



Agilent N9051A Pulse Measurement Software

Software Version 1.5.0.0

User's Reference

Notices

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Contents

1 Introducing the Agilent N9051A Pulse Measurement Software

2 Menu Features

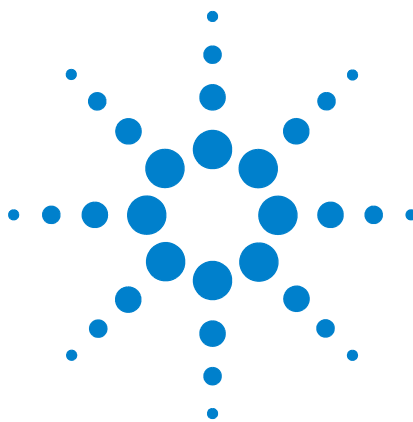
File	8
Save	8
Recall	10
Print	11
Print Setup	11
Preset	11
Disconnect VSA	11
Exit	11
Edit	12
Copy Display (Image)	12
Copy Entire Screen (Image)	12
Copy Analysis Table (Data)	12
Meas Set-up	13
Playback Data from Recording	13
Data From Hardware	13
Set Frequency / Time / Trigger	14
Data Source Group	14
Frequency Parameters Group	15
Time Parameters Group	15
Trigger Group	16
Apply	18
Help	19
OK	19
Cancel	19
Input Range	20
Amplitude Offset	20
Single	21
Continuous	21
Acquire Once	21
Trace	22
Register Operations	22
Display Options	23
Set Scale	25
Auto Scale	25

Markers	26
All Markers Off	26
Delta Markers Off	26
Analysis	27
Select Analysis	27
Configure Analysis Parameters	29
Utility	30
Hardware configuration	30
Calibration	30
Pulse License Status	31
View VSA	31
Set Trace Colors	31
Help	32
Contents	32
About	32
Show Tool Tips	33
Main Toolbar	34
Abort!	34
Run	34
Stop	34
Set Freq/Time/Trigger	34
Register Operations	34
Display Options	34
Select Analysis	34
Set Scale	35
Auto Scale	35
Graphical Trace Displays	36
Display Annotation	37
Control Functions	38
Markers	42
Tabular Results Window	44
Program Status	45

3 Performance Characteristics

4 Appendix

Setting Parameters	50
Relationships	51
Analysis Points	54



1 Introducing the Agilent N9051A Pulse Measurement Software

The Agilent N9051A Pulse Measurement Software provides easy-to-use time-oriented measurements of Pulsed RF or Microwave signals in spectrum analyzers and oscilloscopes. It automatically finds pulse edges in time, and then measures parameters such as rise time, fall time, pulse width, PRI (interval), PRF, duty cycle, peak-to-average ratio and much more. Algorithms determine pulse characteristics according to methods from IEEE standard 181. Parameters are listed in a table for each pulse, up to 1000 pulses.

It also includes time display with zoom, units' conversion, trace math, and markers. Graphs for PDF, CDF, and CCDF are also available.

The vertical axis is calibrated in dBm, Watts, or Volts. Unlike solutions based on diode detectors and oscilloscopes, the amplitude values are trustworthy to within ~1–2 dB.

It is designed to support the Agilent PSA and X-Series Signal Analyzers (to 50 GHz and 140 MHz bandwidth), plus Agilent 8000-, 9000-, 80000-, and 90000-series Infiniium oscilloscopes for even wider bandwidths. This is accomplished by using the Agilent 89600 VSA software for the “front end”. This brings flexibility and supportability for other front end hardware as it becomes available.

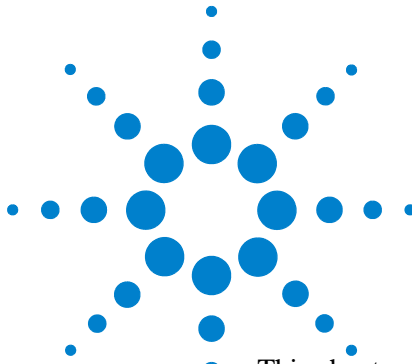
It can be installed inside any X-Series Signal Analyzer and appears in the “MODE” menu where you can access it as needed. Installing the Pulse Measurement Software inside an Infiniium oscilloscope enables you to take advantage of touch-screen capability (if so equipped). In either of these environments, operation of the Pulse Measurement Software is identical to using it in a stand-alone PC.

NOTE

English (United States) is the only Windows regional and language option supported.



1 Introducing the Agilent N9051A Pulse Measurement Software



2 Menu Features

- This chapter provides descriptions and examples of parameter settings for each function available in the Pulse Measurement Software, as well as understanding how to use the graphical trace displays.

The Menu Bar at the top of the application looks like this:

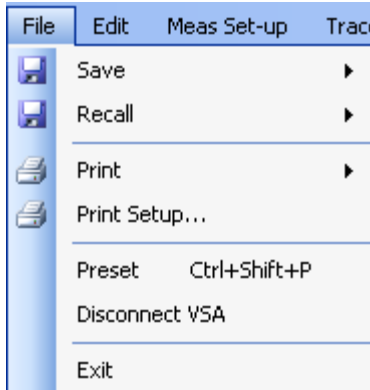
File Edit Meas Set-up Trace Markers Analysis Utility Help

Each pull-down menu is described below.

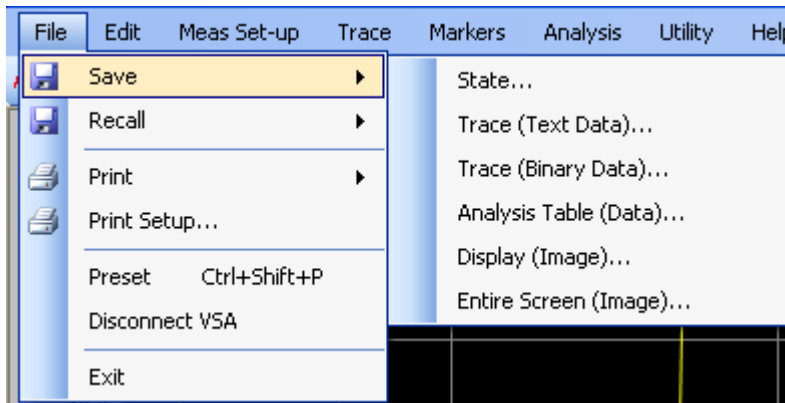


File

Opens the pull-down menu that enables you to handle files, preset the application, disconnect from VSA, or Exit.



Save



State

Enables you to save your measurement setup. Saving a State means you will be saving these parameters of the measurement:

Setup of the RF parameters, such as Center Frequency, Range, Reference level, and time record length.

Selected Analysis, and Analysis parameters.

Trace (Text Data)

Saves the selected trace in a ASCII text comma-separated values (CSV) file. This file can be examined with a text-based editor, and/or easily imported into a spreadsheet program (such as Excel) using the appropriate filter. Data is stored in pairs: a point-number index, and trace value (vertical axis) in volts.

Trace (Binary Data)

Saves the selected trace in a binary file for later recall back into the display. This file format is not supported as a means of importing or exporting data in/out of this software.

Analysis Table (Data)...

Saves the analysis data as a .CSV file for import into a spreadsheet. The data is a 2-dimensional table, where each row represents a distinct pulse, and each column a parameter for that pulse. For details on analysis features, see [“Analysis” on page 27](#).

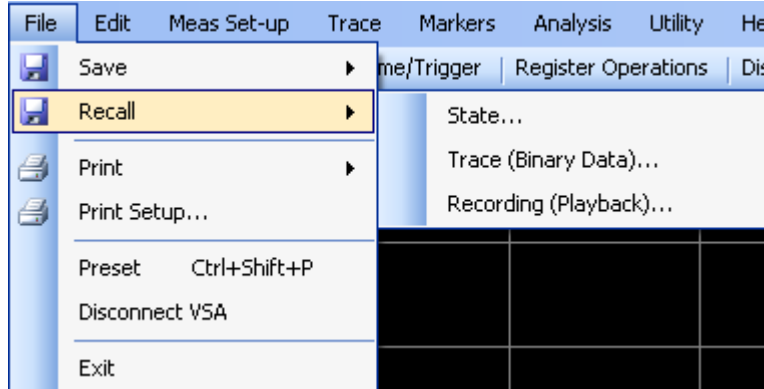
Display (Image)...

Saves the trace display as an image. The image includes the graticule, marginal annotation (e.g. scale factor or time), and all traces that are currently on. Markers also appear; however, their associated numerical values do not. If both displays are on, then select the desired one (make it “active”) by clicking within the graticule area. Several formats are available such as bmp, jpg, gif, and png.

Entire Screen (Image)...

Saves the entire screen (the entire application window) as an image. The formats available are bmp, jpg, gif, tif, and png.

Recall



This selection enables you to recall three file types:

- 1.State
- 2.Trace (Binary Data)...
- 3.Recording (Playback)...

State

Recalls a previously saved state, which allows the user to duplicate a previous measurement setup.

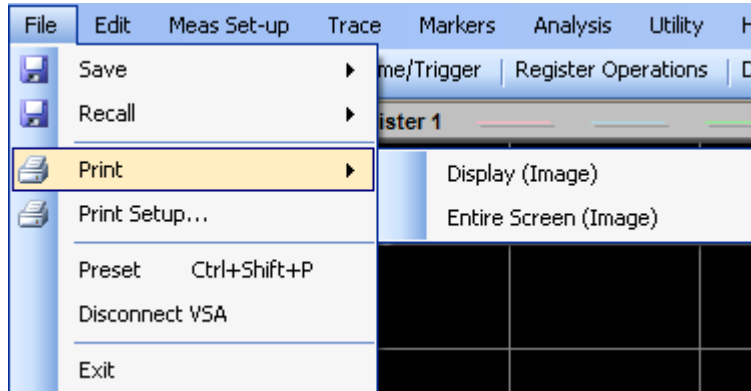
Trace (Binary Data)...

Recalls previous saved trace data back into the display.

Recording (Playback)...

Recalls a VSA “capture” recording. VSA recordings are an alternative to “live” data from hardware, and can be used to demonstrate the features of the software, or to analyze a file that was “captured” by a colleague. You cannot create VSA recordings in the Pulse Measurement Software, but you can play back files that have been recorded with the licensed Agilent 89600 VSA. You can also play back “synthesized” SDF recordings generated with other tools, such as MATLAB. For more information, refer to 89600 VSA documentation (which can be accessed from the Agilent 89600 help directory in the Program Files directory tree) and search for topics “SDF” or “recording”.

Print



Display (Image)

Prints the active trace display as an image.

Entire Screen (Image)

Prints the Entire screen as an image

Print Setup

Brings up the Windows Print Setup dialog, which allows you to select a printer and setup parameters.

Preset

Resets the Pulse Measurement Software to startup configuration.

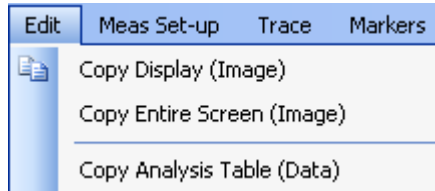
Disconnect VSA

Disconnects the Pulse Measurement Software from the VSA measurement resource. This relinquishes control of the hardware so that another application can access it. If running in an X-Series Analyzer, this allows the user to switch to another mode (such as Spectrum) in the host analyzer without quitting the Pulse Measurement Software. To reconnect, click on the Run toolbar button.

Exit

Exits the Pulse Measurement Software, and shuts down any VSA components in use. Also releases control of measurement hardware. Any data that was not previously saved will be lost.

Edit



Copy Display (Image)

Saves the active trace display to the clipboard, where it can then be pasted into another application.

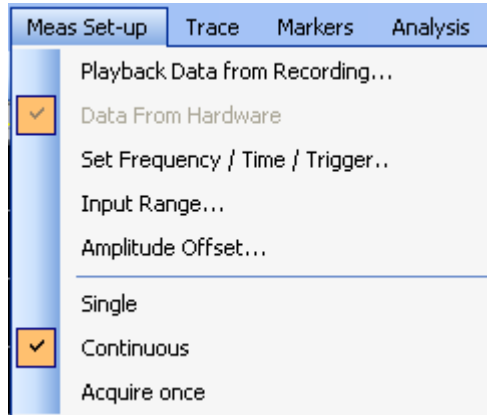
Copy Entire Screen (Image)

Saves the entire screen to the clipboard, where it can then be pasted into another application.

Copy Analysis Table (Data)

Saves the Analysis Table data to the clipboard, where it can then be pasted into another application.

Meas Set-up



Playback Data from Recording

Opens a file selection dialog for selecting a VSA recording file (such as an SDF file). The VSA will now use this recording as input rather than hardware.

Data From Hardware

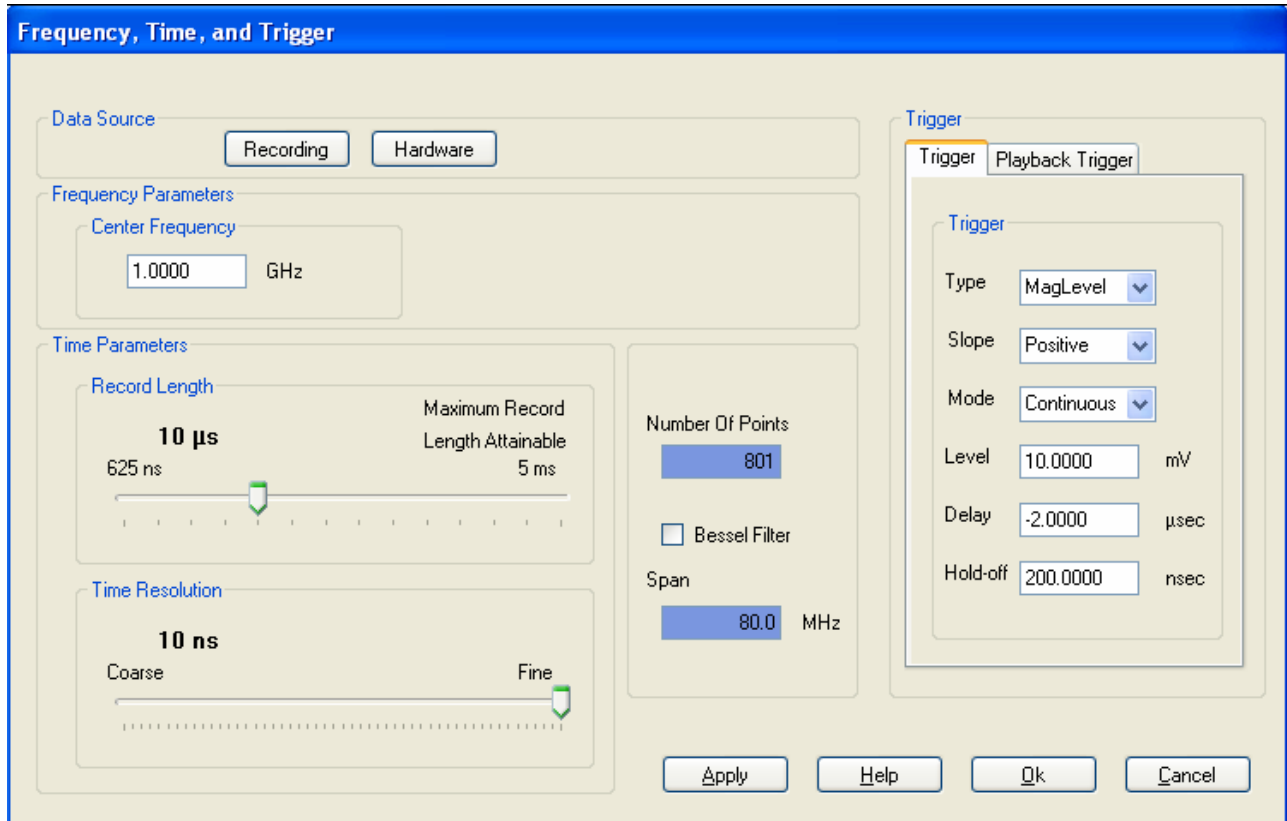
When checked, indicates that data is being taken from the VSA, and not from a recording provided by Pulse software. If you are taking data from a recording, and wish to return to hardware acquisition, check this item.

NOTE

If the Pulse Measurement Software cannot find and control hardware, it may substitute a recording of its own. In this case, the message “Hardware Not Found – Using Simulated Data” will be displayed. If you have measurement hardware to use, but can’t establish a connection to it, refer to “Instrument Control” in the “Troubleshooting” chapter.

Set Frequency / Time / Trigger

Opens the main acquisition setup dialog. This dialog contains selections for Center Frequency, Time display length, and data density (number of points). It also contains controls for trigger setup, both for "live" data as well as recorded data. There is also a convenient section to easily switch between Hardware and recorded data.



Data Source Group

This group is a convenient means to select "Live" or "Recorded" data.

VSA recordings are an alternative to "live" data from hardware, and can be used to demonstrate the features of the software, or to analyze a file that was "captured" by a colleague. You cannot create VSA recordings in the Pulse Measurement Software, but you can play back files that have been recorded with the Agilent 89600 VSA. You can also play back "synthesized" SDF recordings generated with other tools, such as MATLAB. For more information, refer to 89600 VSA documentation (which can be accessed from the Agilent 89600 help directory in the Program Files directory tree) and search for topics "SDF" or "recording".

Frequency Parameters Group

Center Frequency

Sets the center frequency of the Pulse Measurement Software to the desired frequency. When you click on the text box, a small dialog appears in which to enter the digits and multiplier (MHz, for example).

Bessel Filter checkbox

This checkbox is only available when data is being acquired from hardware. When checked, a Bessel "window" filter is applied to the incoming data to reduce ringing effects when the rise time of the pulse approaches the measurement bandwidth of the hardware. Selecting this filter has the apparent effect of reducing the span by a factor of approximately two.

Time Parameters Group

This group is dominated by a set of slider controls which are used to control the time Record Length and the Time Resolution, plus some auxiliary displays.

The Record Length control sets the length of time that is captured and processed. In the default case, this value is approximately the full (un-zoomed) time interval on the trace displays, from left to right edges. The interval begins with a trigger event (unless Trigger Type is Free Run), offset by the Trigger Delay. If you need to see a long time interval, to capture a pulse with a long repetition interval, or to see many consecutive pulses, then increase the value of Record Length.

The Time Resolution control determines the sampling interval, in time, i.e., the time interval between adjacent samples of the waveform. If you need to resolve fast changes in the waveform (e.g. a fast rise time), then move the Time Resolution control toward the "fine" end to increase the number of samples per unit time.

Number of Points is an auxiliary display showing the total number of sample points – approximately the Record Length divided by the Time Resolution. (The user does not have direct control over Number Of Points. Its value is a function of the two sliders.) Increasing the Record Length, or decreasing the Time Resolution interval, will increase the Number of Points. As the Number of Points increases, the overall measurement cycle time will slow down; this is because a large amount of data must be transferred and processed. The maximum Number of Points is ~409,000; if you hit this limit, then you must either (a) reduce the Record Length, in order to make the Time Resolution more fine; or (b) make the Time Resolution more coarse, in order to further increase the Record Length.

Span indicates the frequency bandwidth that is equivalent to the Time Resolution setting. If you are familiar with the "bandwidth" of your signal, this indicator may help you adjust the Time Resolution control. The Span is also the width of the frequency-domain Spectrum display (see "[Display Options](#)" on page 23). For additional details on how these controls function, please refer to "[Setting Parameters](#)" on page 50.

Trigger Group

Trigger settings give you control over the conditions which cause the start of data acquisition. This is useful for “stabilizing” a repetitive waveform, so that successive acquisitions (in Continuous mode) start at the same time relative to the waveform shape. Trigger settings are also important for catching an intermittent or single-shot event.

There are two tabs in the trigger group, one for controlling hardware, and the other for use with recordings. The functions for each are essentially the same. Consult your instrument specifications for a description of instrument trigger capabilities.

Type

The selections available for the trigger type vary depending on the instrument hardware used, and whether using hardware or recording. The default for hardware is Free Run, and for recording is Level.

The Free Run type is especially useful if you are unsure the Pulse software is controlling the hardware, or whether the signal is present and has pulses on it, or what the amplitude excursions of the signal are. By using Free Run, you can at least see the waveform, and start to characterize it.

Slope

Selects rising or falling edge for trigger.

Mode

Sets the state of the measurement acquisition to either Continuous or Single.

NOTE

The triggering conditions must be met before an actual acquisition takes place.

- **Continuous**

Sets the state of the measurement software to be initiated on a continuous (repeated) basis. This setting is the same as the Continuous checkbox under Meas Set-up.

- **Single**

Sets the state of the measurement software to take a single measurement acquisition at a time. This setting is the same as the Single checkbox under Meas Set-up. If in single mode, selecting Acquire Once from the drop-down Meas Set-up menu or selecting Run from the Main Toolbar initiates only a single cycle of acquisition and analysis. Then the system waits for the next instruction.

Level

Sets the threshold level for the trigger.

NOTE The units for Trigger Level are always in Volts, even if the Display Units are set to dBm or Watts.

You may find it useful to briefly examine the waveform in Volts (see [“Display Options” on page 23](#)), with Trigger Type as **Free Run**, to help you set the right Trigger Level.

Delay

Sets the delay from the time the trigger condition is met until the acquisition record starts.

NOTE This value can be negative for "pre-trigger" viewing, so that a short interval of time before the Trigger Level is crossed may be seen.

Hold-off

Sets the time interval required from the time of a trigger until the trigger is re-armed. This may help “stabilize” a waveform that contains a burst or train of pulses.

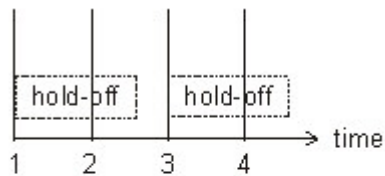
NOTE For Infiniium Series oscilloscopes, the threshold off value needs to be non-zero. Refer to the oscilloscope documentation.

For Input = Hardware

Trigger Hold-off is the "Conventional" definition and specifies the length of time after a trigger before the next trigger can occur. This allows you to configure the analyzer to ignore trigger signals for a specified period of time. The first trigger signal initiates a hold-off; the next trigger signal after the hold-off starts the measurement and a new hold-off. This feature is often used in conjunction with IF Mag trigger to trigger a measurement at the start of a pulse or burst. To insure no false triggers, set the hold-off longer than the pulse to be measured.

In this illustration, the first trigger starts the trigger hold-off. The second trigger is ignored as it occurs during the hold-off. The third trigger starts the next measurement (and a new hold-off).

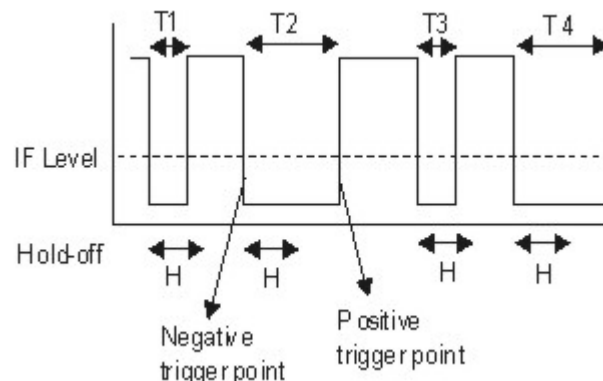
2 Menu Features



1. first trigger -- starts hold-off
2. second trigger -- ignored
3. third trigger -- measurement start
4. fourth trigger -- ignored

For Input = Recording

Trigger Hold-off is the "Below Level" definition. Trigger Hold-off specifies an amount of time that the analyzer's input signal must be a stable low value (below the trigger level) before the next trigger can occur.



- Time T1 is less than the hold-off time (H). The analyzer does not recognize the signal as being low and there is no trigger.
- Time T2 is longer than the hold-off time (H). After the hold-off time, the analyzer triggers at the negative trigger point for a negative slope and the positive trigger point for a positive slope.
- When the trigger input signal goes low again, the hold-off starts. Time T3 is less than the hold-off time (H). The analyzer does not recognize the signal as being low and there is no trigger.
- Time T4 is longer than hold-off time (H), so the analyzer will trigger on the next negative or positive trigger point depending on the specified slope.

Apply

Applies changes made in this dialog without closing the dialog. This is useful for "tuning" parameters such as triggering.

Help

Opens a reference dialog for topics involved with this dialog.

OK

Applies changes and closes the dialog.

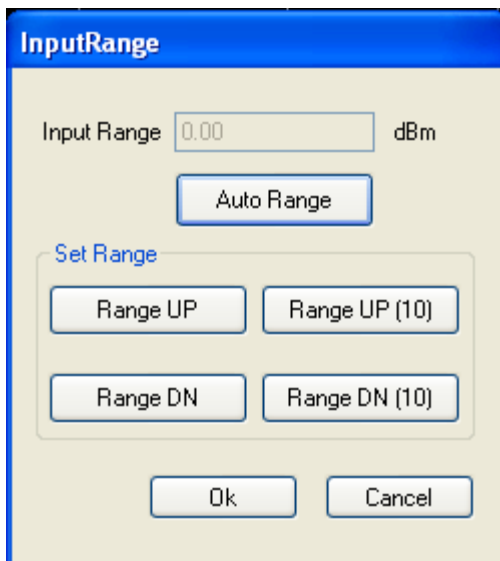
Cancel

Closes the dialog without making changes.

NOTE	Some parameter changes are made in "real time" and therefore are not cancelled when you click, "Cancel".
-------------	--

Input Range

Opens a dialog for setting the input amplitude range of the instrument hardware. This adjusts the attenuation and/or gain of the signal path leading to the ADC. (This should NOT be confused with display full scale.)



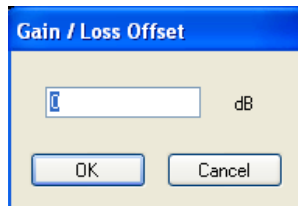
The range of the VSA must be set properly to avoid overloading the mixers and/or ADC in the signal measurement path, while maximizing the dynamic range of the measurement. It affects both the sensitivity of the analyzer as well as the maximum signal without overload.

The range is adjusted by selecting **Range UP** or **Range DN**. It can be adjusted in approximately 1 dB or 10 dB steps. For convenience, there is also an **Auto Range** function, which automatically sets the range to the optimum value. Set the range so that the overload indicator is off.

NOTE A repeatable, triggered signal must be present to ensure proper function of **Auto Range**.

Amplitude Offset

Opens a dialog for setting an amplitude offset. This is useful for compensating for cable losses, attenuators, or even amplifiers so that the display reads the actual signal level at the desired test point. Entering a positive value will increase the displayed result (for example: compensate for a loss). Entering a negative value will decrease the displayed result (for example: compensate for external gain).



Single

Stops continuous measurement acquisition. If in single mode, selecting **Acquire Once** in the Meas Set-up drop-down menu or selecting **Run** from the “[Main Toolbar](#)” on page 34 initiates a single cycle of acquisition and analysis. The system waits for further instruction. Note that the triggering conditions must be met before an actual acquisition takes place. These conditions are either that the trigger is set “on” or you are not in “free run”.

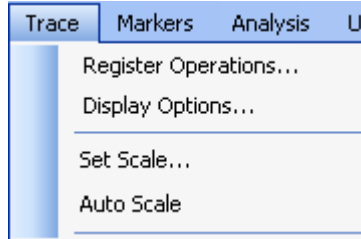
Continuous

Causes measurements to be initiated on a continuous (repeated) basis. Note that the triggering conditions must be met before an actual acquisition takes place! These conditions are either that the trigger is set “on” or you are not in “free run”.

Acquire Once

Causes a single acquisition cycle to be initiated, after which the acquisition stops. Normally used while in Single mode. If in Continuous mode, clicking Acquire Once puts the software into Single mode. Note that the triggering conditions must be met before an actual acquisition takes place!

Trace



Register Operations

Register Operations define the source of the data in a register. There are 6 “registers” in the Pulse Measurement Software to permit trace-based storage and manipulation. The registers and Pulse architecture are described in the Appendix. Register 1 is always used for “raw” data – meaning the latest fresh data acquired, with no processing, whether from measurement hardware or from playback of files (see [“Playback Data from Recording” on page 13](#)). Registers 2 through 6 can be used for a variety of trace functions:

- Max Hold – stores the maximum value for each time-point (horizontally) across successive acquisitions.
- Min Hold – stores the minimum value for each time-point (horizontally) across successive acquisitions.
- Average – stores the running average across successive acquisitions; you can set the average factor.
- Add -- stores the result of adding two selected registers together.
- Subtracts – stores the result of subtracting two selected registers from each other.
- Snapshot from Op1 – stores the current instant value. To repeat snapshot, return to register operations.

Most operations require you to select the source of the operands. Any operations that are continuously cumulative also have a “reset”.

Registers are “off” (empty or null) until one of the above operations is selected. However, the register must also be displayed for it to be visible; see [“Display Options” on page 23](#).

Register	Off	Input Data	Max Hold	Min Hold	Average	Add	Subtract	Snapshot From Op1	Clear	1st Operand Register	2nd Operand Register	Number of Averages
1	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			
2	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Clear 2	1		
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Clear 3	1		
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Clear 4	1		16
5	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
6	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				

The figure above shows Register 2 set to capture the maximum values from Register 1. The Max Hold radio button has been selected. In addition, the 1st Operand Register has been set to 1 to indicate that Register 1 is the source for the Max Hold operation. Register 2 can be cleared by clicking the Clear 2 button. This will reset the system so that a new set of readings are used to calculate the data (Max Hold in this case).

Note that Min Hold, Average, and Snapshot From Op1 behave in a similar manner to Max Hold in that an operation is performed on data from the register listed in 1st Operand Register. Selecting Average makes a drop down box in the Number of Averages column visible.

Functions Add and Subtract take two operands (1st Operand Register and 2nd Operand Register) which refer to the register numbers used for the operation. Although not shown in the figure, Register 4 could be set to the sum (Add) of Registers 3 and 4 by setting the Add button in row 5 along with setting the 1st Operand Register to 3 and the 2nd Operand Register to 4.

Trace math operations are performed with every measurement update.

Display Options

The display is controlled with the **Display Dialog**. There are two windows available in the **Graph Area**; an upper window and a lower window. The upper window is always visible. The lower window is turned on if any **lower window** display items are selected.

The Display Options menu is used to control:

- the registers (or other data source) that are visible, and in which display. (See [“Register Operations”](#) on page 22.)
- which of the two available displays (Upper, Lower, or both) are enabled.
- the units for the vertical axis.

By default, only Register 1 is selected in the Upper display (and Lower display is off). Register 1 can not be turned off, or removed from the upper display.

To use Registers 2 through 6, you must first define the Operation in the Register Operation menu that loads the register, and then also define where to view it in Display Options. A maximum of 3 registers can be selected for either display. If you try to turn on a fourth register, it will be ignored.

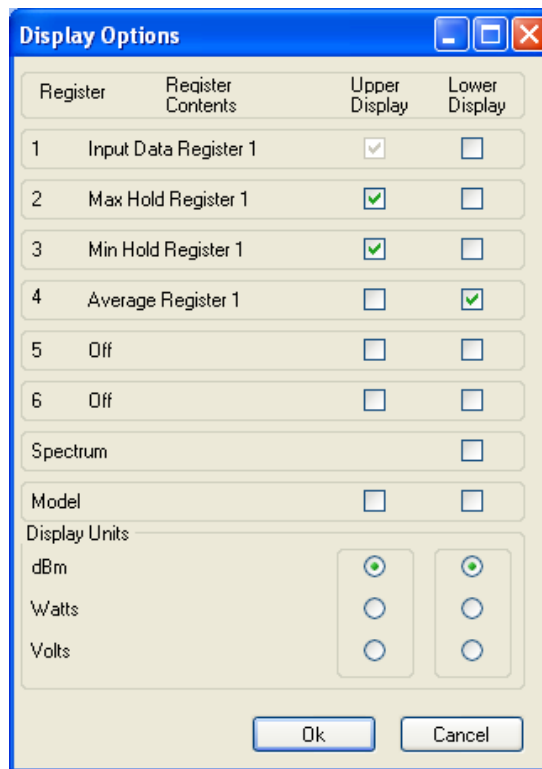
NOTE

You can perform Register Operations “in the background” (not continuously displayed), and display the register only when you want to.

In addition to Registers 1 through 6, there are two other sources of data to display:

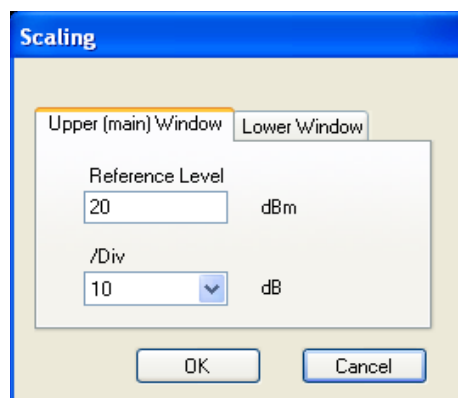
- Spectrum is the power spectrum calculated from the measured data. It can only be displayed in Lower Display, and then converts the display’s horizontal axis to be in units of frequency (instead of time). The frequency span of the spectrum’s horizontal axis is determined by the “span” calculated from the Time settings in the Frequency, Time, & Trigger dialogue (under Meas Set-Up), and can not be adjusted independently. The data source for Spectrum is always Register 1 (Input Data). Mixing spectrum with time-based traces or registers in the same display is not available.
- Model is the straight-line “ideal” pulse that best fits the measured data. The general pulse shape is trapezoidal: horizontal “base” (across the noise floor), sloped sides (rise & fall), and a flat or sloping top. The data source is the register selected for analysis in the Analysis Selection Dialog. For details on analysis algorithms, please refer to the Appendix [“Pulse Measurement Software Approach”](#) on page 51.

Display Units perform amplitude conversion, changing the meaning and scale of the vertical axis. The fundamental measurement units are volts. Watts are calculated based on $V^2/(R)$, where R assumes a 50-Ohm impedance. dBm are calculated based on $10 \log P$, where P is power relative to one milli-watt. Aside from choosing units that are familiar or convenient to you, remember also that linear displays (volts or watts) show detail in large signals (pulse-on period), while logarithmic displays (dBm) will “expand” low signals (pulse-off or noise).



Set Scale

Opens a dialog for setting the scaling in the trace display windows. The units seen in this dialog match the units selected under Display Options dialog. The “Reference Level” refers to the top graticule line in the display, as is customary in a spectrum analyzer.



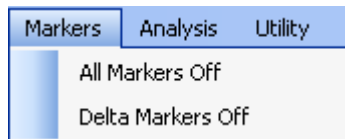
Auto Scale

Auto scales the trace(s) when clicked.

Markers

IMPORTANT The majority of marker functions are controlled via the mouse, using the marker window and displays. See [“Markers” on page 42](#) Only a small number of related functions are located here under Markers in the main menu.

For a more detailed description of Markers, see [“Markers” on page 42](#).



All Markers Off

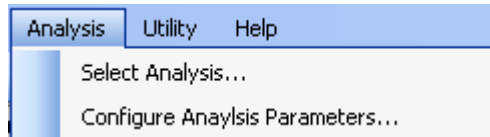
Turns all markers off.

Delta Markers Off

Turns delta markers off.

Analysis

“Analysis” refers to the algorithms in the Pulse Measurement Software to automatically find RF pulses, locate features along each pulse cycle, and characterize those features.



Select Analysis

The Pulse Measurement Software automatically find pulses in the waveform, locate features in those pulses, and then characterize the features. This dialog allows the user to:

- Select the source of the waveform to analyze; you may analyze any of the six data registers (default is register 1, which is the current data from the VSA);
- Turn on or off the individual analysis features (these are grouped into amplitude- and time-related parameters);
- Enable graphical summaries of power statistics: PDF (Power Distribution Function); CDF (Cumulative Distribution Function); CCDF (Complementary CDF).

The results are generally displayed in the bottom section of the application display, under one of the tabs. Click on the appropriate tab to display the results.

Analysis Selection

Analysis Source

Register 1 Register 4
 Register 2 Register 5
 Register 3 Register 6

Amplitude

Max Average Overshoot Top
 Min Peak/Average Ripple Base
 Max/Min Droop

Time

Rise Duty Cycle OFF Time
 Fall PRF Edges
 Width PRI

Aux Functions

PDF CDF / CCDF

Select All Select None OK Cancel

Most of the measurement results are evident from their names. A few that deserve extra comments:

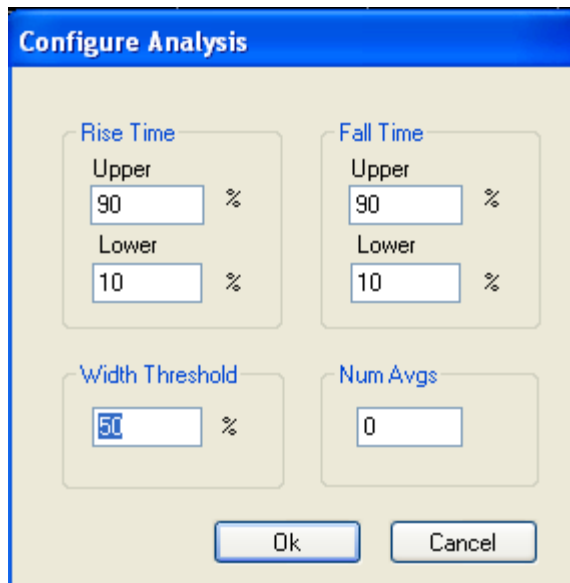
- “Top” refers to the statistically most prevalent amplitude level (straight line) when the pulses are “on”.
- “Base” is the statistically most prevalent amplitude level when the pulses are “off”.
- “Edges” displays the instant in *absolute* time when an edge occurs. For contrast: “Rise” and “Fall” describe the duration of transition from off state to on state.

For details on analysis algorithms, please refer to the [“Pulse Measurement Software Approach”](#) on page 51.

Configure Analysis Parameters

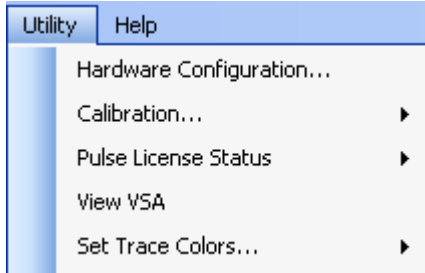
Opens a dialog for selecting and modifying parameters used for calculating measurement values (such as amplitude percentages used for calculating rise and fall times, or width thresholds).

NOTE The resulting level threshold calculations are based in linear volts, even if the display is currently in dBm or Watts.



The image shows a dialog box titled "Configure Analysis" with a blue header. It contains four input fields arranged in a 2x2 grid. The top-left field is labeled "Rise Time" and has two sub-fields: "Upper" with a value of 90 and a percent sign, and "Lower" with a value of 10 and a percent sign. The top-right field is labeled "Fall Time" and also has two sub-fields: "Upper" with a value of 90 and a percent sign, and "Lower" with a value of 10 and a percent sign. The bottom-left field is labeled "Width Threshold" with a value of 50 and a percent sign. The bottom-right field is labeled "Num Avgs" with a value of 0. At the bottom of the dialog are two buttons: "Ok" and "Cancel".

Utility



Hardware configuration

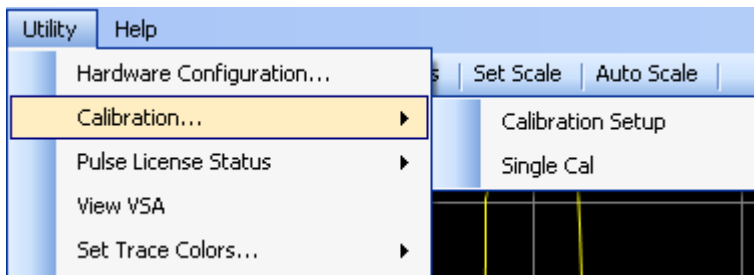
Opens a dialog for selecting the instrument hardware that the Pulse software will use (through the VSA’s control). For most users, there are a few situations where this dialog can help establish a connection to an instrument. (First, ensure there is a valid hardware connection using “Agilent Connection Expert”.)

If you see the error message “Hardware not found, using simulated data”... this means the system is playing back a file instead of using hardware. Try un-checking the “Simulate Hardware” checkbox within the Hardware Configuration dialog. Check that the “ADC1” table lists the instrument you want to use, and it has a check mark against it. If this table lists multiple instruments, un-check any other instruments from the list. Then click “OK” and wait a moment for the software to initialize the hardware.

If this step fails, please see the “Troubleshooting” chapter for “Instrument Control” problems.

Other features in this dialog are intended for advanced users. Please see the Agilent 89601 VSA documentation for detailed information on hardware configuration.

Calibration



Calibration Setup

Opens the VSA Calibration dialog. Please see the 89601 documentation for information on VSA calibration.

Single Cal

Performs an immediate calibration of the VSA input system.

Pulse License Status

Opens the Pulse license dialog.

View VSA

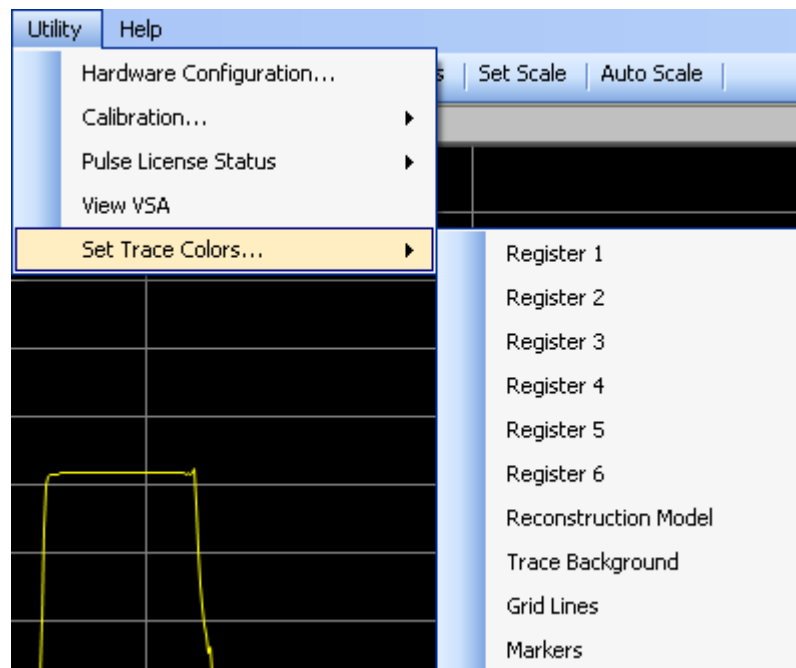
Opens the VSA display window so that the user can see the 89601 VSA software "behind the scenes". This selection is only available if the user has a valid paid-for license to operate the full Agilent 89601 VSA software, which is distinct from the license to operate Agilent N9051A Pulse Measurement Software.

CAUTION

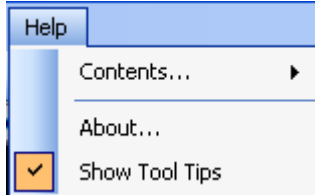
Use this feature *ONLY* for the purpose of *observing* measurements in the VSA. Do not *change* any measurement settings in VSA. Changing settings in the VSA while the Pulse Measurement Software is running can disrupt the program and cause the Pulse Measurement Software to *be terminated!* Use this feature with *extreme* caution!

Set Trace Colors

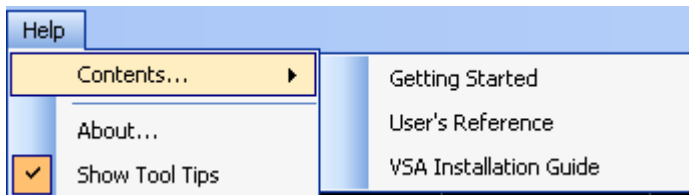
Use this menu to set custom colors for the traces and other graphical features. Each selection will bring up the Windows color selection dialog.



Help



Contents



Opens the appropriate Help file with a PDF viewer.

The *Getting Started Guide* includes:

- procedures for installation, including system configuration and establishing hardware control
- licensing, including redemption of Certificates of Entitlement
- a measurement section to quickly familiarize first-time users with the operation of Pulse Measurement Software.
-

The *User's Reference* contains detailed information on each feature and display in the Pulse Measurement Software. Other sections include:

- error messages and troubleshooting
- an appendix of reference information

The VSA Installation Guide provides detailed information on how the Agilent 89601 is used to establish a connection to the instrument to be controlled.

About

About lists the version number, date created, copyright information, and other pertinent information describing the software.

Show Tool Tips

When checked (default), hovering the mouse over selected areas of the screen shows a short description of that feature. Un-checking this item disables Tool Tips.

Main Toolbar



The toolbar is directly below the main menu. The row of buttons provides the Run/Stop controls, plus a number of convenient one-click buttons to access some of the more commonly-used dialogs and functions.

Abort!

Performs an immediate measurement abort to the VSA to stop an acquisition in progress.

Run

Starts the measurement cycle.

NOTE

The trigger conditions must be met for an acquisition to occur.

This button will also re-connect the VSA session if it had been previously disconnected.

Stop

Stops the measurement cycle.

Set Freq/Time/Trigger

This button is a quick way to open the main acquisition setup dialog described in [“Set Frequency / Time / Trigger” on page 14](#).

Register Operations

This button is a quick way to open the register operations dialog described in [“Register Operations” on page 22](#).

Display Options

This button is a quick way to open the display options dialog described in [“Display Options” on page 23](#).

Select Analysis

This button is a quick way to open the display options dialog described in [“Select Analysis” on page 27](#).

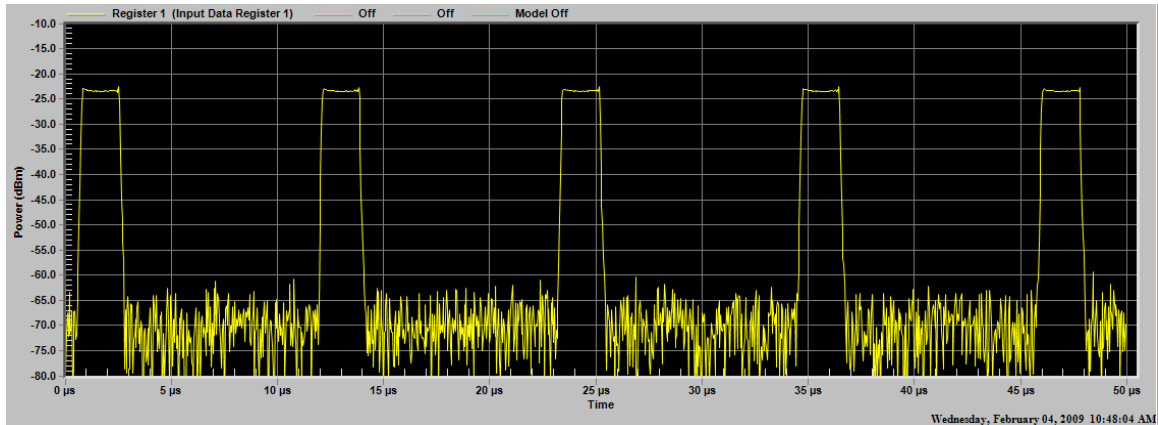
Set Scale

This button is a quick way to open the set scale dialog. See [“Set Scale” on page 25](#) for more information.

Auto Scale

Auto scales the trace(s) when clicked. See [“Auto Scale” on page 25](#) for details.

Graphical Trace Displays



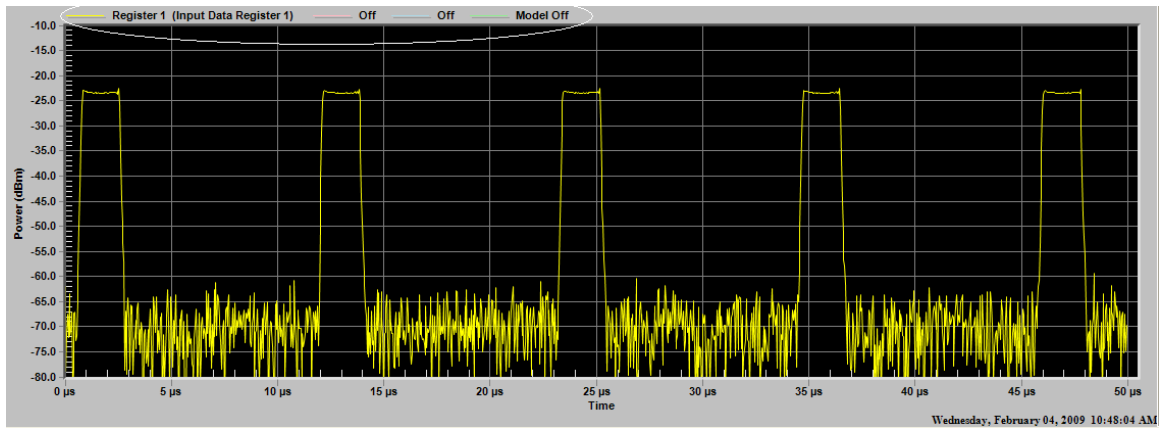
Trace displays are X-Y Cartesian graphs, normally used to plot the input signal versus time. Only one display is shown by default; however, you can enable a second display with the Display Options menu. The horizontal axis is time by default; however, a spectrum display is available via the Display Options menu.

The display(s) are resizable simply by “grabbing” the separator bar(s) between above/below them with the mouse and moving them.

Be aware that the display resolution of the trace is limited by the resolution of physical display device itself. The number of measurement points (up to 409,000) can be much greater than the number of display pixels (perhaps 2000). Therefore, the software can not always display all the information and detail that is captured and measured. Be assured that the “analysis” functions of the Pulse Measurement software use the full-resolution of the data acquired; the software will find, count, and measure pulses even if they cannot be seen. If you need to verify graphically that a pulse is present, use the “zoom” feature (“drag” a box with the mouse) to take a closer look with greater time resolution.

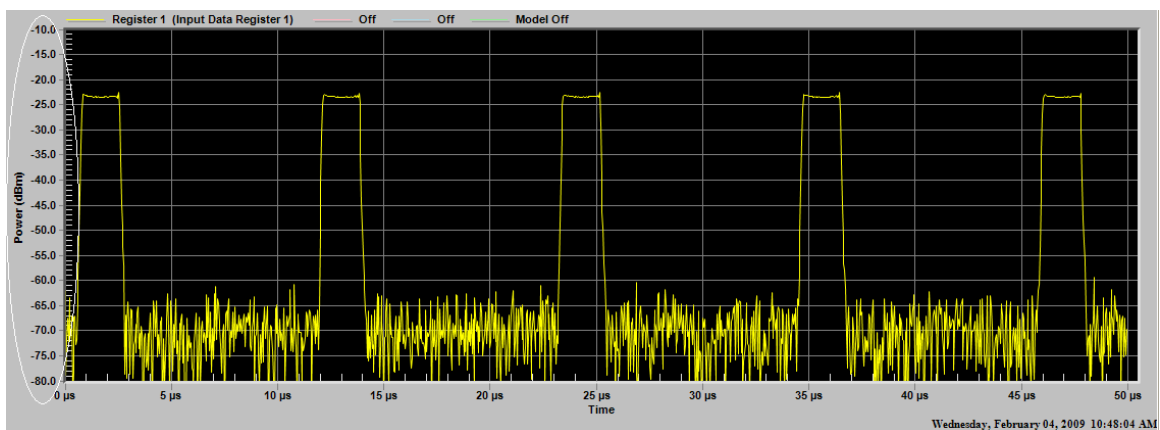
Display Annotation

Graph Title and trace color



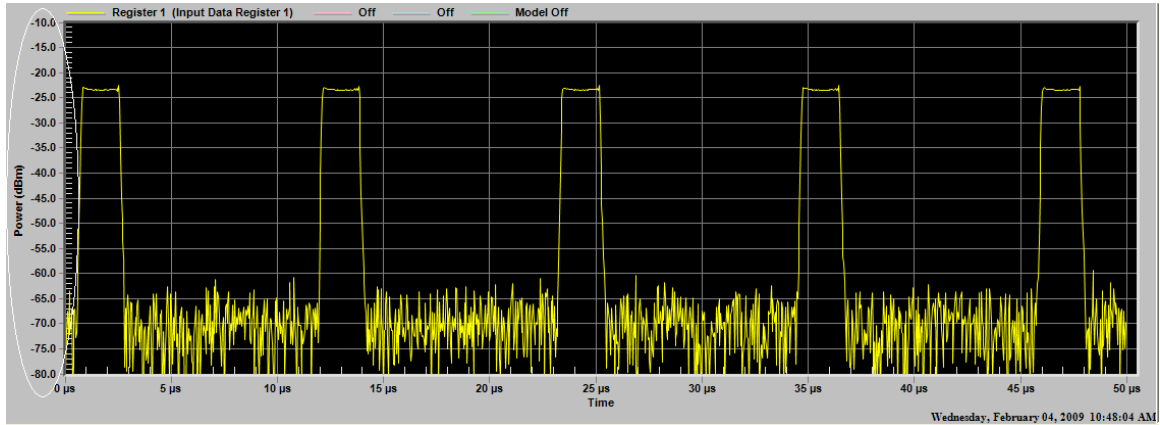
Shows the trace definition and color.

Vertical (Y) axis scale



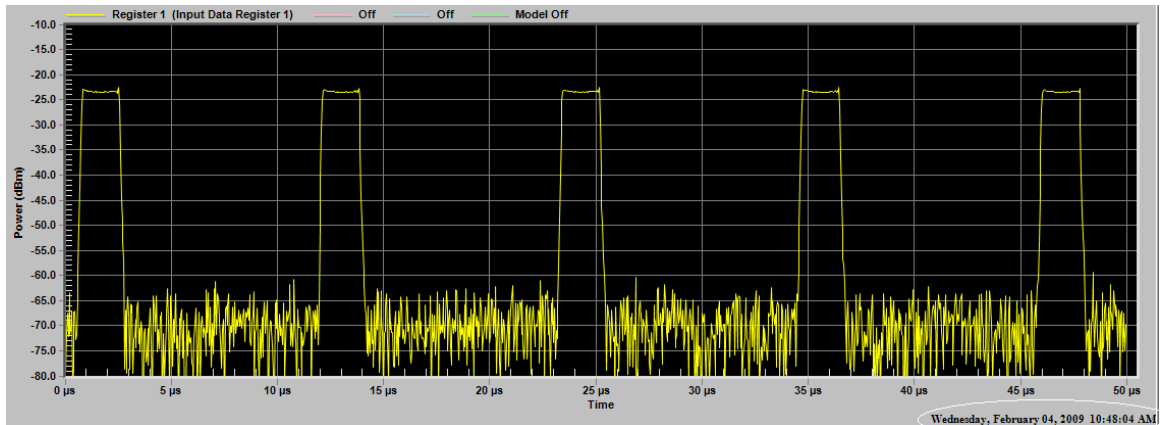
Shows the vertical scaling and units.

Horizontal (X) axis scale



Shows the horizontal scaling and units (time or frequency).

Clock display



Displays the current system time.

Control Functions

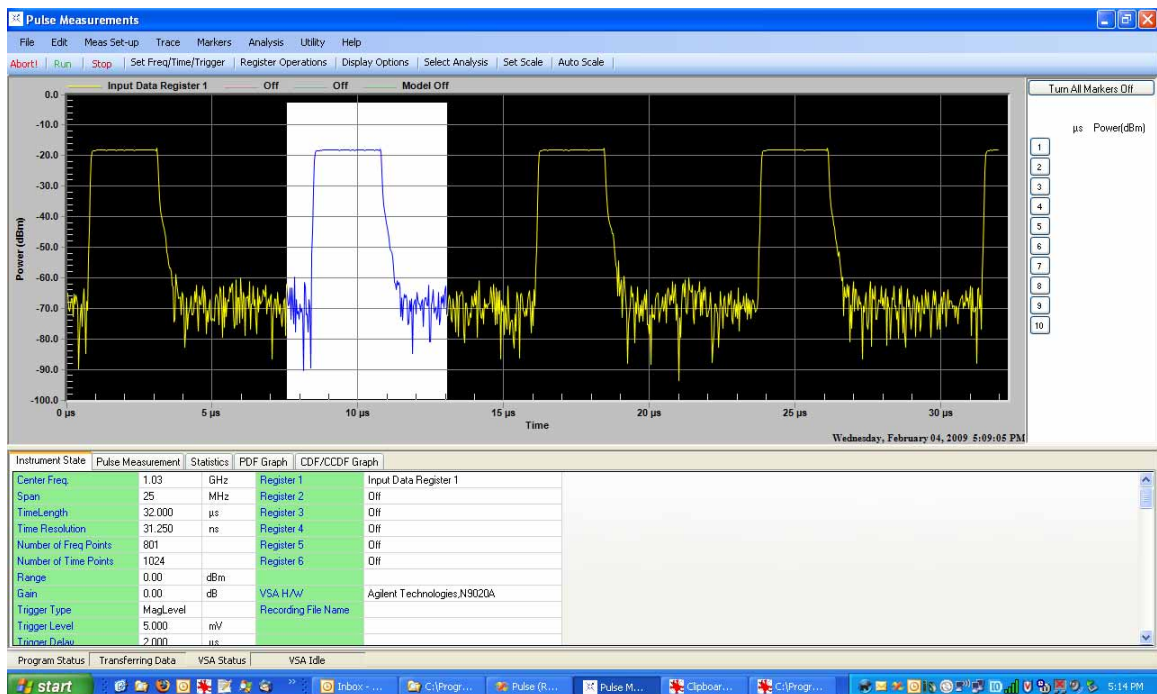
There are several functions that can be performed on the trace display by various mouse maneuvers. The left mouse button is used for selecting items and for zooming. The right mouse button brings up a context menu. The contents of the context menu are dependent upon the mouse cursor location. If the mouse cursor is over a graph window (either upper or lower), then the right mouse context menu contains the following: Set Scale, Increase Y Axis 50%, Autoscale, Set Freq/Time/Trigger, Register, Display, Analysis, All Markers Off, and Delta Markers Off. If the mouse cursor is over the data window in bottom pane the only menu item available is Analysis.

Select Active Display (by Single Click)

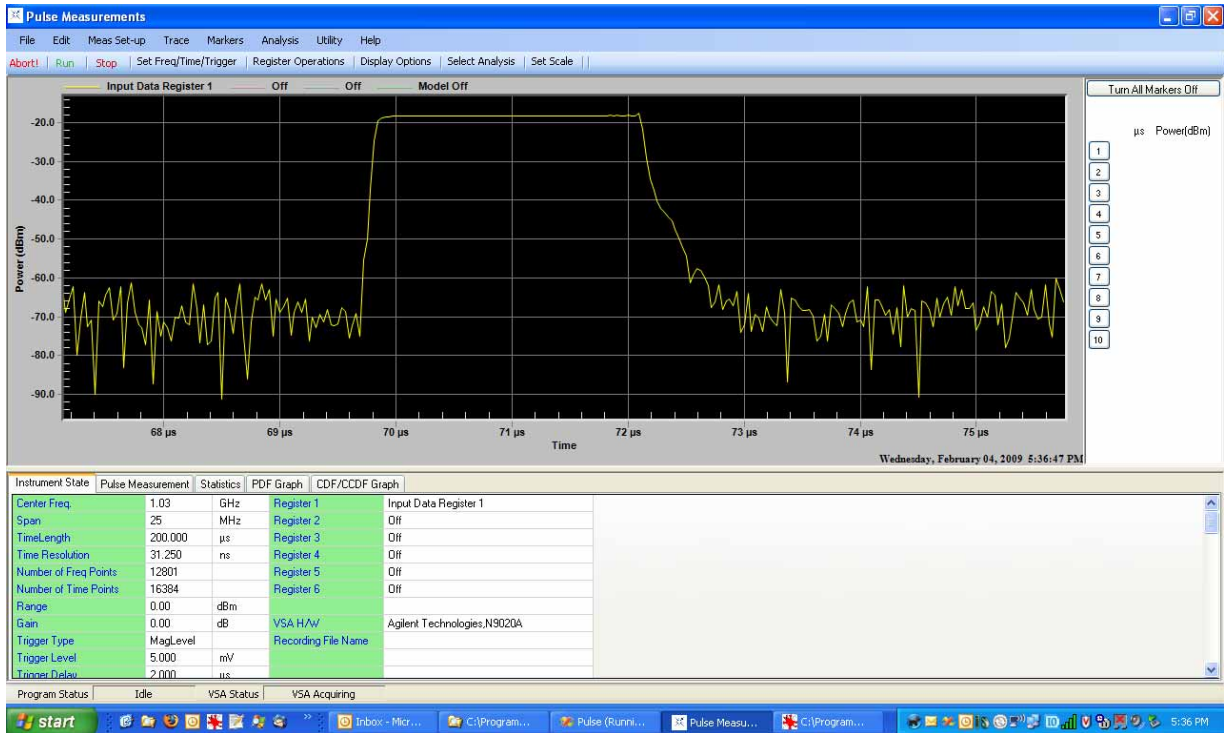
A single click of the mouse will set the specific window as “Active”. This applies when both trace windows are shown and determines which window succeeding commands are directed to. Examples include saving or printing the active window image or data.

Zoom (by Dragging the Mouse)

Dragging the mouse over a desired portion of the trace with the left mouse button pressed executes the “Zoom” function, which expands and scales the selected portion of the trace to fill the entire graph window.

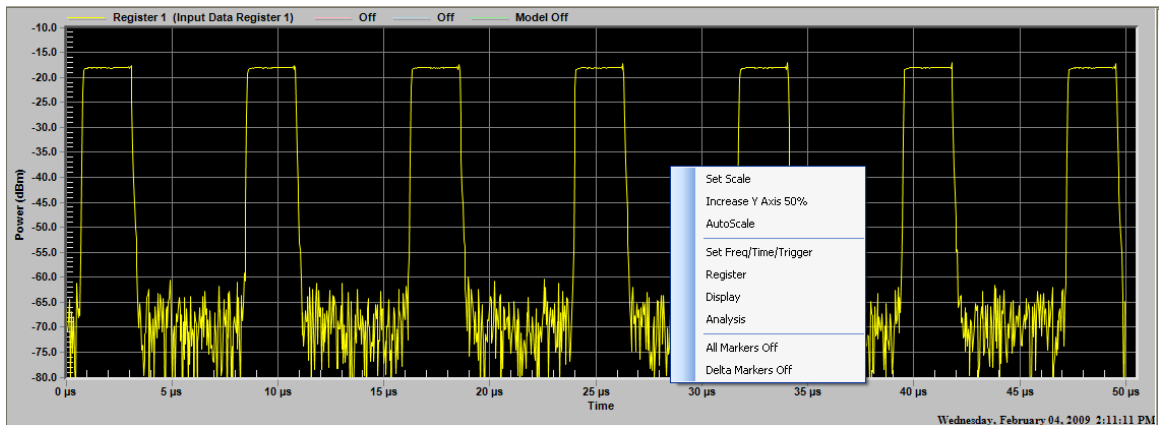


2 Menu Features



Right-click Functions

Right-clicking the mouse brings up a context menu with several useful choices.



Zoom All the Way Out Reduces magnification of the trace, reverting to the original full scale. (You must have already zoomed in to see this option on the menu.)

NOTE This option is only available when you have zoomed in on a signal.

Increase Y-axis 50% Scales the vertical axis by 50%, to allow viewing of data that may have been inadvertently driven off screen or to accommodate changes in the pulse amplitude. Note that the normal Set Scale and Auto Scale functions are not available while in zoomed mode.

Set Frequency / Time / Trigger This context menu item brings up the Main Setup Dialog. See [“Set Frequency / Time / Trigger” on page 14](#) for more information.

Register This context menu item brings up the Register Operations dialog. See [“Register Operations” on page 22](#) for further details.

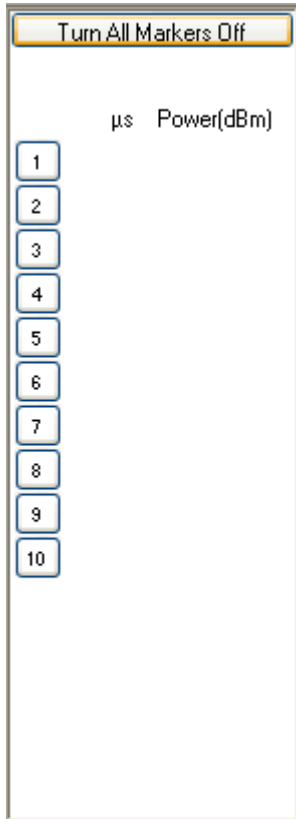
Display This context menu item brings up the Display Operations dialog. See [“Display Options” on page 23](#) for further details.

Analysis This context menu item brings up the Select Analysis dialog. See [“Select Analysis” on page 27](#) for further details.

All Markers Off Turns all the markers in the window off.

Delta Markers Off Turns off the Delta Marker function, but leaves all markers on in “normal” mode.

Markers



The marker window provides a means to select and place markers. It also presents a table of the selected markers and their values.

Marker Selection and Placement

To place a marker, first select the marker you wish to place by clicking on the numbered button. When you move the mouse over to the trace window, a set of cross hairs will appear. Move the mouse to the desired location (actually, only the X axis portion is used). When in the desired location, click the mouse to activate the marker. If you wish to move the marker, or it is not exactly in the desired location, simply repeat this process.

To place a marker more accurately in time (or frequency), it may be useful to temporarily “zoom” in on a portion of the trace, place the marker where you want it, then un-zoom again. (Of course, this assumes that the trace is stable from acquisitions to acquisition (using triggers), or frozen (using Stop).)

When the marker is placed, it is indicated by a white diamond with its number adjacent to it. Also, its values will be shown in the table to the right of the button, and the button will turn a golden color to indicate it is on.

Setting a Delta Marker

Setting a Delta marker is similar to a normal marker. Simply *double*-click the button instead. This will turn on the Delta marker function, and the placed marker will become the reference. The reference button will turn red to indicate that it is the reference, and the other active buttons will turn blue. The values in the marker table for the reference are absolute, and the other values display the difference between that particular maker and the reference.

All Markers Off

A button at the top of the marker window will simultaneously turn off all markers in that window.

Delta Markers Off

If the Delta Markers are on, a second button becomes visible, which when clicked turns off the Delta Marker function and all markers in that window revert to “normal” markers.

Right-Clicking a Marker Button

Right-clicking a marker button will bring up a context menu with the following selections.



Marker Off Turns the selected marker off.

All Markers Off Turns *all* markers off.

Delta Markers Off Turns Delta Marker mode off. All markers revert to “normal” markers.

Viewing Markers on different traces To view the markers on another trace in the window, click on the trace identifier for that trace, located in the upper left corner of the display area. (This also shows the trace color for the desired trace.)

Tabular Results Window

Instrument State	Pulse Measurement	Statistics	PDF Graph	CDF/CCDF Graph	
Center Freq.	1.03165	GHz	Register 1		Input Data Register 1
Span	20.063694...	MHz	Register 2		Off
TimeLength	50.000	μs	Register 3		Off
Time Resolution	38.938	ns	Register 4		Off
Number of Freq Points	3201		Register 5		Off
Number of Time Points	4096		Register 6		Off
Range	0.00	dBm			
Gain	0.00	dB	VSA H/W		Agilent Technologies.N9020A
Trigger Type	MagLevel		Recording File Name		
Trigger Level	10.000	mV			
Trigger Delay	2.000	μs			
Trigger Holdoff	200.000	ns			

The Tabular Results window is the main source for analysis results. There are several tabs, each with specific information.

Instrument State Tab

Presents tabular information on the setup of the Pulse Measurement Software. It includes information on RF settings such as center (tune) frequency, input parameters, triggering, and the VSA front end hardware. It also shows display register contents, and if using pre-recorded signals, the name of the recording file.

Pulse Measurement Tab

Presents the selected measurements. Each column represents the selected measurement(s), and each row represents the specific pulse. Note that some fields may be blank because results could not be computed. For example, PRI would not be calculated after the last complete pulse.

Refer to the Appendix, “[Pulse Measurement Software Approach](#)” on page 51 for specific details on the computational algorithms used for Pulse Measurement Software.

Statistics

Presents statistics on the pulse measurements, both for the current acquisition as well as the cumulative total. There is a reset (in red) to reset the cumulative statistics. For more information, see “[Statistics Tab](#)” on page 56.

PDF Graph

Presents a probability density function (PDF) plot of the data.

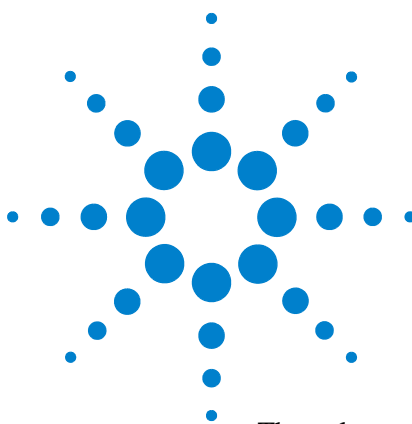
CDF/CCDF Graph

Presents cumulative probability density function (CDF) and complementary cumulative probability density function (CCDF) plots of the data.

Program Status

Shows the current status of the program and of the VSA. There is also a message area for important measurement warnings, such as input overload, and for certain other events. Refer to the “Troubleshooting” section of the *Getting Started Guide* for a complete description of messages, what they mean, and possible actions to be taken.

2 Menu Features



3 Performance Characteristics

The pulse measurement performance of the N9051A is based on the instrument or measuring device used. The table below shows the nominal instrument performance for each device.

Nominal Instrument Performance for Each Device

Instrument Model	Maximum Carrier Frequency	Maximum Bandwidth	Maximum Sample Rate/Second	Minimum instrument rise time	Minimum Detectable Pulse Width
90000 Series Infiniium scope	13 GHz	13 GHz	40 GSa/sec	32 psec	250 psec
E444XA PSA with Option 122 and 123	50 GHz	80 MHz	200 MSa/sec effective	10 nsec	50 ns
E444XA Series PSA	50 GHz	8 MHz	30 MSa/sec	100 nsec	500 ns
N9020A with Option B25*	26.5 GHz	25 MHz	90 MSa/sec	25 nsec	150 ns
N9020A MXA Signal Analyzer*	26.5 GHz	10 MHz	30 MSa/sec	100 nsec	400 ns
N9030A PXA Signal Analyzer	26.5 GHz	10 MHz	100 MSa/sec	100 nsec	400 nsec
N9030A PXA with Option B25	26.5 GHz	25 MHz	100 MSa/sec	25 nsec	150 nsec
N9030A PXA with Option B40	26.5 GHz	40 MHz	200 MSa/sec	17.5 nsec	88 nsec
N9030A PXA with Option B1X	26.5 GHz	140 MHz	400 MSa/sec	5 nsec	25 nsec

* Data also applies to N9010A.

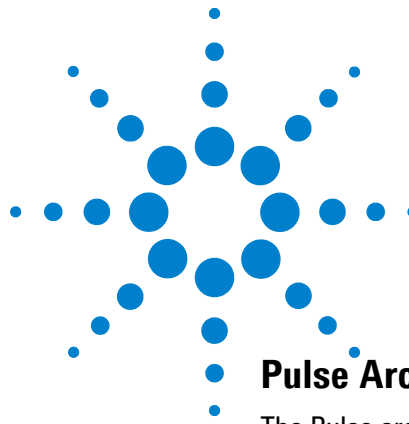
3 Performance Characteristics

Software Characteristics

Maximum number of Traces	6 total
Maximum Markers	10 / Display
Frequency Points	Variable: 51 to 409,601
Record Length [*]	$T = 512,000 / (\text{Span} \times 1.28)$
Types of Triggers (available triggers are instrument dependent)	Level [†] MagLevel External External TTL
Waveform file types	.sdf
Maximum # of pulses	1,000

* The value displayed may not be realized based on certain sample rates.

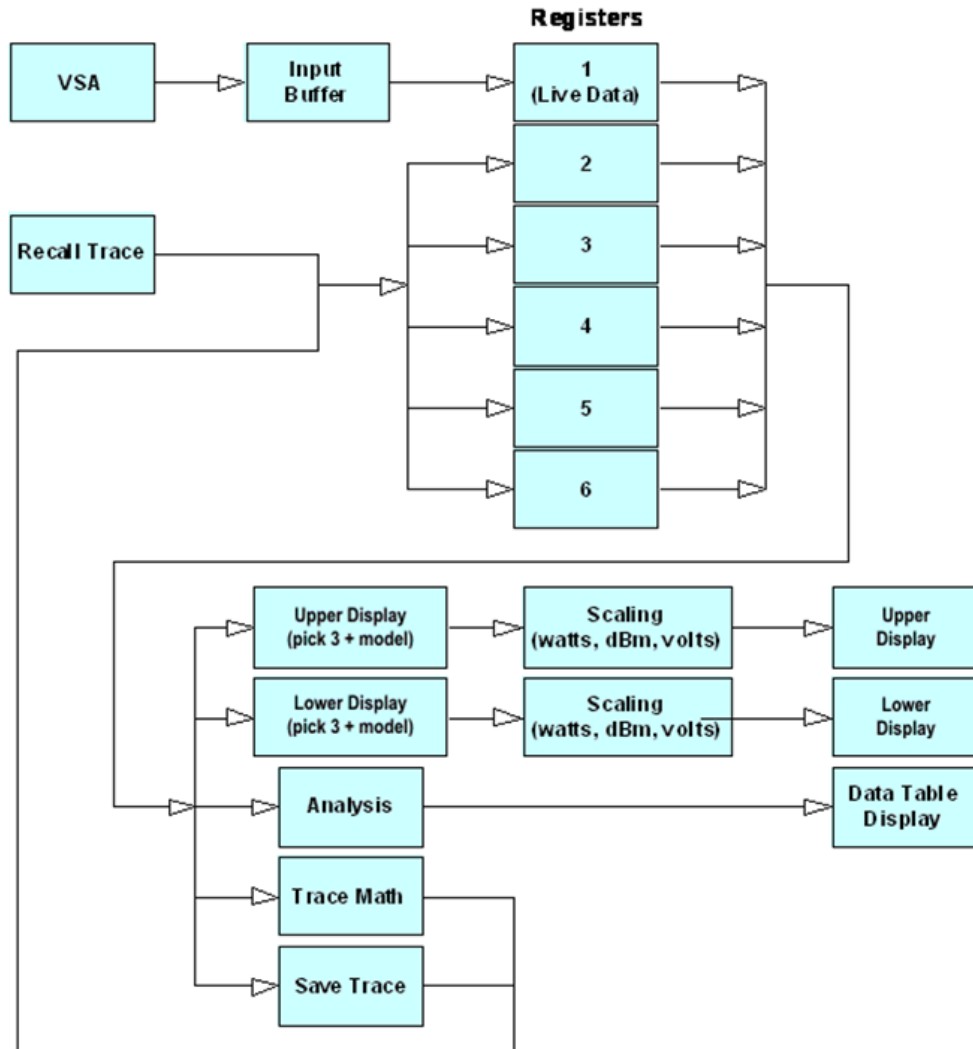
† Level (IF) for the 90000 series oscilloscope – 50% of full scale 0 to 5 GHz (4 Div = full scale)



4 Appendix

Pulse Architecture

The Pulse architecture is shown below. The architecture revolves around a set of registers (numbered 1–6). Data from any of the registers can be directed to the display routines (Window A or B), used for analysis, be a source for trace math, or be saved to disk. Recalled trace data can be placed in registers 2–6.

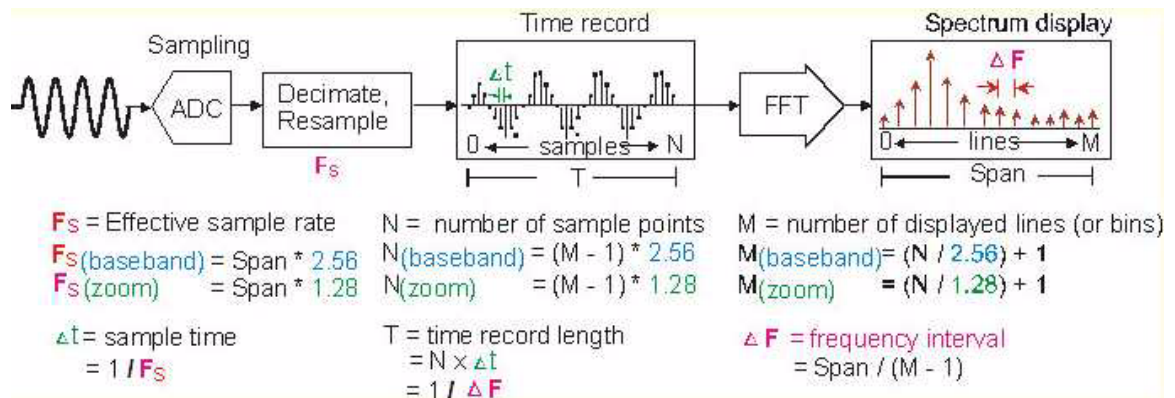


Setting Parameters

Introduction

It is necessary to set several parameters from the Pulse Measurement Software in order to achieve the desired measurement record length and data granularity. These parameters must be set within the limitations of available memory (number of data points) and bandwidth of the measuring instrument.

The following algorithms are based upon VSA documentation taken from the Tasks.chm file (89600) under Theory of Operation, Frequency and Time-Domain Interactions shown below –



Definitions

Based upon the VSA documentation, the following definitions will be used –

CF = center frequency

F_s = effective sample rate

$K = 1.28$

M = number of Frequency Points

N = number of sample points = number of Time Points

S = span (frequency)

T = time record length

t = sampling time (interval)

The factor K is used to add a buffer to measurements. It represents an acknowledgement of real-world phenomena such as finite cutoff regions for low pass filters. This factor has been in common usage in Agilent hardware.

Relationships

$$F_s = K * S = 1 / t$$

$$\text{Therefore, } t = 1 / (K * S)$$

$$N = (M - 1) * K$$

$$T = N * t = N / (K * S)$$

S_{machine} = maximum span that the instrument is capable of

S_{max} (max span) = lesser of 2 * CF or 2 * (S_{machine} – CF)

S_{min} = S_{max} / 10 for spectrum analyzers and 50 MHz for oscilloscopes

Slider Actions

The sliders are defined to reflect a) time resolution, and b) time record length.

Time Resolution Slider

The sampling time (t_{max}) is equal to 1 / (K * Span). [t_{max} = 1 / (1.28 * S_{min}), t_{min} = 1 / (1.28 * S_{max})].

Setting the resolution slider also sets the value of span to $S = 1 / (K * t) = 1 / (1.28 * t)$

Record Length Slider

Record Length (T) is equal to N * t.

The minimum record length (T_{min}) = (M_{min}) / S_{max}.

The maximum record length (T_{max}) = (M_{max}) / S_{max}.

Setting the record length slider also sets the value of number of frequency points (Number of Points listed in the dialog).

Pulse Measurement Software Approach

Introduction

The Pulse Measurement Software makes the following assumptions about the nature of pulses to be measured as listed in Pulse Format and uses the algorithms and analysis approaches listed below. Where possible, the methods used conform to IEEE Std 181 – 1977 “Standard on Transitions, Pulses, and Related Waveforms”. In addition, certain approaches are based on generally accepted procedures for the industry, and/or to maintain consistency with other measuring equipment.

Pulse Format

A typical pulse is assumed to have a format as follows:

The amplitude is initially at some low level representing an off/zero condition (Base).

The amplitude makes the transition to Top during a finite amount of time.

The amplitude remains at Top for a finite amount of time.

The amplitude makes the transition to Base during a finite amount of time.

The amplitude remains at Base level for a finite amount of time before the possible beginning of another pulse.

The following conventions are used –

The Pulse software analyzes a pulse starting from the rising edge from Base to Top. A pulse captured such that Base precedes Top is considered to be separate portions of two pulses.

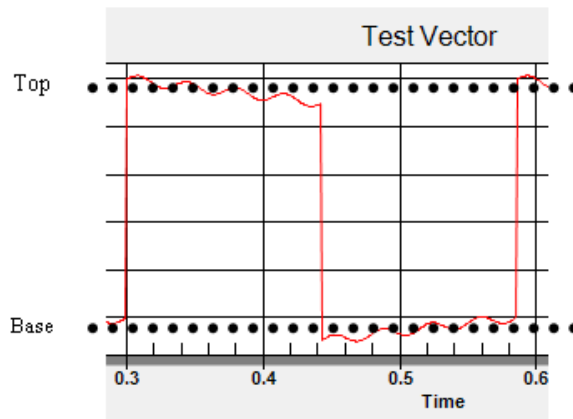
Partial pulses are analyzed to the extent possible, but data from partial pulses are not included in cumulative totals.

The pulse is considered to start once the amplitude exceeds the Rise Time Lower threshold (typically 10% amplitude – see Figure below).

The pulse is considered completed once the next pulse has begun (Rise Time Lower threshold exceeded after Base).

Pulse width is measured at the Width threshold (typically 50% amplitude – see Figure below).

Pulse off time is measured at the Width threshold.



Top and Base

The first analysis operation is the calculation of Top and Base levels (see Figure above). Amplitude samples are collected into a histogram organized frequency-of-occurrence versus magnitude. For pulses, the histogram should be bi-modal, with one “hump” representing the “on” state and the other “hump” representing “off” state. The peaks of each hump – that is, the single most frequent amplitude level for each – becomes the

“top” and “base” respectively. A waveform where these two levels are not well separated, or where the majority of samples are scattered in a wide variety of amplitude values, will fail to yield well-defined “top” and “base” levels.

User-Adjustable Analysis Parameters

The upper and lower threshold values used to calculate pulse parameters are normally 90% and 10% respectively, of the pulse amplitude (see Figure below). The Pulse software allows the user to modify these values to accommodate user preferences and unique circumstances. Rise and Fall time threshold parameters can be adjusted separately.

A parameter defined as Range is computed as the difference between Top and Base.

Top is always greater than Base, so Range is always a positive number.

The following parameters are adjustable under the Analysis/Configure Analysis Parameters menu -

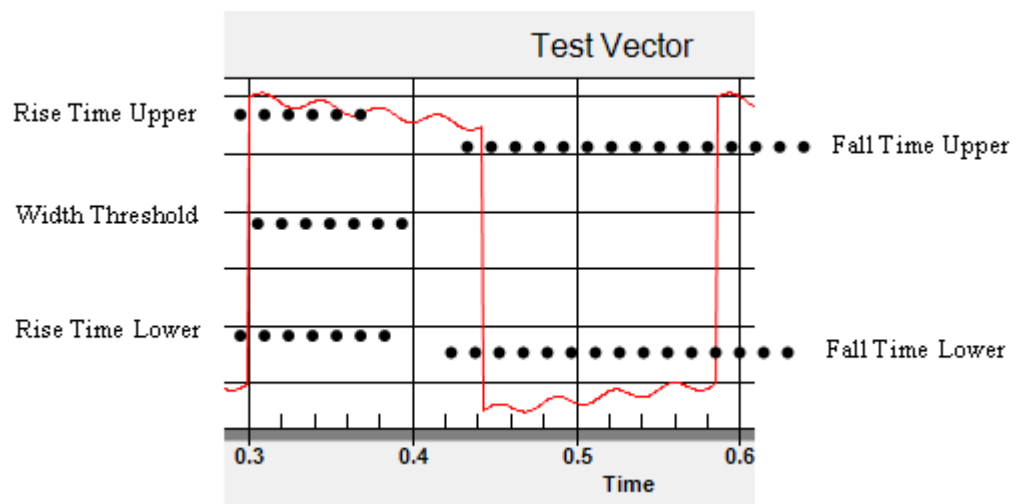
Rise Time Lower – threshold for transition between Base and the rising edge of the pulse. The default value is 10% of Range plus Base.

Rise Time Upper – threshold for transition between rising edge and Top. The default value is 90% of Range plus Base.

Fall Time Upper – threshold for transition between falling edge and Top. The default value is 90% of Range plus Base.

Fall Time Lower – threshold for transition between falling edge and Top. The default value is 10% of Range plus Base.

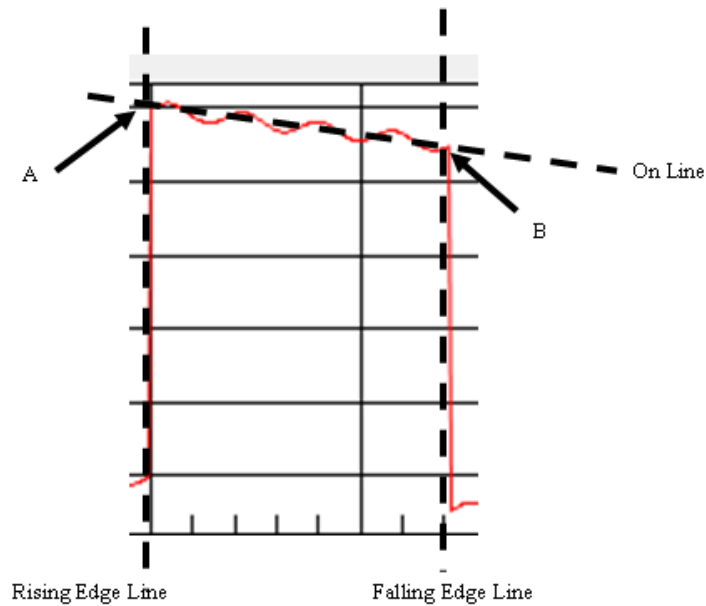
Width Threshold – threshold for pulse mid amplitude. The default value is 50% of Range plus Base.



Analysis Points

Three lines are fit to the pulse data in order to perform the analysis (see Figure below). First, a line is fit between the Rise Time Lower and Rise Time Upper points. Next, a line is fit between the Fall Time Upper and Fall Time Lower points. Linear interpolation is used to arrive at the actual threshold points.

A line (On Line) is fit to the pulse points occurring between the Rise Time Upper and Fall Time Upper thresholds using a least squares approach. Points A and B are the intersections between the three lines (see Figure below).



Analysis Lines

Algorithms

Pulse Measurement Tab

Rising Edge is the instant in absolute time that the pulse exceeds the Rise Time Lower threshold.

Falling Edge is the instant in absolute time that the pulse amplitude drops below the Fall Time Lower threshold.

Max is the maximum amplitude of the pulse.

Min is the minimum amplitude of the pulse.

Max/Min is the ratio of Max to Min.

Avg is the average amplitude during the entire pulse cycle. Remember that a full cycle is the “on-period” plus the “off-period”, ending at the next rising edge.

Peak/Avg is the ratio of peak amplitude to average amplitude.

Droop is the reduction in amplitude from point A to point B. Droop is not calculated unless there are at least ten data points associated with the pulse on portion.

Droop % is the droop computed as above, divided by Range and expressed as a percentage.

Droop/Time is the droop computed in H divided by the pulse On Time in μsec .

Overshoot is the maximum of the absolute value of the difference between pulse amplitude On Line. Overshoot is not calculated unless there are at least ten data points associated with the pulse on portion.

Overshoot % is the overshoot computed in K divided by Range and expressed as a percentage.

Undershoot is the maximum amount that the pulse amplitude is less than Base (undershoot is a positive number of the pulse amplitude being below Base).

Undershoot % is undershoot computed in M divided by Range and expressed as a percentage.

Ripple % is the maximum difference between the waveform and the On Line while in the on position divided by Range and expressed as a percentage.

Top is the level of Top.

Base is the level of Base.

Rise Time is the time between the Rise Time Lower threshold and the Rise Time Upper threshold.

Fall Time is the time between the Fall Time Upper threshold and the Fall Time Lower threshold.

Pulse Width is the time between where the Rising Edge Line crosses the Width Threshold and where the Falling Edge Line crosses the Width Threshold (typically at the 50% level).

Off Time is the time between where the Rising Edge Line of the next pulse crosses the Width Threshold and the Falling Edge Line crosses the Width Threshold (typically at the 50% level).

Duty Cycle is the pulse width computed in T divided by the PRI (see W below).

PRI (Pulse Repetition Interval) is the sum of the Pulse Width and the Off Time.

PRF (Pulse Repetition Frequency) is the inverse of the PRI.

Statistics Tab

The Statistics tab presents data from the current stream of pulses. Each measurement is considered a new group of data. For example, if there are four pulses in a measurement, then the statistical parameters of the four pulses are calculated. The maximum of the four pulses is computed and listed as the maximum.

The parameters are calculated for each parameter. For example, if there are four pulses and the rise time parameter is active, then Max will be the maximum rise time for the four pulses. Similarly, Min is the minimum rise time for the four pulses:

- Max – maximum value for given parameter in pulse stream,
- Min – minimum value for given parameter in pulse stream,
- Mean – average of given parameter for all of the pulses,
- Pulses -- number of pulses included the statistical total; for “Current” this is the latest single acquisition, for “Cumulative” this is the combined pulses for multiple acquisitions.

The statistics are shown in a single tab (*Statistics* tab – see figure below).

Statistics Tab

Instrument State	Pulse Measurement	Statistics	PDF Graph	CDF/CCDF Graph									
			Max	Min	Max	Avg	Peak	Droop	Droop	Droop	Over-	Over-	Ripple
					/Min		/Avg	Mag		/Time	shoot	shoot	
			(dBm)	(dBm)		(dBm)		(μ V)	(%)	(μ V/ μ s)	(mV)	(%)	(%)
Current Record													
	Parameter Minimum	---	-30.69	-96.15	41.1	-42.32	3.8	-165.56	-2.03	-169.64	0.82	10.12	10.26
	Parameter Average	---	-30.36	-76.36	467.6	-42.25	3.9	-20.28	-0.25	-20.80	1.19	14.59	14.89
	Pulses	12											
Cumulative													
	Parameter Maximum	---	-29.60	-48.28	34588.0	-42.03	4.3	371.60	4.47	380.89	1.94	23.57	36.41
	Parameter Minimum	---	-30.87	-121.27	7.6	-42.40	3.7	-495.04	-5.88	-508.51	0.26	3.09	6.71

Statistics are divided into two groups: A) statistics for the current record, and B) statistics gathered since the last reset (or since turning on the analysis functions).

Before any data is captured, the data cells show three dashes ('---') to indicate that there is no data.

The statistics captured are *max*, *min*, and *average*. The only parameters shown are those chosen in the *Select Analysis* dialog. The data listed in the upper half pertain to the current record. The data in the lower half are aggregates across all readings since the last reset.

Average in the cumulative is calculated by taking the sum of all of the readings and dividing by the number of pulses. The number of pulses listed is the number of complete pulses. Any pulse without complete data (e.g. crossing 10% starting threshold or rising to at least 50% for the following pulse to compute PRI is considered incomplete and not included in the calculations).

The Reset button changes the state of all data cells to a null state ('---').