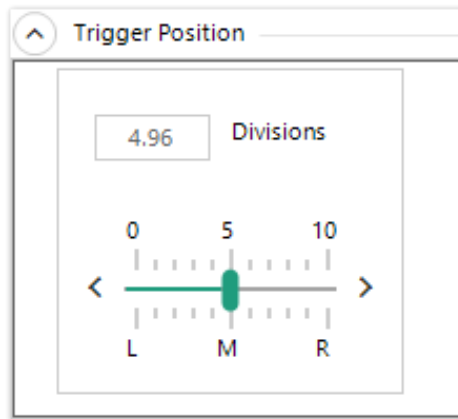
Timebase Setting	Trigger Delay Range
<b>5 ns/div to 10 us/div</b>	–1.26 ms to 100 ms
<b>20 us/div</b>	–1.26 ms to 200 ms
<b>50 us/ div</b>	–5.04 ms to 200 ms
<b>100 us/ div</b>	–6.3 ms to 500 ms
<b>200 us/div</b>	–12.6 ms to 1
<b>500 us/div</b>	–31.5 ms to 1 s
<b>1 ms/div</b>	–63 ms to 1 s
<b>2 ms/div to 10 ms/div</b>	–126 ms to 1 s
<b>20 ms/div</b>	–252 ms to 1 s
<b>50 ms/div</b>	–628 ms to 1 s



**Note** Trigger delay ranges in [Table 3-1 on page 3-6](#) are for the trigger position set to 0 divisions (Left). If trigger delay and position settings result in a pretrigger capture interval greater than 1.26 ms, the sensor automatically reduces the sample rate to avoid overflowing its pretrigger memory.

**Trigger Position Control**

This setting affects the position of the acquired waveform.

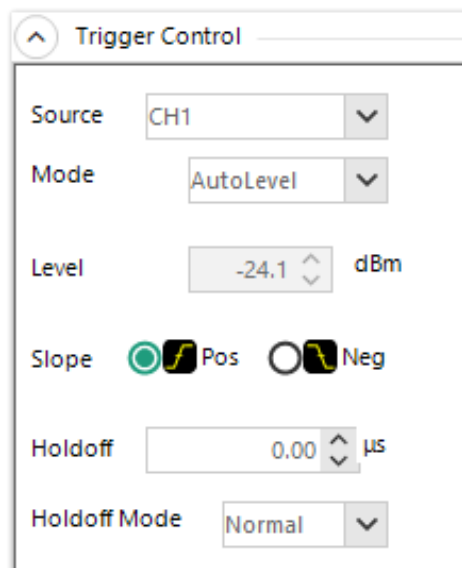


**Figure 3-7.** Trigger Position Setting

**Trigger Position:** This control sets the location of the trigger point on the acquired trace waveform. Change by entering numerical values into the Divisions field from -30 to +30 divisions, by positioning the horizontal slider bar, or by clicking on the L, M, or R indicators to select one of three default positions: Left (zero divisions), Middle (five divisions) or Right (ten divisions).

**Trigger Control**

Settings in the Trigger Control group provide controls to affect these aspects of a trigger: the source, mode, level, slope, holdoff duration, and holdoff mode.



**Figure 3-8.** Trigger Control Setting

**Source:** The trigger source can be any of the resource channels (CH1, CH2, etc.), or the Ext(ernal) trigger input signal. The Ind (Independent) trigger setting allows each connected sensor to trigger independently from its own RF input.

The external trigger is attached to the MA244xxA Peak Power Sensors via the multi-I/O connector adjacent to the USB port on the MA244xxA Peak Power Sensors. The connector is an SMB type. The external trigger requires a TTL signal level, minimum pulse width of 10 ns, and maximum frequency of 50 MHz.

In a multichannel set-up, the sensors can be triggered independently as described above or in a primary/secondary configuration. In primary/secondary configuration, one channel (CH1, CH2... etc.) is selected as the source (primary) and the remaining sensors automatically operate in secondary mode. See multichannel mode for additional information.

**Mode:** There are four available trigger modes: Normal, Auto, Autolevel, and Freerun.

**Normal:** Triggers when the amplitude of selected trigger source transitions above the preset trigger level when positive trigger slope is selected or if it transitions below the preset trigger level when negative trigger slope is selected. No automatic trigger actions take place.

**Auto:** Operates in much the same way as Normal trigger mode, but automatically generates a trace if no trigger edges are detected for a period of time. If a triggerable signal edge occurs during auto-trigger operation, the trigger system resynchronizes with the signal. For trigger rates below approximately 10 Hz, the Auto trigger time delay might interfere with resynchronization. Use Normal mode if this occurs.

**AutoLevel:** Performs the same function as Auto and, in addition, automatically sets the trigger level based on the peak-to-peak amplitude of the signal. For many signals this provides a fully automatic trigger system. For slow rate signals and complex level patterns, it might not produce the desired display. Use Normal mode if this occurs.

**Freerun:** Generates horizontal sweeps asynchronously, without regard to trigger conditions. This mode is useful for locating low duty-cycle events visually.

**Level:** Sets the threshold level for the trigger signal in the Auto and Normal trigger modes. The trigger level can be entered numerically or changed by using arrow keys. The trigger level range has a maximum value of 20 dBm and a minimum range that is sensor model dependent (refer to the sensor specifications for your specific sensor model)

The trigger range is automatically adjusted to include the dB Offset parameter selected in the Cal & Corrections section of the Channel Control window. For example, if the trigger level = 10 dBm and the dB Offset is changed from 0 to 20 dB, then the offset-adjusted trigger level is adjusted to 30 dBm. Likewise, the maximum trigger level range is extended to 40 dBm. The trigger level set point and setting range are both shifted upward by 20 dB

**Slope:** Sets the trigger slope or polarity. When set to Pos(itive), trigger events are generated when a signal's rising edge crosses the trigger level threshold. When Neg(ative) is selected, trigger events are generated when the falling edge of the pulse crosses the threshold. Trigger slope can be selected by using Pos and Neg button boxes under slope.

**Holdoff (Time):** The holdoff time, in microseconds, can be entered and adjusted numerically to 0.01  $\mu$ s resolution, or using the up and down arrow keys in 1  $\mu$ s increments. The effect of Holdoff time depends on the Holdoff Mode.

**Holdoff Mode:** There are two trigger holdoff modes: Normal and Gap.

**Normal:** Normal trigger holdoff is used to disable the trigger for a specified amount of time after each trigger event. The holdoff time starts immediately after each valid trigger edge, and not permit any new triggers until the time has expired. When the holdoff time is up, the trigger re-arms, and the next valid trigger event (edge) causes a new sweep.

This feature is used to help synchronize the MA244xxA Peak Power Sensors with burst waveforms such as a TDMA or GSM frame. For periodic burst signals, the trigger holdoff time should be set slightly shorter than the burst or frame repetition interval.

**Gap:** Gap or frame holdoff is very useful for packet-based communication signals where the transmission burst contains deep modulation which may fall briefly below the trigger threshold, or when bursts or pulses are of varying length and spacing, and so make normal holdoff ineffective. In most cases, the off time between transmission bursts, or frames, is considerably longer than the instantaneous modulation dips.

In Gap Holdoff the trigger is not armed until the trigger source remains inactive (below the trigger threshold for positive trigger slope, or above the threshold for negative slope) for at least the set duration. So if trigger polarity is positive, and gap holdoff is set for 1  $\mu$ s, then the signal must stay below the trigger level for at least 1  $\mu$ s before the trigger is armed. Then, the next rising edge following a gap of 1  $\mu$ s or longer triggers the acquisition.

### Trigger Skew Adj(ust)

Trigger Skew aligns the edge crossing with the trigger point for each of the trigger sources. This is done internally by adding a trim value to the trigger delay setting. Because the different trigger sources (Int (internal), Ext (external), and secondary) have different delays, the system stores a value for each.

Trigger Skew requires a fast RF pulse ( $T_{rise} < 10$  ns) to adjust Int skew. To auto-adjust Ext also requires a fast RF pulse aligned with a fast external trigger pulse applied to the sensor's MIO input. Adjusting the secondary source requires two sensors connected to a common, fast RF pulse ( $T_{rise} < 10$  ns) and interconnected for cross-trigger via their MIO inputs. You can deskew one setting at a time until all three sources are calibrated.

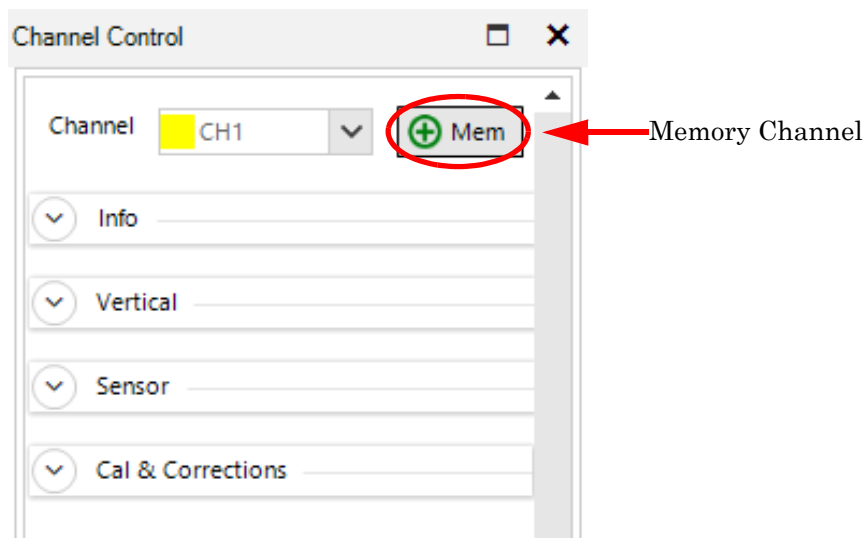
Deskewing can be done automatically by clicking the double slope icon on the left of ns, shown in [Figure 3-9](#). Automatic deskewing requires a fast-edge, repetitive signal.



**Figure 3-9.** The Automatic Deskew Icons

## Channel Control Window

The Channel Control window allows you to change all related settings to control sensor channels.



**Figure 3-10.** Channel Control Dialog

The MA244xxA Peak Power Analyzer has the capability of handling multiple control channels by selecting each individually from the drop-down list. The Channel Control settings are defined by these parameters.

### Channel

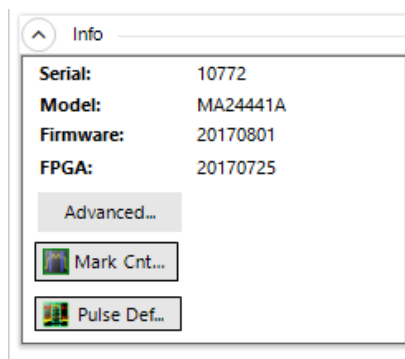
Channel selects an individual channel or, for multi-channel operation, all measurement channels from the drop-down list. The channel labeled MEM1 is a memory channel which is a reference trace that can be stored and recalled as needed. See [Figure 3-10](#).

The Mem button causes the current trace to be stored in the Memory Channel. The current memory channel can be stored to the computer hard drive using the Save Mem Chan button in the Memory Channel toolbar. Likewise, a previously stored memory trace can be recalled using the Upload Mem Chan button.

To turn off the Memory Channel, select MEM1 or MEM2 from the Channel drop down menu, then click On next to Enabled in the Sensor menu (see [Figure 3-16](#), “Channel Control: Sensor Group”) to select Off.

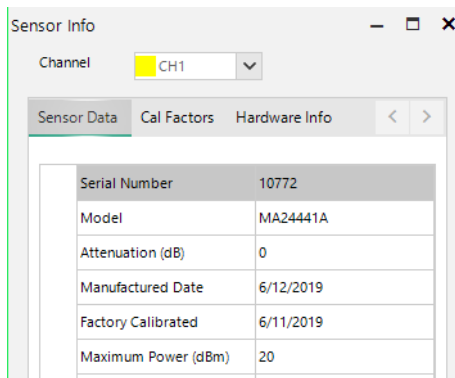
### Info

Shows the pertinent information for the selected sensor. The model number, serial number, and firmware and FPGA versions for the selected channel are displayed in this group.



**Figure 3-11.** Channel Control: Info Group

Advanced: Displays the Sensor Info popup (see [Figure 3-12](#)).



**Figure 3-12.** Channel Control: Sensor Group

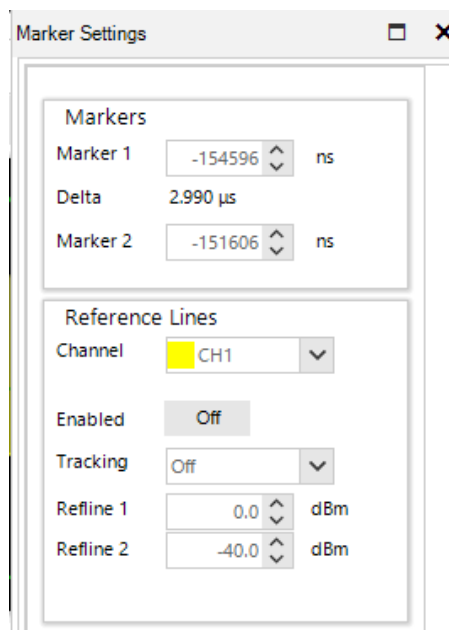
The popup has these tabs:

**Sensor Data** contains identification and calibration information for the sensor.

**Cal Factors** contains the frequency response calibrations factors for both high and low bandwidth calibration.

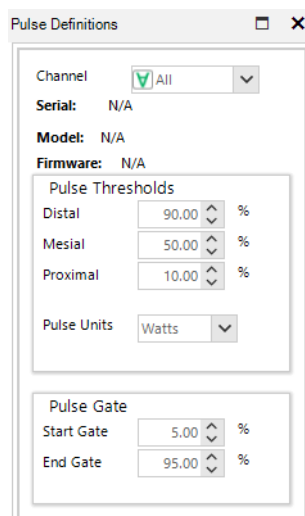
**Hardware Info** contains information on the current state of the sensor hardware including the detector temperature and key power source voltage readings.

**Mark Control:** Brings up the Marker Settings control dialog (see [Figure 3-13](#)).



**Figure 3-13.** Channel Control: Info Marker Settings Dialog

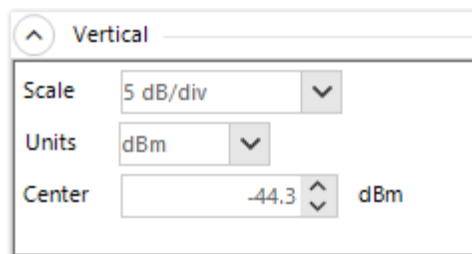
Pulse Definition: Brings up the Pulse Definition dialog; refer to “Pulse Definitions Window” on page 3-19.



**Figure 3-14.** Channel Control: Info Pulse Definitions Dialog

### Vertical

These controls affect the vertical settings for the selected power sensor.



**Figure 3-15.** Channel Control: Vertical Group

**Scale:** Vertical scale sets the scaling of the level axis of the Trace View based on the selection of units as shown in [Table 3-2](#).

**Table 3-2.** Vertical Scale range for each Units setting

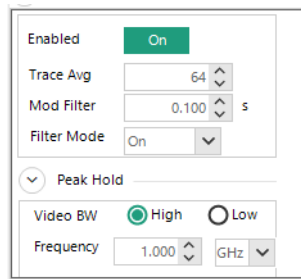
Units	Scale
<b>dBm</b>	0.1, 0.2, 0.5 1, 2, 5, 10, 20, 50 dB/div
<b>Watts</b>	1 pW to 500 MW/div in a 1-2-5 progression
<b>Volts</b>	1 $\mu$ V to 100 kV/ div in a 1-2-5 progression

**Units:** The trace presentation may be shown in units of dBm, Watts or Volts. The Units selection determines the range of the scale values. Note that the Units setting also affects text measurement values in the Measurement windows.

**Center:** Set the power or voltage level of the horizontal centerline of the graph for the specified channel in the selected channel units. The center position can be entered numerically or adjusted by using up and down arrow keys.

## Sensor

These settings control the acquisition parameters for the selected power sensor.



**Figure 3-16.** Channel Control: Sensor Group

**Enabled:** Individual sensors or all the selected sensors can be enabled or disabled by using the alternate action On/Off button. This functionality also enables or disables the MEM channels.

**Trace Avg:** Trace averaging can be used to reduce display noise on both the visible trace, and on automatic marker and pulse measurements. Trace-averaging is a continuous process in which the measurement points from each sweep are weighted (multiplied) by an appropriate factor and averaged into the existing trace data points. In this way, the most recent data always have the greatest effect upon the trace waveform, and older measurements are decayed at a rate determined by the averaging setting and trigger rate. This averaging technique is often referred to as 'exponential' averaging because averaging imposes a first-order Infinite Impulse Response (IIR) exponential filter with a time constant of  $n$ , where  $n$  is the Trace Avg (number of averages) setting.

**Sensor Avg:** Sensor averaging can be set by selecting a number of averages from 1 (no averaging) to 16384 in binary steps using the up and down arrow buttons in the Trace Avg field.

**Note**

For timebase settings of 200 ns/div and faster, the sensor acquires samples using a technique called equivalent time or random interleaved sampling (RIS). In this mode, not every pixel on the trace gets updated on each sweep, and the total number of sweeps needed to satisfy the average setting is increased by the sample interleave ratio of that particular timebase. At all times the average trace is the average of all samples for each pixel, and the min/max are the lowest and highest of that same block of samples for each pixel.

**Mod Filter:** Sets the modulation filter integration time. It is used in modulated mode measurements and does not affect the pulse mode (triggered) measurements shown in the trace view. The modulation filter is a sliding window filter which averages samples taken within a time window whose duration is set by this field. All samples within the time window are equally weighted.

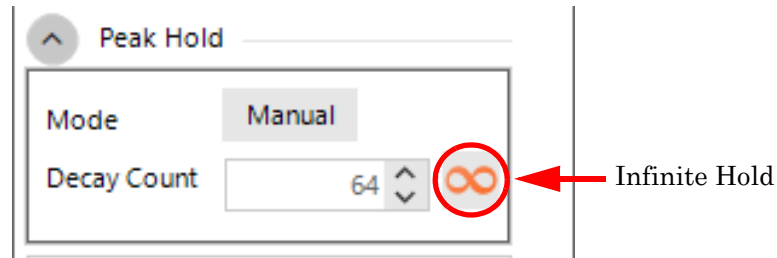
**Filter Mode:** Controls the modulation filter. The filter can be set to On (manual filter time setting), None (integration time is set to the minimum 1 ms value), or Auto (integration time automatically selected based upon input level).

**Video BW:** Sets the sensor video bandwidth for the selected sensor. High is appropriate for most measurements, and the actual bandwidth depends upon the sensor model. Low bandwidth offers additional noise reduction for CW or signals with very low modulation bandwidth. If Low bandwidth is used on signals with fast modulation, measurement errors may result if the sensor cannot track the fast-changing envelope of the signal.

**Frequency:** Sets to the RF frequency that is applied to the sensor for the current measurement. The appropriate frequency calibration factor from the sensor's calibration table is interpolated and applied automatically. Application of this calibration factor compensates for the effect of variations in the flatness of the sensor's frequency response.

The power sensor has no way to determine the carrier frequency of the applied signal, so you must always enter the frequency.

**Peak Hold:** Controls the operating mode of the selected channel's peak hold function. Peak Hold affects the envelope trace (if displayed) as well as peak or dynamic range marker and pulse measurements.



**Figure 3-17.** Channel Control: Peak Hold

**Mode:** Click the button to toggle between Tracking and Manual modes.

**Tracking mode:** Traces the maximum and minimum decay towards the average with a time constant that is the same as the averaging setting. If averaging is set fast (Trace Avg is set to a low value), then the maximums and minimums decay quickly (are not held very long) while long averaging (Trace Avg is set to a high value) settings yields a 'flatter' trace and maximums and minimums peaks decay slowly back to the average power level.

**Manual mode:** Makes the averaging and peak time constants independent (they do not track each other). Rather, peaks are held for a time proportional to the Decay Count setting.

Manual mode sets the averaging short to watch short-term signal fluctuations from one trace to the next, and holds peaks for a long time to get a better feel of longer-term peak stress on your system.

**Decay Count:** Specifies the decay from 1 to 16384 and increments in binary steps.

**Infinite Hold:** (Manual mode only) Sets the Decay Count to infinity. Signal peaks and dips are held indefinitely and never decayed. This is useful for long-term monitoring for glitches, spikes, dropouts, and other intermittent signal events.

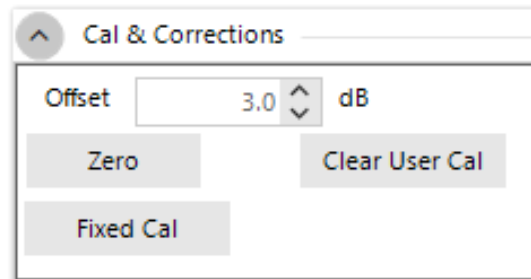
**Note**

The effects of the Peak Hold, i.e. min/max decay, are only visible when the envelope or min/max display is enabled in the view options (refer to [“Display \(Graph\) Settings Window”](#) on page 2-22). However, marker min/max values are always affected.



### Cal & Corrections

The Calibration and Corrections group controls coarse and fine corrections to the measurements.



**Figure 3-18.** Channel Control: Cal & Corrections

**Offset:** Sets a measurement offset in dB for the selected sensor. This compensates for external couplers, attenuators, or amplifiers in the RF signal path ahead of the power sensor.

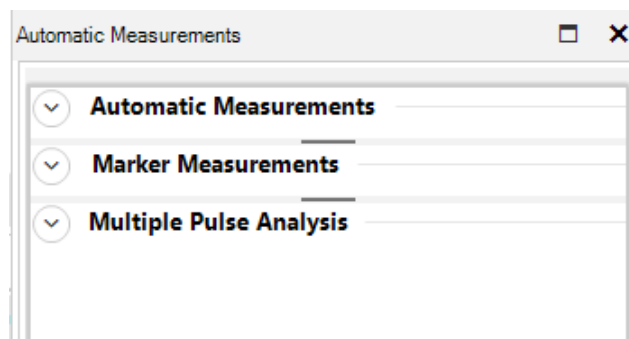
**Zero:** Performs a zero offset null adjustment. The sensor does not need to be connected to any calibrator for zeroing. This action removes the effect of small, residual power offsets, and should be performed prior to low-level measurements. Note that there should be no RF signal applied to the sensor input prior to zeroing.

**Clear User Cal:** Clears any user calibration for the selected sensor (refer to [“Channel” on page 2-14](#)).

**Fixed Cal:** Performs a calibration at 0 dBm at the currently set frequency. This requires a calibrated 0 dBm (1.00 mW) signal source at the current measurement frequency.

### Automatic Measurements Display

Clicking AutoMeas icon in the Measurement Control Toolbar brings up the Automatic Measurements window to the left of the Trace View as shown in [Figure 3-19](#). This window includes two, related, sub-windows: Pulse Measurements and Marker Measurements.



**Figure 3-19.** Automatic Measurements

**Note**

All field parameters are customizable, can be edited or deleted from the list by selecting individual parameter fields and then by using right click button of the mouse. The whole table can be copied and pasted into a spreadsheet to make any custom report file along with captured screenshots by selecting export button as provided by the software.

### Automatic Measurements

Shows the 16 default, field-pulse parameters. The field pulse parameter measurements are computed with methods described in IEEE Std 181™-2011 (refer to “[Standard IEEE Pulse](#)” on page 4-1.).

Parameter	CH1
Width	-. ---- S
Rise	-. ---- S
Fall	-. ---- S
Period	-. ---- S
PRF	-. ---- HZ
Duty	-. ---- %
Offtime	-. ---- S
WavAv	-. ---- dBm
PulsAv	-. ---- dBm
PulsPk	-. ---- dBm
OvrSht	-. ---- dB
Droop	-. ---- dB
Top	-. ---- dBm
Bottom	-. ---- dBm
EdgDly	-. ---- S
Skew	0.00 ns

[Click here to add a new row](#)

**Figure 3-20.** Automatic Measurements Parameters Window

The Pulse Def button brings up the Pulse Definitions dialog. See “[Pulse Definitions Window](#)”.

Clicking the printer icon opens a Print Preview window allowing you to print the table.

**Marker Measurements**

Shows 21 marker measurements.

Parameter	CH1
MkAvg	-Low- dBm
MkMin	-Low- dBm
MkMax	-31.193 dBm
MkMaxF	-Low- dBm
MkMinF	-Low- dBm
MkPk2A	-. --- dB
Mk1Lvl	-Low- dBm
Mk2Lvl	-Low- dBm
MkMaxAv	-Low- dBm
MkMinAv	-Low- dBm
Mk1Min	-Low- dBm
Mk1Max	-33.287 dBm
Mk2Min	-Low- dBm
Mk2Max	-31.373 dBm
MkRatio	2.376 dB
MkDelta	-. --- dBm
MkRDelta	0.000 dBm
MkRRatio	-2.376 dB
Mk1Time	-154.60 μs
Mk2Time	-151.61 μs
MkTimeDelt	2.9900 μs

[Click here to add a new row](#)

**Figure 3-21.** Marker Measurements Display

Any individual parameter or group of parameters on Automatic or Marker measurements can be highlighted by holding the Cntl key and left-clicking each parameter. Selected cells can be copied by right-clicking on the parameter(s) and selecting copy. The copied cells can be pasted into a spreadsheet or document.

Clicking the printer icon opens a Print Preview window allowing you to print the table.

Clicking Export opens a viewer showing the whole table. The contents of the viewer can be saved or printed as PDF or CSV files if desired.

The Mark Cntrl button brings up the Marker Settings dialog. See “[Marker Settings Window](#)”.

**Multiple Pulse Analysis**

Shows the list of parameter for pulse analysis and allows you to edit them and modify the list.

Parameter	CH1
PulseCount	0
RiseTime1	-. --- S
FallTime1	-. --- S
PulsePos1	-. --- S
PulseWidth1	-. --- S
PulseAvg1	-. --- dBm
RiseTime2	-. --- S
FallTime2	-. --- S
PulsePos2	-. --- S
PulseWidth2	-. --- S
PulseAvg2	-. --- dBm
RiseTime3	-. --- S
FallTime3	-. --- S
PulsePos3	-. --- S
PulseWidth3	-. --- S
PulseAvg3	-. --- dBm

**Figure 3-22.** Multiply Pulse Analysis Settings

Click **Config...** to open the Pulse configuration wizard. Through it you can set the number of pulses (1 to 20) to analyze and set the measurements you want displayed.

Multi Pulse Config

Multi Pulse Configuration Tool

Select which measurements you want displayed.

- Pulse Count
- Rise Time
- Fall Time
- Pulse Width
- Pulse Position
- Pulse Avg
- Pulse Peak
- Pulse Min

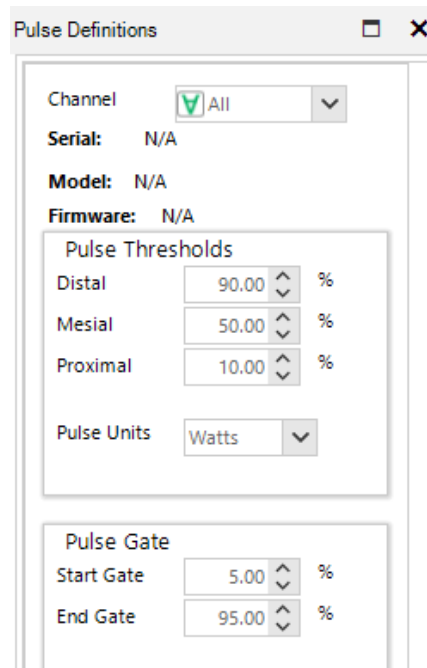
< Back    Next >    Cancel

**Figure 3-23.** Pulse Configuration Wizard

Clicking the printer icon opens a Print Preview window allowing you to print the table.

## Pulse Definitions Window

Clicking Pulse Def in the Measurement Control Toolbar opens the Pulse Definitions window shown in [Figure 3-24](#). This window contains the pulse thresholds, pulse analysis units, and the gate settings for the selected sensor.



**Figure 3-24.** The Pulse Definitions Window

### Basic Information

**Channel:** Contains several choices: All, CH1-N, and MEM1-N, where N is an integer 1 to 8.

**Serial:** Shows the serial number for the sensor.

**Model:** Shows the model of the sensor.

**Firmware:** Shows the version identifier of the firmware loaded on the sensor.

### Pulse Thresholds

Pulse thresholds settings allow users to define distal, mesial, and proximal values for pulse thresholds, and the pulse units.

- Distal:** Sets the pulse amplitude percentage that defines the end of a rising edge or beginning of a falling edge transition. Typically, this is 90% voltage or 81% power relative to the top level of the pulse. This setting is used when making automatic pulse risetime and falltime calculations.
- Mesial:** Sets the pulse amplitude percentage that defines the midpoint of a rising or falling edge transition. Typically, this is 50% voltage or 25% power relative to the top level of the pulse. This setting is used when making automatic pulse width and duty cycle calculations.
- Proximal:** Sets the pulse amplitude percentage that defines the beginning of a rising edge or end of a falling edge transition. Typically, this is 10% voltage or 1% power relative to the top level of the pulse. This setting is used when making automatic pulse risetime and falltime calculations.

**Pulse Units:** Controls whether the distal, mesial, and proximal thresholds are computed as voltage or power percentages of the top/bottom amplitudes. If volts is selected, the pulse transition thresholds are computed as voltage percentages, and if watts, they are computed as power percentages.

Many pulse measurements call for 10% to 90% voltage (which equates to 1% to 81% power) for risetime and falltime measurements, and measure pulse widths from the half-power (–3 dB, 50% power, or 71% voltage) points. The Pulse Units setting is independent of the channel's display units setting.

### Pulse Gate

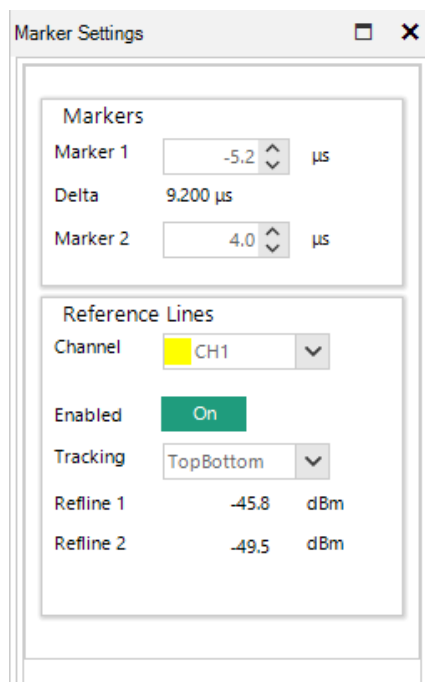
The Pulse Gate settings define the measurement interval for the following power related pulse measurements: Pulse Average, Pulse Peak, Pulse Minimum and Pulse Droop/Tilt. Pulse timing measurements between mesial crossings such as width and period are not affected. The purpose of the Pulse Gate setting is to exclude edge transition effects from the pulse power measurements. Automatic pulse measurements are then performed between Start Gate and End Gate points.

**Start Gate:** Sets the beginning of the pulse measurement region as a percentage of the pulse width. The Start Gate has a continuous range of 0.0% to 40% of the pulse width and may be entered numerically or varied using the up or down arrows.

**End Gate:** Sets the end of the pulse measurement region as a percentage of the pulse width. The End Gate has a continuous range of 60.0% to 100.0% of the pulse width and may be entered numerically or varied using the up or down arrows.

### Marker Settings Window

Clicking Mark in the Measurement Control Toolbar opens the Marker Settings window shown in [Figure 3-25](#).



**Figure 3-25.** Marker Settings Window

This window contains vertical marker locations and marker delta and horizontal reference line locations for the selected sensor.

## Markers

Time Markers are a pair of vertical cursors that allow level measurements at specific times relative to the trigger event. Markers can be moved to any portion of the trace that is visible on the screen, and these can be used to identify regions of interest for detailed power analysis. Power measurements can be performed at each marker, as well as average, minimum and maximum power in the time interval between the two markers.

### Marker 1 and Marker

- 2: Marker settings allow you to change both marker 1 and marker 2 positions by using either arrow keys or entering numerical values into the field. The Marker locations can also be set graphically by clicking on the marker in the Trace View and dragging the marker left or right.

**Marker Delta:** The Marker Delta window indicates the time interval between Marker 1 and Marker 2.

## Reference Lines

**Channel:** Selects the channel to which the reference lines are applied.

**Enabled:** Turns the reference lines on or off for the selected channels. When off, reference lines are not visible.

**Tracking:** The Reference Line Tracking setting allows the selection of either manual control of the reference line amplitudes or selection of a set of commonly used reference amplitudes.

**Off:** Allows the reference levels to be set independently using the Refline 1 and Refline 2 entry fields. Levels can be entered numerically or by using the up and down arrows. The reference levels can also be set graphically by clicking on the reference line in the Trace View and dragging the line up or down. The vertical units match the Units selection in the Channel Control window.

**Markers:** Links the reference levels to the amplitudes where the markers cross the pulse waveform on the Trace View. Reference level Refline 1 tracks the amplitude where Marker 1 crosses the pulse waveform and Refline 2 tracks the amplitude where Marker 2 crosses the pulse waveform.

**TopBottom:** Moves Refline1 to the measured Top amplitude and Refline 2 to the measured Bottom amplitude.

**DistalMesial:** Moves Refline 1 to the measured distal (upper pulse threshold) amplitude and Refline 2 to the measured mesial (mid pulse threshold) amplitude. Pulse threshold levels are those set in the Pulse Definitions window.

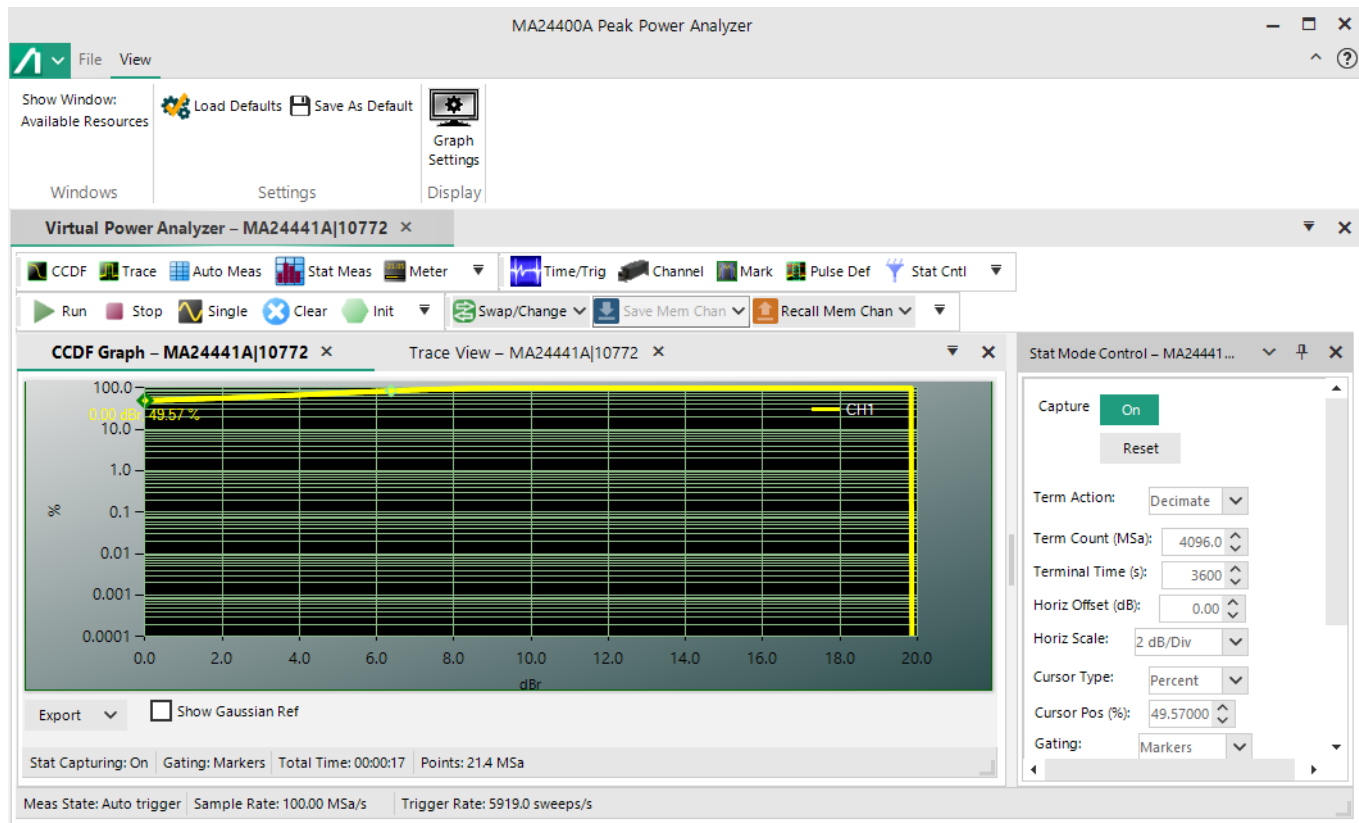
**DistalProximal:** Moves Refline 1 to the measured distal (upper pulse threshold) amplitude and Refline 2 to the measured proximal (lower pulse threshold) amplitude. Pulse threshold levels are those set in the Pulse Definitions window.

### Reflines 1 and Refline

- 2: Displays these horizontal lines on the Trace View, and may be used to indicate user-set amplitude levels for each sensor, or measurement-specific levels.

## Statistical CCDF Graph Display

The statistical analysis of the current sample population is displayed using a normalized Complementary Cumulative Distribution Function (CCDF) presentation shown in [Figure 3-26](#). The CCDF expresses the probability of occurrence of a range of peak-to-average power ratios on a log-log scale, and a cursor (green diamond) allows measurement of power or percentage at a user-defined point on the CCDF. As with all other graphical displays, the trace can be easily scaled and zoomed, or the statistical data may be presented in a tabular format.



**Figure 3-26.** The CCDF Graph

The CCDF Graph view provides a statistical view of the peak-to-average power ratio. It has become a useful tool for analyzing communication signals that have a Gaussian like distribution (CDMA, OFDM) where signal compression can be observed at rarely occurring peaks. It is most often presented graphically using a log-log format where the X axis represents the relative offset in dB from the average power level and the log-scaled Y axis is the percent probability that power exceed the X-axis value.

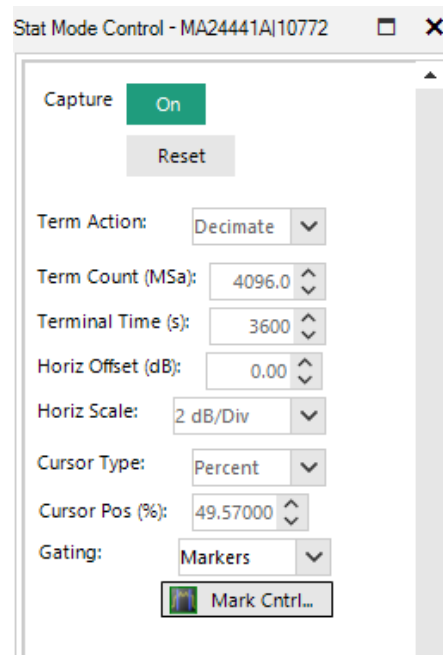
At the bottom of the CCDF Graph window is a status bar reporting Stat Capturing status (On or Off), Gating type (Markers or Freerun), Total Time (HH:MM:SS), and the number of Points (MSa/s) in the statistical population.

Additionally, there is an Export button and a Show Gaussian Ref check box. Clicking Export brings up a Viewer popup window offering the ability to export the CCDF Graph in PDF or CSV format. Actuating the Show Gaussian Ref displays a Gaussian CCDF reference curve on the graph, as shown in [Figure 3-26](#).



## Statistical Mode Control Window

The Stat Mode Control window, shown in [Figure 3-27](#), appears with the CCDF Graph is displayed or by clicking the Stat Ctrl button on the Control Windows toolbar. The Stat Mode Control window controls the data acquisition for the CCDF Graph.



**Figure 3-27.** The CCDF Stat Mode Control window

**Capture:** Select On to begin acquiring samples. Off stops the acquisition.

**Reset:** Clears the acquired statistical sample population. If Capture is ON, a new acquisition begins.

**Term Action:** Selects the action to take when either the terminal count is reached or the terminal time has elapsed. The available choices are Stop, Restart, or Decimate.

**Stop:** Stop accumulating samples and hold the result.

**Restart:** Clears the statistical sample population starts a new one.

**Decimate:** Divide all sample bins by 2 and continue. The total sample count is halved each time decimation occurs. This should have very little visible effect on the CCDF values, because the entire population is decimated uniformly and the shape of the distribution is maintained.

**Term Count:** Sets the terminal sample count for the CCDF acquisition. The range of values is 1 to 1 billion MSa.

**Terminal Time:** Terminal Time sets the terminal running time for the CCDF acquisition. The range of values is 1 to 3600 seconds.

**Horiz Offset Horiz(ontal):** Sets the horizontal offset for the CCDF Graph statistical display. The value in dB<sub>r</sub> chosen appears at the leftmost edge of the graph. The range of values is -50.00 dB<sub>r</sub> to +50.00 dB<sub>r</sub>.

**Horiz Scale:** Selects the horizontal scale for CCDF Graph statistical display. Scale factors are from 0.1 to 5 dB/div in a 1-2-5 progression.

**Cursor Type:** Select the independent variable for the CCDF cursor. If **Percent** is selected, relative power at the cursor's intersection with the CCDF curve is measured. If **Power** is selected, probability at the cursor's intersection with the CCDF curve is measured.

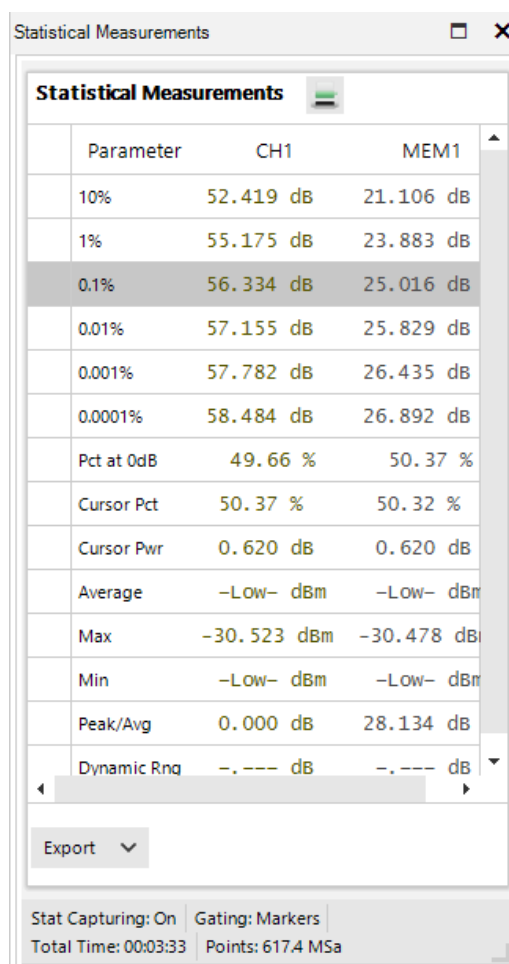
**Cursor Pos:** Sets the CCDF cursor to the desired probability or power depending on the setting of Cursor Type.

**Gating:** Select either **Markers** or **Freerun** gating for statistical acquisition. If **Markers** is selected, then only samples within the time marker interval on the Pulse Mode triggered sweep are included in the statistical sample population. If **Freerun** is selected, then all the samples are acquired without regard to sweep acquisition.

**Mark Ctrl:** Brings up the Marker Settings window allowing Marker locations to be set when marker gating is used for statistical capture. See [“Marker Settings Window”](#) on page 3-20.

## Statistical Measurements Display

Click the Stat Meas icon on the Measurement Control toolbar to bring up the Statistical Measurements window, shown in [Figure 3-28](#).



The screenshot shows the 'Statistical Measurements' window with a table of parameters. The table has columns for 'Parameter', 'CH1', and 'MEM1'. The '0.1%' row is highlighted. Below the table are 'Export' and 'Stat Capturing: On' buttons, and status information including 'Gating: Markers', 'Total Time: 00:03:33', and 'Points: 617.4 MSa'.

Parameter	CH1	MEM1
10%	52.419 dB	21.106 dB
1%	55.175 dB	23.883 dB
0.1%	56.334 dB	25.016 dB
0.01%	57.155 dB	25.829 dB
0.001%	57.782 dB	26.435 dB
0.0001%	58.484 dB	26.892 dB
Pct at 0dB	49.66 %	50.37 %
Cursor Pct	50.37 %	50.32 %
Cursor Pwr	0.620 dB	0.620 dB
Average	-Low- dBm	-Low- dBm
Max	-30.523 dBm	-30.478 dBm
Min	-Low- dBm	-Low- dBm
Peak/Avg	0.000 dB	28.134 dB
Dynamic Rng	-, --- dB	-, --- dB

Export ▾

Stat Capturing: On | Gating: Markers  
Total Time: 00:03:33 | Points: 617.4 MSa

**Figure 3-28.** Statistical Measurements Window

The tabulated field parameters are displayed on the left side of the CCDF Graph by default. [Table 3-3](#) describes the key statistical parameters.

**Table 3-3.** Statistical Parameters

Parameter	Measurement Description
10% to 0.0001%	Displays crest factor relative to population average power at each specified percent CCDF.
Pct at 0 dB	Displays percent CCDF at the average power.
Cursor Pct	Displays percent CCDF at the stat mode cursor.
Cursor Pwr	Displays crest factor relative to population average power at the Stat Mode cursor.
Average	Displays absolute average power of the statistical sample population.
Max	Displays absolute maximum power.
Min	Displays absolute minimum power.
Peak/Avg	Displays crest factor (pk/avg ratio).
Dynamic Rng	Displays dynamic range (max/min ratio).

Status is reported by the four fields at the bottom of the Statistical Measurements window:

Stat Capturing: Choose On or Off to enable or disable sampling.

Gating: Choose the style of gating involved: Markers or Freerun.

Total Time: Shows the total elapsed time of the sampling in HH:MM:SS format.

Points: Shows the number of points used in generating the statistics in MSa.

Export PDF: Brings up a PDF Viewer popup so that the CCDF Graph can be exported in PDF format.

## Meter View Display

Meter View mode is designed for continuous, true average power measurements of complex, continuously modulated CW signals. The mode is similar to the operation of a conventional CW power meter, but it does not have the measurement inaccuracies of some diode sensors.

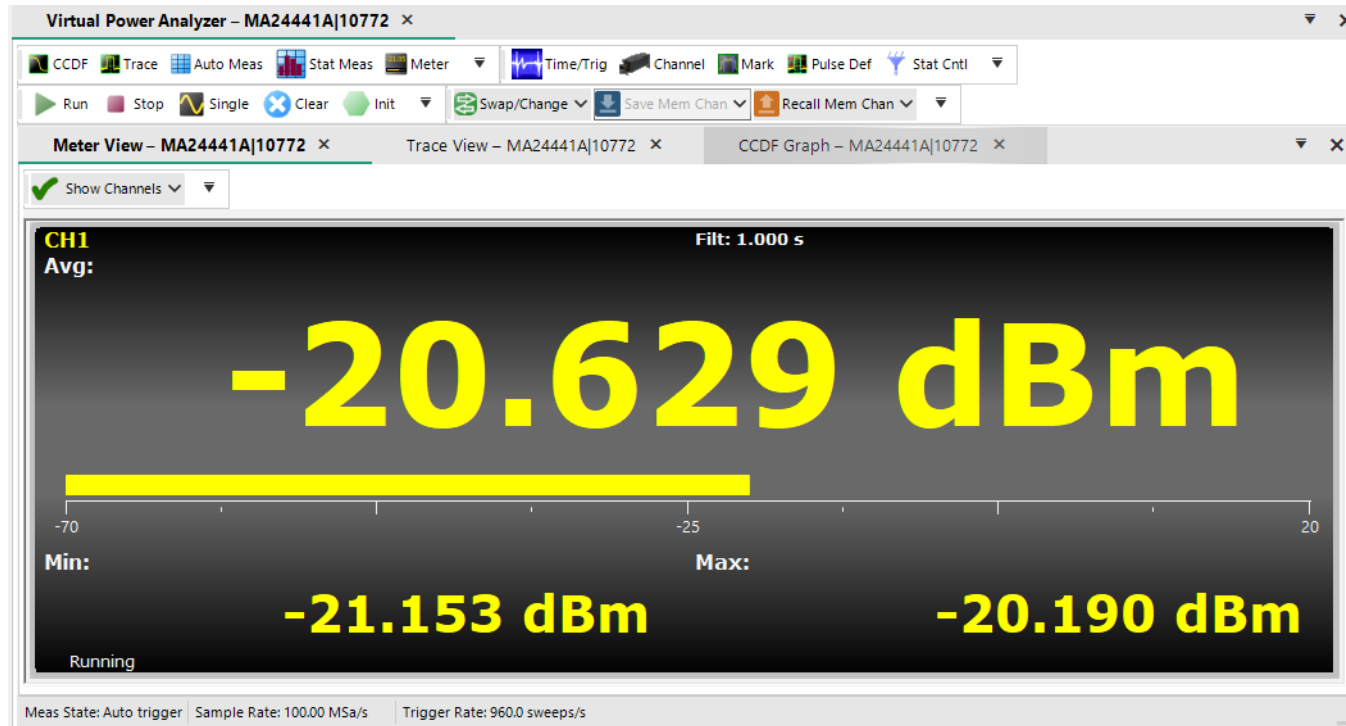
Continuous (untriggered / freerun) sample acquisition is performed using sliding-window filtering on the samples. Filtered average power, peak power, and minimum power measurements are continuously performed. The measured result is the average power of the signal. Because the graphic display would basically just show a straight line, measurements in this mode are best viewed using the Meter View display window. [Figure 3-29](#) shows a Modulated Mode measurement displaying the average, minimum and maximum power in modulated signal.

Because this mode performs a continuous measurement, it does not differentiate when a pulsed or periodic signal is off or when it is on. If you wish to make measurements that are synchronous with a period of a waveform, consider using a triggered sweep and marker analysis instead.

### Note

The MA244xxA peak power sensors belong to the family of peak power sensors which respond to the amplitude modulation of a modulated carrier with constant amplitude modulation schemes such as frequency and phase modulations (FM/PM) that can be considered as a continuous wave (CW) carrier for power measurement purposes. Therefore, the Trace View display for a CW, PM/FM modulated (PSK, QPSK, etc) signal appears as a flat line trace in the time domain.

The Meter View measurement display window showing the average, minimum, and maximum power of a modulated waveform.



**Figure 3-29.** The Meter View Measurement Display Window

Anritsu Company recommends Meter View for measuring these signal types:

- Noise-like digitally modulated signals such as CDMA and OFDM when only average measurements are needed.
- When simple, non-synchronous measurements on a periodic or non-periodic signal are needed (overall average and peak power).

Controls for the Meter View can be found in the Channel Control panel's Sensor section. Refer to [“Meter View Display”](#).

Filter Mode sets the setting of the integration filter on the selected channel to one of these settings:

- **Off** provides minimal filtering (1 ms integration window), and can be used at high signal levels when minimum settling time is required.
- **On** allows a user-specified integration time as entered in the Mod Filter setting.
- **Auto** uses a variable amount of filtering, which is set automatically, by the power meter based on the current signal level, to a value that gives a good compromise between measurement noise and settling time at most levels.
- **Mod Filter** sets the current length of the modulation mode integration filter on the selected channel when Filter Mode is set to On. The integration time can be set from 2 milliseconds to 2.048 seconds in 1 ms increments.

## Acquisition Status Bar

Figure 3-30 highlights the Acquisition status bar with a red rectangle. This bar, located beneath the graphical display, contains three status readouts: Meas State, Sample Rate, and Trigger Rate.

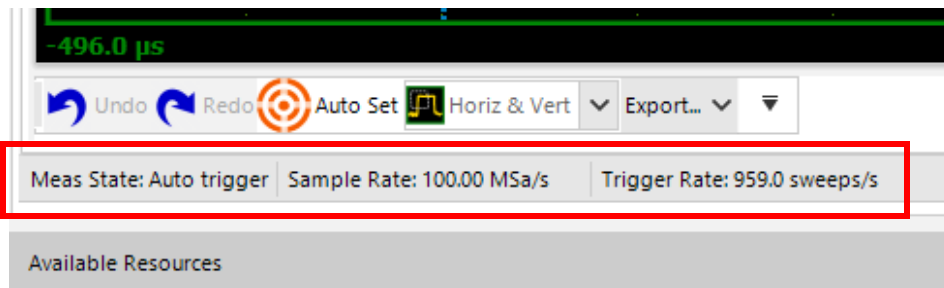


Figure 3-30. The Acquisition Status Bar

The sampling rate and trigger rate are not reported in any other control window. These are affected by the Timebase setting in the Time/Trigger Control window.

## Archiving Measurement Setups

Measurement setups can be stored and recalled using the Save and Load buttons under the File menu as shown in Figure 3-31.

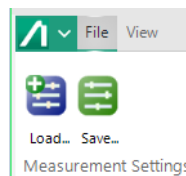


Figure 3-31. Load and Save Buttons

Load and Save buttons for saving and recalling measurement setups.

After the Power Analyzer Software is configured for a particular measurement, the application state can be saved by clicking File>Save. You are prompted to enter a file name and path to save the measurement state. Measurement States are stored in BMS file format.

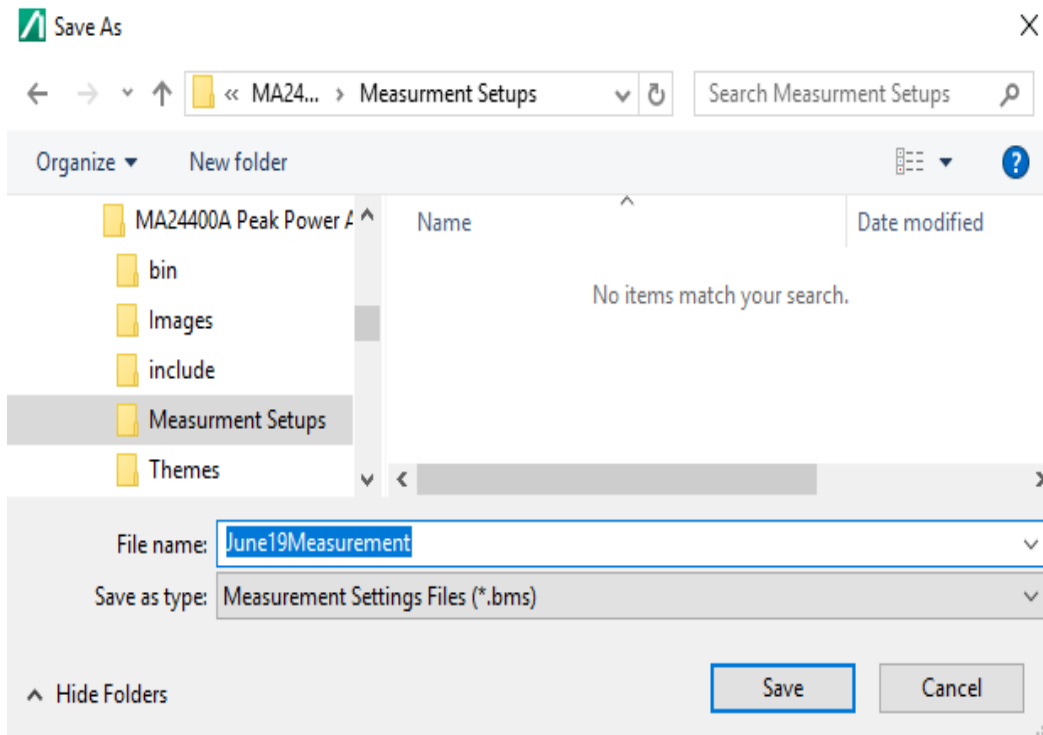


Figure 3-32. Save Measurement Setup Dialog

Saved measurement states can be restored with the Load button; it prompts you to choose the desired .BMS file.

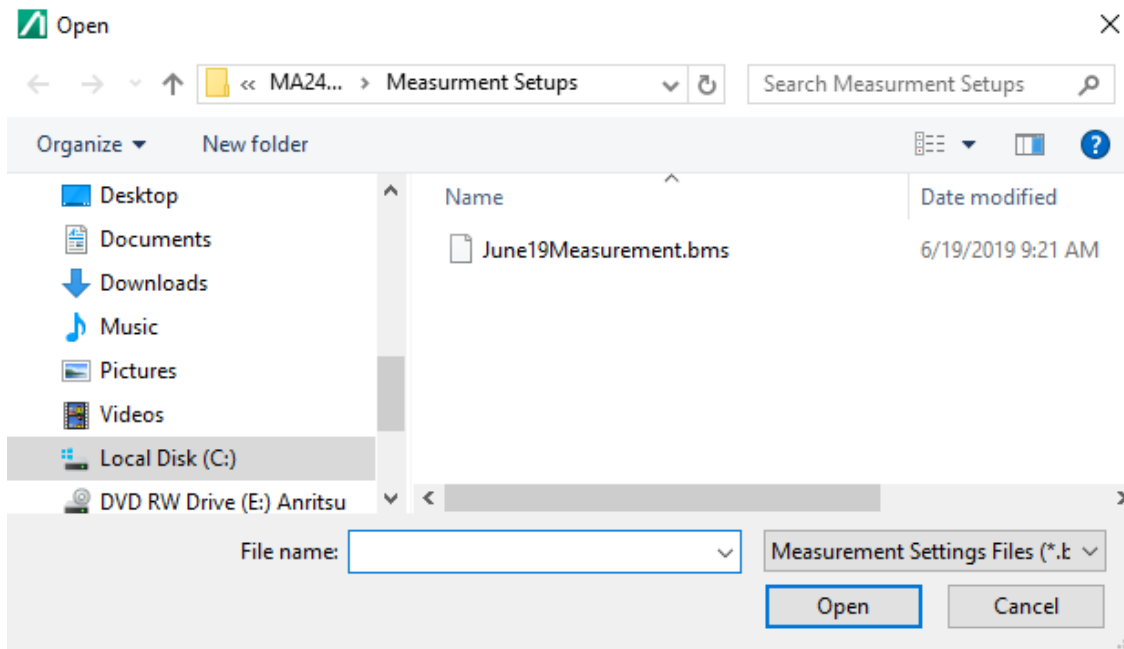


Figure 3-33. Load Measurement Setup Dialog

### 3-3 Multichannel Operation

The MA244xxA Peak Power Analyzer supports simultaneous operation of up to eight MA244xxA Peak Power Sensors. Figure 3-34 shows a Trace View example using two power sensors each in a distinct color which matches the on-screen annotation.

#### Multichannel Measurements

When multiple sensors are connected to the USB ports of the computer, make sure all sensors are displayed in the Available Resources. If a sensor is not selectable, this means it is already assigned to a Virtual Power Analyzer instance. All sensors assigned to a Virtual Power Analyzer instance are displayed on the same Trace Window, if enabled.

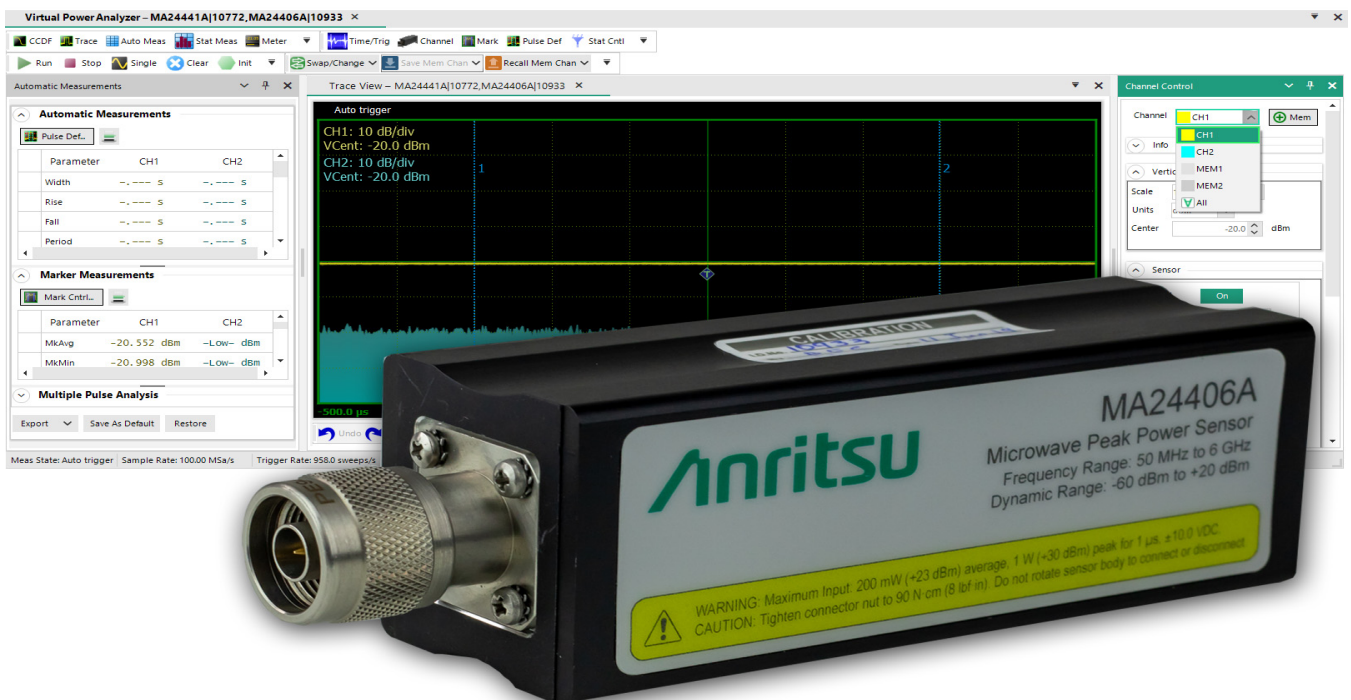


Figure 3-34. Power Analyzer Software Display

The Channel Control selection list offers control of individual sources CH1, CH2, ..., CH8, as well as corresponding memory channels MEM1, MEM2, ..., MEM8, and ALL. If an individual measurement or memory channel is selected, then the channel control settings only affect that channel. If ALL is selected, then the channel control settings affect all measurements simultaneously (memory channels are not grouped with some ALL settings). The timebase settings are common to all measurement channels displayed with the same Virtual Power Analyzer instance.

#### Multichannel Automatic Measurement

Clicking Auto Meas in the measurement toolbar displays the Automatic Measurements, Marker Measurements, and Multiple Pulse Analysis windows and these show measurements for each active sensor. Pulse definitions, like channel control, can be applied to each trace source individually or to all sources simultaneously. Marker location settings, being time locations, are common to all traces. Reference Lines are also associated, individually, with each displayed trace. Reference lines are color-coded to match each trace.

Multichannel CCDF Graph View

Statistical analysis behaves identically to the trace view. All the CCDF channel traces are displayed on a common axis. Each has a measurement column for each sensor as shown in Figure 3-35.

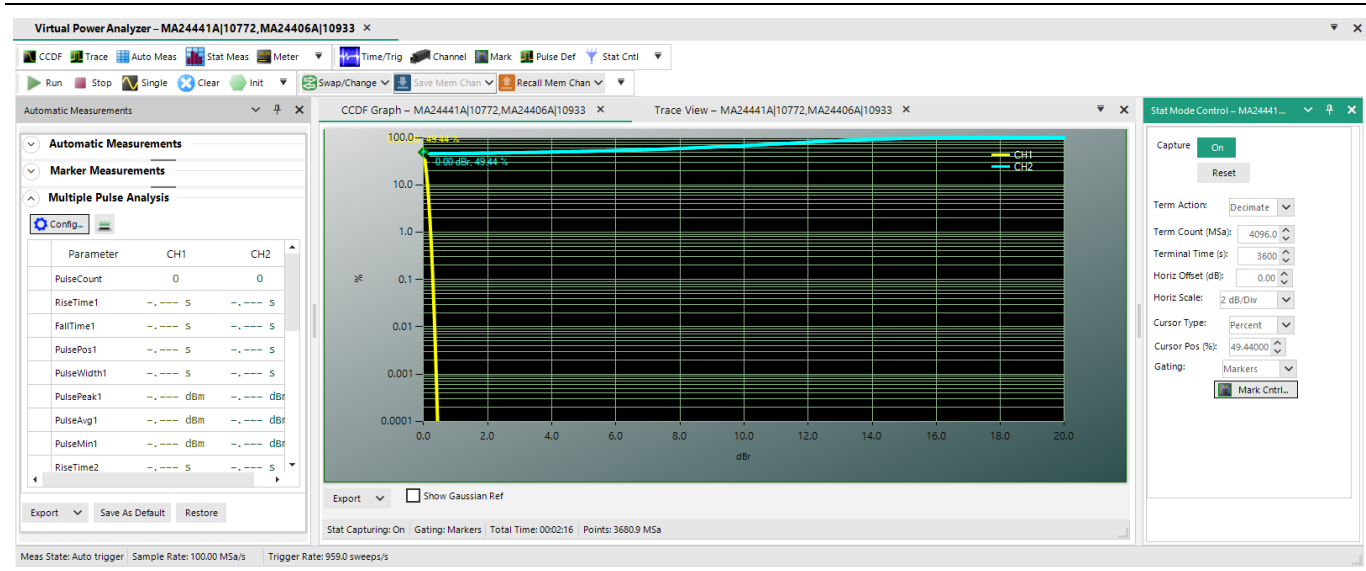


Figure 3-35. CCDF Graph Window

Similar to the Trace View, there is a color-coded trace for each sensor in the CCDF Graph View displayed on a common grid. Statistical Mode controls affect all traces in the common display.

Triggering Options

When using more than one sensor, there are different triggering options as shown in Figure 3-36.

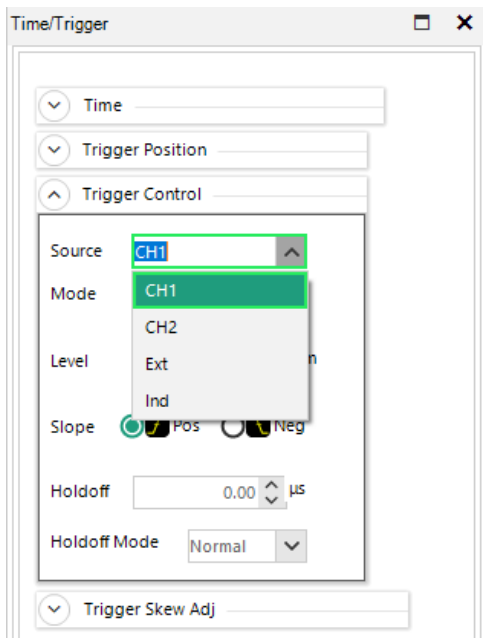


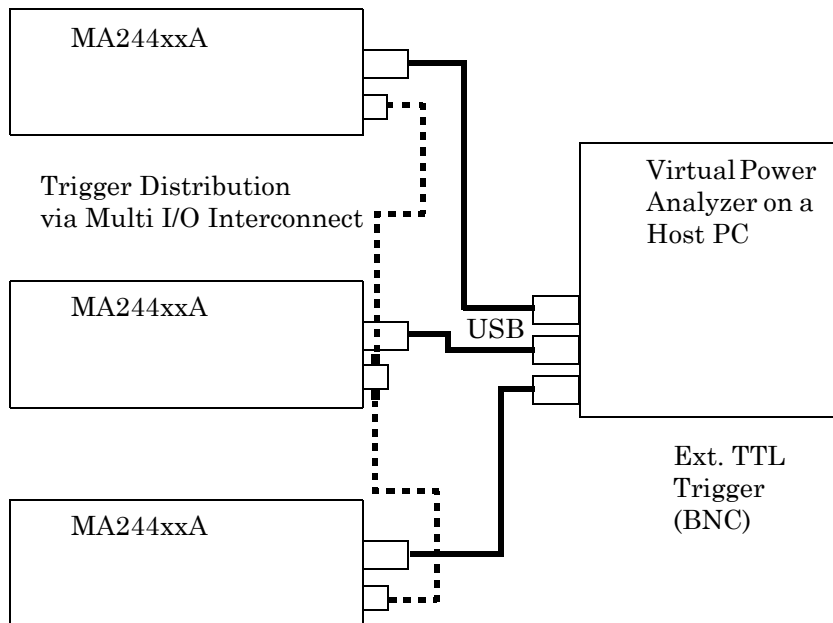
Figure 3-36. Trigger Source Selection Dialog for Two Sensors



Unless they are intended to be triggered independently, power sensors should be connected to each other using the configuration shown in [Figure 3-37](#). To establish a communications path between the modules, a *trigger sync bus* is used to control both arming and triggering.

#### Multichannel Internal

**Triggering :** When the Trigger Source for a multichannel Virtual Power Analyzer is set to CH1, CH2, etc., one of the connected sensors is used as a common trigger for all channels. To facilitate this, the multi-I/O connectors of all active sensors (channels) must be interconnected to create a *trigger distribution bus*. The primary sensor (selected trigger source) detects the trigger condition and distributes that event to other secondary sensors to ensure synchronized triggering of all channels. [Figure 3-37](#) illustrates this connection.

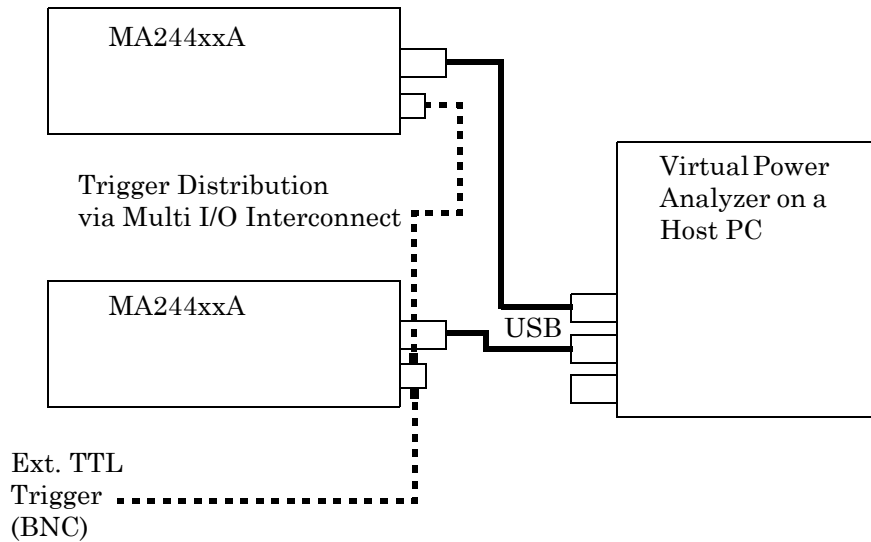


**Figure 3-37.** Multichannel Triggering

**Note** When three or more channels are present, use a “tee” adapter to interconnect them in parallel.

Due to propagation delays in the primary-to-secondary trigger distribution, there is a small timing skew between the primary and secondary channels. Sensors come preadjusted to minimize this skew, but you can perform a fine trigger-skew adjustment for performing critical channel-to-channel timing measurements. Refer to [“Trigger Skew Adj\(ust\)”](#) on page 3-9.

**External Triggering:** When the Trigger Source for a single channel or multichannel Virtual Power Analyzer is set to EXT, a single, user-supplied TTL signal is used as a common trigger for all channels. To facilitate this, the multi-I/O connectors of all active sensors (channels) must be driven by the external trigger signal to ensure synchronized triggering of all channels. [Figure 3-38](#) illustrates this connection.



**Figure 3-38.** Multi I/O Setup for Using a Common External Trigger

When two or more channels are present, a tee adapter is required to drive all multi-I/O connectors in parallel.

Due to propagation delays in the external trigger system, there is a small amount of timing skew between the external trigger edge and the RF signal for each channel. Sensors come preadjusted to minimize this skew, but it is possible to perform a fine trigger skew adjustment for performing critical channel-to-channel timing measurements. Refer to [“Trigger Skew Adj\(ust\)”](#) on page 3-9.

#### Independent

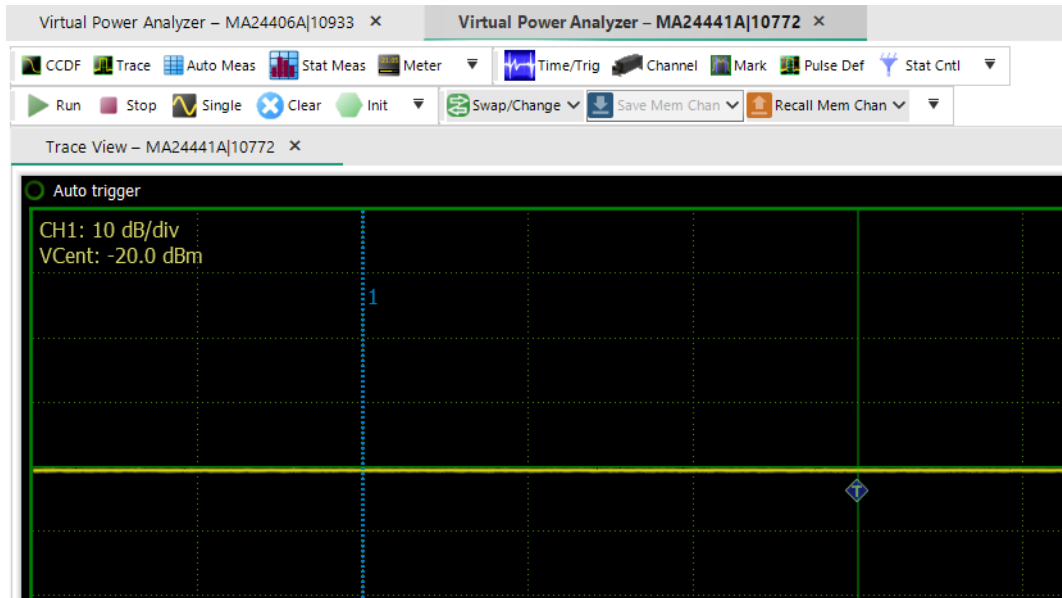
**Triggering:** Each sensor is internally triggered from its RF input signal. Select *Ind* from the drop-down menu of Source located in the Trigger Control panel of the Time/Trigger control window. See [Figure 3-36](#). Note that *Ind* source does not use the Multi-I/O connector.

### Multichannel Individual Sensor Tabs

Multiple sensors can also be employed individually, each associated to its own Virtual Power Analyzer. To accomplish this:

1. Starting with multiple sensors listed in the Available Resources window, click one sensor, then click **New Virtual Power Analyzer** button. A Virtual Power Analyzer (VPA) tab is opened, listing the model and serial number of the selected sensor.
2. Click another sensor in the Available Resources window and then click **New Virtual Power Analyzer** button again. A second VPA tab is opened as shown in [Figure 3-39](#). This mode of multichannel operation treats each sensor individually.

3. Select a VPA tab and all the control windows apply only to the selected sensor. Each VPA Trace View shows the selected sensor as Channel 1 (CH1). They are differentiated by the model and serial number listed on the tab. Likewise, all measurement windows list measurements only for the selected sensor.



**Figure 3-39.** Multichannel Sensors Virtual Power Analyzer (VPA) Tabs.

Each sensor has its own control and measurement windows associated with it which are available when the sensor VPA tab is selected.

In this mode, it is like having two different instances of the MA244xxA Peak Power Analyzer and switching between them by selecting the appropriate VPA tab. There is no method to add a second sensor to an existing single-channel VPA. The only way to do that is to close the VPA channel and restart it as a multi-channel VPA.

### 3-4 Data Buffer Mode (API Remote Programming Only)

The MA244xxA Peak Power Sensors Data Buffer Mode works in conjunction with real-time processing to provide all relevant burst information including power and crest factors while eliminating the need to buffer, download and post-process large sample buffers.

Data Buffer Mode captures and analyzes the input signal during time intervals of interest and discards information that occurs during non-relevant intervals. This mode of operation performs most analysis in real-time during capture. The big advantage this data buffer mode offers is that it reduces the stream of sample data to a single data record for each pulse, burst, or event. Even for the fastest pulse rates, the data rate to the user is orders of magnitude less than the sample data rate, so in most situations it becomes possible to store and transfer power analysis results to the user in real-time with no gaps in acquisition or analysis.

The Data Buffer Mode circuitry analyzes and buffers points at better than 2M buffered points per second (depending upon operating mode). The MA244xxA Peak Power Sensors internal data buffer can capture, analyze, and store measurements for up to 2048 bursts at full rate. Additionally, a circular or FIFO capability allows continuous readout of buffered measurements by a host computer during capture and analysis. This real-time feature effectively removes the 2048-point internal buffer limitation, and permits capture and storage of test sequences of any size or duration to an external host data buffer. Continuous, buffered capturing is possible at sustained rates of better than 100K buffered points per second to a host memory array or disk file.

## Overview

The MA244xxA Peak Power Sensors measurement buffer consists of 2048 buffer entries, each containing information about a unique time interval.

### Buffer Entries

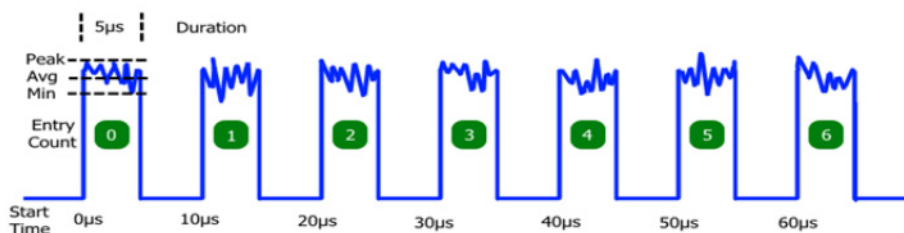
Each "Buffer Entry" contains the following measurement values for that time interval:

- Average interval power
- Peak interval power
- Minimum interval power
- Interval start time (relative to start time of first entry)
- Interval duration (time from start to end of interval)
- Entry count (buffer reading number - increments for each entry). This counter (called sequence number in the IVI driver), keeps track of the number buffer entries processed and stored.

Table 3-4 shows a sample measurement buffer consisting of seven buffer entries, each corresponding to a single burst.

**Table 3-4.** Example of a Data Buffer Mode measurement containing seven entries

Entry Count	Interval Start	Interval Duration	Interval Average	Interval Minimum	Interval Peak
0	0.00 us	5.01 us	-0.043 dBm	-39.042 dBm	8.826 dBm
1	9.99 us	5.00 us	-0.006 dBm	-38.431 dBm	8.827 dBm
2	19.99 us	5.01 us	0.039 dBm	-41.549 dBm	9.742 dBm
3	30.00 us	5.00 us	0.017 dBm	-38.551 dBm	9.802 dBm
4	40.01 us	5.00 us	0.022 dBm	-40.699 dBm	9.477 dBm
5	49.99 us	5.00 us	-0.020 dBm	-39.706 dBm	8.102 dBm
6	60.00 us	5.00 us	0.036 dBm	-37.803 dBm	9.750 dBm



**Figure 3-40.** Sample Burst Signal Showing Buffer Entry Elements

### Buffer Gates

The measurement interval for each Buffer Entry is defined by a “gate” signal that controls the start and end of data acquisition for that entry. At the start of each gate interval, a fresh acquisition interval is initiated, and at the end of the gate, the acquisition interval is concluded and the result (the “buffer entry”), as shown in Figure 3-40, is written to memory. The gate signal may be internally or externally generated in several different ways - refer to “Gating Modes”.

## Buffer Sessions

Each Buffer Session consists of a series of acquired buffer entries, stored in sequential order to an on board memory. The duration of a session may be monitored and controlled by user command, by an external run signal, or limited to a preset number of entries or a preset time period. Refer to “[Session Arming \(Start\) Control](#)” on page 3-37 and “[Session Auto-Stop Conditions](#)” on page 3-37. In the example above, the session consists of seven buffer entries, acquired over approximately 65 microseconds.

## Data Buffer Mode Operation

### Gating Modes

Each Buffer Entry is controlled by a buffer gate that defines the start and end of the entry time interval. The gate signal may be internally or externally generated in several different ways.

**Marker Gate:** Each buffer entry is between markers interval for one triggered sweep. This mode is used with the power sensor operating in triggered pulse mode, and the sweep system and the markers are used to define the start and end of each gate interval. The entire gate interval must fall within the limits of the visible trace, so trigger and timebase settings must be appropriate for the signal.

**Burst AutoGate:** Each buffer entry consists of a single pulse or burst. The start and end of the burst are automatically identified by comparing the measured input signal to the trigger level threshold. Gate-qualifying and delay options are available to align the gate interval with the desired portion of a burst.

**External Gate:** Each buffer entry consists of a single measurement interval gated by the logic state of the multi-I/O input. Qualifying and delay options are available to align the gate interval with the multi-I/O input.

#### External Trigger

**Gate:** Each buffer entry is initiated by assertion of the multi-I/O input and ends after a user-defined duration. Qualifying and delay options are available to align the gate start with the multi-I/O input. If a qualified multi-I/O assertion (rising edge) occurs prior to the programmed duration, the gate interval in progress ends immediately and a new interval begins with no gap between intervals.

**Periodic Gate:** Buffer entries are self-timed intervals with user-defined period and duration. If period setting is less than or equal to duration setting, the period setting is used for both and there is no gap between successive intervals.

Acquisition of each entry begins with the assertion of the buffer gate, and concludes upon deassertion of the buffer gate. When the gate interval starts, a fresh accumulation of power samples begins. When the entry interval ends, the accumulated power samples are processed to yield one set of avg/min/max and duration values for the entire interval, and this result is stored to the next available buffer location in memory.

Power samples are not accumulated when the gate is inactive. Buffer entries (gates) may not overlap; however gap-less buffering (zero gate-inactive time) is possible in certain modes. In these cases, new gate intervals begin immediately upon the end of the preceding gate interval.

### Gate Qualifying

If the Gate Mode is set for Burst AutoGate or External Gate/Trigger, additional criteria and time delays may be imposed to aid in aligning the gated measurement on a desired signal interval. Start and End qualifying values indicate the time that the controlling input (RF signal level or MIO external gate) must remain above or below the qualifying threshold (trigger level for RF input, TTL levels for MIO) to be recognized.

The Start qualifier can be used to reduce sensitivity to brief noise spikes while the burst is "off". Typically, the start qualify time is short - perhaps 10 to 50 ns.

The End qualifier is commonly used to avoid premature burst end detection when burst modulation causes the RF signal to briefly fall below the qualifying threshold. For wideband modulation, this value must be longer than expected modulation dips, but shorter than intra-burst gaps - typically 50 to 200 ns.

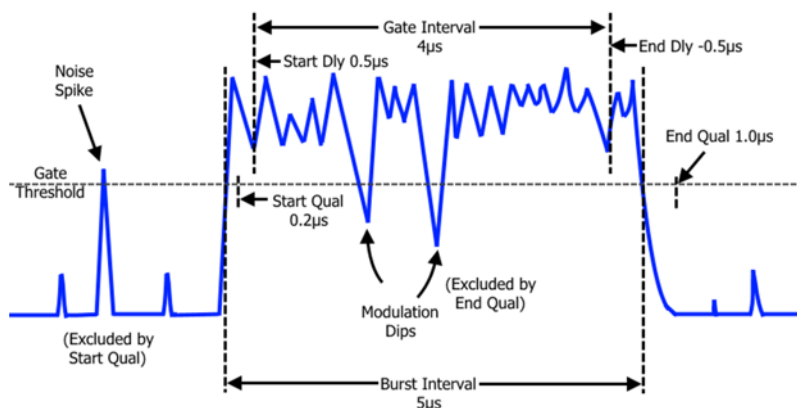
The internal gate signal is automatically adjusted to align with the beginning of recognized qualifying intervals - no user adjustment is necessary. This means that the qualified gate which controls buffering corresponds to the actual start and end of the burst and will not be delayed by the qualifying times.

### Gate Start/End Delay

If time adjustment of the qualified gate interval is needed to align the desired gate interval with signal timing, the start and end times may be delayed by a user-controlled value. Gate delays may be positive or negative to permit moving the gate interval ahead or back in time, respectively.

A positive start delay can be used to exclude the rising edge of a burst, or to exclude a training sequence of known duration. Similarly, a negative end delay causes the qualified gate to end early, so can be used to exclude the falling edge of a burst.

Because all processing is done in real-time, a built-in signal FIFO is used to permit the look-back action necessary to start or end a gate interval prior to the qualifying event. Therefore, the difference of the qualifying time and gate delay for both the start and end gates cannot exceed the FIFO depth of 20 microseconds (implementation specific). This means that if the end qualify time is 2  $\mu$ s, the end delay may be no more negative than  $-18 \mu$ s. To simplify settings control, the available time is split in half between the gate qualify and negative delay limits.



**Figure 3-41.** Gate Qualify and Delay

Figure 3-26 on page 3-22 illustrates how gate qualify and delay options may be combined to align the desired buffer gate with a signal burst.

- StartQualify:** Time is set to 0.2  $\mu$ s so the start of the burst is only recognized when the signal remains above the gate threshold for 0.2  $\mu$ s or longer. This ensures that brief noise spikes while the burst is off are not recognized as a valid burst.
- EndQualify:** Time is set to 1.0  $\mu$ s so the end of the burst is only recognized when the signal remains below the gate threshold for 1.0  $\mu$ s or longer. This ensures that brief modulation dips during the burst do not prematurely end the gate interval.
- StartDelay:** Time is set to 0.5  $\mu$ s. This begins the gate interval 0.5  $\mu$ s after the beginning of the StartQualify interval and is used to exclude rising edge effects such as transition time or overshoot from the gate measurement.
- EndDelay:** Time is set to  $-0.5 \mu$ s. This ends the gate interval 0.5  $\mu$ s before the beginning of the EndQualify interval and is used to exclude falling edge effects such as transition time from the gate measurement.

The entire, qualified burst interval is 5  $\mu$ s long, starting and ending at the beginning of the StartQualify and EndQualify times. The final gate interval is offset at the start and end of the burst to exclude rising and falling edge effects. Therefore, the measured duration stored in the buffer for the 5  $\mu$ s burst shown is about 4  $\mu$ s.

### Session Arming (Start) Control

Although buffered acquisition may be enabled (running), no data are collected unless the session is armed to accept gate signals (refer to “[Gating Modes](#)” on page 3-35). Recognition of the selected gate signal is controlled by arming or disarming the session.

When a session is armed, one buffer entry is written to the buffer memory at the conclusion of each gate interval. When the session is not armed, gate signals are ignored, and no entries are saved. This permits a session to be launched or controlled by user software or an external signal.

These settings are available to arm or control Mbuf sessions:

- Immediate:** The session is armed immediately - each valid gate signal generates a buffer entry. The session remains armed until disarmed by other means (refer to “[Session Auto-Stop Conditions](#)” below).
- ExtStart:** The session is armed upon assertion of an external start (arming) pulse on the multi-I/O. After arming, the buffer system remains armed, and each valid gate signal generates a buffer entry. The session remains armed until disarmed by other means (refer to “[Session Auto-Stop Conditions](#)” below).
- ExtEnable:** The session is armed when the external enable signal to the multi-I/O is asserted, and remains armed as long as the multi-I/O is asserted. If the multi-I/O is de-asserted, the system disarms and sample acquisition halts. Asserting the multi-I/O signal again re-arms and continues collecting buffer entries from the previous location - it does not reset the buffer.

At the start of any Buffer Session, the buffer status is reset. This clears the entry count and discards any unread entries.

### Session Auto-Stop Conditions

Each Buffer Session may be automatically terminated; this disarms the session so no further entries are stored. Entries already started are aborted without being stored. Automatic stops (buffer session terminations) can occur in several ways:

- Counted:** When N buffer entries are acquired during the current buffer session.
- Timed:** When T seconds have elapsed after the start of the session.
- ExtEnable:** Upon de-assertion of an external-buffer-enable signal on the multi-I/O.
- Overflow:** When the number of unread entries reaches the capacity of the buffer.

#### Note

Auto-stop criteria are all examined; therefore, the session terminates for whichever event occurs first. Users may opt to configure or disable any or all of the auto-stop criteria.

### Mbuf Enablement Modes

Overall control of the Mbuf system is handled in much the same way as other measurements: user controls for "Run", "Stop" and "Reset" are available.

**MbufEnable=ON:** Reset the MBuf system and enable a new MBUF session. Acquisition begins with the first buffer entry after the system is armed (refer to “[Session Arming \(Start\) Control](#)”) and a valid gate signal is received (refer to “[Gating Modes](#)” on page 3-35).

**MbufEnable=OFF:** Halts any MBUF session in progress. If the gate is currently active, its acquisition data are lost. This functions as a stop command and all acquired buffer data are still available to read. Note that sessions may already be stopped due to auto-stop conditions being met.

**MbufReset:** Halts and clears the Mbuf system. This forces MbufEnable to OFF. The read count and write index are returned to zero and no buffer data are available to read.

### Buffer Read

Users may read the entire buffer contents after the session is complete, or may read any newly acquired entries while the buffer session is in progress. User-settings control the maximum number of entries to be returned for each I/O read, up to the full capacity of the buffer. However, the number of returned entries is limited to the number of new (i.e., acquired, unread) buffer entries.

Each time the user reads entries from the buffer, a read pointer is incremented by the number of entries returned, and subsequent user reads return new buffer elements beginning with the first unread entry.

### Circular/Continuous Buffer Acquisition

If the number of entries in a buffer session reaches the end of the measurement buffer without stopping, buffered acquisition continues in circular fashion—that is, entries wrap and begin refilling the buffer from its start.

Ordinarily, this would overwrite the buffer contents, resulting in loss of acquired measurements. However, because users can read buffer sessions during acquisition, it is possible to periodically empty the buffer so overwriting of old data does not occur.

From a user's perspective, the buffer appears as a 2048-element FIFO. Provided the user avoids FIFO overflow by reading the buffer periodically, the buffer entries may be stored externally by the user to create buffers of any size desired.

If the user is not able to read the buffer before overflow occurs, two options are available to control behavior:

#### Overflow Protection

**ON:** (Default) Enables auto-stop for pending buffer overflow. Buffer entries continue to be acquired in circular fashion provided the user periodically reads the buffer. But if the buffer fills to capacity (2048 unread entries) without being emptied, the session is terminated and no further entries are stored. This mode gives priority to the earliest acquired entries and ignores events after the session terminates.

#### Overflow Protection

**OFF:** Disables auto-stop for buffer overflow. Buffer entries continue to be acquired in circular fashion without regard to read status by the user. If the buffer fills to capacity (2048 unread entries) without being emptied, new entries are stored, and overwrite the oldest entries. This mode gives priority to the latest acquired entries, and discards older events regardless of whether the user has read them.

### Data Buffer Mode User Settings

The following settings, queries and controls are exposed to the user with the applicable modes and argument options or numeric ranges shown. Note that this is the SENSOR command interface, and may not align exactly with the API interface. Refer to *MA244xxA Peak Power Sensors Programming Reference Manual* for available settings and queries.



**Table 3-5.** Gate Settings

Setting	Value	Description
MbufGateMode	[ MarkerGate   BurstAutoGate   ExtGate   ExtTrigGate   PeriodicGate ]	
MbufGateStartQual	0.0 to 10 $\mu$ s	(BurstAutoGate, ExtGate and ExtTrigGate)
MbufGateStartDelay	-10 $\mu$ s to 100 ms	(BurstAutoGate, ExtGate and ExtTrigGate)
MbufGateEndQual	0.0 to 10 $\mu$ s	(BurstAutoGate and ExtGate)
MbufGateEndDelay	10 $\mu$ s to 100 ms	(BurstAutoGate and ExtGate)
MbufGatePeriod	100 ns to 10 s	PeriodicGate)
MbufGateDuration	100 ns to 100 ms	(ExtTrigGate and PeriodicGate)

**Table 3-6.** Session Control Settings

Setting	Value	Description
MbufStartMode	[ Immediate   ExtStart   ExtEnable ]	
MbufStopCount	1 to 1M rdgs	(<=0 disables counted auto-stop)
MbufStopTime	1 ms to 1000 s	(<=0 disables timed auto-stop)
MbufProtection	[on   off]	Enables auto-stop for buffer overwrite
MbufEnable	[on   off]	"run/stop" control
MbufReset		Stops and resets mbuf

**Table 3-8.** Measbuf Readback Settings

Setting	Value	Description
MbufFetchCount	1 to 2048	Sets # of entries to be returned to user
MbufAvailCount?		Returns # of unread entries in MBUF
MbufFetchNext?		Returns next "MbufFetchCount" entries, incr ptr
MbufFetchIndex[?]		Sets or returns current read pointer index

**Multi-I/O Priority:** The MA244xxA Peak Power Sensors multi-I/O connector may be used as input or output in several different ways. When conflicts occur, priority must be determined or undefined behavior will result.

#### Multi-Channel

**Operation:** When synchronized buffering between multiple channels is required, the concept of "primary" and "secondary" is needed to ensure gate intervals align between sensors. The "Trigger Source" logic can be used here.

For all configurations requiring a separate primary and secondary, the supplied [TriggerSync](#) cable must be used to interconnect the multi-I/O connectors of the primary and all secondaries. When more than one secondary is used, use additional cables and tee adapters for each parallel connection.

The multi-I/O connector is not required by the Mbuf system in many single-channel configurations

**Table 3-9.** Summary of the Data Buffer functions in a multi-channel environment

Mode	Primary	Secondary	Required Connections
Marker Gate	Pulse mode trigger out/arm status in signal to/from the multi-I/O connector. Mbuf gate signal is internally generated by sweep system in each sensor.	Pulse mode trigger in/arm status out signal to/from multi-I/O. Mbuf gate signal are internally generated by sweep system using the same marker settings as primary, so they are synchronized.	Interconnect multi-I/O inputs of primary and all secondaries.
Burst AutoGate	RF Burst is qualified/delayed by primary to create the Mbuf gate. Primary multi-I/O outputs the Mbuf gate to all secondaries.	Multi-I/O receives qualified/delayed burst-detect signal from primary. Each secondary operates in "Ext Gate" Mbuf mode, so they follow primary.	Interconnect multi-I/O inputs of primary and all secondaries.
External Gate	There are no "primary" and "secondary" for this mode. All multi-I/O inputs receive the ExtGate signal from a user source to gate each Mbuf entry. Mbuf entries for all connected sensors start and end in sync upon assertion and de-assertion of user ExtGate signal.		Drive multi-I/O inputs of all sensors from user-supplied External Gate logic signal.
External TrigGate	There are no "primary" and "secondary" for this mode. All multi-I/O inputs receive the ExtTrigGate signal from a user source to initiate each Mbuf entry. Mbuf entries for all connected sensors start in sync upon assertion of user ExtTrigGate signal and end after user-configured time duration.		Drive multi-I/O inputs of all sensors from user-supplied External Gate logic signal.
PeriodicGate	Primary uses internal period and duration timers to control start and end of each Mbuf entry. Multi-I/O of primary outputs 100 ns "start pulse" at the start of each Mbuf period.	Secondaries operate in External Trigger Mbuf mode. All secondary multi-I/O inputs receive the start pulse from primary to initiate each Mbuf entry. Each secondary times the duration to end each entry.	Interconnect multi-I/O inputs of primary and all secondaries.

#### Driver for MA244xxA Peak Power Sensors

**Functionality:** The API for MA244xxA Peak Power Sensors exposes all of the measurement buffer controls and functions described in this section. However, for most use cases, the API offers a simplified set of methods and properties to allow you to specify an arbitrary number of measurements to capture. This allows the programmer to specify the pertinent modes and gate qualifications, acquire a user-specified number of measurements, and then retrieve the buffered measurement arrays.

For further information, refer to the *MA244xxA Peak Power Sensors Programming Reference Manual*.

# Chapter 4 — Measurements

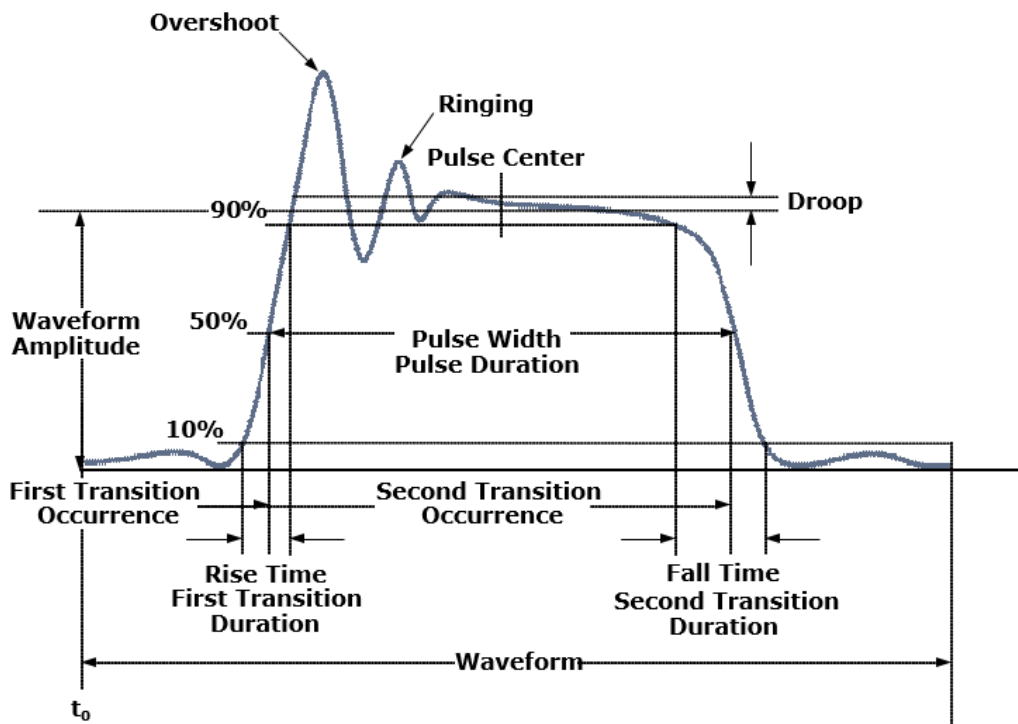
## 4-1 Pulse Measurements

### Pulse Definitions

*IEEE Std 181™-2011 IEEE Standard for Transitions, Pulses, and Related Waveforms*, provides fundamental definitions for general use in time domain pulse technology. Several key terms defined in the standard are reproduced in this subsection, which also defines the terms appearing in the MA244xxA Peak Power Sensors text mode display of automatic measurement results.

### Standard IEEE Pulse

The key terms defined by the IEEE standard are abstracted and summarized below. These terms are referenced to the standard pulse illustrated in [Figure 4-1](#).



**Figure 4-1.** IEEE Standard Pulse

**Note**

Many of the terms used below have been deprecated by the IEEE. However, these terms are widely used in the industry and are familiar to users.

**Table 4-1.** Pulse Measurement Amplitude Threshold Terms

TERM	DEFINITION
Base Line	The two portions of a pulse waveform which represent the first nominal state from which a pulse departs and to which it ultimately returns.
Top Line	The portion of a pulse waveform which represents the second nominal state of a pulse.
First Transition	The major transition of a pulse waveform between the base line and the top line (commonly called the rising edge).
Last Transition	The major transition of a pulse waveform between the top of the pulse and the base line. (Commonly called the falling edge).
Proximal Line	A magnitude reference line located near the base of a pulse at a specified percentage (normally 10%) of pulse magnitude.
Distal Line	A magnitude reference line located near the top of a pulse at a specified percentage (normally 90%) of pulse magnitude.
Mesial Line	A magnitude reference line located in the middle of a pulse at a specified percentage (normally 50%) of pulse magnitude

### Automatic Pulse Measurements

The MA244xxA Peak Power Sensors and the Power Analyzer Software or API automatically analyzes the waveform data in the buffers and calculates key waveform parameters. The calculated values are displayed in the Auto Meas window.

[Table 4-2](#) summarizes the automatic field parameters available. The Pulse Measurements can be edited and customized. Amplitude related parameters be displayed in the same units as selected in the Channel Control Window.

**Table 4-2.** Automatic Field Parameters

Field Label	Parameter	Definition
<b>Width</b>	Pulse Width	The interval between the first and second signal crossings of the mesial line.
<b>Rise</b>	Risetime	The rising edge time interval from the first crossing of the proximal line to the first crossing of the distal line.
<b>Fall</b>	Falltime	The falling edge time interval from the last crossing of the distal line to the last crossing of the proximal line.
<b>Period</b>	Pulse Period	The time interval between two successive rising edges or two successive falling edges. (This is the reciprocal of the Pulse Repetition Frequency).
<b>PRF</b>	Pulse Repetition Frequency	The number of cycles of a repetitive signal that take place in one second.
<b>Duty</b>	Duty Cycle	The ratio of the pulse on-time to off-time.
<b>Offtime</b>	Off-time	The time a repetitive pulse is off. (It is equal to the pulse period minus the pulse width).
<b>WavAv</b>	Waveform Average Power	Waveform Average Power.
<b>PulsAv</b>	Pulse Average On Power	The average on power level across the pulse width, defined by the intersection of the pulse rising and falling edges with the mesial line, and offset by the StartGate and EndGate settings.

**Table 4-2.** Automatic Field Parameters

Field Label	Parameter	Definition
<b>PulsPk</b>	Pulse Peak Power	The maximum power level of the captured waveform.
<b>OvrSht</b>	Overshoot	Leading edge overshoot (The difference between the maximum amplitude of the overshoot and the top line).
<b>Droop</b>	Pulse Droop	Rise or Droop in amplitude between the start and end of the pulse, as defined by the StartGate and EndGate settings.
<b>Top</b>	IEEE Pulse Top Amplitude	The amplitude of the top line. (See IEEE definitions).
<b>Bot</b>	IEEE Pulse Bottom Amplitude	The amplitude of the base line. (See IEEE definitions).
<b>EdgDly</b>	Edge Delay	The delay time relative to the trigger of the first onscreen mesial level transition of either polarity. The Edge Delay value be negative if the mesial transition occurs before the trigger event, and positive if it occurs after the trigger event.
<b>Skew</b>	Channel-to-Channel Skew	The time between the mesial level of a pulse on Channel 1 and a pulse on Channel 2. The pulse can be the power or trigger signal.

**Automatic Pulse Measurement Criteria**

Automatic measurements are made on repetitive signals that meet the following conditions:

**Amplitude:** The difference between the top and bottom signal amplitudes must exceed 6 dB to calculate waveform timing parameters (pulse width, period, duty cycle). The top-to-bottom amplitude difference must exceed 13 dB to measure rise and falltime.

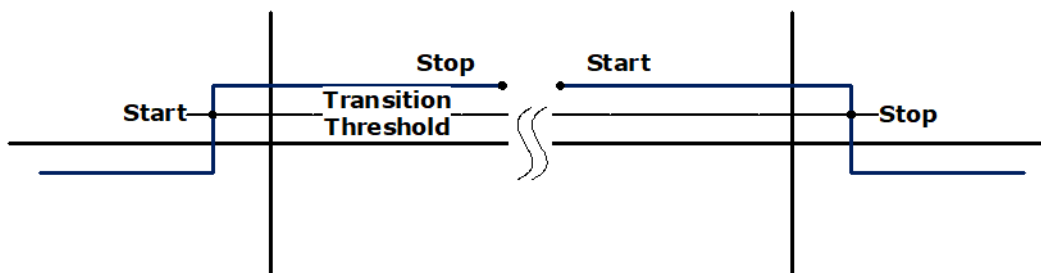
**Timing:** To measure pulse repetition frequency and duty cycle, there must be at least three signal transitions. The interval between the first and third transition must be at least 1/5 of a division (1/50 of the screen width). For best accuracy on rise and falltime measurements, the timebase should be set so the transition interval is at least one-half division on the display.

**Automatic Pulse Measurement Sequence**

The Automatic Measurement process (the “process”) analyzes the captured signal data in the following sequence:

1. Approximately 500 samples of the waveform (equivalent to one screen width) are scanned to determine the maximum and minimum sample amplitudes.
2. The difference between the maximum and minimum sample values is calculated and stored as the Signal Amplitude.

- The Transition Threshold is computed as one-half the sum of the maximum and minimum sample amplitudes.



**Figure 4-2.** Step Waveforms

- The processor locates each crossing of the Transition Threshold.
- Starting at the left edge of the screen, the processor classifies each Transition threshold crossing according to whether it is positive-going (– +) or negative-going (+ –). Because the signal is repetitive, only three transitions are needed to classify the waveform, as shown in [Table 4-3](#):

**Table 4-3.** Waveform Classification Types

Type	Edge Sequence	Description
0	none	No crossings detected
1	Not used	
2	+ –	One falling edge
3	– +	One rising edge
4	+ – +	One falling, followed by one rising edge
5	– + –	One rising, followed by one falling edge
6	+ – + –	Two falling edges
7	– + – +	Two rising edges

- If the signal is Type 0, (No crossings detected) no measurements can be performed and the routine is terminated, pending the next reload of the data buffers.
- The process locates the bottom amplitude (baseline) using the IEEE histogram method. A histogram is generated for all samples in the lowest 12.8 dB range of sample values. The range is subdivided into 64 power levels of 0.2 dB each. The histogram is scanned to locate the power level with the maximum number of crossings. This level is designated the baseline amplitude. If two or more power histograms contain equal counts, the lower is selected.
- The process follows a similar procedure to locate the top amplitude (top line). The power range for the top histogram is 5 dB and the resolution is 0.02 dB, resulting in 250 levels. The level-crossing histogram is computed for a single pulse, using the samples which exceed the transition threshold. If only one transition exists in the buffer (Types 2 and 3), the process uses the samples that lie between the edge of the screen and the transition threshold as shown in [Figure 4-2](#).
- The process establishes the proximal, mesial, and distal levels as a percentage of the difference between top amplitude and bottom amplitude power. The percentage can be calculated on a power or voltage basis. The proximal, mesial, and distal threshold values are user settable from 1% to 99%, with the

restriction that the proximal < mesial < distal. Normally, these values be set to 10%, 50% and 90%, respectively.

- The process determines horizontal position, in pixels, at which the signal crosses the mesial value. This is done to a resolution of 0.1 pixel, or 1/5000 of the screen width. Ordinarily, the sample values do not fall precisely on the mesial line, and it is necessary to interpolate between the two nearest samples to determine where the mesial crossing occurred. This process is illustrated in the example shown in Figure 4-3.

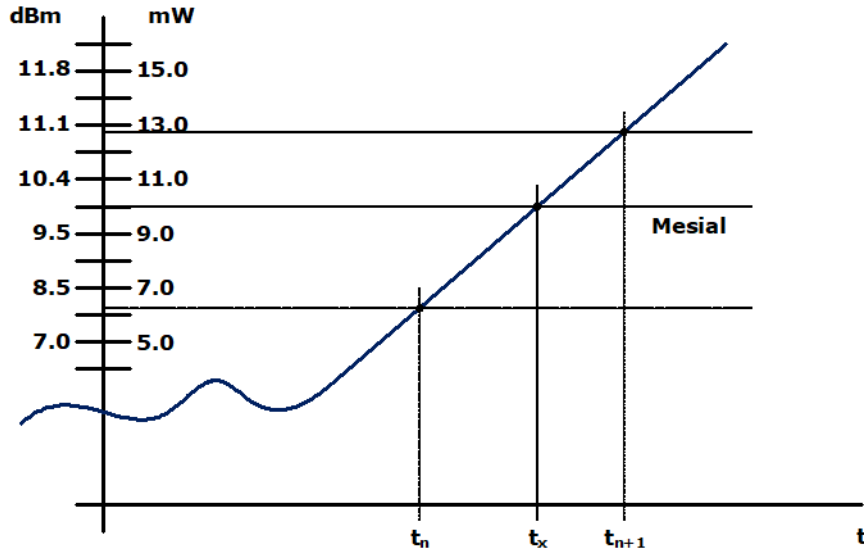


Figure 4-3. Time Interpolation Example

Table 4-4. Values from Time Interpolation Example

Item	dBm	mW
Mesial value	10.0	10.0
Sample n	8.0	6.3
Sample n+1	11.0	12.6

The interpolated crossing time,  $t_x$ , is calculated as follows:

$$t_x = t_n + \frac{P_{mes} - P_n}{P_{n+1} - P_n}$$

where P is in watts and n is the number of the sampling interval, referenced to the trigger event.

For this example:

$$t_x = t_n + \frac{10 - 6.3}{12.6 - 6.3}$$

$$t_x = t_n + 0.6$$

11. The processor computes the rise and/or falltimes of waveforms that meet these conditions:
  - The waveform must have at least one usable edge (Types 2 through 7, as shown in [Table 4-3](#))
  - The signal peak must be at least 13 dB greater than the minimum sample value.  
The risetime is defined as the time between the proximal and distal crossings (– +).  
The falltime is defined as the time between the distal and proximal crossings (+ –).  
If no samples lie between the proximal and distal values for either edge (rise or fall), the risetime for that edge is set to 0 seconds.
12. The processor calculates the output values if applicable according to these definitions:
  - Pulse Width Interval between rising and falling edge mesial points
  - Risetime - See [Step 11](#)
  - Falltime - See [Step 11](#)
  - Period Cycle time between successive mesial points of the same polarity
  - Pulse Repetition Frequency Reciprocal of Period
  - Duty Cycle Pulse Width/Period
  - Off-time (Period) - (Pulse Width)
  - Peak Power Maximum sample value between StartGate time and EndGate time (See [Step 1](#))
  - Pulse Power Average power between StartGate time and EndGate time
  - Overshoot (Peak Power) - (Top Amplitude)
  - Average Power. Refer to “[Average Power Over a Time Interval](#)”.
  - Top Amplitude. See [Step 8](#).
  - Bottom Amplitude. See [Step 7](#).
  - Droop between StartGate time and EndGate time
  - Skew. Refer to “[Channel-to-Channel Skew](#)”.

## 4-2 Marker Measurements

[Table 4-5](#) summarizes the Marker Measurements available. Note that the Marker Measurements can be edited and customized. Amplitude-related measurements are displayed in the same units selected in the Channel Control window.

**Table 4-5.** Marker Measurements

Field Label	Parameter	Definition
MkAvg	Marker Average	Average power over marker interval
MkMin	Marker Minimum	Minimum instantaneous power over marker interval
MkMax	Marker Maximum	Maximum instantaneous power over marker interval
MkMaxF	Marker Maximum Filtered	Maximum average (filtered) power over marker interval
MkMinF	Marker Minimum Filtered	Minimum average (filtered) power over marker interval
MkPk2A	Marker Peak to Average	Peak-to-Average power ratio over marker interval
Mk1Lvl	Marker 1 Level	Average power at marker 1
Mk2Lvl	Marker 2 Level	Average power at marker 2
MkMaxAv	Marker Max Interval Average	Highest value of average-between-markers



**Table 4-5.** Marker Measurements

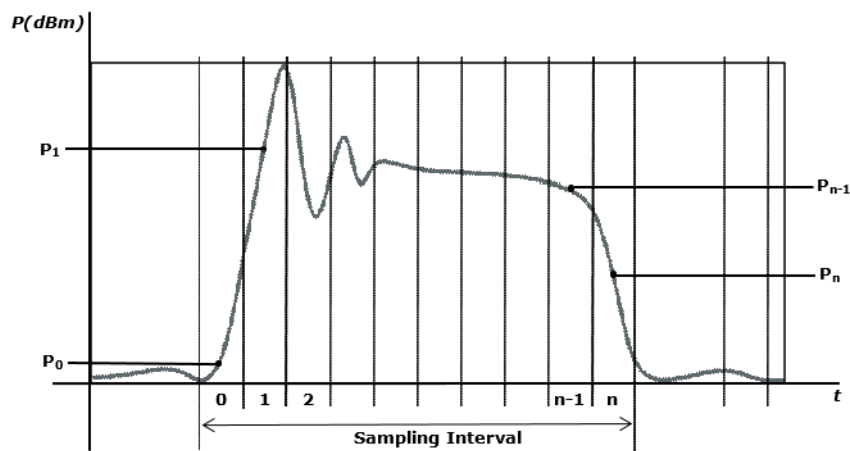
Field Label	Parameter	Definition
MkMinAv	Marker Min Interval Average	Lowest value of average-between-markers
Mk1Min	Marker 1 Minimum	Minimum power or voltage at the Marker 1
Mk1Max	Marker 1 Maximum	Maximum power or voltage at the Marker 1
Mk2Min	Marker 2 Minimum	Minimum power or voltage at the Marker 2
Mk2Max	Marker 2 Maximum	Maximum power or voltage at the Marker 2
MkRatio	Marker Ratio	Ratio of Marker 1 to Marker 2
MkDelta	Marker Amplitude Difference	Amplitude difference between Marker 1 and Marker 2
MkRDelta	Marker Reverse Difference	Amplitude difference between Marker 2 and Marker 1
MkRRatio	Marker Reverse Ratio	Ratio of Marker 2 to Marker 1
Mk1Time	Marker 1 Time	Time at Marker 1
Mk2Time	Marker 2 Time	Time at Marker 2
MkTimeDelt	Marker Time Difference	Time Difference between Marker 1 and Marker 2

**Average Power Over a Time Interval**

The average power of the signal over a time interval is computed by:

1. Summing the power values at each point within the interval.
2. Dividing the sum by the number of points.

This process calculates Pulse Power, Average Power, and the average power between markers. Because each point represents the power over a finite time interval, the endpoints are handled separately to avoid spreading the interval by one-half pixel at each end of the interval (see [Figure 4-4](#)).



**Figure 4-4.** Sampling Intervals

For the interval in [Figure 4-4](#), the average power is given by:

$$P_{ave} = \frac{1}{2}(P_0 + P_n) + \frac{1}{(n-1)} \sum_{i=1}^{n-1} P_i$$

### Channel-to-Channel Skew

To compute channel-to-channel Skew, the processor calculates the delay between the two measurement channels. The time reference for each channel is established by the first signal crossing (starting from the left edge of the screen) which passes through the mesial level (or 50% point in trigger view). The signal excursion must be at least 6 dB.

## 4-3 Automatic Statistical Measurements

Statistical Measurements based on the CCDF Graph are summarized in [Table 4-6](#).


**Table 4-6.** Automatic Statistical Measurements

Field Label	Parameter	Definition
10%	Power at 10% probability	Peak to average power corresponding to 10% probability.
1%	Power at 1% probability	Peak to average power corresponding to 1% probability.
0.1%	Power at 0.1% probability	Peak to average power corresponding to 0.1% probability.
0.01%	Power at 0.01% probability	Peak to average power corresponding to 0.01% probability.
0.001%	Power at 0.001% probability	Peak to average power corresponding to 0.001% probability.
0.0001%	Power at 0.0001% probability	Peak to average power corresponding to 0.0001% probability.
Pct at 0 dB	Probability (percent) at 0 dB	Probability corresponding to 0 dB on the CCDF Graph.
Cursor Pct	Cursor Probability (percent)	Probability at the Cursor Position on the CCDF Graph.
Cursor Pwr	Cursor Power	Peak to average power at the Cursor position on the CCDF Graph.
Average	Average	The unweighted average of all power samples occurring since acquisition started.
Max	Maximum	The highest power sample occurring since acquisition was started.
Min	Minimum	The lowest power sample occurring since acquisition was started.
Peak/Avg	Peak /Average Ratio	The ratio (in dB) of the Peak Power to the Average Power.
Dynamic Rng	Dynamic Range	The ratio (in dB) of the Peak Power to the Minimum Power.



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