PicoScope 6
PC Oscilloscope Software

User's Guide

psw.en-8

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1 Welcome

Welcome to PicoScope 6, the PC Oscilloscope software from Pico Technology.

With a scope device from Pico Technology, PicoScope 10 turns your PC into a powerful PC Oscilloscope 9 with all the features and performance of a bench-top oscilloscope 8 at a fraction of the cost.

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2 Version 6.0 update

PicoScope 6 is a major new release of PicoScope, Pico Technology's software for PC Oscilloscopes.

- Higher performance
  - Faster capture rates, making it easier to see fast-moving signals
  - Faster data processing
  - Better support for the latest PicoScope USB oscilloscopes including the PicoScope 5000 Series

- Improved usability and appearance
  - Clearer graphics and text
  - Tool tips and help messages to explain all features
  - Easy point-and-click tools for panning and zooming

- New features
  - The latest Windows .NET technology enabling us to deliver updates sooner
  - Custom probes 42 manager to make it easy for you to use your own probes and sensors with PicoScope
  - Multiple views of the same data, with individual zoom and pan settings for each view
  - Advanced triggering conditions 82
  - Properties sheet 25 displaying all settings at a glance
  - Spectrum mode 11 - not just a spectrum view of your scope data, but a fully optimised spectrum analyser

See the Release Notes on our website for the latest information on your version of PicoScope 6.

3 Introduction

PicoScope is a comprehensive software application for Pico Technology PC Oscilloscopes. Used with a scope device from Pico Technology, it creates a virtual oscilloscope, spectrum analyser and multimeter on your PC.

PicoScope 6 supports the following scope devices:

- PicoScope 5000 Series
- PicoScope 3000 Series
- PicoScope 2000 Series
- ADC-212 Series (PicoScope 6 Automotive only)

PicoScope 6 runs on any 32-bit computer with Windows XP SP2 or Windows Vista. (See System requirements 6 for further recommendations.)

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How to use PicoScope 6

- Getting started: see using PicoScope for the first time 7, and PicoScope's Features. 8
- For further information: see descriptions of Menus 27 and Toolbars 65, and the Reference 103 section.
- For step-by-step tutorials, see the "How to 89" section.

3.1 Legal statement

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This software was continuously monitored for viruses during production, but you are responsible for virus-checking the software once it is installed.

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If you are dissatisfied with the performance of this software, please contact our technical support staff, who will try to fix the problem within a reasonable time. If you are still dissatisfied, please return the product and software to your supplier within 14 days of purchase for a full refund.

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Trademarks
Windows is a registered trademark of Microsoft Corporation. Pico Technology and PicoScope are internationally registered trade marks.

3.2 Contact information

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Web site:	www.picotech.com

3.3 How to use this manual

If you are using a PDF viewer to read this manual, you can turn the pages of the manual as if it were a book, using the back and forward buttons in your viewer. These buttons should look something like this:


back


forward

You can also print the entire manual for reading away from your computer. Look for a print button similar to this:


print

For your first introduction to PicoScope, we suggest that you start with these topics:

- Using PicoScope for the first time 7
- Oscilloscope basics 8
- PCO basics 9
- PicoScope basics 10

3.4 System requirements

To ensure that PicoScope operates correctly, you must have a computer with at least the minimum system requirements to run one of the supported operating systems, as shown in the following table. The performance of the oscilloscope will be better with a more powerful PC, and will benefit from a multi-core processor.

<table>
<tr><th>Item</th><th>Absolute minimum</th><th>Recommended minimum</th><th>Recommended full specification</th></tr>
<tr><td>Operating system</td><td>Windows XP SP2
Windows Vista</td><td>Windows XP SP2
Windows Vista</td><td>Windows XP SP2
Windows Vista</td></tr>
<tr><td>Processor</td><td rowspan="3">As required by Windows</td><td>300 MHz</td><td>1 GHz</td></tr>
<tr><td>Memory</td><td>256 MB</td><td>512 MB</td></tr>
<tr><td>Free disk space
(See note 1)</td><td>1 GB</td><td>2 GB</td></tr>
<tr><td>Ports</td><td>USB 1.1 compliant port</td><td colspan="2">USB 2.0 compliant port</td></tr>
</table>

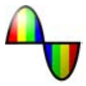
Note 1: The PicoScope software does not use all the disk space specified in the table. The free space is required to make Windows run efficiently.

4 Using PicoScope for the first time

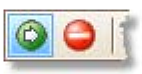
We have designed PicoScope to be as easy as possible to use, even for newcomers to oscilloscopes. Once you have followed the introductory steps listed below, you will soon become a PicoScope expert.

1. Install the software. Load the CD-ROM that is included with your scope device, then click the "Install Software" link and follow the on-screen instructions.

2. Plug in your scope device. Windows will recognise it and prepare your computer to work with it. Wait until Windows tells you that the device is ready to use.



3. Click the new PicoScope icon on your Windows desktop.



4. PicoScope will detect your scope device and prepare to display a waveform. The green Start 79 button will be highlighted to show that PicoScope is ready.

5. Connect a signal to one of the scope device's input channels and see your first waveform! To learn more about using PicoScope, please read the PicoScope Primer. 8

"Why did it do that?"

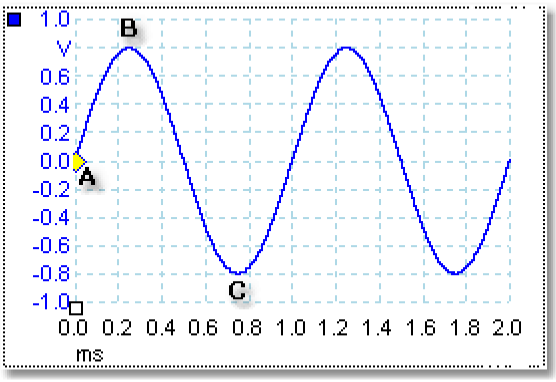
Help is at hand! Our technical support staff are always ready to answer your telephone call during office hours (see our Contact Details 5). At other times, you can leave a message on our support forum or send us an email.

5 PicoScope and oscilloscope primer

This chapter explains the fundamental concepts that you will need to know before working with the PicoScope software. If you have used an oscilloscope before, then most of these ideas will be familiar to you. You can skip the Oscilloscope basics 8 section and go straight to the PicoScope-specific information. 9 If you are new to oscilloscopes, please take a few minutes to read at least the Oscilloscope basics 8 and PicoScope basics 10 topics.

5.1 Oscilloscope basics

An oscilloscope is a measuring instrument that displays a graph of voltage against time. For example, the picture below shows a typical display on an oscilloscope screen when a varying voltage is connected to one of its input channels.



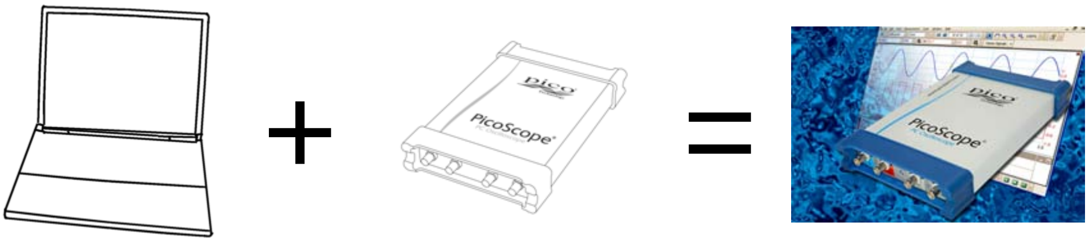
Oscilloscope displays are always read from left to right. The voltage-time characteristic of the signal is drawn as a line called the trace. In this example, the trace is blue and begins at point A. If you look to the left of this point, you will see the number "0.0" on the voltage axis, 112 which tells you that the voltage is 0.0 V (volts). If you look below point A, you will see another number "0.0", this time on the time axis, which tells you that the time is 0.0 ms (milliseconds) at this point.

At point B, 0.25 milliseconds later, the voltage has risen to a positive peak of 0.8 volts. At point C, 0.75 milliseconds after the start, the voltage has dropped to a negative peak of -0.8 volts. After 1 millisecond, the voltage has risen back to 0.0 volts and a new cycle is about to begin. This type of signal is called a sine wave, and is one of a limitless range of signal types that you will encounter.

Most oscilloscopes allow you to adjust the vertical and horizontal scales of the display. The vertical scale is called the voltage range (in this example at least, although scales in other units, such as milliamperes, are possible). The horizontal scale is called the timebase and is measured in units of time - in this example, thousandths of a second.

5.2 PCO basics

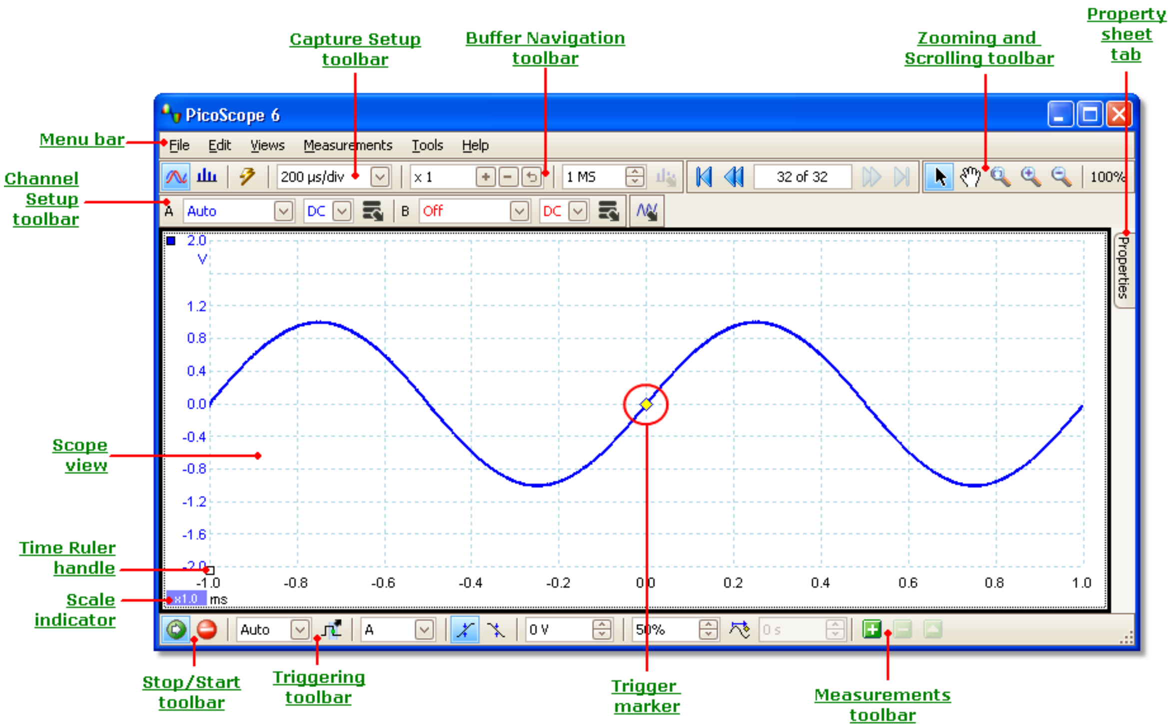
A PCO (PC Oscilloscope) is a measuring instrument that consists of a hardware scope device and an oscilloscope program running on a PC. Oscilloscopes were were originally stand-alone instruments with no signal processing or measuring abilities, and with storage only available as an expensive extra. Later oscilloscopes began to use new digital technology to introduce more functions, but they remained highly specialised and expensive instruments. PC Oscilloscopes are the latest step in the evolution of oscilloscopes, combining the measuring power of Pico Technology's scope devices with the convenience of the PC that's already on your desk.



PC | scope device | PCO

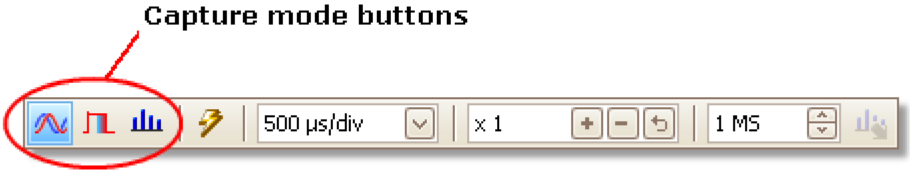
5.3 PicoScope basics

PicoScope can display simple waveforms such as the example we saw in the Oscilloscope basics 8 topic, but has many advanced features. The screen shot below shows the PicoScope window. Click on any of the underlined labels to learn more. See PicoScope window 13 for an explanation of these important concepts.



5.3.1 Capture modes

PicoScope can operate in three capture modes: scope mode, spectrum mode and persistence mode. The mode is selected by buttons in the Capture Setup Toolbar 71.



- In scope mode, PicoScope displays a main scope view, 14 optimises its settings for use as a PC Oscilloscope, and allows you to directly set the capture time. You can still display one or more secondary spectrum views.
- In spectrum mode, PicoScope displays a main spectrum view, 16 optimises its settings for spectrum analysis, and allows you to directly set the frequency range in a similar way to a dedicated spectrum analyser. You can still display one or more secondary scope views.
- In persistence mode 17, PicoScope displays a single, modified scope view in which old waveforms remain on the screen in faded colors while new waveforms are drawn in brighter colors. See also: How to find a glitch using persistence mode 99 and the Persistence Options dialog 74.

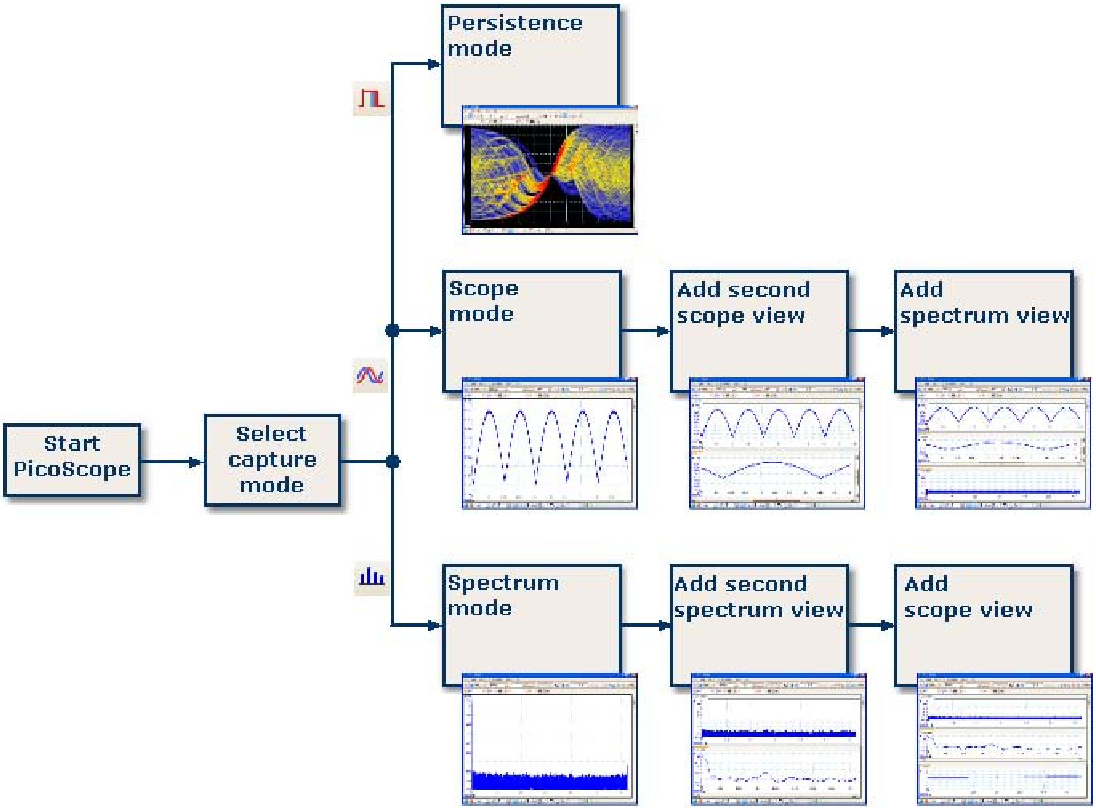
When you save waveforms and settings, 28 PicoScope only saves data for the mode that is currently in use. If you wish to save settings for both capture modes, then you need to switch to the other mode and save your settings again.

See also: How do capture modes work with views? 12

5.3.2 How do capture modes work with views?

The capture mode 11 tells PicoScope whether you are mainly interested in viewing waveforms (scope mode 11) or frequency plots (spectrum mode 11). When you select a capture mode, PicoScope sets up the hardware appropriately and then shows you a view that matches the capture mode (a scope view 14 if you selected scope mode or persistence mode 17, or a spectrum view 16 if you selected spectrum mode). The rest of this section does not apply in persistence mode, which allows only a single view.

Once PicoScope has shown you the first view, you can, if you wish, add more scope or spectrum views, regardless of the capture mode you are in. You can add and remove as many extra views as you wish, as long as one view remains that matches the capture mode.

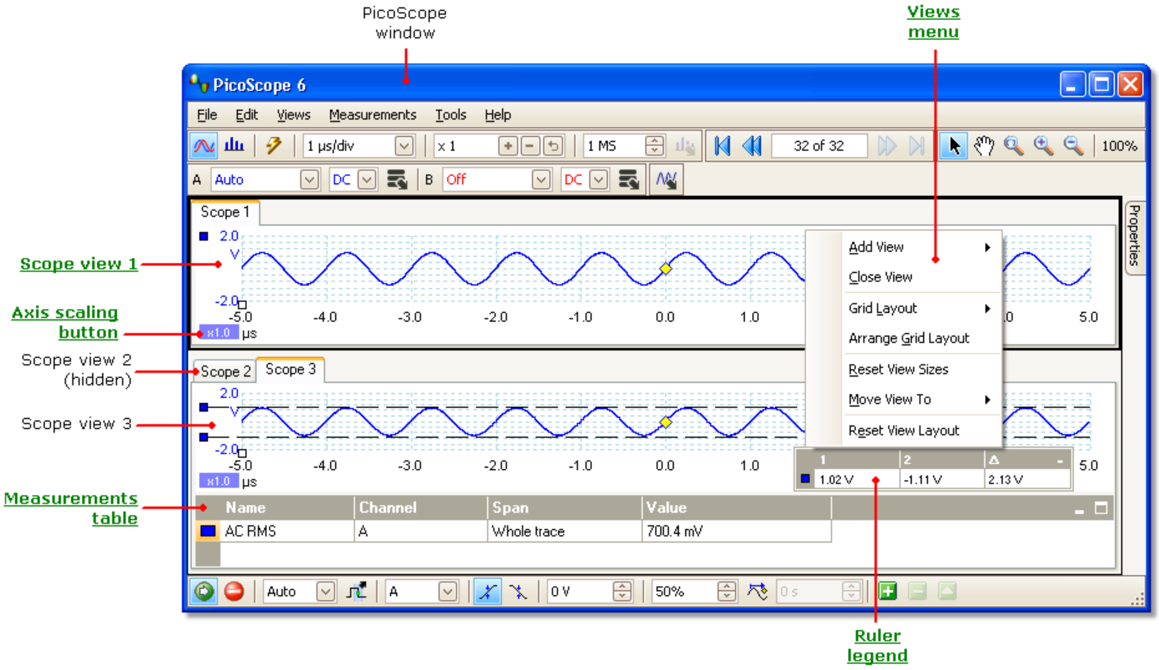


Examples showing how you might select the capture mode and open additional views in PicoScope. Top: persistence mode (one view only). Middle: scope mode. Bottom: spectrum mode.

When using a secondary view type (a spectrum view in scope mode, or a scope view in spectrum mode), you may see the data compressed horizontally rather than displayed neatly as in a primary view. You can usually overcome this by using the zoom tools.

5.4 PicoScope window

The PicoScope window shows a block of data captured from the scope device 113. When you first open PicoScope it contains one scope view, 14 but you can add more views by clicking Add view in the Views menu. 35 The screen shot below shows all the main features of the PicoScope window. Click on the underlined labels for more information.



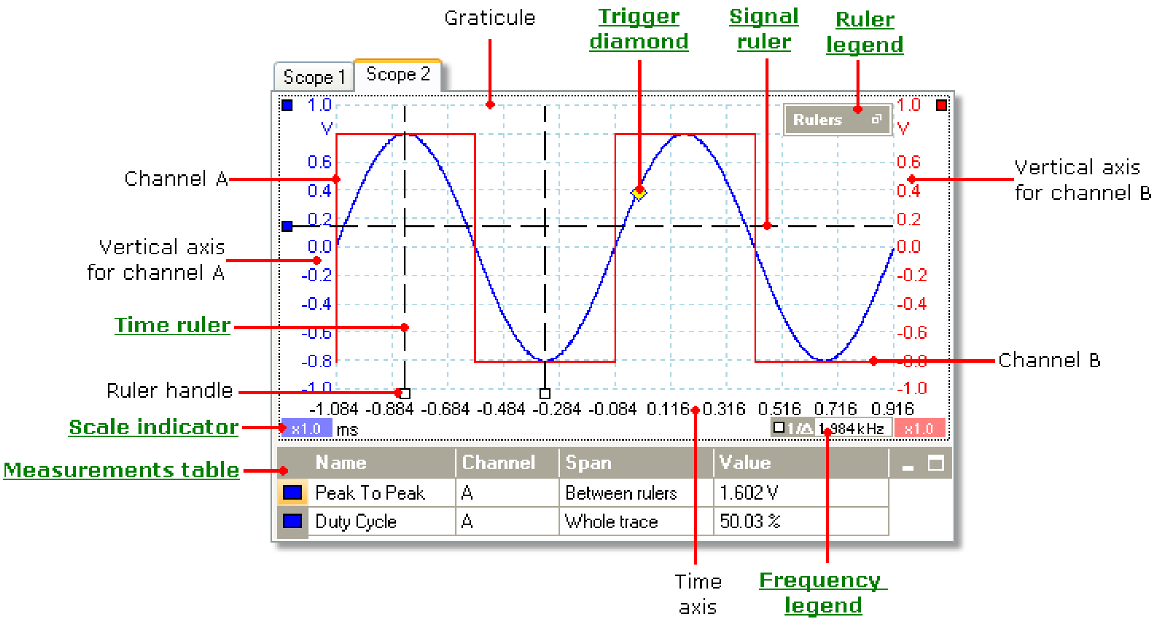
To arrange the views within the PicoScope window

If the PicoScope window contains more than one view, 113 PicoScope arranges them in a grid. This is arranged automatically, but you can customize it if you wish. Each rectangular space in the grid is called a viewport 113. You can move a view 113 to a different viewport by dragging its name tab (show me 92), but you cannot move it outside the PicoScope window. You can also put more than one view in a viewport, by dragging a view and dropping it on top of another.

For further options, right-click on a view to obtain the View menu 35, or select View from the Menu bar 27, then select one of the menu options to arrange the views.

5.5 Scope view

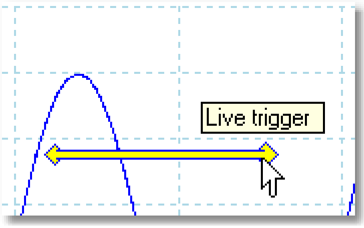
A scope view shows the data captured from the scope as a graph of signal amplitude against time. (See Oscilloscope basics 8 for more on these concepts.) PicoScope opens with a single view, but you can add more views by using the views menu 35. Similar to the screen of a conventional oscilloscope, a scope view shows you one or more waveforms with a common horizontal time axis, with signal level shown on one or more vertical axes. Each view can have as many waveforms as the scope device has channels. Click on one of the labels below to learn more about a feature.



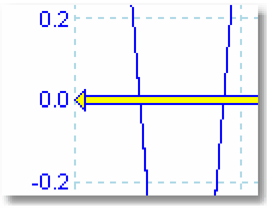
Scope views are available regardless of which mode - scope mode 11 or spectrum mode 11 - is active.

5.6 Post-trigger arrow

The post-trigger arrow is a modified form of the trigger marker 15 that appears temporarily on a scope view 14 while you are setting up a post-trigger delay, or dragging the trigger marker after setting up a post-trigger delay. (What is a post-trigger delay? 110)



The left-hand end of the arrow indicates the trigger point, and is aligned with zero on the time axis. If zero on the time axis is outside the scope view, 14 then the left-hand end of the post-trigger arrow appears like this:

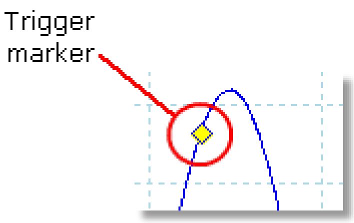


The right-hand end of the arrow (temporarily replacing the trigger marker 15) indicates the trigger reference point.

Use the buttons on the Triggering toolbar 80 to set up a post-trigger delay.

5.7 Trigger marker

The trigger marker shows the level and timing of the trigger point.



The height of the marker on the vertical axis shows the level at which the trigger is set, and its position on the time axis shows the time at which it occurs.

You can move the trigger marker by dragging it with the mouse or, for more accurate control, by using the buttons on the Triggering toolbar 80.

Other forms of trigger marker

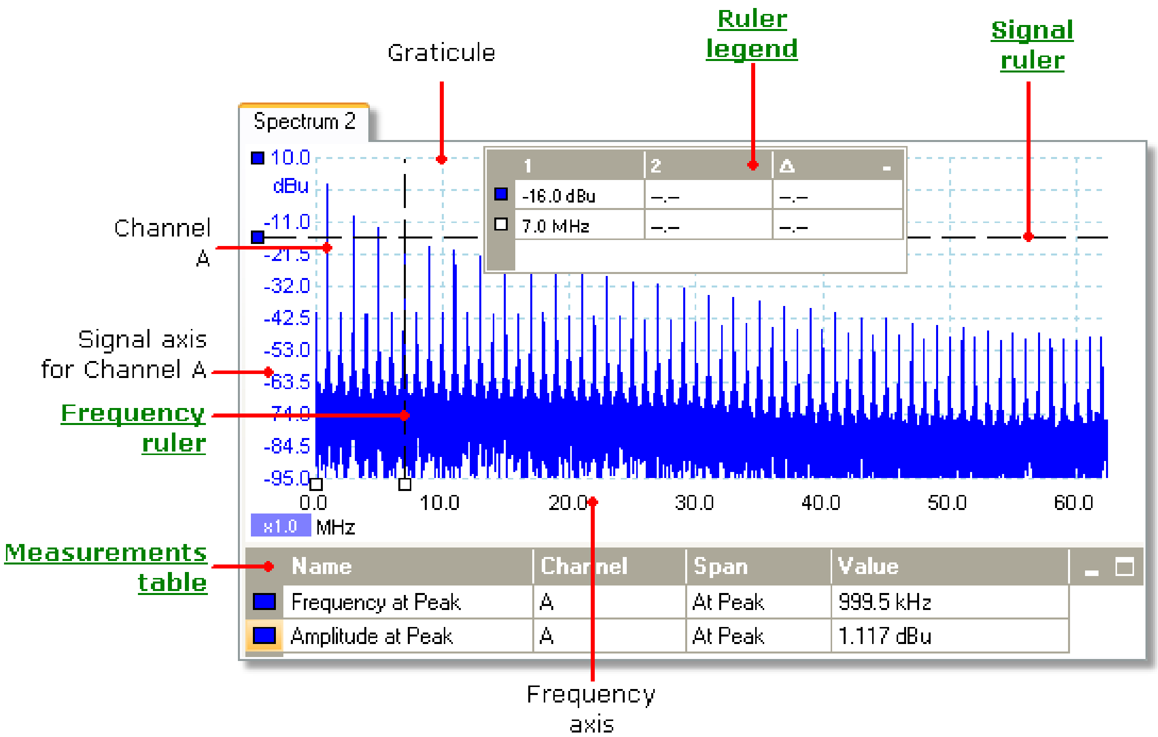
In post-trigger delay mode, the trigger marker is temporarily replaced by the post-trigger arrow 15 while you adjust the post-trigger delay.

When some advanced trigger types 83 are in use, the trigger marker changes to a window marker, which shows the upper and lower trigger thresholds.

For more information, see the section on Trigger timing. 109

5.8 Spectrum view

A spectrum view is one view of the data from a scope device. A spectrum is a diagram of signal level on a vertical axis plotted against frequency on the horizontal axis. PicoScope opens with a scope view, but you can add a spectrum view by using the views menu 35. Similar to the screen of a conventional spectrum analyser, a spectrum view shows you one or more spectra with a common frequency axis. Each view can have as many spectra as the scope device has channels. Click on one of the labels below to learn more about a feature.



Unlike in the scope view, in the spectrum view the data is not clipped at the limits of the range displayed on the vertical axis, so you can apply axis scaling or offset to see more data. Vertical axis labels are not provided for data outside what is considered to be the 'useful' range, but rulers will still work outside this range.

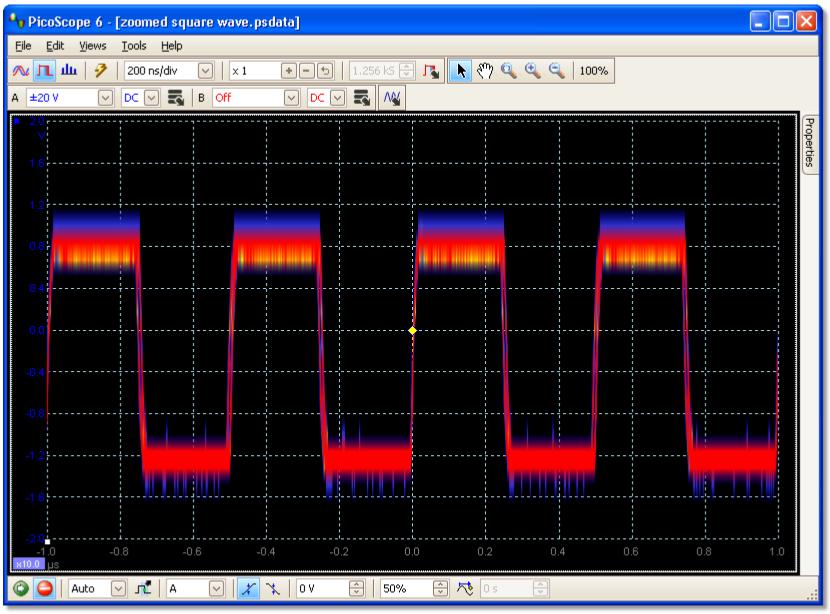
Spectrum views are available regardless of which mode - Scope Mode 11 or Spectrum Mode 11 - is active.

For more information, see: How to set up the spectrum view 98 and Spectrum Options dialog. 72

5.9 Persistence mode

Persistence mode superimposes multiple waveforms on the same view, with more frequent data or newer waveforms drawn in brighter colors than older ones. This is useful for spotting glitches, when you need to see a rare fault event hidden in a series of repeated normal events.

Enable persistence mode by clicking the Persistence Mode button  on the Capture Setup toolbar 71. If you have not changed any of the persistence options 74, the screen will look something like this:



The colors indicate the frequency of the data. Red is used for the highest-frequency data, with yellow for intermediate frequencies and blue for the least frequent data. In the example above, the waveform spends most of its time in the red region, but noise causes it to wander occasionally into the blue and yellow regions.

This example shows persistence mode in its most basic form. See the Persistence Options dialog 74 for ways to modify the display to suit your application, and How to find a glitch using persistence mode 99 for a worked example.

5.10 Measurements table

A measurements table contains the automatic measurements that you have instructed PicoScope to make on a particular view. 14 You can add, delete or edit measurements from this table.

	Name	Span	Value	Min	Max	Average	Standard Deviation	Capture Count
	AC RMS	Whole trace	321.4 mV	320.8 mV	321.4 mV	321.1 mV	154.1 µV	20
	Frequency	Whole trace	1.086 kHz	1.086 kHz	1.086 kHz	1.086 kHz	22.98 mHz	20
	Rise Time [90/10%]	Whole trace	307 µs	307 µs	307 µs	307 µs	0 s	20

Column heading	Explanation
Name	The name of the measurement that you selected in the Add Measurement 38 or Edit Measurement 38 dialog. An "F" after the name indicates that the statistics for this measurement are filtered 40 .
Span	The section of the waveform or spectrum that you want to measure. This is 'Whole trace' by default.
Value	The live value of the measurement, from the latest capture
Min	The minimum value of the measurement since measuring began
Max	The maximum value of the measurement since measuring began
Average	The arithmetic mean of the measurements from the last *n* captures, where *n* is set in the General 56 page of the Preferences 55 dialog
Standard Deviation	The standard deviation 113 of the measurements from the last *n* captures, where *n* is set in the General 56 page of the Preferences 55 dialog
Capture Count	The number of captures used to create the statistics above. This starts at 0 when triggering is enabled, and counts up to the number of captures specified in the General 56 page of the Preferences 55 dialog.

To add a measurement

Click the Add Measurement button on the measurements toolbar 70.

To delete a measurement

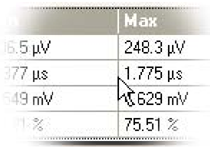
Select a measurement in the table by clicking once on it, and then click the Delete Measurement button on the measurements toolbar 70.

To edit a measurement

If the measurement you wish to edit is selected, click the Edit Measurement button on the measurements toolbar 70. Otherwise, double-click on the measurement.

To change the width of a measurement column

Drag the vertical separator between columns to create the column width you need, as shown opposite.



To change the update rate of the statistics

The statistics (Min, Max, Average, Standard Deviation) are based on the number of captures shown in the Capture Count column. You can change the maximum capture count using the Capture Size control in the General page 56 of the Preferences 55 dialog.

5.11 Resolution enhancement

Resolution enhancement is a technique for increasing the effective vertical resolution of the scope at the expense of high-frequency detail. Selecting resolution enhancement does not change the scope's sampling rate or the number of samples available.

For this technique to work, the signal must contain a very small amount of Gaussian noise, but for many practical applications this is generally taken care of by the scope itself and the noise inherent in normal signals.

The resolution enhancement feature uses a flat moving-average filter. This acts as a low-pass filter with good step response characteristics and a very slow roll-off from the pass-band to the stop-band.

Some side-effects will be observed when using resolution enhancement. These are normal and can be counteracted by reducing the amount of enhancement used, increasing the number of samples captured or changing the timebase. Trial and error is usually the best way to find the optimum resolution enhancement for your application. The side-effects include:

- Widened and flattened impulses (spikes)
- Vertical edges (such as those of square waves) turned into straight-line slopes
- Inversion of the signal (sometimes making it look as if the trigger point is on the wrong edge)
- A flat line (when there are not enough samples in the waveform)

Procedure

- Click the Channel Options button in the Channel Setup toolbar 67.
- Use the Resolution Enhance control in the Advanced Options menu 68 to select the effective number of bits, which can be equal to or greater than the vertical resolution 112 of your scope device.

Quantifying Resolution Enhancement

The table below shows the size of the moving-average filter for each resolution enhancement setting. A bigger filter size requires a higher sampling rate to represent a given signal without significant side-effects (as detailed above).

Resolution enhancement *e* (bits)	Number of values *n*
0.5	2
1.0	4
1.5	8
2.0	16
2.5	32
3.0	64
3.5	128
4.0	256

Example. Your scope device is a PicoScope 5204 (resolution = 8 bits). You have selected an effective resolution of 9.5 bits. The resolution enhancement is therefore:

e = 9.5 - 8.0 = 1.5 bits.

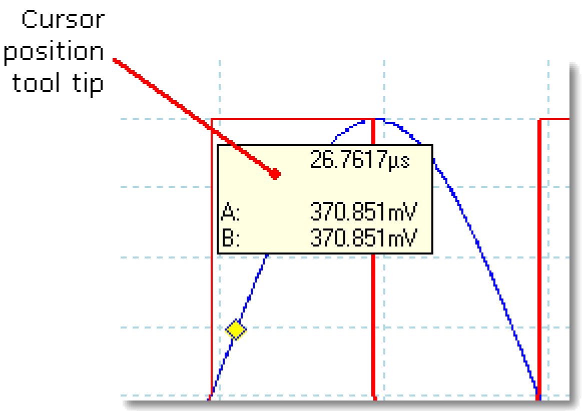
The table shows that this is achieved using a moving average of:

n = 8 samples.

This number gives a clue to what sort of filtering effect the resolution enhancement will have on the signal. The best way of seeing the actual low-pass filter effect is to add a spectrum view and look at the shape of the noise floor (try dragging the axis offset upwards to see it more clearly).

5.12 Cursor position tool tip

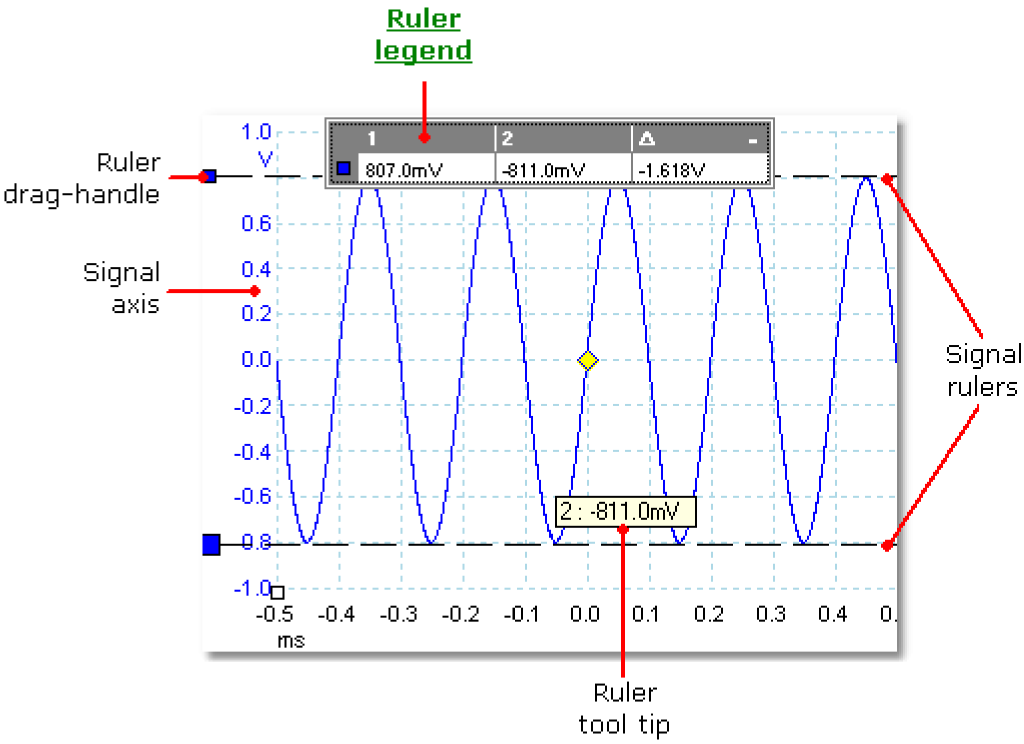
The cursor position tool tip is a box that displays the horizontal and vertical axis values at the cursor location. It appears temporarily when you click the background of a view.113 In a scope view,14 it shows time and signal values, and in a spectrum view,16 it shows frequency and signal values.



Cursor position tool tip in a scope view

5.13 Signal rulers

The signal rulers help you measure absolute and relative signal levels on a scope view 14 or spectrum view 16.



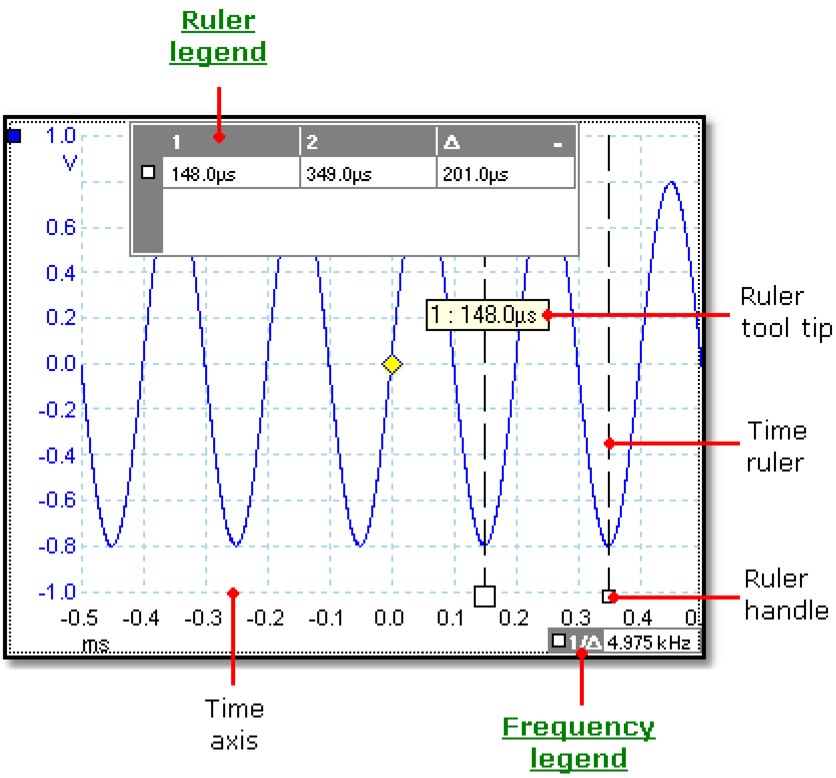
In the scope view 14 above, the two colored squares to the left of the vertical axis are the ruler drag-handles. You can drag these from the top-left corner to the positions you want to measure on the waveform. The two horizontal dashed lines are the signal rulers. The signal rulers work in the same way on a spectrum view. 16

Ruler tool tip

If you move the mouse pointer over one of the rulers, PicoScope displays a tool tip 113 with the ruler number and the signal level of the ruler. You can see an example of this in the picture above.

5.14 Time rulers

The time rulers measure time on a scope view 14 or frequency on a spectrum view. 16



In the scope view 14 above, the two white squares on the time axis are the time ruler handles. You can drag these from the bottom left corner to the positions on the time axis you want to measure. The two vertical dashed lines are the time rulers. The rulers work in the same way on a spectrum view, 16 but the ruler legend shows their horizontal positions in units of frequency rather than time.

Ruler tool tip

If you hold the mouse pointer over one of the rulers, as we did in the example above, PicoScope displays a tool tip with the ruler number and the time value of the ruler.

Ruler legend

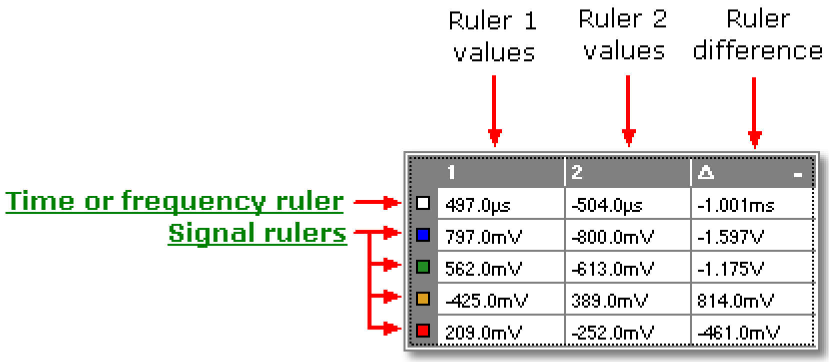
The table at the top of the view is the ruler legend. In this example, the table shows that time ruler 1 is at 148.0 microseconds, ruler 2 is at 349.0 microseconds and the difference between them is 201.0 microseconds.

Frequency legend

The frequency legend in the bottom right-hand corner of a scope view shows 1/Δ, where Δ is the difference between the two time rulers. The accuracy of this calculation depends on the accuracy with which you have positioned the rulers. For greater accuracy with periodic signals, use the frequency measurement 104 function built in to PicoScope.

5.15 Ruler legend

The ruler legend displays the positions of all the rulers 113 you have placed on the view. 113 It appears automatically whenever there is a ruler on the view.



For a reminder of which row refers to which signal, point using the mouse to one of the color-coded boxes in the left-hand margin and a label will appear, like this: 

.

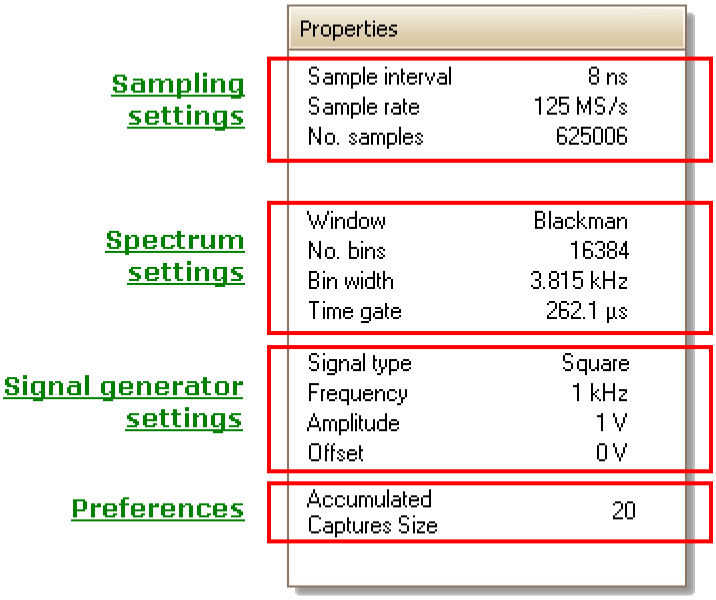
See also: frequency legend. 24

5.16 Frequency legend

The frequency legend appears when you have placed two time rulers 23 on a scope view 14. It shows 1/Δ in hertz (the SI unit of frequency, equal to cycles per second), where Δ is the time difference between the two rulers. You can use this to estimate the frequency of a periodic waveform, but you will get more accurate results by creating a frequency measurement using the Add Measurements button on the Measurements toolbar 70.

5.17 Properties sheet

The Properties sheet is a summary of the settings that PicoScope 6 is using. It normally appears to the right of the waveforms in the PicoScope window, but you can move it if you wish.



Positioning the Properties sheet

The Properties sheet has a number of modes. When you first start PicoScope 6, it is in "hidden" mode.

- Hidden. All you can see is a tab labelled Properties at the right-hand edge of the window.
- Quick view. To use "quick view", move the pointer over the tab but do not click on it. The sheet will then slide into view, and will disappear when you move the pointer away from it.
- Focused view. To enter this mode, click on the Properties tab. The Properties sheet will then remain in view until you click elsewhere on the PicoScope 6 window.
- Fixed view. Click the pin icon in the title bar of the Properties sheet. The icon changes to 'pinned', and the sheet remains visible while you use the other functions of PicoScope. In this mode, you can also move the sheet to any part of the window by dragging its title bar. To hide the sheet, click the pin icon again to return to "quick view" mode. The sheet then disappears when you move the pointer away.

Glossary

Window. The window function 108 applied to the data before computing the spectrum. This is selected in the Spectrum options dialog. 72

Time gate. The number of samples that PicoScope uses to compute a spectrum is equal to half the number of bins. This number of samples is expressed as a time interval called the time gate. It is measured from the start of the capture.

Accumulated Captures Size. The number of captures used to produce each measurement in the measurements table 18.

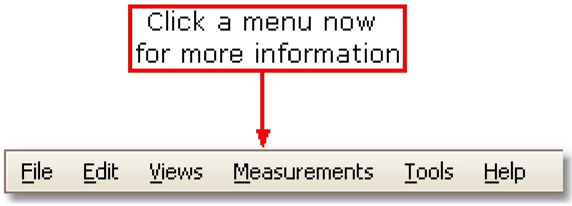
5.18 Custom probes

A **probe** is any connector, transducer or measuring device that you connect to an input channel of your scope device 113. PicoScope has a built-in library of common probe types, such as the x1 and x10 voltage probes used with most oscilloscopes, but if your probe is not included in this list you can use the Custom Probes dialog 42 to define a new one. Custom probes can have any voltage range within the capabilities of the oscilloscope, display in any units, and have either linear or nonlinear characteristics.

Custom probe definitions are particularly useful when you wish to display the probe's output in units other than volts, or to apply linear or nonlinear corrections to the data.

6 Menus

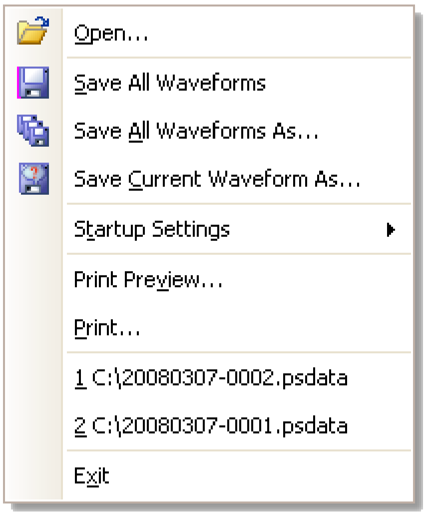
Menus are the quickest way to get to PicoScope's main features. The Menu bar is always present at the top of the PicoScope main window, just below the window's title bar. You can click any of the menu items, or press the Alt key and then navigate to the menu using the cursor keys, or press the Alt key followed by the underlined letter in one of the menu items.



The list of items in the menu bar may vary depending on the windows that you have open in PicoScope.

6.1 File menu

Click File on the Menu bar 27 to open the File menu.



Connect Device. This command appears only when there is no scope device connected. It opens the Connect Device dialog 64, which allows you to select the scope device you wish to use.

Open. Allows you to select the file you want to open. PicoScope can open `.psdata` and `.psd` files, which contain both waveform data and scope device settings, and `.pssettings` and `.pss` files, which contain only scope device settings. You can create your own files using the Save and Save As... commands, described below. If the file was saved using a different scope device from the one that is presently connected, PicoScope may need to modify the saved settings to suit the present device.

Hint: Use the Page Up and Page Down keys to cycle through all the waveform files in the same directory.

Save All Waveforms. Saves all waveforms using the filename shown in the title bar.

Save All Waveforms As. Opens the Save As dialog 29, which allows you to save the settings and waveforms for all views 13 in various formats. Only the waveforms for the mode currently in use (Scope Mode 71 or Spectrum Mode 71) will be saved.

Save Current Waveform As. Opens the Save As dialog 29, which allows you to save the settings and waveforms for all views in various formats. Only the waveforms for the mode currently in use (Scope Mode 71 or Spectrum Mode 71) will be saved.

In persistence mode 17, this command is called Save Persistence As and saves only the data for this mode.

Startup Settings. Opens the Startup Settings menu. 33

Print Preview. Opens the Print Preview window, which allows you to see how your workspace will be printed when you select the Print command.

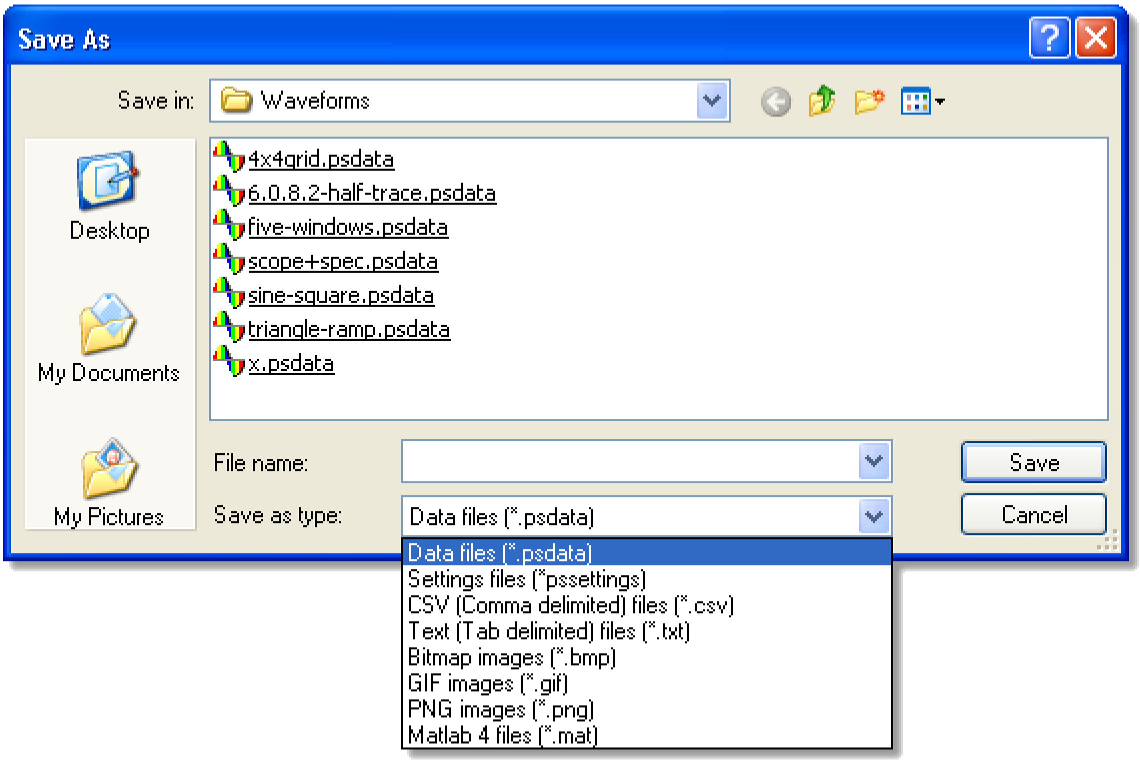
Print. Opens a standard Windows Print dialog, which allows you to choose a printer, set printing options and then print the selected view.

1, 2... Recently opened or saved files. This list is compiled automatically, but you can clear it using the Files page of the Preferences 55 dialog.

Exit. Close PicoScope without saving any data.

6.1.1 Save As dialog

Go to the File menu 28 and click Save All Waveforms As or Save Current Waveform As.



The Save As dialog allows you to save your waveforms and settings to a file in various formats. 30

Type your chosen file name in the File name box, and then select a file format in the Save as type box. You can save data in the following formats:

Data files (`.psdata`)	Stores waveforms and settings from the current scope device. Can be opened on any computer running PicoScope.
Settings files (`.pssettings`)	Stores all settings (but not waveforms) from the current scope device. Can be opened on any computer running PicoScope.

CSV (Comma delimited) files (.csv)	Stores waveforms as a text file with comma-separated values. This format is suitable for importing into spreadsheets such as Microsoft Excel. The first value on each line is the time stamp, and it is followed by one value for each active channel. (Details) 31
Text (Tab delimited) files (.txt)	Stores waveforms as a text file with tab-separated values. The values are the same as those in the CSV format. (Details) 31
Bitmap images (.bmp)	Stores a picture of the waveforms, graticule 112 and rulers 113 in Windows BMP format. The image is 800 pixels wide by 600 pixels high, in 16 million colors, and uncompressed. BMP files are suitable for importing into Windows desktop-publishing programs.
GIF images (.gif)	Stores the waveforms, graticule 112 and rulers 113 in Compuserve GIF format. The image is 800 pixels wide by 600 pixels high, in 256 colors, and compressed. GIF files are widely used to illustrate web pages.
PNG images (.png)	Stores the graticule 112, rulers 113 and waveforms in Portable Network Graphics format. The image is 800 pixels wide by 600 pixels high, in 16 million colors, and compressed.
Matlab 4 files (.mat)	Stores the waveform data in Matlab 4 format 31.

6.1.1.1 File formats for exported data

PicoScope 6 can export raw data in either text or binary format: -

Text-based file formats

- Easy to read without special tools
- Can be imported into standard spreadsheet applications
- Files are very large if there are many samples in the data (so files are limited to about 1 million values per channel)

Text file format details 31

Binary file format

- Files remain relatively small and can even be compressed in some situations (this means that the amount of saved data is unlimited)
- Either a special application is required to read the files or the user must write a program to read the data from the file

If you need to save more than 64 K values per channel, then you must use a binary file format such as the Matlab® MAT-file format.

Binary file format details 31

Data types for storing PicoScope 6 data

Regardless of whether the data types were loaded from a binary file or from a text-based file, we recommend the following data formats for storing the values loaded from a PicoScope 6 data file: -

- Sampled data (such as voltages) should use 32-bit single-precision floating-point data types.
- Times should use 64-bit double-precision floating-point data types.

6.1.1.1.1 Text formats

Text-format files exported by PicoScope 6 30 are encoded in UTF-8 format by default. This is a popular format which is capable of representing a huge range of characters, whilst still retaining some compatibility with the ASCII character set if only standard Western European characters and numbers are used in the file.

CSV (comma-separated values)

CSV files store data in the following format: -

```
Time, Channel A, Channel B
(μs), (V), (V)
-500.004, 5.511, 1.215
-500.002, 4.724, 2.130
-500, 5.552, 2.212
…
```

There is a comma after each value on a line to represent a column of data and a carriage return at the end of the line to represent a new row of data. The 1 million values per channel limit prevents excessively large files being created.

Note. CSV files are not the best choice of format if you are working in a language that uses the comma character as the decimal point. Instead, try using the tab-delimited format which works in almost the same way.

Tab-delimited

Tab-delimited files store data in the following format: -

```
Time        Channel A    Channel B
(μs)        (V)          (V)
500.004     5.511        1.215
-500.002    4.724        2.130
-500        5.552        2.212
…
```

The files have a tab character after each value on a line to represent a column of data and a carriage return at the end of the line to represent a new row of data. These files work in any language and are a good choice for sharing data internationally. The 1 million values per channel limit prevents excessively large files being created.

6.1.1.1.2 Binary formats

PicoScope 6 can export data 30 in version 4 of the .mat binary file format. This is an open format and the full specification is freely available from the www.mathworks.com website. PicoScope 6 saves data into the MAT-File format in a specific way, which is detailed below.

Importing into Matlab®

Load the file into your workspace using this syntax: -

```
load myfile
```

Each channel's data is stored in an array variable named by the channel. So, the sampled data for channels A to D would be in four arrays named A, B, C and D.

There is only one set of time data for all channels and this is loaded in one of two possible formats:

1. A start time, an interval and a length. The variables are named Tstart, Tinterval and Tlength.
2. An array of times (sometimes used for ETS data). The time array is named T.

If the times are loaded in as Tstart, Tinterval and Tlength then you can use the following command to create the equivalent array of times: -

```
T = [Tstart : Tinterval : Tstart + (Tlength – 1) * Tinterval];
```

Exploring the file format

The full file specification, available from www.mathworks.com, is comprehensive so this guide does not describe the entire format. Instead, this guide describes enough of the format to allow you to get data from the file and use it in your own program.

The variables described above (under Importing into Matlab® 32) are stored in a series of data blocks, each preceded by a header. Each variable has its own header and data block and the corresponding variable names are stored with them (such as A, B, Tstart). The following sections describe how to read each variable from the file.

The order of the data blocks is not specified, so programs should look at the variable names to decide which variable is currently being loaded.

The header

The file consists of a number of data blocks preceded by 20-byte headers. Each header contains five 32-bit integers (as described in the table below).

Bytes	Value
0 – 3	Data format (0, 10 or 20)
4 – 7	Number of values
8 – 11	1
12 – 15	0
16 – 19	Name length

Data format

The 'Data format' in the first 4-bytes describes the type of numerical data in the array.

Value	Description
0	Double (64-bit floating point)
10	Single (32-bit floating point)
20	Integer (32-bit)

Number of values

The 'Number of values' is a 32-bit integer describing the number of numerical values in the array. This value may be 1 for variables that only describe one value; but for arrays of samples or times, expect this to be a large number.

- Name length

The 'Name length' is the length of the name of the variable as a null-terminated 1-byte per character ASCII string. The last null terminating character ('\0') is included in the 'Name length' so if the variable name is "TStart" (same as 'TStart\0') then the name length will be 7.

- The data block

The data block begins with the name of the variable (such as A, Tinterval) and you should read in the number of bytes described by the 'Name length' part of the header (not forgetting that the last byte in the string is '\0' if your programming language needs to take account of this).

The remaining part of the data block is the actual data itself, so read in the number of values described in the 'Number of values' part of the header. Remember to take account of the size of each value as described in the 'Data format' part of the header.

Channel data such as voltages, in variables such as A and B, are stored as 32-bit single-precision floating-point data types. Times such as Tstart, Tinterval and T are stored as 64-bit double-precision floating-point data types. Tlength is stored as a 32-bit integer.

6.1.2 Startup Settings menu

Go to the File menu 28 and click Startup Settings.

The Startup Settings menu allows you to load, save and restore the PicoScope 6 startup settings.

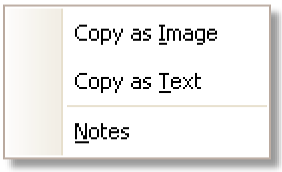
Save Startup Settings. Saves your current settings ready for when you next select Load Startup Settings. These settings are remembered from one session of PicoScope 6 to the next.

Load Startup Settings. Returns to the settings you created with the Save Startup Settings command.

Reset Startup Settings. Deletes the startup settings you created with the Save Startup Settings command, and restores the installation default settings.

6.2 Edit menu

Click Edit on the Menu bar 27.



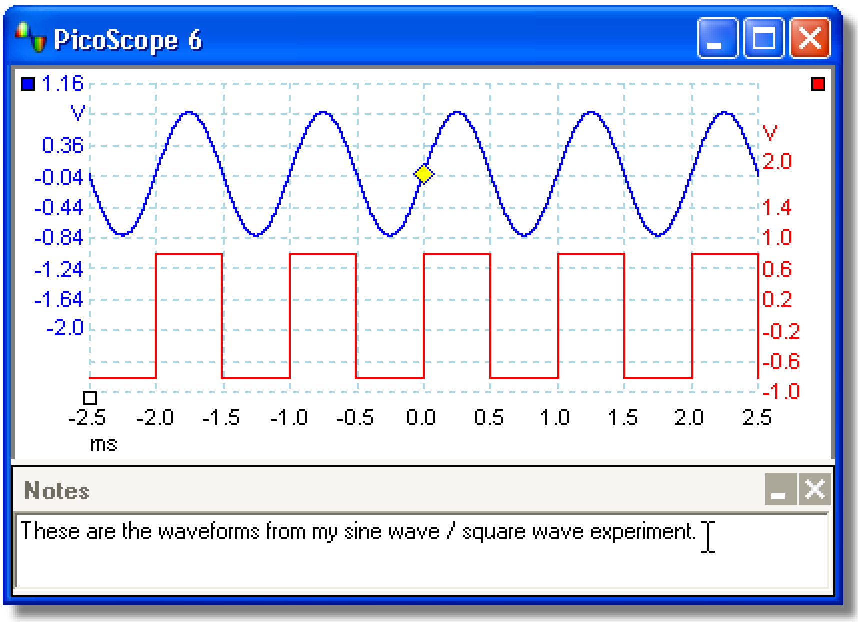
Copy as Image. Copies the active view to the clipboard as a bitmap. You can then paste the image into any application that accepts bitmap images.

Copy as Text. Copies the data in the active view to the clipboard as text. You can paste the data into a spreadsheet or other application. The text format is the same as that used by the Save As dialog 29 when you select the `.txt` format.

Notes. Opens a Notes area 34 at the bottom of the PicoScope window. You can type or paste your own notes in this area.

6.2.1 Notes area

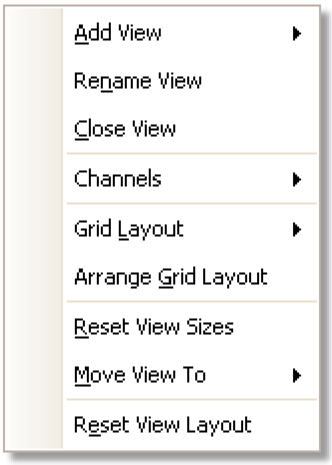
To display the Notes area, click the Edit 34 menu and select Notes.



A Notes area can be displayed at the bottom of the PicoScope window. You can enter any text you wish in this area. You can also copy text from another program and paste it here.

6.3 Views menu

Click Views on the Menu bar 27 or right-click on a view 113.



This menu controls the layout of PicoScope views 113. If you have more than one view, then they are arranged in a grid. Each location, or viewport, in this grid may contain a view or may be empty.

The contents of the Views menu may vary depending on where you click and how many views are open. The menu is sometimes combined with the Measurements menu 37.

Add View: Add a view of the selected type (scope 14 or spectrum 16). In automatic grid layout mode (the default), PicoScope rearranges the grid to make room for the new view, up to a limit of four views. Any further views will be added as tabs in existing viewports. 113 If you have selected a fixed grid layout, PicoScope will not change it.

Rename View: Change the standard 'Scope' or 'Spectrum' label to a title of your choice.

Close View: Remove a view from the PicoScope window. In automatic grid layout mode (the default), PicoScope rearranges the grid to make the best use of the remaining space. In fixed grid layout mode (if you have selected a grid fixed layout), PicoScope will not change the grid.

Channels: Select which channels are visible in the current view. Each view, when created, shows all the channels, but you can switch them on and off using this command. Only the channels that are enabled (not set to "Off" in the Channel Setup Toolbar 67) are available for viewing.

Grid Layout: The grid layout defaults to "Automatic" mode, in which PicoScope automatically arranges views in a grid. You can also select one of the standard grid layouts or create a custom layout, which PicoScope will preserve as you add or remove views.

Arrange Grid Layout: Adjust the grid layout to fit the number of views. Moves any tabbed views to empty viewports. Overrides any previous choice of grid layout.

Reset View Sizes: If you have resized any of the views by dragging the vertical or horizontal separator bars between viewports, this option resets all the viewports to their original sizes.

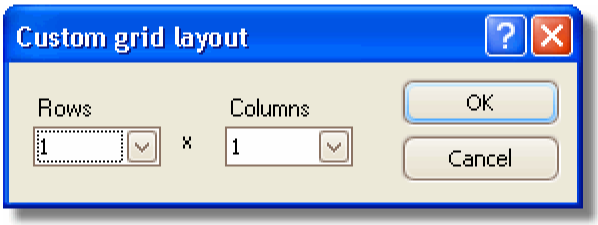
Move View To: Lets you move a view to a specified viewport. You can achieve the same effect by dragging the view by its name tab and dropping it in a new place. See How to move a view 92.

Arrange Views: Redistribute the views to fill the existing grid.

Reset View Layout: Reset the scale factor and offset of the selected view to their default values.

6.3.1 Custom grid layout dialog

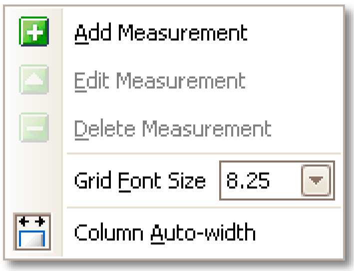
Right-click on the PicoScope window to get the Views menu 35, then select the Grid Layout submenu and then the Custom layout... command. You can also find the View menu on the Menu bar 27.



If the Grid Layout section of the Views menu 35 does not contain the layout you want, this dialog allows you to lay out the view 113 grid with any number of rows and columns up to 4 by 4. You can then drag the views to different locations in the grid.

6.4 Measurements menu

Click Measurements on the Menu bar 27.



Add measurement. Adds a row to the measurements table 18, and opens the Edit Measurement Dialog 38. You can also find this button on the Measurements toolbar 70.

Edit measurement. This takes you to the Edit Measurement Dialog 38. You can find this button on the Measurements toolbar 70, or you can edit a measurement by double-clicking on a row of the measurements Table 18.

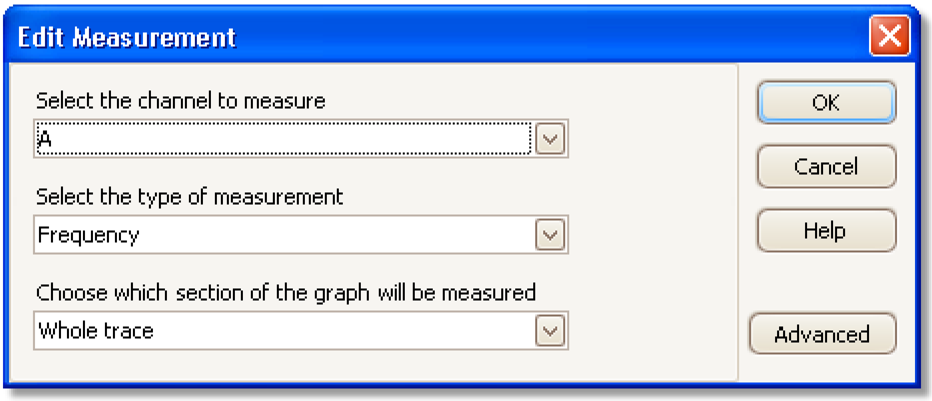
Delete measurement. Removes the selected row from the measurements table 18. You can also find this button on the Measurements toolbar 70.

Grid font size. Sets the font size for the entries in the measurements table 18.

Column Auto-width. If this button is pressed, the columns of the measurements table 18 will continually adjust to fit the contents whenever the table changes. Click again to release the button.

6.4.1 Add / Edit Measurement dialog

Click the Add Measurement or Edit Measurement button on the Measurements toolbar 70 or in the Views menu 35, or double-click a measurement in the measurements table 18.

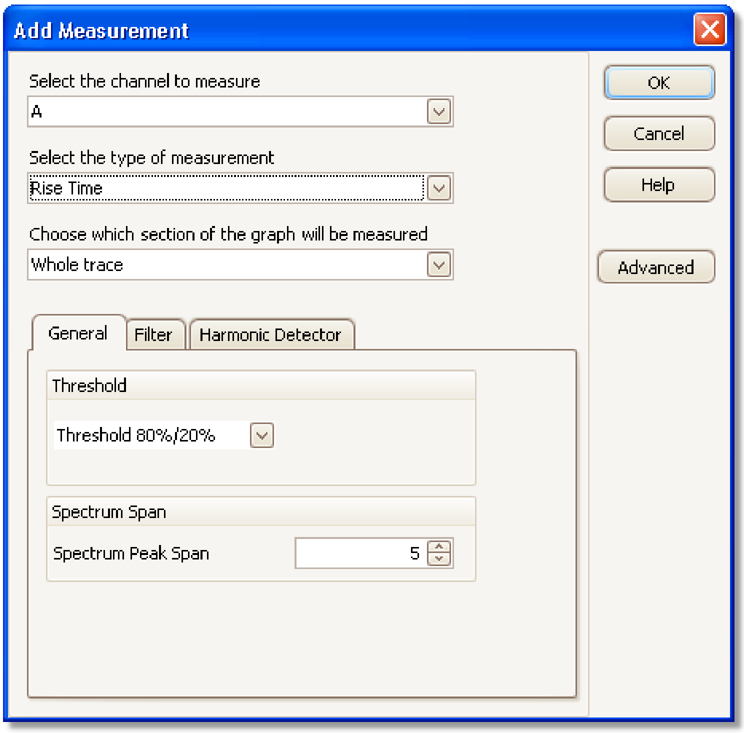


This dialog allows you to add a measurement of a waveform to the selected view, 113 or edit an existing measurement. PicoScope automatically refreshes the measurement every time it updates the waveform. If this is the first measurement for the view, PicoScope will create a new measurements table 18 to display the measurement; otherwise, it will add the new measurement to the bottom of the existing table.

Channel	Which of the scope device's 113 channels to measure.
Type	PicoScope can calculate a wide range of measurements for waveforms. See Measurement Types 103 for details.
Section	Measure the whole trace, just the section between rulers 113, or, where appropriate, a single cycle marked by one of the rulers.
Advanced	Gives access to advanced measurement settings 39.

6.4.2 Advanced measurement settings

This dialog appears when you click the Advanced button in the Add Measurement 38 or Edit Measurement dialog.



Threshold	Some measurements, such as Rise Time and Fall Time, can be made using different thresholds. Select the appropriate ones here. When comparing rise and fall times with manufacturers' specifications, it is important to use the same thresholds for all measurements.
Spectrum span	When measuring peak-related parameters such as 'Frequency at Peak' 106 in a spectrum view 16, PicoScope can search for a peak near to the specified ruler 23 location. This option tells PicoScope how many frequency bins to search. The default is 5, which tell PicoScope to search from 2 bins below to 2 bins above the ruler frequency, giving a total range of 5 bins including the ruler frequency.
Filter control	PicoScope can low-pass filter the statistics to produce more stable and more accurate numbers. Filtering is not available on all measurement types. Enable - check to enable low-pass filtering, if available. An "F" will appear after the measurement name in the measurements table 18. Automatic - check to set the low-pass filter characteristics automatically
Control	Cutoff Frequency - the filter cut-off frequency normalised to the measurement rate. Range: 0 to 0.5. Filter Size - the number of samples used to construct the filter
Harmonic control	This option applies only to distortion measurements in spectrum views 16. You can specify which harmonics PicoScope uses for these measurements. Harmonic Level - the highest harmonic to include when calculating distortion power Area Search - the number of frequency bins to search, centred on the expected frequency, when looking for a harmonic peak Harmonic Noise Floor - the level in dB above which signal peaks will be counted as harmonics.

6.5 Tools menu

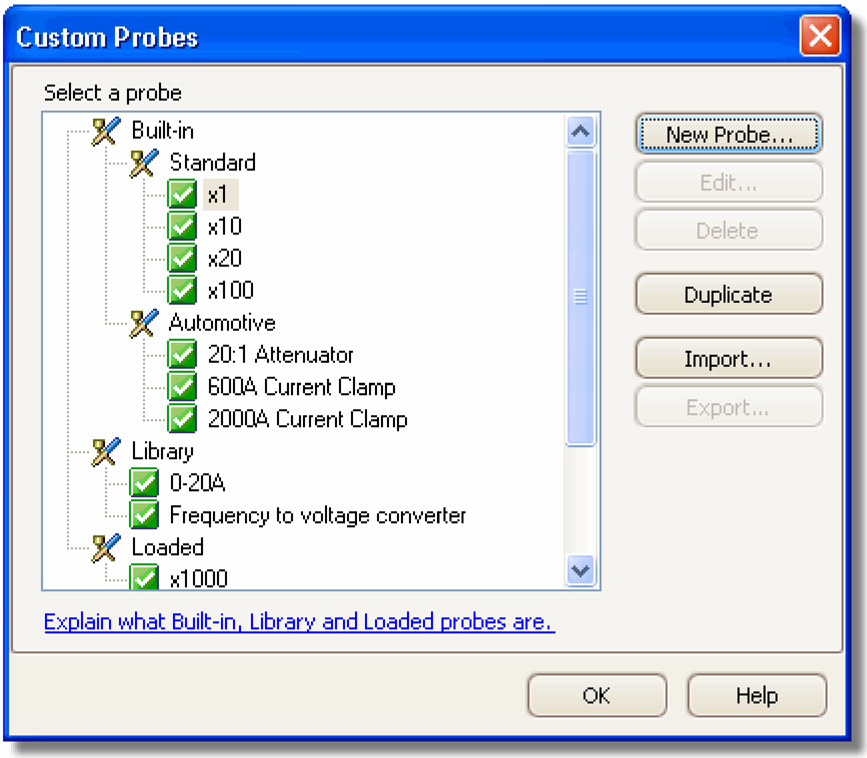
Click Tools on the Menu bar 27.

Custom Probes: Opens the Custom probes 42 dialog, which allows you to define new probes and copy, delete, move and edit existing ones.

Preferences: Opens the Preferences dialog 55, which contains various options that control PicoScope's behaviour.

6.5.1 Custom Probes dialog

Choose Custom Probes in the Tools menu 41 or click the Channel Advanced Options button.



This dialog allows you to define your own probes and set up custom probes 26.

Understanding the probe list

All the probes that PicoScope knows about are listed under three main headings: Built-in, Library and Loaded. The probe list is preserved between sessions, so that PicoScope will never forget your custom probes unless you delete them.

- Built-in probes. The built-in probes are supplied by Pico Technology and do not change unless you download an authorised update from us. As a safeguard, PicoScope does not allow you to edit or delete these probes. If you want to modify one of them, you can copy it to your library by clicking Duplicate, and then edit the copy in your library.
- Library probes. These are the probes that you have created using any of the methods described in this topic. You can edit, delete or duplicate any of these probes by clicking the appropriate button in this dialog.
- Loaded probes. Probes in PicoScope data files `(.psdata)` or settings files `(.pssettings)` that you have opened appear here until you copy them to your library. You cannot edit or delete these probes directly, but you can click Duplicate to copy them to your library where you can edit them. You can also import probes from the custom ranges stored in PicoScope 5 `.psd` and `.pss` files, but these lack some of the features provided by PicoScope 6. (See "Upgrading from PicoScope 5 2" for more details.)

Adding a new probe to your library

There are three ways to create a new probe:

1. Use the Duplicate button as described above.

2. Click New Probe... to define a new probe.

3. Click Import to load a probe definition from a *.psprobe file and add it to your library. These files are normally supplied by Pico, but you can also create your own by defining a new probe and then clicking Export.

The second and third methods open the Custom Probe Wizard 44 to guide you through the probe definition process.

6.5.2 Custom Probe wizard

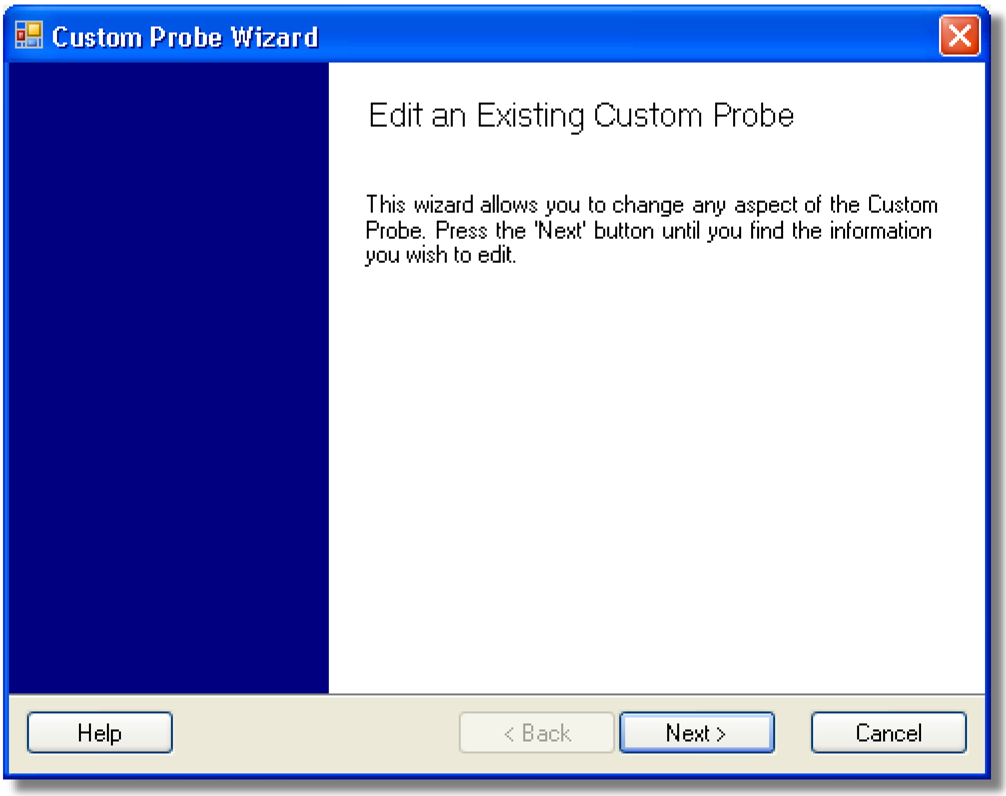
Click New Probe in the Custom Probes dialog 42.

The Custom probe wizard allows you to define custom probes 26 and set up custom ranges.

The first dialog in the series is either the Create a new Custom Probe dialog 44 or the Edit an existing Custom Probe dialog 45.

6.5.2.1 Create New Custom Probe dialog

Click the New Probe button in the Custom Probes dialog 42.



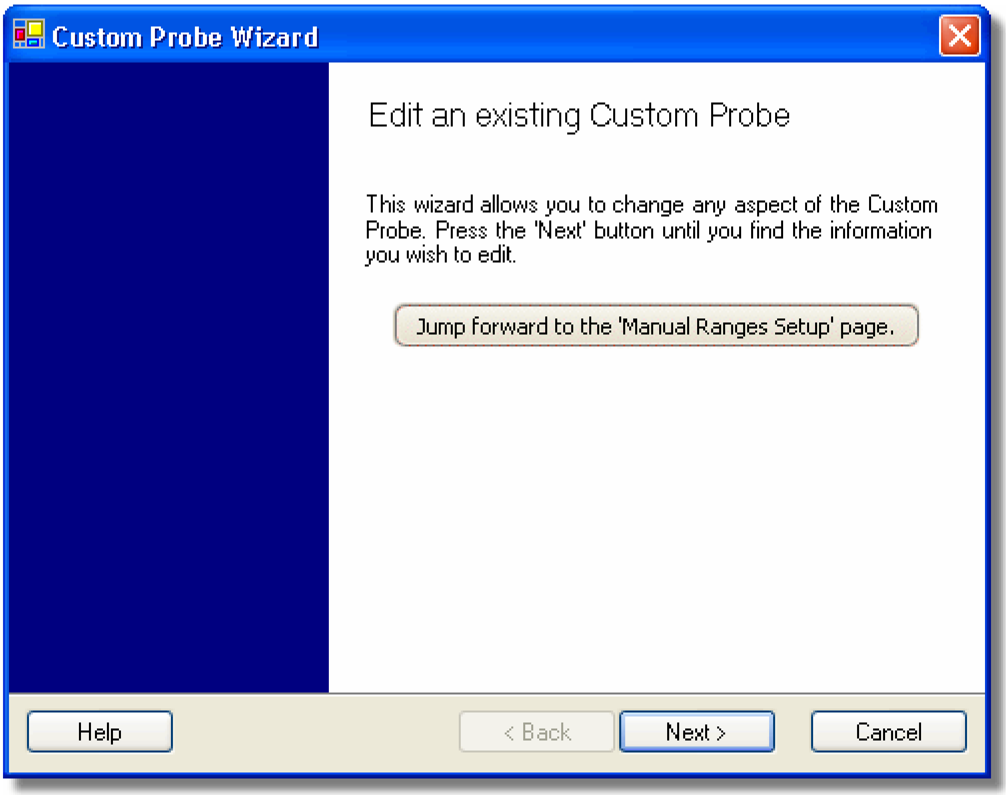
This dialog introduces you to the process for creating a new custom probe.

How to use the dialog

Click Next to continue to the Probe Output Units dialog 46.

6.5.2.2 Edit Existing Custom Probe dialog

Get here by clicking the Edit button in the Custom Probes dialog 42.



This dialog introduces you to the process for editing an existing custom probe.

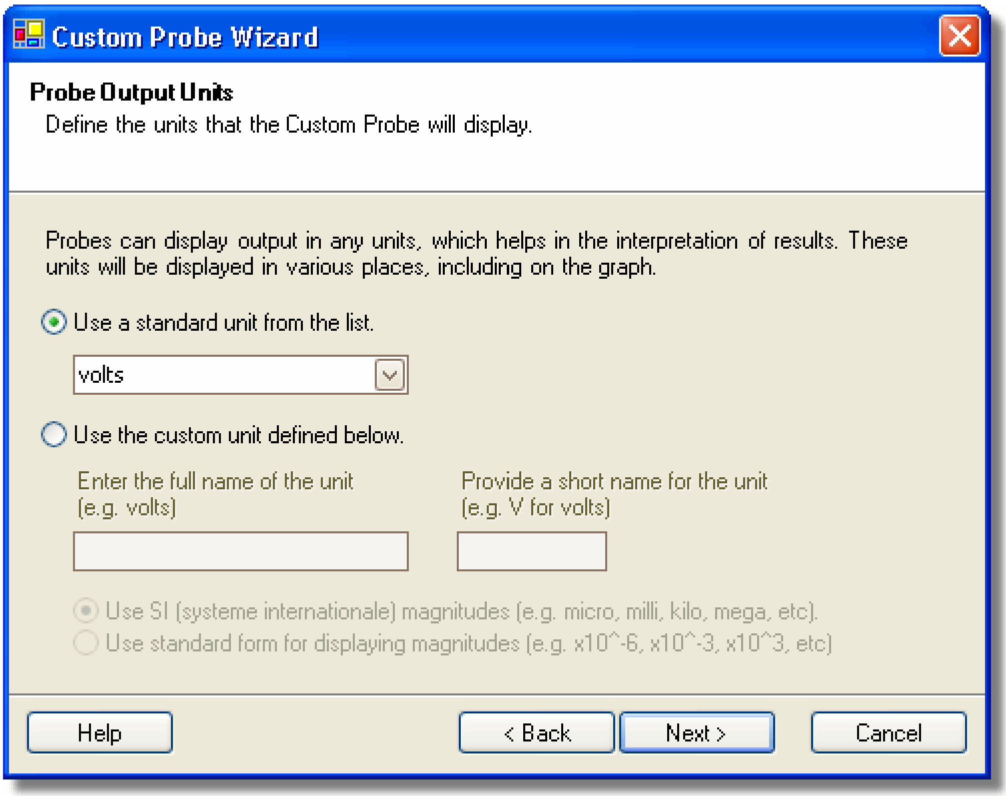
How to use the dialog

Click Next to continue to the Probe Output Units dialog 46, where you can edit the custom probe.

Click Jump forward... if you have already set up the custom probe's basic characteristics and want to add or change a custom range manually.

6.5.2.3 Probe Output Units dialog

This dialog follows the Create new Custom Probe dialog 44. It allows you to choose the units that PicoScope will use to display the output of your custom probe 112.



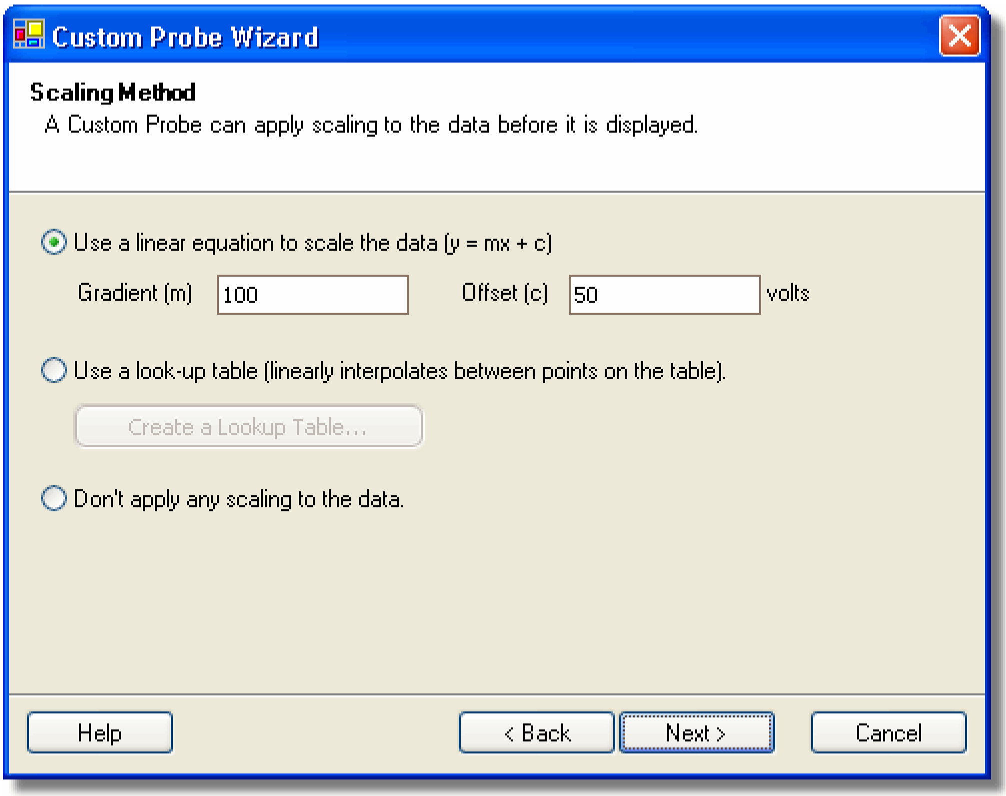
How to use the dialog

- To choose a standard SI unit, click Use a standard unit from the list and select one from the list.
- To enter a custom unit, click Use the custom unit defined below and type the unit name and symbol.

- Click Next to continue to the Scaling Method dialog 47.
- Click Back to return to the Create New Custom Probe dialog 44 if this is a new probe, or the Edit Existing Custom Probe dialog 45 if this is an existing probe.

6.5.2.4 Scaling Method dialog

This dialog follows the Probe Output Units dialog 46. It allows you to define the characteristic that PicoScope will use to convert the probe's voltage output to a measurement on the display.

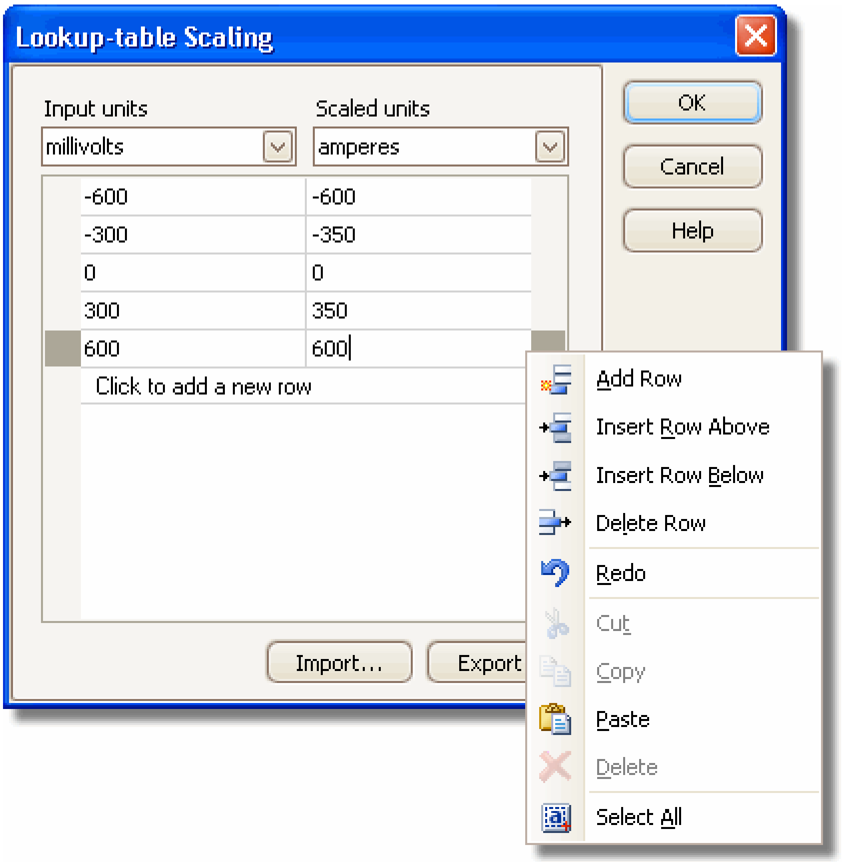


How to use the dialog

- If you do not require any scaling or offset, click the Don't apply any scaling button.
- If the probe requires linear scaling, click the Use a linear equation button and enter the gradient (or scale factor) m and the offset c in the equation $y = mx + c$, where y is the displayed value and x is the probe's voltage output.
- If you wish to apply a nonlinear function to the probe's output, choose Use a look-up table..., then click the Create a Lookup Table... button to create a new lookup table. This will take you to the Lookup-table Scaling dialog 48.
- Click Next to continue to the Range Management dialog 49.
- Click Back to return to the Probe Output Units dialog 46.

6.5.2.4.1 Lookup-table Scaling dialog

This dialog allows you to enter a look-up table to calibrate a custom probe. You can get here by clicking the Create a Look-up Table button or Edit the Lookup Table... button in the Scaling Method dialog 47.



Editing the Look-up Table

First, select suitable values in the Input units and Scaled units drop-down boxes. For example, if your probe is a current clamp that outputs one millivolt per ampere over the range -600 to +600 amperes, select Input units of millivolts and Output units of amperes.

Next, enter some data in the scaling table. Click the first empty cell at the top of the table and type "-600", then hit the Tab key and type "-600". When you are ready to enter the next pair of values, press the Tab key again to start a new row. You can also right-click on the table to obtain a more detailed menu of options, as shown in the picture. In the example above, we have entered a slightly nonlinear response; if the response had been linear then it would have been easier to use the linear option in the Scaling Method Dialog 47.

Import/Export

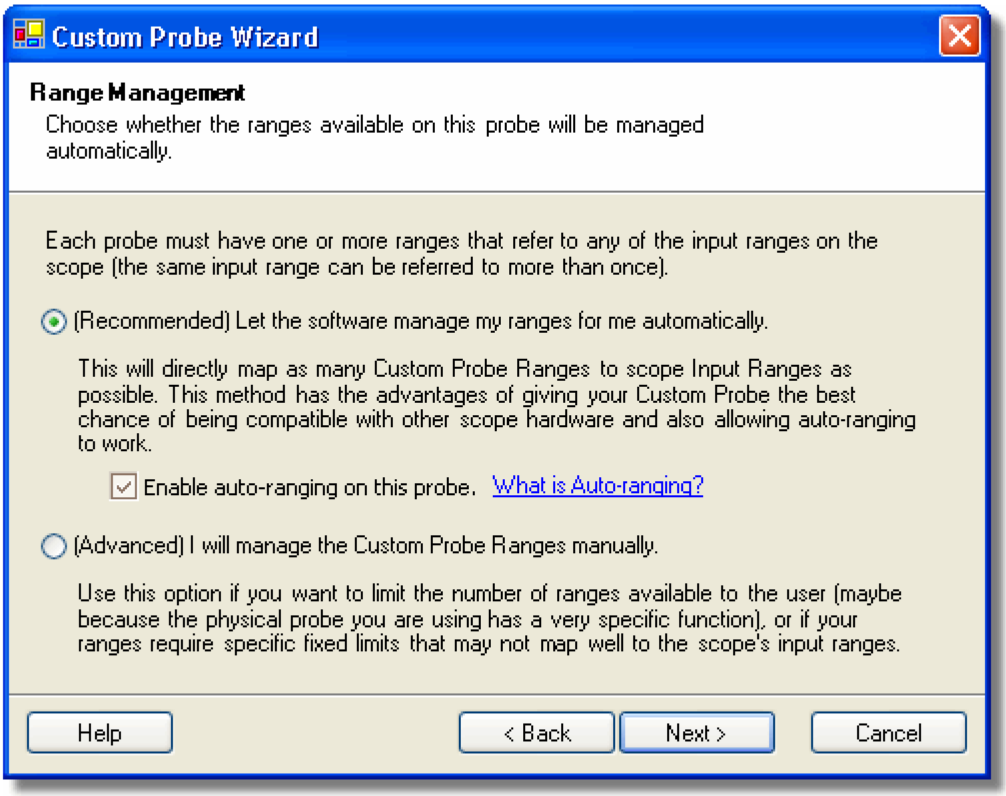
Using the Import and Export buttons, you can fill the look-up table from data in a comma-separated or tab-delimited text file, and save the look-up table to new file.

Finishing

Clicking OK or Cancel will return you to the Scaling Method dialog 47.

6.5.2.5 Range Management dialog

This dialog follows the Scaling Method dialog 47. It allows you to override PicoScope's automatic range-creation feature for custom probes. In most cases, the automatic procedure will be ideal.



How to use the dialog

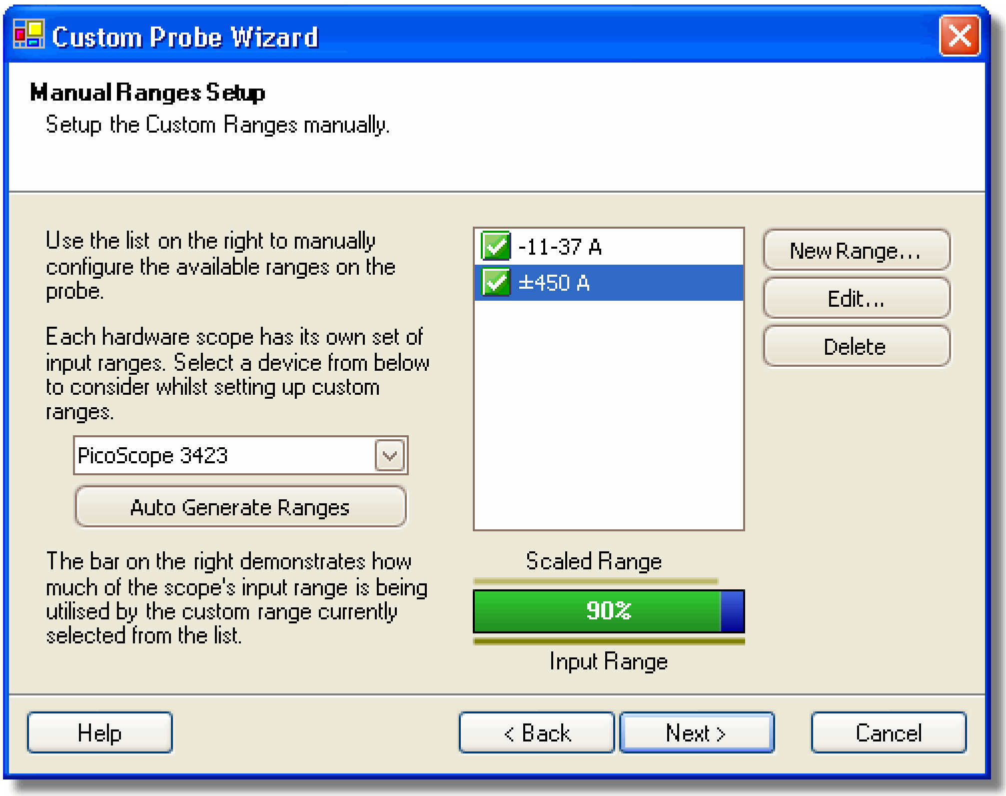
- If you select Let the software manage my ranges for me automatically, then clicking Next will take you to the Custom Probe Identification dialog 53. PicoScope's automatic ranges should be ideal for most applications.
- If you select I will manage the Custom Probe Ranges manually, clicking Next will take you to the Manual Ranges Setup dialog 50.
- Click Back to return to the Scaling Method dialog 47.

What is Auto-ranging?

When the Auto-ranging function is selected, PicoScope continually monitors the input signal and adjusts the range when necessary to allow it to display the signal with maximum resolution. This function is available on all standard ranges, and can be used with custom ranges only if you select Let the software manage my ranges for me automatically in this dialog.

6.5.2.6 Manual Ranges Setup dialog

This dialog appears when you select the Advanced option in the Range Management dialog 49 and then click Next >. It allows you to create ranges manually for your custom probe.



How to use the dialog

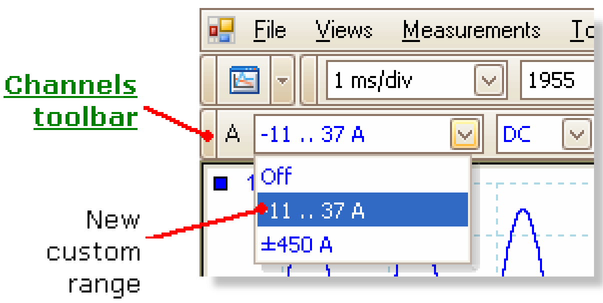
If you wish, you can click Auto Generate Ranges and the program will create a number of ranges for the selected device. This will create the same list of ranges that you would have obtained by selecting Let the software manage my ranges for me automatically in the previous dialog. When you select a range, a diagram below the list will show its relationship to the scope device's input range — this is explained further under Edit range dialog 51. You can then edit the ranges by clicking Edit, or you can also add a new range by clicking New Range. Both of these buttons take you to the Edit Range dialog 51.

Click Next to continue to the Custom Probe Identification dialog 53.

Click Back to return to the Range Management dialog 49.

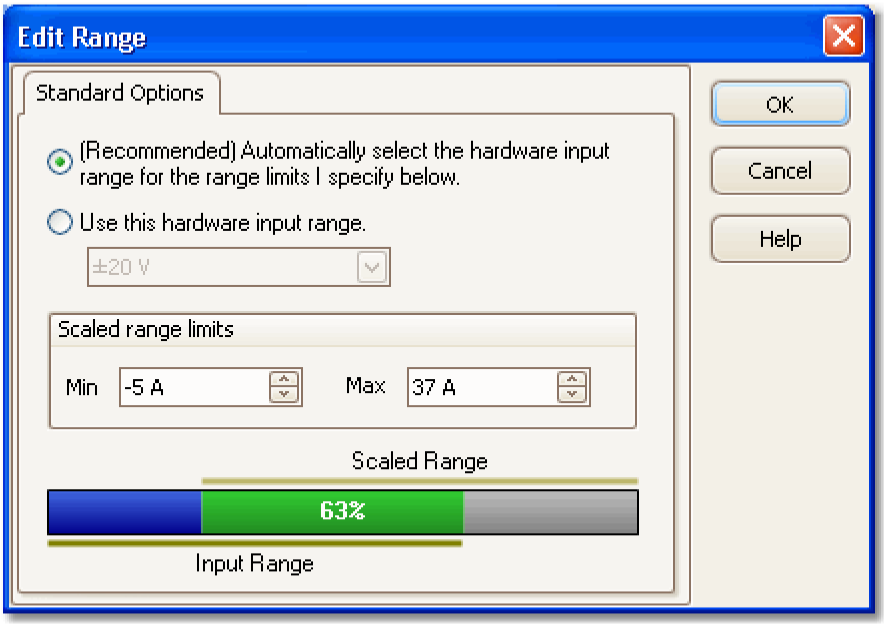
How to use a new custom range

After you have created a custom range, it will appear in the drop-down list of ranges in the channels toolbar, 67 like this:



6.5.2.6.1 Edit Range dialog

Get here by clicking the Edit or New Range buttons in the Manual Ranges Setup dialog 50.



This dialog allows you to edit a manual range for a custom probe.

Automatic mode

If you leave the "Automatic" radio button pressed, the program will automatically determine the best hardware input range for the device as you change the Scaled range limits. This is the best mode to use for almost all ranges. You should set the Scaled range limits to the maximum and minimum values you wish to see on the vertical axis of the scope display.

Fixed range mode

If you press the "Hardware input range" radio button and select a hardware input range from the drop-down box, PicoScope will then use that hardware input range whatever scaled range limits you choose. Set the upper and lower scaled range limits to the limits you wish to appear at the top and bottom of the vertical axis in PicoScope's scope view. 14

What is an input range?

An input range is the signal range, usually in volts, on the input channel of the scope device 113. Your scaled range should match this as closely as possible to make the most of the scope's resolution.

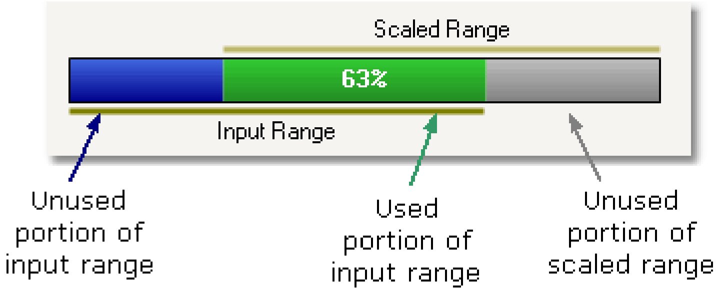
What is a scaled range?

The scaled range is the range that will appear on the vertical axis of the scope display when the probe is selected.

The scaling that you chose on the Scaling Method 47 page defines the relationship between the input range and the scaled range. This dialog enables you to set up ranges to display the scaled data on the scope view.

The range utilisation bar

This diagram at the bottom of the dialog represents the relationship between the scaling and the hardware input range of the scope device.

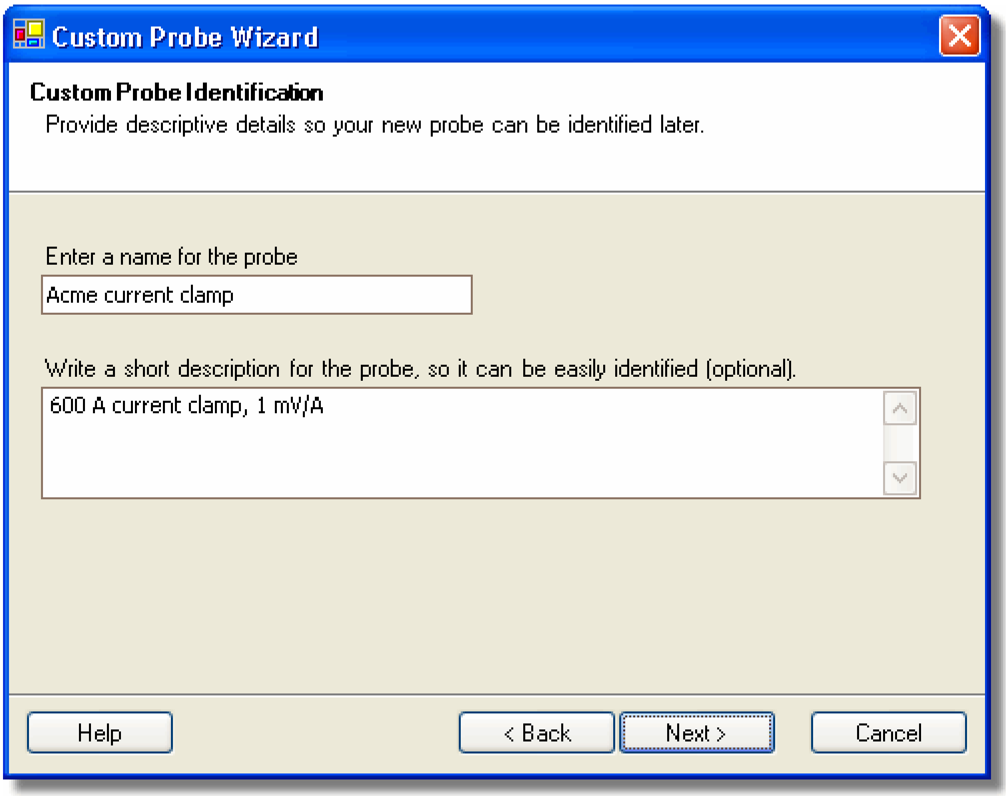


- Green - The section of the input range that is used by the scaled range. This should be as large as possible, to maximise the use of the scope device's resolution.
- Blue - Areas of the input range that are not being used. These indicate wasted resolution.
- Grey - Parts of the scaled range that are not covered by the input range. These will result in wasted space on the graph. The range utilisation bar may not represent these areas accurately when non-linear scaling is being used, so you should always test the scaled range limits on the scope view.

Finishing
Clicking OK or Cancel will return you to the Manual Ranges Setup dialog 50.

6.5.2.7 Custom Probe Identification dialog

This dialog follows the Range Management dialog. 49 It allows you to enter text to identify the custom probe.



How to use the dialog

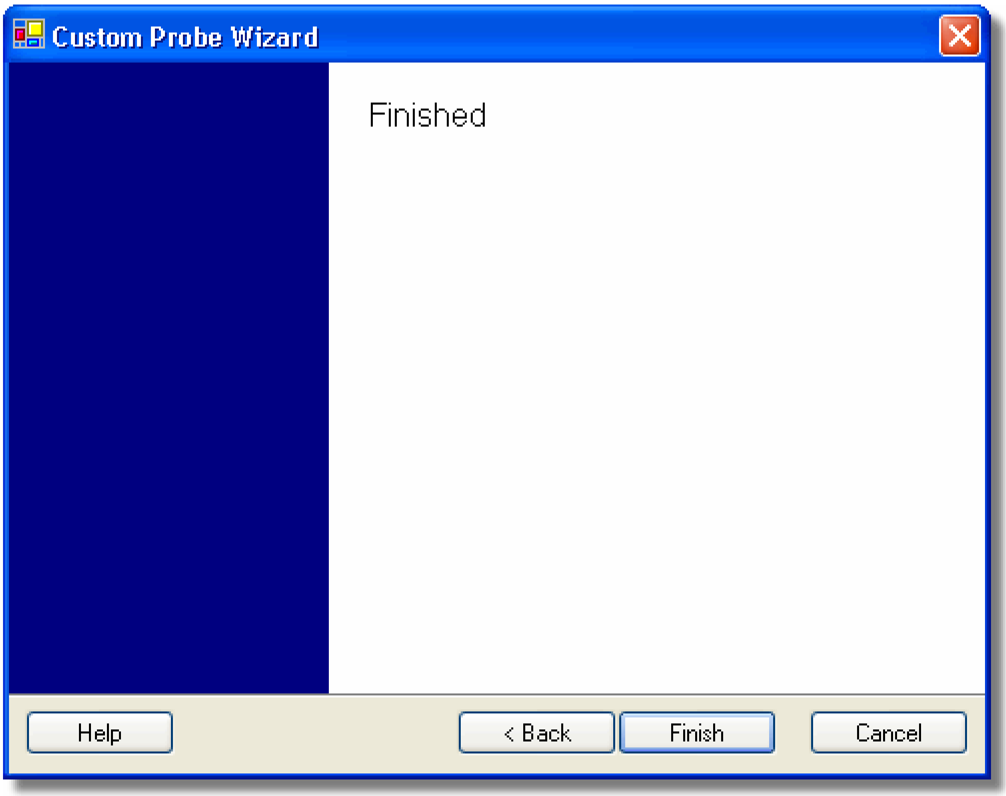
Click Back to return to the Range Management dialog 49 (or the Manual Ranges Setup dialog 50 if you chose manual setup).

- The probe name will appear in the probe list.
- The description is not used in the present version of the software.

Fill in the text fields and click Next to continue to the Custom Probe Finished dialog. 54

6.5.2.8 Custom Probe Finished dialog

This dialog follows the Custom Probe Identification dialog 53. It displays a summary of the custom probe that you have just set up.



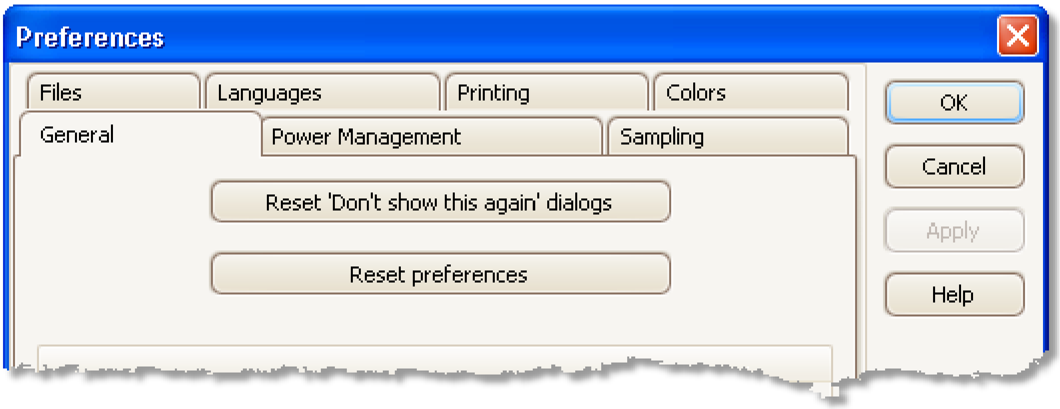
How to use the dialog

Click Back to return to the Custom Probe Identification dialog 53.

Click Finish to accept your custom probe settings and return to the Custom Probes dialog 42.

6.5.3 Preferences dialog

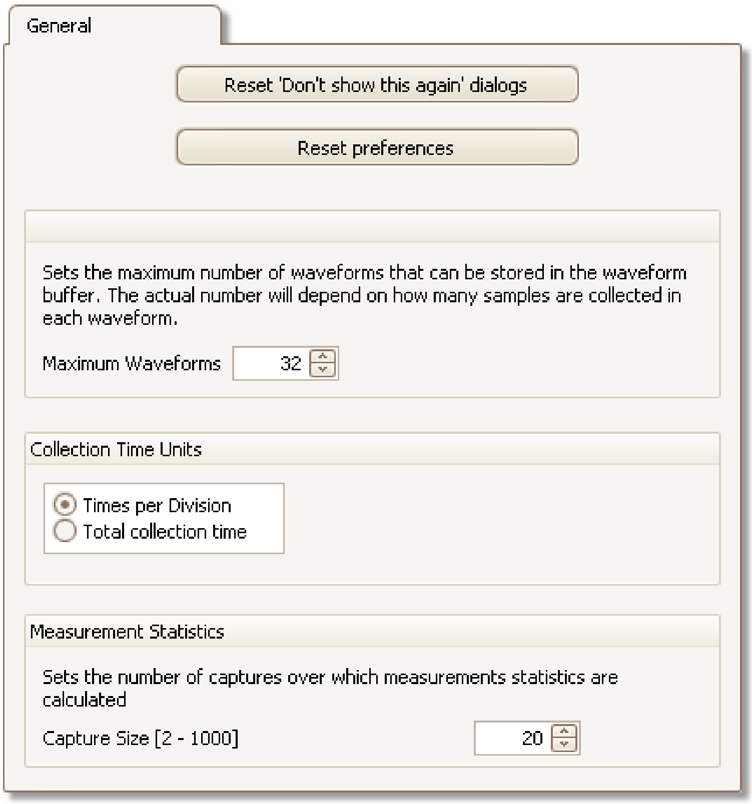
Click the Preferences command in the Tools menu 41 on the Menu bar 27.



This dialog allows you to set miscellaneous options for the PicoScope software. Click one of the tabs on the screen shot above to learn more.

6.5.3.1 General page

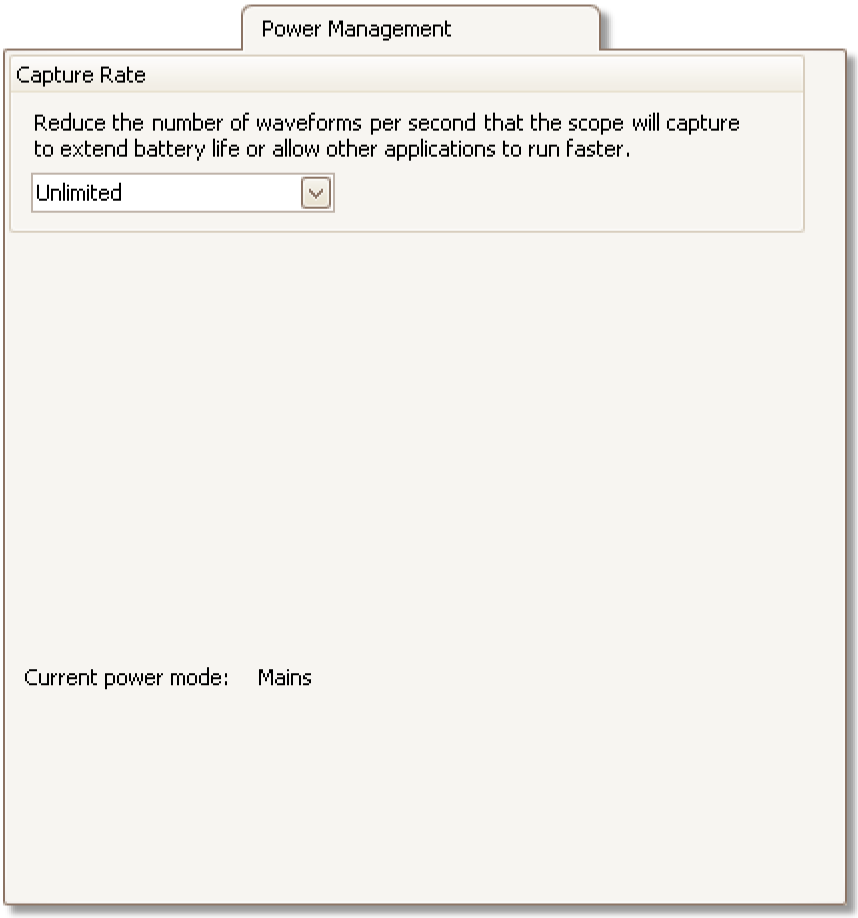
This page is part of the Preferences dialog 55. It contains general controls for PicoScope.



Reset 'Don't show this again' dialogs	Restore any missing dialogs that you asked PicoScope not to show again.
Reset preferences	Set all preferences back to their default values.
Waveform Buffer	Maximum Waveforms: This is the maximum number of waveforms that PicoScope will store in the waveform buffer 66. The actual number of waveforms stored depends on the available memory and the number of samples in each waveform. PicoScope allows up to 1,000 waveforms to be stored.
Collection Time Units	Change the mode of the Timebase control in the Capture Setup toolbar 71. Times per division - the Timebase control displays time units per division - for example, '5 ns /div'. Most laboratory oscilloscopes display timebase settings in this way. Total collection time - the Timebase control displays time units for the entire width of the scope view - for example, '50 ns'.
Measurement Statistics	Capture Size - the number of successive captures that PicoScope uses to calculate the statistics in the Measurements Table 18. A larger number produces more accurate statistics but causes them to be updated less frequently.

6.5.3.2 Power management page

This page is part of the Preferences dialog 55. It controls features of the oscilloscope that affect its power consumption.



Capture Rate

This control limits the speed at which PicoScope captures data from the scope device. The other PicoScope settings, the type of scope device 113 and the speed of the computer will all affect whether this limit can actually be reached. PicoScope automatically selects the appropriate limit according to whether your computer is running on batteries or on mains (line) power.

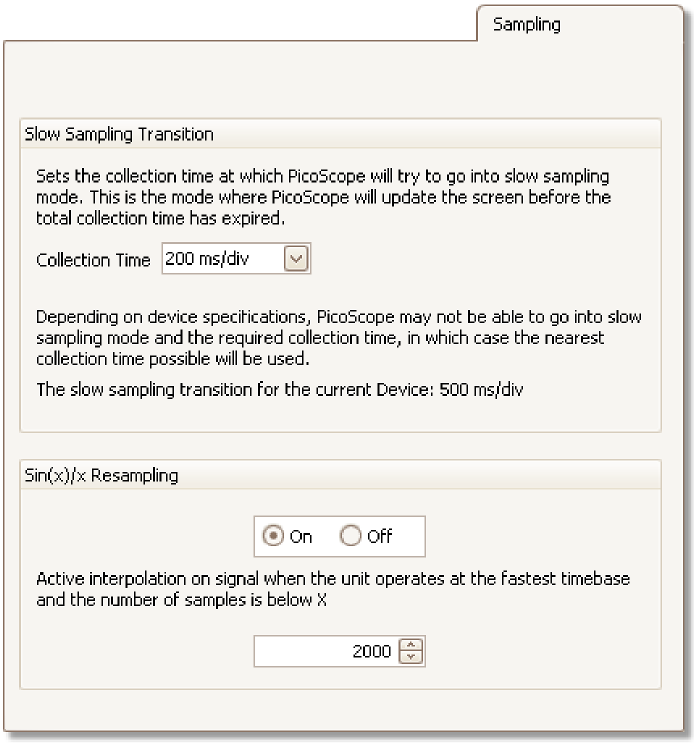
The settings are in captures per second. By default, the capture rate is set to "Unlimited" when your computer is running on Mains (AC) power, for maximum performance. If other applications run too slowly on your PC whilst PicoScope is capturing, then reduce the capture rate limit. When your computer is running on Battery power, PicoScope imposes a performance limit to save the battery. You can increase this limit manually, but this will cause the battery power to drain very quickly.

Probe Light

Some PicoScope oscilloscopes have a built-in probe tip light, which is switched on by default. You can switch it off here to save power.

6.5.3.3 Sampling page

This page is part of the Preferences dialog 55. It controls the sampling behaviour of the oscilloscope.



Slow Sampling Transition

In normal (fast) sampling mode, PicoScope collects enough data to fill the scope view 14, then redraws the whole view at once. This method is suitable for fast timebases, when the whole process repeats many times each second, but with slow timebases it can cause a unacceptable delay between the start of capture and the data appearing on the screen. To avoid this delay when using slow timebases, PicoScope automatically switches to slow sampling mode, in which you can see the scope trace being drawn across the screen from left to right as the scope device captures data.

The Collection Time control lets you select the timebase at which PicoScope switches to slow sampling mode.

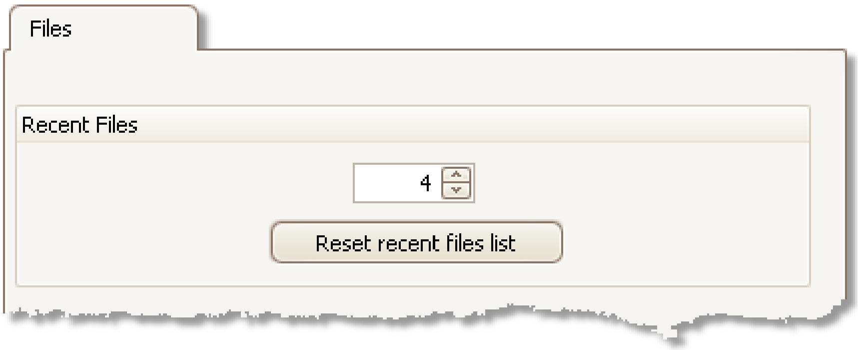
Sin(x)/x Resampling

When the number of pixels across the scope view is greater than the number of samples in the waveform buffer, PicoScope interpolates - that is, it fills the space between the samples with estimated data. It can either draw straight lines between the samples (linear interpolation) or connect them with smooth curves (sin(x)/x interpolation). Linear interpolation makes it easier to see where the samples are, which is useful for high-accuracy measurements, but results in a jagged waveform. Sin(x)/x interpolation gives a smoother waveform, but disguises the true locations of the samples, so should be used with care when the number of samples on the screen is low.

The numerical control box lets you set the number of samples below which sin(x)/x interpolation is switched on. Sin(x)/x interpolation is only used on the scope's fastest timebase.

6.5.3.4 Files page

This page is part of the Preferences dialog 55. It controls features related to the File menu 28.



Recent Files	The File menu 28 includes a list of recently opened and saved files. This control allows you to specify the maximum number of files on the list. Click the button to clear the list.

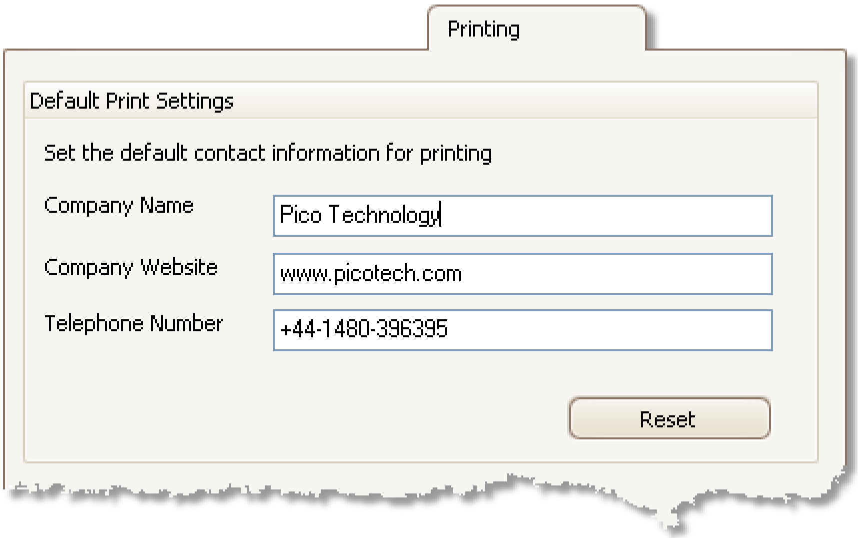
6.5.3.5 Languages page

This page is part of the Preferences dialog 55. It lets you select the language for PicoScope's user interface.

Language	Select a language from the drop-down box.

6.5.3.6 Printing page

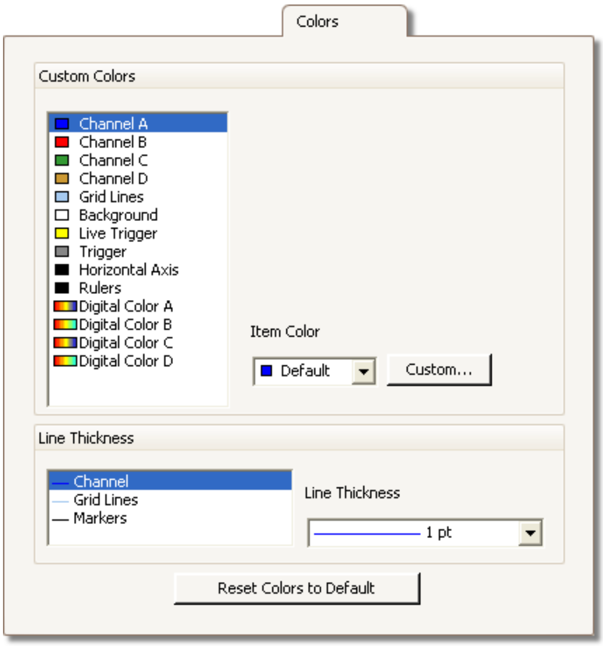
This page is part of the Preferences dialog 55. It lets you enter the details that will appear at the bottom of printed output.



Default Print Settings	When you print a view from the File menu 28, these details will be added to the bottom of the page.

6.5.3.7 Colors page

This page is part of the Preferences dialog 55. It lets you set the colors for various parts of the user interface.



Custom Colors

These controls let you specify the colors for various parts of the PicoScope screen:

Channel A	- the waveform for the first scope channel 14 (and so on)
Grid lines	- the horizontal and vertical lines on the graticule 112
Background	- the area behind the waveforms and graticule. (In persistence mode 17 this setting can be overridden by the Persistence Options dialog 74.)
Live trigger	- the trigger marker 15 for the current trigger position
Trigger	- secondary trigger marker (appears when the live trigger has moved since the last waveform capture)
Horizontal axis	- the numbers across the bottom of each view 14, which usually indicate time measurements
Rulers	- the horizontal and vertical rulers 113 that you can drag into position to help measure features on the waveform.
Digital Color A	- the three colors to use for digital color persistence mode 17. The top color is for "hot" data (new or more frequent, depending on the mode), the middle color for intermediate data, and the bottom color for "cold" data (old or intermittent, depending on the mode).]

Line Thickness

These controls let you specify the thickness of the lines drawn on the scope 14 and spectrum 16 views:

Channel	- the waveforms and spectrum traces for all scope channels
Grid Lines	- as above
Markers	- as above

Reset Colors Default

Resets all of the color and line thickness settings to their default values.

6.6 Help menu

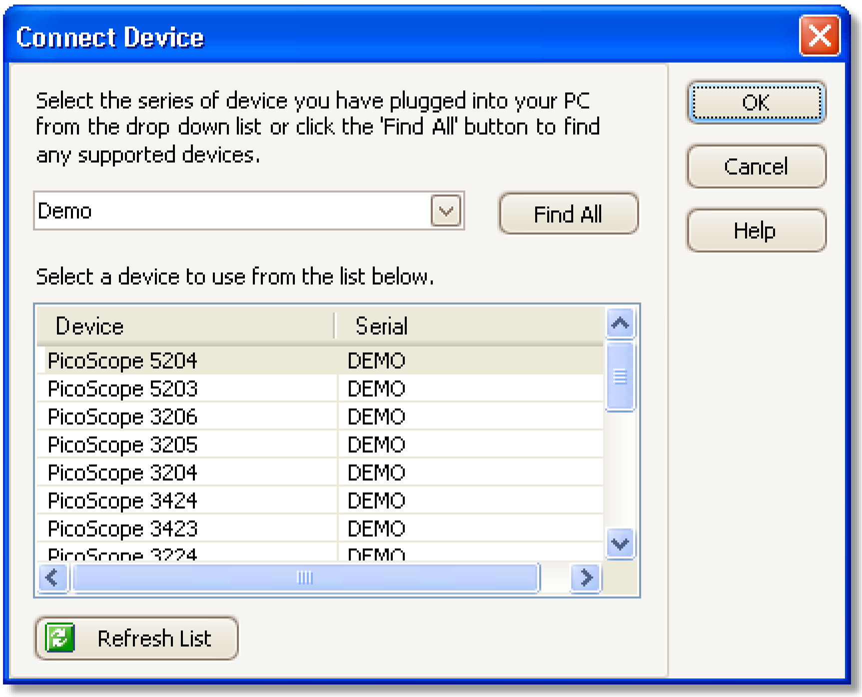
Click Help on the Menu bar 27.

Reference Manual. This is the main help manual, containing complete information on the program. Contents, Index and Search are shortcuts to the functions of the same names that can be found in the help window.

About PicoScope... Shows information about this version of PicoScope.

6.7 Connect Device dialog

Select the File menu 28 and then the Connect Device command.



When PicoScope is not sure which scope device 113 to use, it displays a list of all the units attached to your computer and allows you to select which one to use.

See "How to change to a different scope device 90" if you wish to switch to a different scope device later.

Procedure

- To restrict the selection to a particular series of devices, click on the device drop-down box and select a device series; otherwise, click the Find All button.
- Wait for a list of devices to appear in the grid.
- Select one device and click the OK button.
- PicoScope will open a scope view 14 for the selected scope device.
- Use the toolbars 65 to set up the scope device 113 and the scope view 14 to display your signals.

Demonstration mode

If you start PicoScope with no scope device 113 connected, the Connect Device dialog automatically appears with a list of Demonstration devices for you to choose from. Once you have selected a demonstration device and clicked OK, PicoScope adds a Demo Signals toolbar 87 to the main window. Use this toolbar to set up the test signals from your demonstration device.

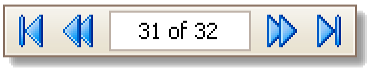
7 Toolbars

A toolbar is a collection of buttons and controls with related functions. The Measurements toolbar 70, for example, looks like this:

PicoScope 6 contains the following toolbars:

7.1 Buffer Navigation toolbar

The Buffer Navigation toolbar allows you to select a waveform from the waveform buffer.



What is the waveform buffer?

Depending on the settings you have chosen, PicoScope may store more than one waveform in its waveform buffer. When you click the Start 79 button or change a capture setting 71, PicoScope clears the buffer and then adds a new waveform to it each time the scope device captures data. This continues until the buffer is full or you click the Stop 79 button. You can limit the number of waveforms in the buffer to a number between 1 and 1,000 using the General preferences 56 page.

You can review the waveforms stored in the buffer using these buttons:

First waveform button. Display waveform 1.

Previous waveform button. Display the previous waveform in the buffer.

Waveform number indicator. Show which waveform is currently displayed, and how many waveforms the buffer holds. You can edit the number in the box and press Enter, and PicoScope will jump to the specified waveform.

Next waveform button. Display the next waveform in the buffer.

Last waveform button. Display the last waveform in the buffer.

7.2 Channel Setup toolbar

The Channel Setup toolbar controls the settings for each vertical input channel [112]. The screen shot below shows the toolbar for a two-channel scope device [113], but different scope devices may have different numbers of channels.

Each channel has its own set of buttons:

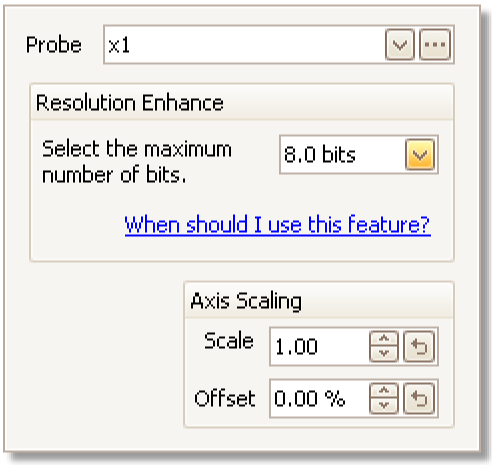
Scale Control. Determines the maximum and minimum signal levels at the top and bottom of the vertical axis for this channel. The number of options depends on the selected scope device [113] and probe [112]. If you select Auto, PicoScope will continually adjust the vertical scale so that the height of the waveform fills as much of the view as possible.

Coupling Control. Selects AC coupling [112] or DC coupling [112].

Channel Options button. Opens the Advanced Options menu [68] with options for probes, [112] resolution enhancement [20] and scaling. [69]

7.2.1 Advanced Options menu

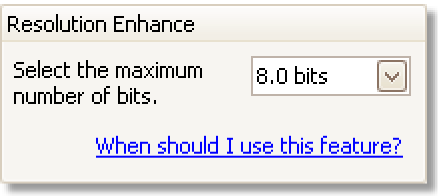
The Advanced Options menu appears when you click the  Channel Options button on the Channel Setup toolbar 67.



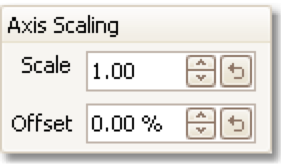
Probe list. Indicates the probe currently in use and allows you to select a different one. Use it to tell PicoScope what type of probe is connected to a channel. By default, the probe is assumed to be x1, which means that a one-volt signal at the input to the probe will appear as one volt on the display.

Expand probe list. Click this to select from a list of probes.

Open Custom Probes dialog. The Custom Probes dialog 42 allows you to edit your library of custom probes.



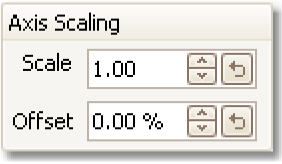
Resolution enhance. Allows you to increase the effective resolution of your scope device using Resolution enhancement 20. The number in this box is a target value that the software will attempt to use whenever possible.



Axis Scaling. These are the axis scaling controls 69 that allow you to set the scale and offset for each vertical axis individually.

7.2.1.1 Axis scaling controls

The axis scaling controls let you change the scale and offset of each vertical axis individually.

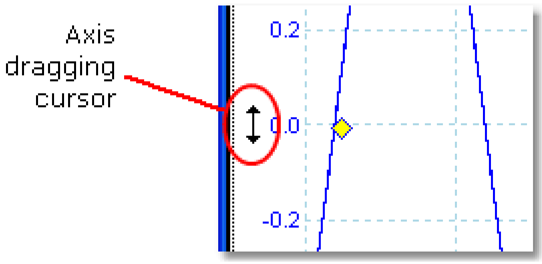


There are two ways to obtain these controls: -

- Click the axis tab (x1.0) at the bottom of a vertical axis in a view 13
- Click the probe drop-down menu 68

Scale control. Increase to magnify the waveform, decrease to reduce it. The vertical axis rescales accordingly so that you can always read the correct voltage from the axis. Click the reset button () to return to a scale of 1.0.

Offset control. Increase to move the waveform up the display, decrease to move it down. The vertical axis shifts accordingly so that you can always read the correct voltage from the axis. Adjusting this control is equivalent to clicking and dragging the vertical axis. Click the reset button () to return to an offset of 0.00%.



7.3 Measurements toolbar

The Measurements toolbar controls the measurements table [18].

It contains the following buttons:

	Add Measurement	Adds a row to the table, and then opens the Add Measurement dialog. [38]
	Edit Measurement	Opens the Edit Measurement dialog [38] for the currently selected measurement. You can also edit a measurement by double-clicking on a row of the measurements table. [18]
	Delete Measurement	Deletes the currently selected row from the measurements table [18].

7.4 Capture Setup toolbar

The Capture Setup toolbar controls the time-related or frequency-related settings of your oscilloscope.

Scope Mode

In scope mode, 11 the toolbar looks like this:

(See below for different versions of the toolbar in spectrum mode 72 and persistence mode 17.)

Scope Mode. Sets up PicoScope to operate as an oscilloscope 11. Use the Auto Setup button to optimise the settings. If you wish, you can add a secondary spectrum view 16 from the context menu (by right-clicking on the scope view).

Persistence Mode. Toggles persistence mode 17, which allows old traces to remain on the screen in faded colors while new traces are drawn on top in brighter colors. The use of colors is controlled by the Persistence Options dialog. PicoScope will remember any views that were open, so that you can return to them by clicking the Persistence Mode button again.

Spectrum Mode. Sets up PicoScope to operate as a spectrum analyser 11. Use the Auto Setup button to optimise the settings. If you wish, you can add a secondary scope view 14 from the context menu (by right-clicking on the scope view).

Auto Setup. Searches for a signal on one of the enabled input channels, then sets up the timebase and signal range to display the signal correctly.

Timebase control. Sets the time represented by a single division of the horizontal axis when the horizontal zoom control is set to x1. The timebases available depend on the type of scope device 113 you are using.

Choosing a timebase of 200 ms/div or slower causes PicoScope to switch to a different mode of data transfer. The internal details of this are taken care of by PicoScope, but the slow mode limits the sampling rate to a maximum of 1 million samples per second.

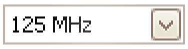
You can change this control to display the total time across the scope view, rather than the time per division, using the Collection Time Units control in the General 56 page of the Preferences dialog 55.

Horizontal zoom control. Zooms the view, in the horizontal direction only, by the specified amount. Click the [+] and [-] buttons to adjust the zoom factor, or the [reset] button to reset.

Samples control. Sets the maximum number of samples that will be captured. If this is larger than the number of pixels across the scope view, then you can zoom in to see more detail. The actual number of samples captured is displayed on the Properties sheet, 25 and may be different from the number requested here, depending on which timebase is selected.

Spectrum Mode

In spectrum mode, 11 the Capture Setup toolbar looks like this:



Frequency range control. Sets the frequency range across the horizontal axis of the spectrum analyser when the horizontal zoom control is set to x1.

Spectrum Options. Appears if a spectrum view 16 is open, regardless of whether scope mode 11 or spectrum mode 11 is selected. It opens the Spectrum Options dialog 72.

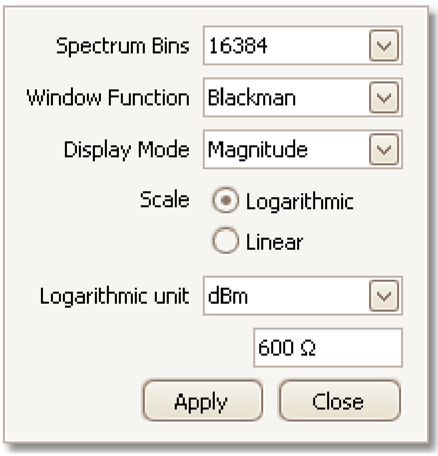
Persistence Mode

In persistence mode, 17 the Capture Setup toolbar looks like this:

Persistence Options. Opens the Persistence Options dialog 74, which controls the colors used to represent old and new waveforms in persistence mode.

7.4.1 Spectrum Options dialog

This dialog appears when you click the Spectrum Options button in the Capture Setup toolbar 71. It is available only when a spectrum view 16 is open. It contains controls that determine how PicoScope converts the source waveform in the current scope view to a spectrum view.



Spectrum Bins

The number of frequency bins into which the spectrum is divided. This control sets the maximum number of frequency bins, which the software may or may not be able to provide depending on other settings. The main constraint is that the number of bins cannot greatly exceed half the number of samples in the source waveform.

If the source waveform contains fewer samples than required (that is, fewer than twice the number of frequency bins), then PicoScope zero-pads the waveform up to the next power of two. For example, if the scope view contains 10,000 samples, and you set Spectrum Bins to 16384, then PicoScope zero-pads the waveform to 16,384 samples, which is the nearest power of two above 10,000. It then uses these 16,384 samples to provide 8,192 frequency bins, not the 16,384 requested.

If the source waveform contains more samples than required, then PicoScope uses as many samples as necessary, starting from the beginning of the waveform buffer. For example, if the source waveform contains 100,000 samples and you request 16,384 frequency bins, PicoScope needs only 2 x 16,384 = 32,768 samples, so it uses the first 32,768 samples from the waveform buffer and ignores the rest. The amount of data actually used is displayed as the Time Gate setting in the Properties sheet. [25]

Window Function

Allows you to choose one of the standard window functions to reduce the effect of operating on a time-limited waveform. See Window functions. [108]

Display Mode

You can choose Magnitude, Average or Peak Hold.

Magnitude: the spectrum view shows the frequency spectrum of the last waveform captured, whether live or stored in the waveform buffer. [66]

Average: the spectrum view shows an rolling average of spectra calculated from all the waveforms in the waveform buffer [66]. This has the effect of reducing the noise visible in the spectrum view. To clear the averaged data, click Stop [79] and then Start, [79] or change from Average mode to Magnitude mode.

Peak Hold: the spectrum view shows a rolling maximum of the spectra calculated from all the waveforms in the buffer. In this mode, the amplitude of any frequency band in the spectrum view will either stay the same or increase, but never decrease, over time. To clear the peak hold data, click Stop [79] and then Start, [79] or change from Peak Hold mode to Magnitude mode.

Note: when you switch to Average or Peak Hold mode, there may be a noticeable delay while PicoScope processes the entire contents of the waveform buffer, which may contain many waveforms, to build up the initial display. If this occurs, a progress bar appears at the bottom of the window to show that PicoScope is busy:

Scale

Specifies the labelling and scaling of the vertical (signal) axis. This can be one of the following:

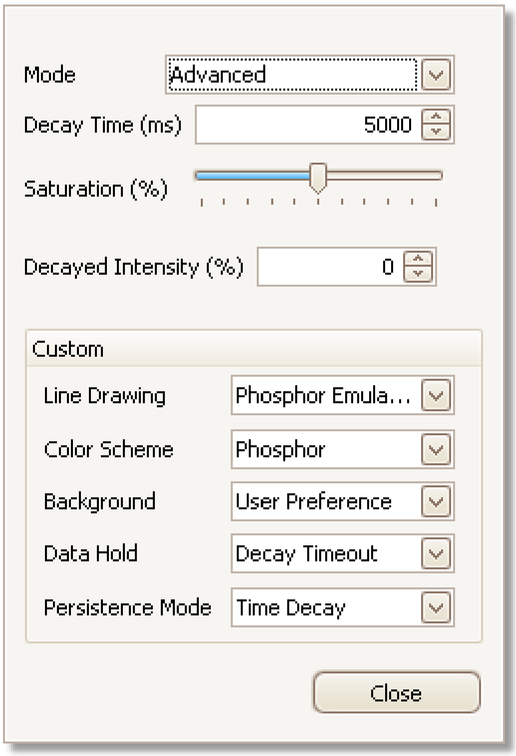
Linear: The vertical axis is scaled in volts.

Logarithmic: The vertical axis is scaled in decibels, referred to the level selected below in the Logarithmic unit control.

- dBV: Reference level is 1 volt.
- dBu: Reference level is 1 milliwatt with a load resistance of 600 ohms. This corresponds to a voltage of about 775 mV.
- dBm: Reference level is one milliwatt into the specified load impedance. You can enter the load impedance in the box below the Logarithmic unit control.
- Arbitrary dB: Reference level is an arbitrary voltage, which you can specify in the box below the Logarithmic unit control.

7.4.2 Persistence Options dialog

This dialog appears when you click the Persistence Options button  in the Capture Setup toolbar 71. It is available only when persistence mode 17 is selected. It controls the colors and fading algorithm used to distinguish new or frequent data from old or intermittent data in the persistence view.



Mode Digital Color. This mode uses a range of colors to indicate the frequency of waveform data. Red is used for the most frequent data, and less frequent data is represented successively by yellow and blue.

	Analog Intensity. This mode uses color intensity to indicate the age of waveform data. The latest data is drawn at full intensity in the selected color for that channel, with older data being represented by paler shades of the same color. Advanced. This mode opens up a Custom Options section at the bottom of the dialog that let you customise the persistence mode display.
Decay Time	The time, in milliseconds, taken for waveform data to fade from maximum intensity to minimum intensity or from red to blue. The longer the decay time, the longer the older waveforms will remain on the screen.
Saturation	The intensity or color with which new waveforms are drawn.
Decayed Intensity	The intensity or color to which the oldest waveforms decay when the decay time expires. If the decayed intensity is zero, then older waveforms will be completely erased from the display after the decay time. For non-zero values of decayed intensity, old waveforms will remain indefinitely on the screen at that intensity unless overwritten by new ones.
Custom Options	
Line Drawing	The type of line drawn between samples that are adjacent in time. Phosphor Emulation. Joins each pair of sample points with a line whose intensity varies inversely with the slew rate. Constant Density. Joins each pair of sample points with a line of uniform color. Scatter. Draws sample points as unconnected dots.
Color Scheme	Phosphor. Uses a single hue for each channel, with varying intensity. Color. Uses a color from red to blue to represent the age of each waveform.
Background	Black. Overrides the Color Preferences dialog 62. This is the default. White. Overrides the Color Preferences dialog 62. User Preference. Sets the background color to the preference set in the Colors 62 page of the Preferences dialog 55.
Data Hold	This option is enabled only when Persistence Mode (see below) is set to Time Delay. Decay Timeout. Old waveforms fade until they reach Decayed Intensity and then disappear. Infinite. Old waveforms fade until they reach Decayed Intensity and then remain indefinitely unless overwritten by new waveforms.
Persistence Mode	Frequency. Points on the display are drawn with a color or intensity that depends on the frequency with which they are hit by waveforms. Time Delay. Points on the display are drawn at full intensity when hit by a waveform, and are then allowed to decay to Decayed Intensity. The behaviour after this depends on the Data Hold setting (see above).

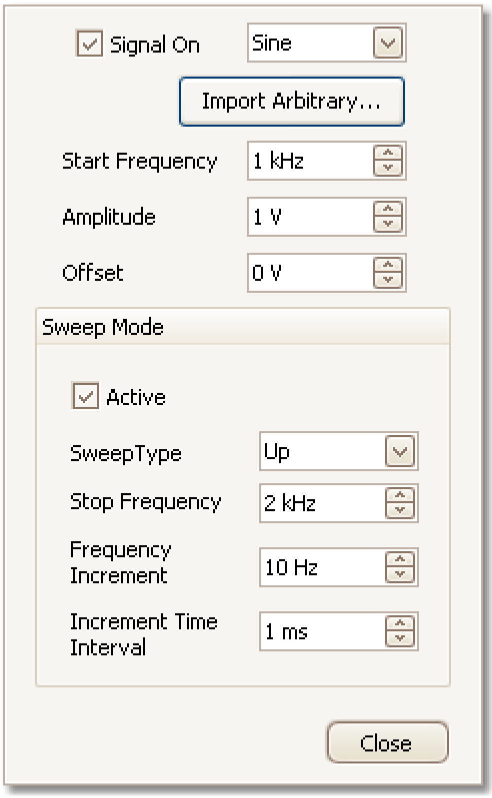
7.5 Signal Generator toolbar

The Signal Generator toolbar allows you to set up your scope device's 113 test signal output. This toolbar appears only when you are using a scope device with a built-in signal generator.

Clicking the Signal Generator button opens the Signal Generator dialog 76.

7.5.1 Signal Generator dialog

Click the Signal Generator button 76 on the toolbar.



Signal generator dialog for the PicoScope 5204

This dialog controls the scope device's 113 built-in signal generator. Not all scope devices have a signal generator, and those that do have a varying range of controls in the signal generator dialog.

How to use it

Signal On. Tick this box to enable the signal generator.

Frequency. Type in this box or use the spin buttons to select the frequency. If the scope device has a frequency sweep generator, then this box sets the start frequency of the sweep.

Signal Type. Select the type of signal to be generated. The list of options depends on the capabilities of the scope device.

Import Arbitrary. For scope units that support arbitrary waveforms, click to import an arbitrary waveform file. 78

Sweep Mode Active. Tick this box to enable sweep mode. Otherwise, the generator will operate at a fixed frequency set by the Start Frequency box.

Repeat Signal. Tick this box to generate a repetitive sweep. Otherwise, the generator will reach Stop Frequency and then remain there.

Dual Slope. In normal mode, the generator increases the frequency linearly from Start Frequency to Stop Frequency, and then immediately begins again at Start Frequency. In Dual Slope mode, it reaches Stop Frequency and then decreases the frequency linearly to Start Frequency before beginning again.

Sweep Type. Specifies the direction in which the frequency sweeps.

Stop Frequency. In Sweep Mode, the generator stops increasing the frequency when it reaches Stop Frequency.

Frequency Increment. In Sweep Mode, the generator increases or decreases the frequency by this amount every Increment Time Interval.

Increment Time Interval. In Sweep Mode, the generator increases or decreases the frequency by Frequency Increment once every time interval of this duration.

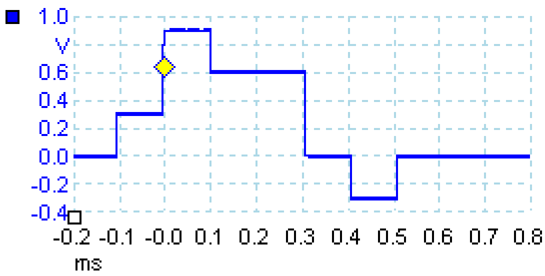
7.5.2 Arbitrary waveform files

Some PicoScope PC Oscilloscopes have an arbitrary waveform generator 112 (AWG). PicoScope can program this with a standard waveform, such as a sine or a square wave, or can import an arbitrary waveform from a text file.

A text file for PicoScope 6 is a list of decimal floating-point values, as in this example:

```
0.0
0.3
0.9
0.6
0.6
0.0
-0.3
0.0
0.0
0.0
```

→



The file may have between 10 and 8,192 values, as many it needs to define the waveform. Each line may have more than one value, in which case the values must be separated by tabs or commas.

The values are samples between –1.0 and +1.0 and must be equally spaced in time. The output is scaled to the amplitude selected in the Signal Generator dialog. 76 and the selected offset is added if necessary. For example, if the signal generator amplitude is set to "1 V", then a sample value of -1.0 corresponds to an output of -1.0 V and a sample of +1.0 corresponds to an output of +1.0 V.

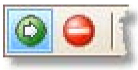
The file should contain exactly one cycle of the waveform, which will then be played back at the speed specified in the Signal Generator dialog 76. In the example above, the signal generator was set to 1 kHz, so one cycle of the waveform lasts for 1 ms. There are 10 samples in the waveform, so each sample lasts for 0.1 ms.

Using files saved from PicoScope 6

As PicoScope 6 can export CSV and TXT files, 31 you can capture a waveform and then play it back using the arbitrary waveform generator. You must first modify the file by removing the header rows and time values so that its format matches the example above.

7.6 Start / Stop toolbar

The Start / Stop toolbar allows you to start and stop the scope device 113 (the scope device whose view 113 is currently in focus 112). The Start button is highlighted if the scope device is sampling; otherwise, the Stop button is highlighted.



 Start button. Click to start sampling.

 Stop button. Click to stop sampling.

You can also use the space bar to start and stop sampling.

7.7 Triggering toolbar

The Triggering toolbar tells the scope device when to start capturing data. See also: Trigger. 113

Trigger Mode.

None: PicoScope acquires waveforms repeatedly without waiting for a signal.

Auto: PicoScope waits for a trigger event before capturing data. If there is no trigger event within a specified time, it captures data anyway. It repeats this process until you click the Stop button. 79 "Auto" mode does not set up the trigger level automatically; you still need to do this yourself.

Repeat: PicoScope waits indefinitely for a trigger event before displaying data. It repeats this process until you click the Stop button 79. If there is no trigger event, PicoScope displays nothing.

Single: PicoScope waits once for a trigger event, then stops sampling. To make PicoScope repeat this process, click the Start 79 button.

ETS: Equivalent Time Sampling. 112 PicoScope captures several cycles of a repetitive signal, then combines the results to produce a single waveform with higher time-resolution than a single capture. For accurate results, the signal must be perfectly repetitive and the trigger must be stable.

If you select ETS when an Advanced Trigger 82 type is enabled, the trigger type will revert to Simple Edge and the Advanced Triggering button will be disabled.

Advanced Triggering. Click to open the Advanced Triggering dialog, 82 which gives you extra trigger types beyond the simple edge trigger. If this button is disabled, it is because either None or ETS is selected in the trigger mode control. If you want to enable the Advanced Triggering button, set the control to another trigger mode, such as Auto, Repeat or Single.

Trigger Source. This is the channel that PicoScope monitors for the trigger 113 condition.

Rising Edge. Click to trigger on the rising edge of the waveform.

Falling Edge. Click to trigger on the falling edge of the waveform.

Trigger Level. Sets the trigger 113 level. You can also set the trigger level by dragging the trigger marker 15 up or down on the screen.

Pre-trigger Time (0% to 100%). This parameter controls how much of the waveform appears before the trigger point. It defaults to 50%, which puts the trigger marker 15 in the middle of the screen. You can also control this parameter by dragging the trigger marker 15 to the left or right.

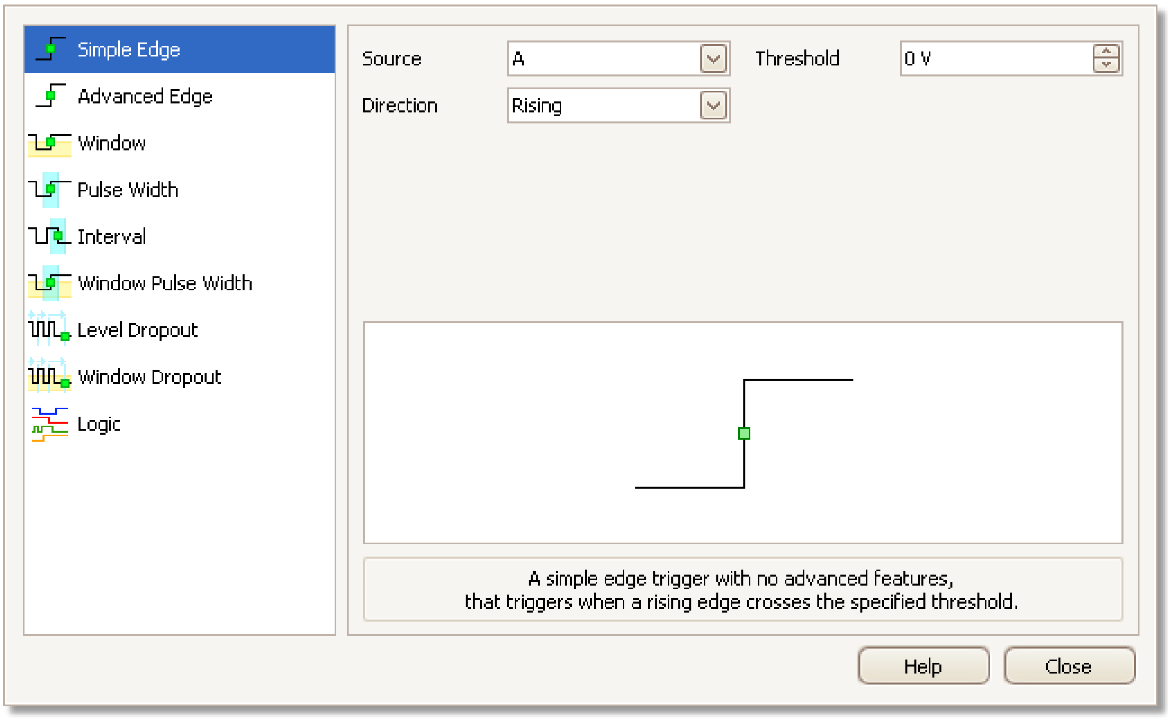
Post-trigger Delay Enable. Click this button to toggle the Post-trigger Delay control (see next item).

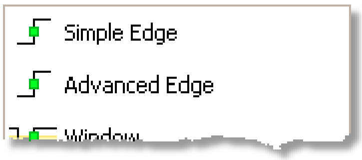
Post-trigger Delay. The post-trigger delay is the time that PicoScope waits after the trigger point before sampling. You can also modify this parameter by dragging the trigger marker 15 while the Post-trigger Delay button is enabled. As you drag the marker, you will see the post-trigger arrow 15 displayed briefly. For this control to have an effect, you must first make sure that the Post-trigger Delay button is enabled.

See the reference topic "Trigger Timing 109" for information on how the Pre-trigger Time and Post-trigger Delay controls interact.

7.7.1 Advanced Triggering dialog

This dialog appears when you click the Advanced Triggering button in the Triggering toolbar. 80 It allows you to set up more complex trigger types than simple edge-triggering.





Advanced trigger types list. This control lists all the available advanced trigger types. 83 Click on the condition you require, and a diagram and description will appear on the right of the dialog.

If ETS triggering 112 is enabled in the triggering toolbar 80, then selecting any trigger type except Simple Edge switches off ETS mode.

Advanced triggering options. The options available depend on the trigger type selected. See Advanced trigger types. 83 Instructions and diagrams also appear in the dialog.

7.7.2 Advanced trigger types

The advanced trigger types can be switched on in the Advanced Triggering dialog. 82

For all trigger types, the first step is to select which signal the scope should use as the trigger; so set Source to either A, B, Ext or AuxIO. These names correspond to the BNC input connectors on the scope device. Then choose one of the trigger types below.

Simple Edge. This type provides the same Rising and Falling edge triggers that are available from the Triggering toolbar. 80 It is included in this dialog as an alternative method of setting up the Simple Edge trigger.

You can set the trigger Threshold while in the advanced triggering dialog, or alternatively you can drag the Trigger marker 15 on the scope view.

This is the only trigger type that is compatible with ETS 112 mode.

Advanced Edge. This trigger type adds an extra Rising or Falling edge trigger, and Hysteresis, to the Simple Edge trigger. The Rising or Falling option triggers on both edges of a waveform, and is useful for monitoring pulses of both polarities at once. Hysteresis 85 is described in a separate topic.

Window. This trigger type detects when the signal enters or leaves a specified voltage window. The Direction control specifies whether the trigger should detect the signal entering the window, leaving it, or both. Threshold 1 and Threshold 2 are the upper and lower voltage limits of the window. The order in which you specify the two voltages does not matter. Hysteresis 85 can be set to reduce the number of false triggers on a noisy signal, and is described in a separate topic.

Pulse Width. This trigger type detects pulses of a specified width.

First set the Pulse Direction to either Positive or Negative according to the polarity of the pulse you are interested in.

Next, set one of the four Condition options:

Greater than triggers on pulses wider than the specified time.

Less than triggers on pulses that are narrower (useful for finding glitches).

Inside time range triggers on pulses that are wider than Time 1 but no wider than Time 2 (useful for finding pulses that meet a specification).

Outside time range does the opposite: it triggers on pulses that are either narrower than Time 1 or wider than Time 2 (useful for finding pulses that violate a specification).

Next, set the trigger Threshold in volts or other units, or drag the Trigger marker 15 on the scope view.

Finally, set up Time 1 (and Time 2 if present) to define the pulse width.

Interval. This type lets you search for two successive edges of the same polarity that are separated by a specified interval of time.

First, set the **Starting edge** to either **Rising** or **Falling** according to the polarity of the edges you are interested in.

Next, select one of the four **Condition** options:

Greater than triggers when the second edge occurs later than **Time 1** after the first edge (useful for detecting missing events).

Less than triggers when the second edge occurs earlier than **Time 1** after the first edge (useful for detecting timing violations and spurious edges).

Inside time range triggers when the second edge is later than **Time 1** after the first edge and earlier than **Time 2** (useful for finding valid edges).

Outside time range triggers when the second edge is earlier than **Time 1** after the first edge or later than **Time 2** (useful for finding spurious edges).

Finally, set up **Time 1** (and **Time 2** if present) to define the time interval.

Window pulse width. This is a combination of the window trigger and the pulse width trigger. It detects when the signal enters or leaves a voltage range for a specified period of time.

Level dropout. This detects an edge followed by a specified time with no edges. It is useful for triggering on the end of a pulse train.

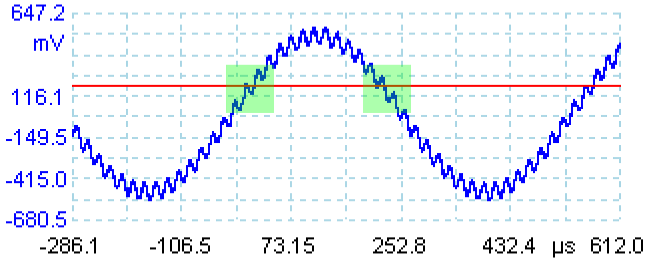
Window dropout. This is a combination of the window trigger and the dropout trigger. It detects when the signal enters a specified voltage range and stays there for a specified time. This is useful for detecting when a signal gets stuck at a particular voltage.

Logic. This can detect a number of logical combinations of the scope's four inputs: A, B, Ext and AUXIO. The conditions that can be applied to each input vary: A and B can be edge-, level- or window-qualified; Ext is level-qualified with a variable threshold; and AUXIO is level-qualified with a fixed TTL threshold.

You can choose to combine the channels with an AND, NAND, OR, NOR, XOR or XNOR function.

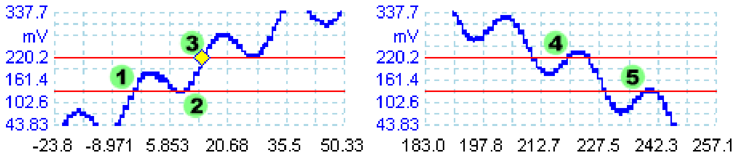
7.7.2.1 Hysteresis

Hysteresis is a feature of the advanced trigger types 83 in PicoScope 6 that reduces false triggering on noisy signals. When hysteresis is enabled, a second trigger threshold voltage is used in addition to the main trigger threshold. The trigger fires only when the signal crosses the two thresholds in the correct order. The first threshold arms the trigger, and the second causes it to fire. An example will help to illustrate how this works.



Noisy signal with a single threshold

Consider the very noisy signal above. It is difficult to trigger reliably on this signal with a normal rising edge trigger because it crosses the trigger threshold, the red line in this picture, several times in one cycle. If we zoom in on the highlighted parts of the signal, we will see how hysteresis can help.



Noisy signal with hysteresis threshold

In these zoomed-in views, the original threshold is the lower red line. The upper red line is the second threshold used by the hysteresis trigger.

The signal rises across the lower threshold at (1) and (2), arming the trigger but not firing it. At (3) the signal finally crosses the upper threshold, firing the trigger. On the falling edge of the signal, at (4) and (5), rising edges of noise pulses cause the signal to cross the upper and lower thresholds, but in the wrong order, so the trigger is not armed and does not fire. Thus the trigger occurs at only one well-defined point in the cycle (3), despite the noise on the signal.

Hysteresis is enabled by default for all the advanced trigger types. The Hysteresis controls in the Advanced triggering dialog 82 let you change the hysteresis voltage as a percentage of full scale. The trigger marker  shows the size of the hysteresis window.

7.8 Zooming and Scrolling toolbar

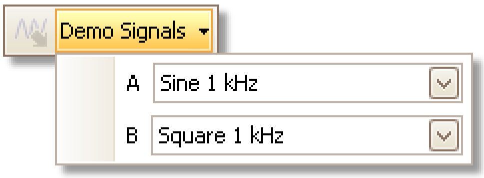
The Zooming and Scrolling toolbar allows you to move around a scope view [14] or spectrum view. [16] Each button has a keyboard shortcut, as listed below.

	Ctrl+S or Esc	Normal Selection tool. Restores the pointer to its normal appearance. You can use this pointer to click buttons, drag rulers [113] and operate any other controls in the PicoScope window.
	Ctrl+D	Hand tool. Turns the pointer into a hand ( ) that you can use to click and drag the view to pan it vertically and horizontally when you are zoomed in. You can also pan using the scroll bars. Press the Esc key to return to the Normal Selection tool.
	Ctrl+M	Marquee Zoom tool. This button turns the pointer into a marquee zoom tool: . Use it to draw a box (called a marquee) on the view and PicoScope will magnify that box to fill the view. Scroll bars will appear, which you can drag to pan around in the view, or you can pan by using the Hand tool (see above). Press the Esc key to return to the Normal Selection tool. If you point to the time axis, the pointer changes into the horizontal marquee zoom tool ( ), which restricts zooming to the horizontal axis. This lets you zoom in by an arbitrary amount without disturbing the vertical zoom factor.
	Ctrl+I	Zoom-in tool. Turns the pointer into a zoom-in tool: Click on the view with this tool to zoom in to the specified location. If you point to the time axis, the pointer changes into the horizontal zoom-in tool ( ), which restricts zooming to the horizontal axis. This lets you zoom in without disturbing the vertical zoom factor.
	Ctrl+O	Zoom-out tool. Turns the pointer into a zoom-out tool: . Click on the view with this tool to zoom out around the specified location. If you point to the time axis, the pointer changes into the horizontal zoom-out tool ( ), which restricts zooming to the horizontal axis. This lets you zoom out without disturbing the vertical zoom factor.
100%	Ctrl+U	Zoom to full view. Resets the view to normal size. The view will no longer have scroll bars, and panning will no longer be possible.

7.9 Demonstration Signals toolbar

The Demonstration Signals toolbar allows you to set up test signals so that you can experiment with PicoScope when no scope device is connected. To use this feature, close PicoScope, unplug all scope devices and then restart the program. PicoScope will prompt you to select a demonstration device using the Connect Device dialog 64.

When you click the button, a drop-down list of all the available channels in your demonstration device appears, like this:

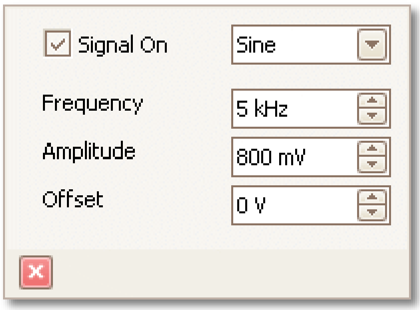


Click one of the channels to open the Demonstration Signals dialog, 88 which will allow you to set up a signal from that channel.

7.9.1 Demonstration Signals dialog

Click the 

button on the Demonstration Signals toolbar. 87 You must have previously selected a "Demo" scope device 113 type in the Connect Device dialog. 64



This dialog controls one channel of the demonstration signal generator, a feature of PicoScope that creates a variety of test signals to simulate a scope device. Open it by clicking the **Demo Signals** button on the Demonstration Signals toolbar 87 and then selecting a channel. It is available only when you start PicoScope with no scope device 113 connected to your computer, and then select a scope device type of "Demo" in the Connect Device dialog 64.

Signal On: Tick this box to enable the demonstration signal generator.

Frequency: Type your desired frequency in hertz, or use the spin buttons.

Amplitude: Type your desired amplitude in millivolts, or use the spin buttons.

Offset: Enter a number to add a d.c. offset to the demo signal. By default, the demo signals have a mean value of zero volts.

8 How to...

This chapter explains how to perform some common tasks.

8.1 How to change to a different scope device

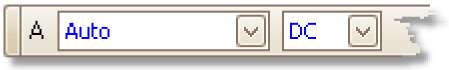
- Close PicoScope
- Unplug the old scope device 113
- Plug in the new scope device
- Restart PicoScope

PicoScope detects that the scope device has changed and immediately starts using the new device. If there is more than one scope device connected, PicoScope continues to use the device that was last selected.

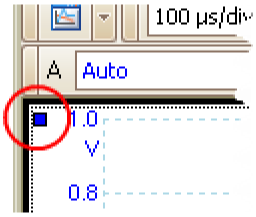
8.2 How to use rulers to measure a signal

Using a single ruler for signal-to-ground measurements

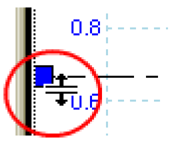
- Look at the Channels toolbar 67 to find the color code for the channel 112 you wish to measure:



- Find the ruler handle (the small colored square in the top-left or top-right corner of the scope view 14 or spectrum view 16) of this color:



- Drag the ruler handle downwards. A signal ruler 22 (horizontal broken line) will appear across the view. Release the ruler handle when the ruler is where you want it.



- Look at the ruler legend 24 (the small table that appears on the view). It should have a row marked by a small colored square matching the color of your ruler handle. The first column shows the signal level of the ruler.

1	2	Δ -
586.0mV	-.-	-.-

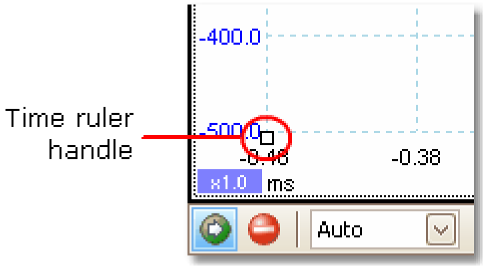
Using two rulers for differential measurements

- Follow the steps above for "using a single ruler".
- Drag the second ruler handle of the same color downwards until its ruler is at the signal level to be measured.
- Look at the ruler legend 24 again. The second column now shows the signal level of the second ruler, and the third column shows the difference between the two rulers.

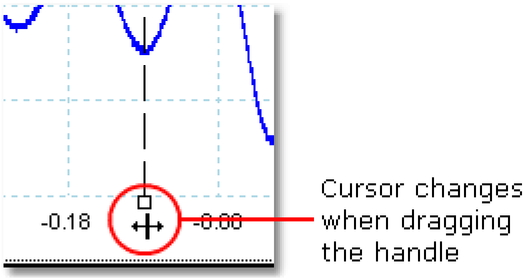
1	2	Δ -
586.0mV	-493.0mV	1.079V

8.3 How to measure a time difference

- Find the time ruler handle (the small white square in the bottom left corner of the scope view 14).



- Drag the ruler handle to the right. A time ruler 23 (vertical broken line) will appear on the scope view. Release the ruler handle when the ruler is at the time you wish to use as the reference.



- Drag the second white ruler handle to the right until its ruler is at the time to be measured.
- Look at the ruler legend 24 (the small table that appears on the scope view). It should have a row marked by a small white square. The first two columns show the times of the two rulers, and the third column shows the time difference.

	1	2	Δ
□	-129.0 µs	-44.0 µs	85.0 µs

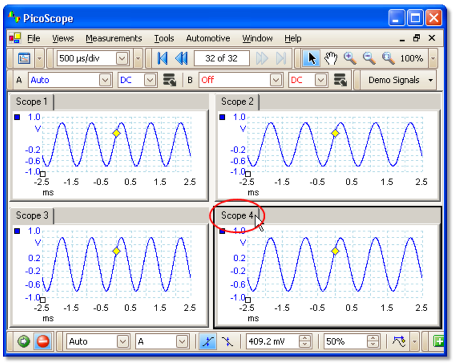
- The frequency legend 24 shows 1/Δ, where Δ is the time difference.

□ 1/Δ 26.32 kHz

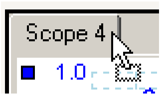
You can use a similar method to measure a frequency difference on a spectrum view. 16

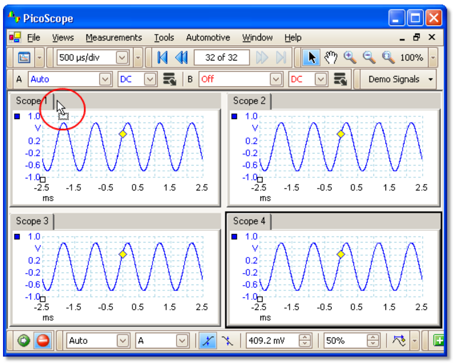
8.4 How to move a view

You can easily drag a view 13 from one viewport 113 to another. This example shows four viewports, which contain scope views 14 called "Scope 1" to "Scope 4". Suppose that you wish to move the "Scope 4" view to the top left viewport.

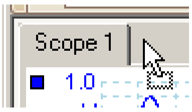


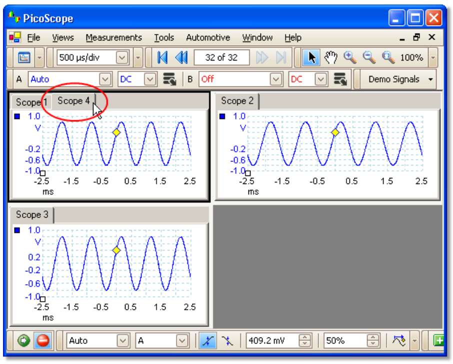
1. Click on the name tab of the "Scope 4" view and hold the mouse button down.





2. Drag the mouse pointer to the new location next to the name tab of the "Scope 1" view.





3. Release the mouse button, and the view will move to the new location.

8.5 How to scale and offset a signal

PicoScope offers two ways to change the size and position of a signal during or after capture. These methods apply equally to scope views 14 and spectrum views. 16 They do not change the stored data, only the way in which it is displayed.

Global zooming and scrolling

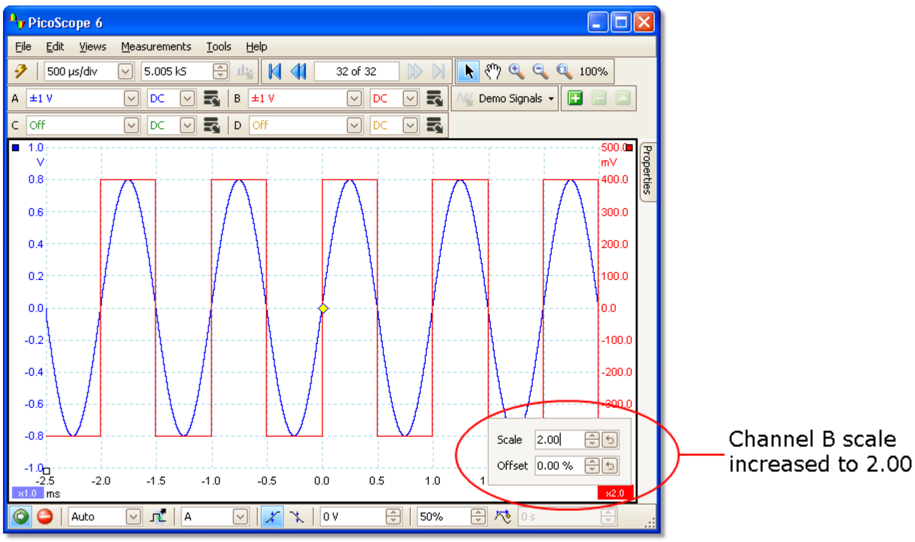
This is usually the quickest way to get a closer look at the fine detail on your signals. The global zooming and scrolling tools move all the signals at once and are found on the zooming and scrolling toolbar. 86

When a view is zoomed in, it has vertical and horizontal scroll bars that let you move the signals around as a group. You can also use the hand tool to scroll around the graph.

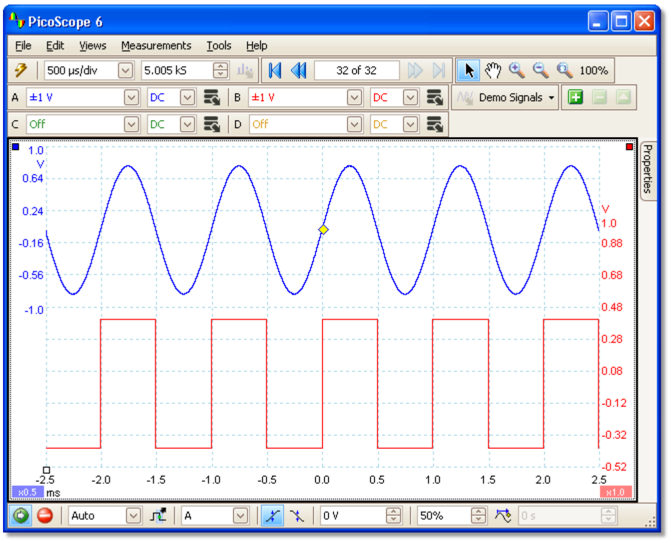
Axis scaling and offset

Use these tools to position individual signals on the graph (unlike the global zooming and scrolling tools, which are applied to all of the signals at the same time). Axis scaling and offset tools are ideal when a signal on one channel is smaller than on another or when you just want to make the best use of available screen space. Common uses are: -

- Aligning signals that have different amplitudes or offsets, for an overlay comparison:



- Arranging the signals in their own rows for side-by-side comparison:

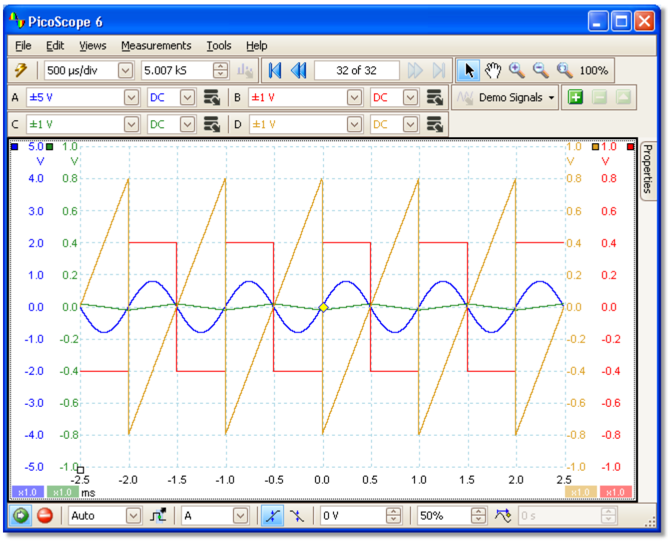


Click the axis tab 69 x1.0 at the bottom of the axis you wish to modify, and the axis scaling controls 69 will appear. To adjust the offset without using the axis scaling controls, click on the vertical axis and drag it up or down.

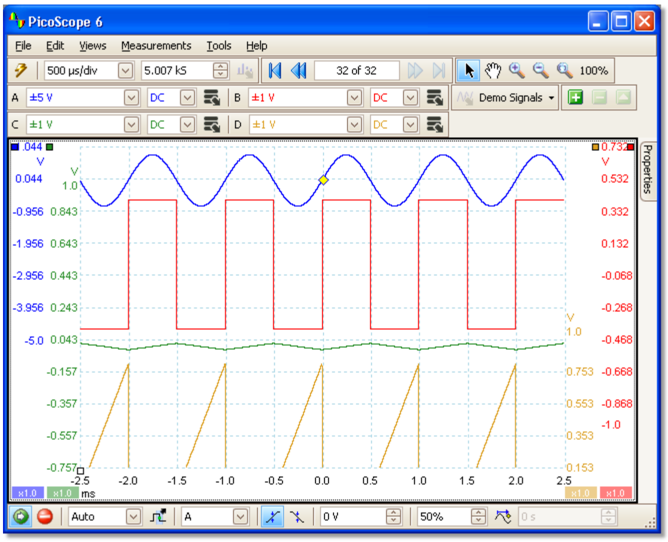
How to use these tools together

These global and axis-specific tools work smoothly together and make it easy to move around your data once you know how. We will take a look at a common example of usage to explain how the tools can be used together.

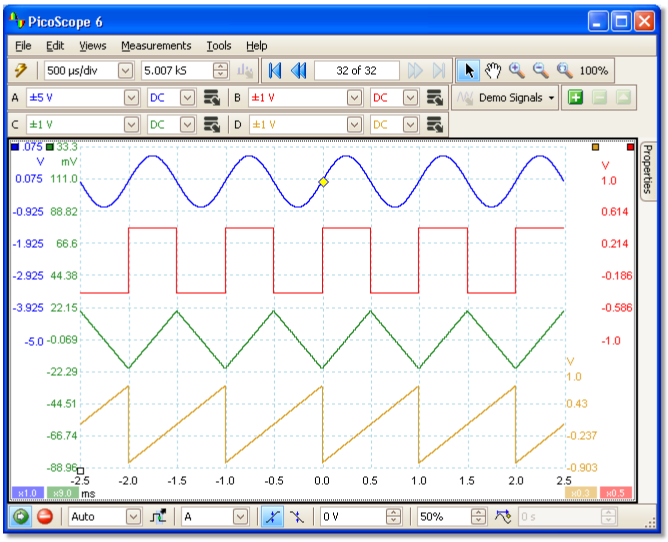
Consider this common setup where all 4 channels are being displayed on the centreline of the graph.



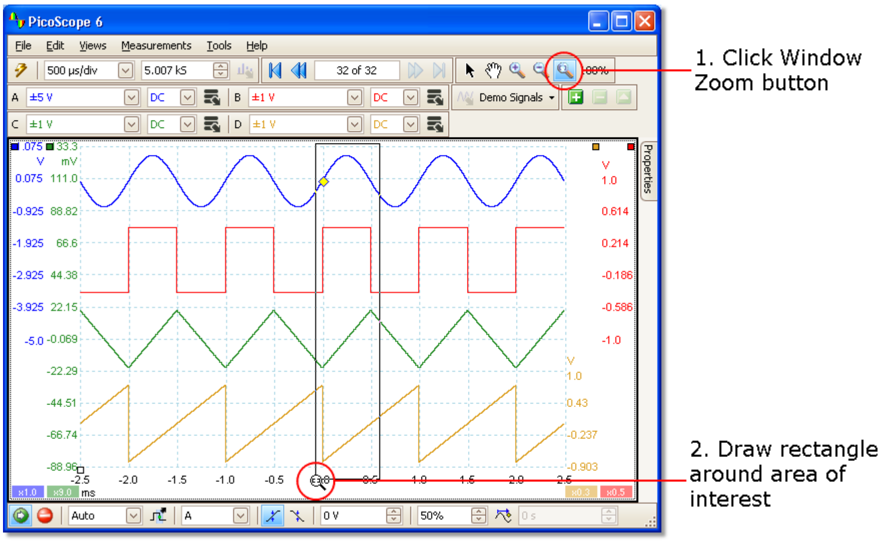
- Step 1. Arrange the signals into rows using the axis offset tool, so we can clearly see them all side by side.

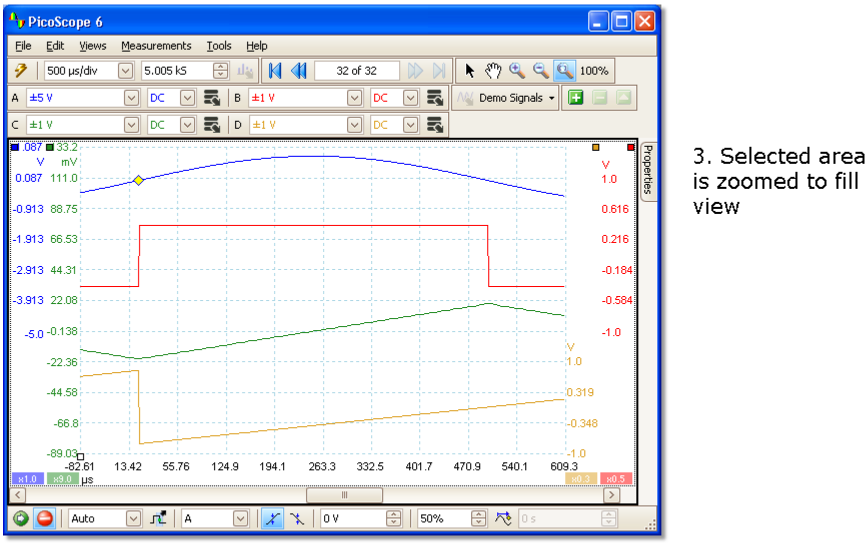


- Step 2. Scale the signals so that they have roughly equal amplitudes. This eliminates the overlap and makes the smaller signal easier to read.



- Step 3. Now we want to take a closer look at a specific time range of the signal in greater detail. We don't want to mess around with the neat axis scaling and offset that we have spent time creating, so instead we use the global windowed-zoom tool to select a specific section of the entire graph to zoom.





We can of course use the scrollbars or the hand tool to navigate around this zoomed view without ever changing our carefully arranged signals. Clicking the Zoom 100% button will take us back to the full view of our data; and again, this happens without affecting our axis scaling and offset set-up.

How is this different from scaling my data with a Custom Probe?

You can create a Custom Probe 26 to apply scaling to the raw data. A Custom Probe may change the scale and position of data on the graph but it has a few important differences from the other scaling methods.

- Custom Probe scaling is a permanent transformation. The scaling is applied when the data is captured and cannot be changed afterwards.
- The actual data values themselves are changed so the graph axes may no longer display the voltage range of the device.
- Custom Probe scaling can be nonlinear and so may alter the shape of the signal.

Custom Probes are useful when you want to represent the characteristics of a physical probe or transducer that you plug into your scope device. All of the zooming, scrolling, scaling and offset tools still apply to data that has been scaled with a Custom Probe in exactly the same way that they would apply to the raw data.

8.6 How to set up the spectrum view

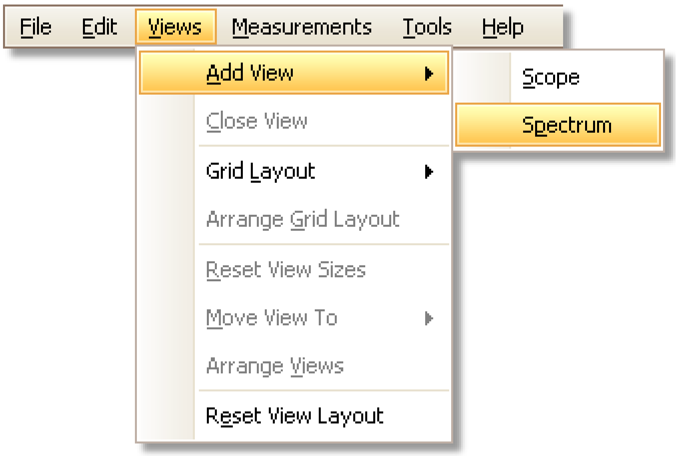
Creating a spectrum view

First, ensure that the trigger mode 80 is not set to ETS, 112 as it is not possible to open a spectrum view in ETS trigger mode.

There are three ways to open a spectrum view: 16

- Click the Spectrum Mode button in the Capture Setup toolbar. 71 We recommend using this method to get the best spectrum analysis performance from your scope. Once in Spectrum Mode, you can still open a scope view to see your data in the time domain, but PicoScope optimizes the settings for the spectrum view.

- Go to the Views menu 35 select Add view, then select Spectrum.



  This method opens a spectrum view in the currently selected mode, whether this is Scope Mode or Spectrum Mode. For best results, we recommend that you switch to Spectrum Mode, as described in the method immediately above.

- Right-click on any view 14, select Add view, then select Spectrum. The menu is similar to the Views menu 35 shown above.

Configuring the spectrum view

See Spectrum Settings dialog. 72

Selecting the source data

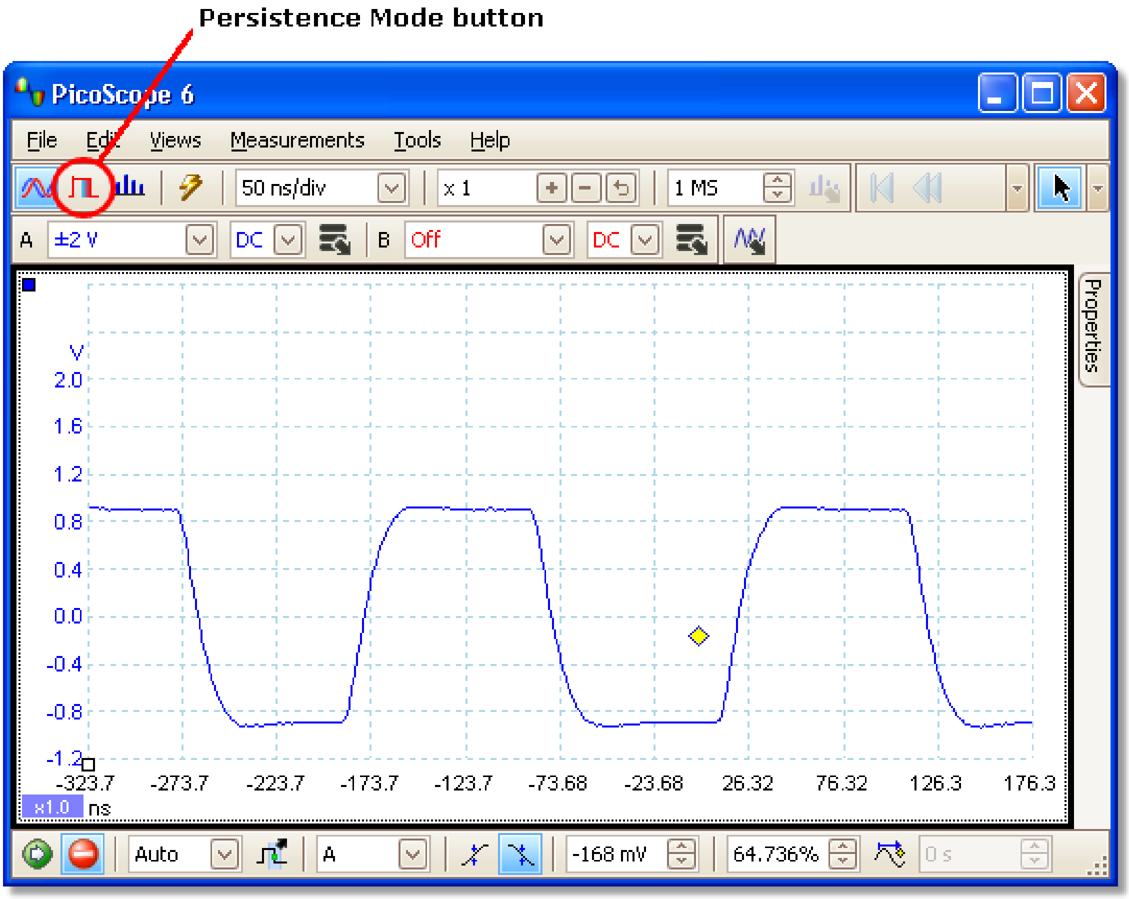
PicoScope can produce a spectrum view 16 based on either live or stored data. If PicoScope is running (the Start 79 button is pressed in), the spectrum view represents live data. Otherwise, with PicoScope stopped (the Stop 79 button pressed in), the view represents data stored in the currently selected page of the waveform buffer. When PicoScope is stopped, you can use the buffer controls 66 to scroll through the buffer and the spectrum view will be recalculated from the waveform currently selected.

8.7 How to find a glitch using persistence mode

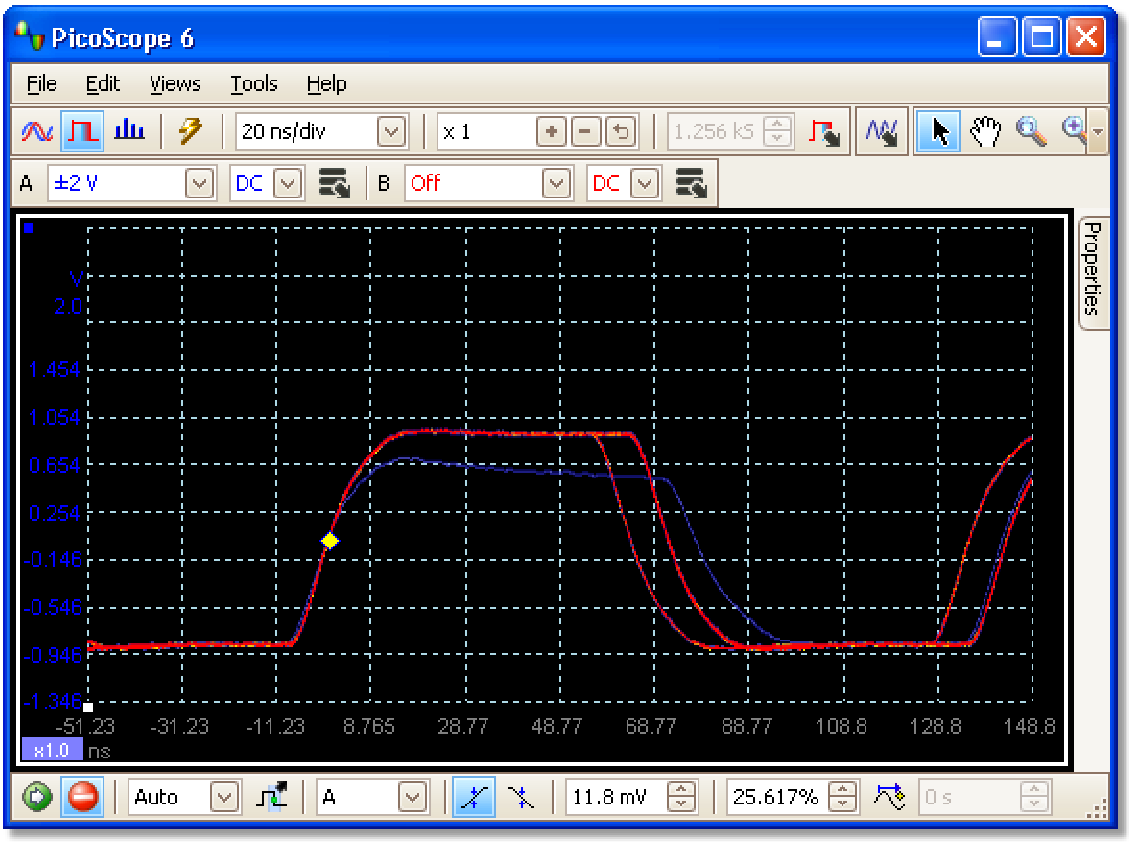
Persistence mode 17 is designed to help you find rare events hidden in otherwise repetitive waveforms. In normal scope mode, such an event may appear on the display for a fraction of a second, too quickly for you to press the space bar to freeze it on the screen. Persistence mode keeps the event on the display for a predetermined time, allowing you to set up the trigger options to capture it more reliably.

Step-by-step guide

- Set up the scope to trigger on a repetitive waveform like the one below. We suspect that there are occasional glitches but we can see nothing wrong yet, so we shall use persistence mode to investigate.
  Click the Persistence Mode button 11 to continue.

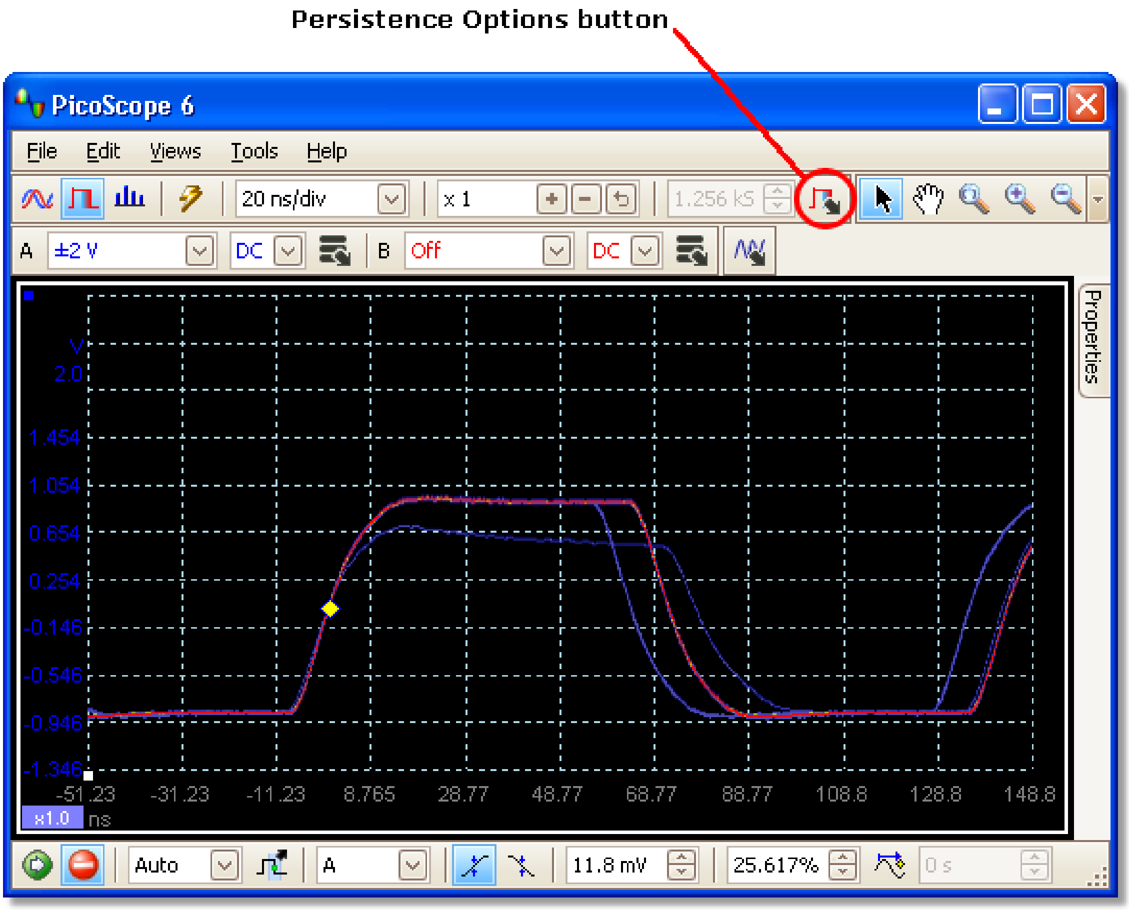


- Our original scope view is replaced by a persistence view, as shown below. Immediately, we can see three pulses with different shapes. At this point we have the Saturation control in Persistence Options [74] turned up to maximum to help us spot the various waveforms easily.



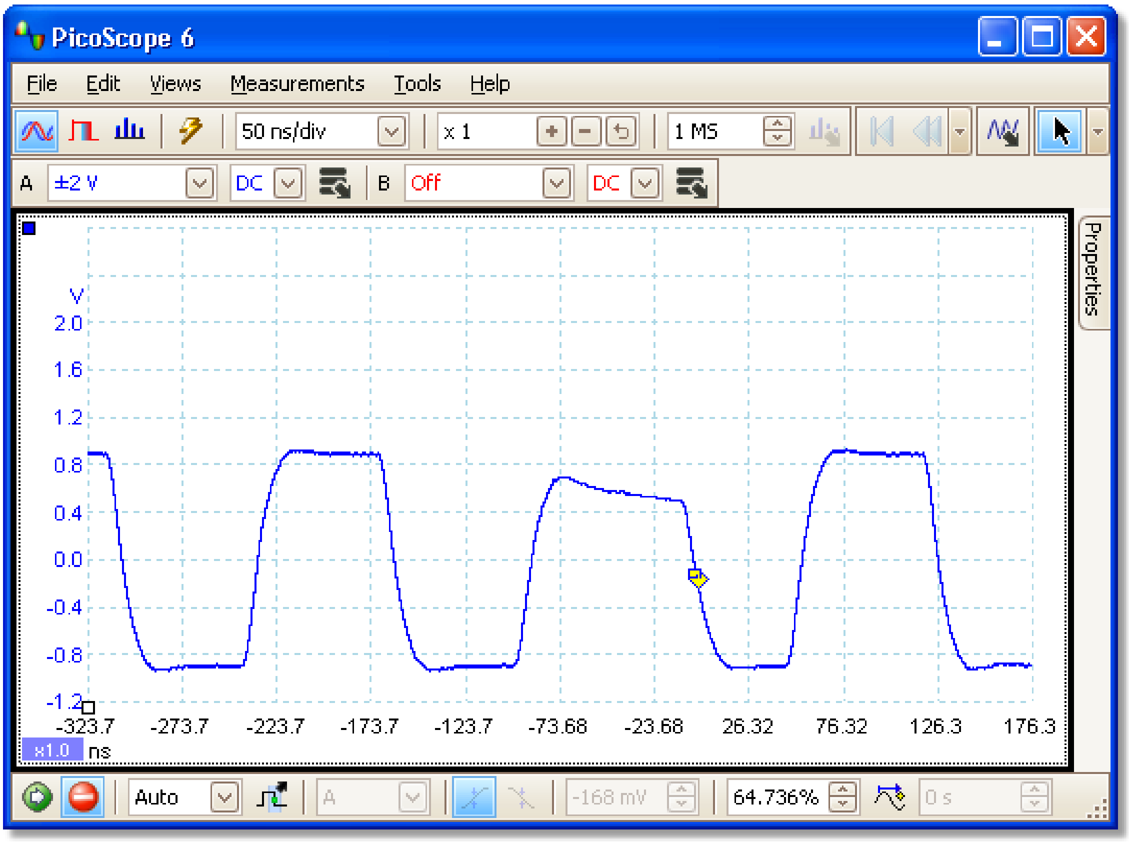
- Now that we have found some glitches, we will turn the Saturation control down to minimum. Click the Persistence options button to open the Persistence Options dialog [74], and then use the slider to adjust the saturation. The display then appears as below.

  The waveforms are now darker but have a wider range of colors and shades. The most frequently occurring waveform is shown in red, and is the normal shape of the pulse. A second waveform is drawn in light blue to shows that it occurs less frequently, and it shows us that there is an occasional jitter of about 10 ns in the pulse width. The third waveform is drawn in dark blue because it occurs less frequently than the other two, and indicates that there is an occasional runt pulse about 300 mV lower in amplitude than normal.



- Persistence mode has done its job. We have found our glitches, and now we want to examine them in more detail. The best way to do this is to switch back to normal scope mode 11, so that we can use the advanced triggering 83 and automatic measurement 18 functions built in to PicoScope.

  Click the Scope Mode button. Set up an advanced pulse-width trigger to look for a pulse wider than 60 ns. PicoScope then finds the runt pulse straight away.



We can now add automatic measurements or drag the rulers into place to analyse the runt pulse in detail.

9 Reference

This is where you can find detailed information on the operation of PicoScope.

9.1 Measurement types

The Edit Measurement dialog 38 allows you to select one of a range of measurements that PicoScope can calculate for the selected view. The list of measurements available depends on whether the view is a scope view 14 (see scope measurements 104) or a spectrum view 16 (see spectrum measurements 106).

9.1.1 Scope measurements

AC RMS:	The root mean square (RMS) value of the AC component of the waveform. This measurement subtracts any DC offset from the waveform. It is equivalent to a *ripple* measurement.
Cycle Time:	PicoScope will attempt to find a repeated pattern in the waveform and measure the duration of one cycle.
DC Average:	The mean value of the waveform.
Duty Cycle:	The amount of time that a signal spends above its mean value, expressed as a percentage of the signal period. A duty cycle of 50% means that the high time is equal to the low time.
Falling Rate:	The rate at which the signal level falls, in signal units per second. Click the Advanced button in the Add Measurement or Edit Measurement dialog to specify the signal level thresholds for the measurement.
Fall Time:	The time the signal takes to fall from the upper threshold to the lower threshold. Click the Advanced button in the Add Measurement or Edit Measurement dialog to specify the signal level thresholds for the measurement.
Frequency:	The number of cycles of the waveform per second.
High Pulse Width:	The amount of time that the signal spends above its mean value.
Low Pulse Width:	The amount of time that the signal spends below its mean value.
Maximum:	The highest level reached by the signal.
Minimum:	The lowest level reached by the signal.
Peak To Peak:	The difference between maximum and minimum.
Rise Time:	The time the signal takes to rise from the lower threshold to the upper threshold. Click the Advanced button in the Add Measurement or Edit Measurement dialog to specify the signal level thresholds for the measurement.
Rising Rate:	The rate at which the signal level rises, in signal units per second. Click the Advanced button in the Add Measurement or Edit Measurement dialog to specify the signal level thresholds for the measurement.

9.1.2 Automotive scope measurements

These measurements are available only in PicoScope Automotive.

Burn Time: For a secondary ignition waveform, the duration of the spark.

Burn Voltage: For a secondary ignition waveform, the voltage across the spark gap during the burn time.

Crank RPM: The turning rate of the crankshaft, as measured by the crankshaft sensor. Expressed in revolutions per minute.

Dwell Angle: In a primary ignition waveform, dwell time converted to an angle, using the formula:

dwell angle = (dwell time x crankshaft RPM / 60) x 360 degrees

Dwell Time: In a primary ignition waveform, the time during which battery current flows in the ignition coil, as the magnetic field builds up in its winding.

Injector Duration: The duration of the fuel injector pulse, as battery current flows through the injector coil.

Peak Burn Voltage: For a secondary ignition waveform, the voltage of the initial peak as the spark begins.

See also: Scope measurements 104

9.1.3 Spectrum measurements

To add a spectrum measurement, open a spectrum view 16 and then click the Add Measurement 70 button. You can use these measurements in either scope mode 11 or spectrum mode 11.

Frequency at peak

The frequency at which the peak signal value appears.

Amplitude at peak

The amplitude of the peak signal value.

Total power

The power of the whole signal captured in the spectrum view.

The total power P is given by:

$$P = \sqrt{\sum_{n=1}^{b} p_n^2}$$

where *b* is the number of spectrum bins and p_n is the power in the *nth* bin.

Total Harmonic Distortion (THD)

The ratio of the harmonic power to the power at the specified frequency.

$$THD = 20\log_{10}\left(\frac{\sqrt{V_2^{\ 2} + V_3^{\ 2} + V_4^{\ 2} + V_5^{\ 2} + V_6^{\ 2} + V_7^{\ 2}}}{V_1}\right)$$

Total Harmonic Distortion plus Noise (THD+N)

The ratio of the harmonic power plus noise to the fundamental power. THD+N values are almost be greater than the THD values for the same signal.

$$THD + N = 20\log_{10}\left(\frac{\sqrt{\textit{sum of squares of RMS values excluding datum}}}{\textit{RMS value of datum}}\right)$$

Spurious-free Dynamic Range (SFDR)

This is the ratio of the amplitude of the specified point (normally the peak frequency component) and the frequency component with the second largest amplitude (call it "SFDR frequency"). The component at the "SFDR frequency" is not necessarily a harmonic of the fundamental frequency component. For example, it might be a strong, independent noise signal.

Signal+Noise+Distortion to Signal+Noise Ratio (SINAD)

The ratio, in decibels, of the signal-plus-noise-plus-distortion to noise-plus-distortion.

$$SINAD = 20\log_{10}\left(\frac{\textit{RMS value of datum}}{\sqrt{\textit{sum of squares of all RMS components except datum}}}\right)$$

Signal to Noise Ratio (SNR)

The ratio, in decibels, of the mean signal power to the mean noise power. Hanning or Blackman windows are recommended because of their low noise.

$$SNR = 20log_{10}\left(\frac{RMS\ value\ of\ datum}{\sqrt{sum\ of\ squares\ of\ all\ values\ excluding\ datum\ and\ harmonics}}\right)$$

Intermodulation Distortion (IMD)

A measure of the distortion caused by the nonlinear mixing of two tones. When multiple signals are injected into a device, modulation or nonlinear mixing of these two signals can occur. For input signals at frequencies f1 and f2, the two second-order distortion signals will be found at frequencies: f3 = (f1 + f2) and f4 = (f1 - f2).

IMD is expressed as the dB ratio of the RMS sum of the distortion terms to the RMS sum of the two input tones. IMD can be measured for distortion terms of any order, but the second-order terms are most commonly used. In the second-order case, the intermodulation distortion is given by:

$$IMD = 20log_{10}\sqrt{\frac{F_3^{\ 2} + F_4^{\ 2}}{F_1^{\ 2} + F_2^{\ 2}}}$$

where

F3 and F4 are the amplitudes of the two second-order distortion terms (at frequencies f3 and f4 defined above)

and

F1 and F2 are the amplitudes of the input tones (at frequencies f1 and f2, as marked by the frequency rulers in the spectrum window).

For reference, the third-order terms are at frequencies (2F1 + F2), (2F1 - F2), (F1 + 2F2) and (F1 - 2F2).

Note: Hanning or Blackman windows are recommended because of their low noise. An FFT size of 4096 or greater is recommended in order to provide adequate spectral resolution for the IMD measurements.

9.2 Window functions

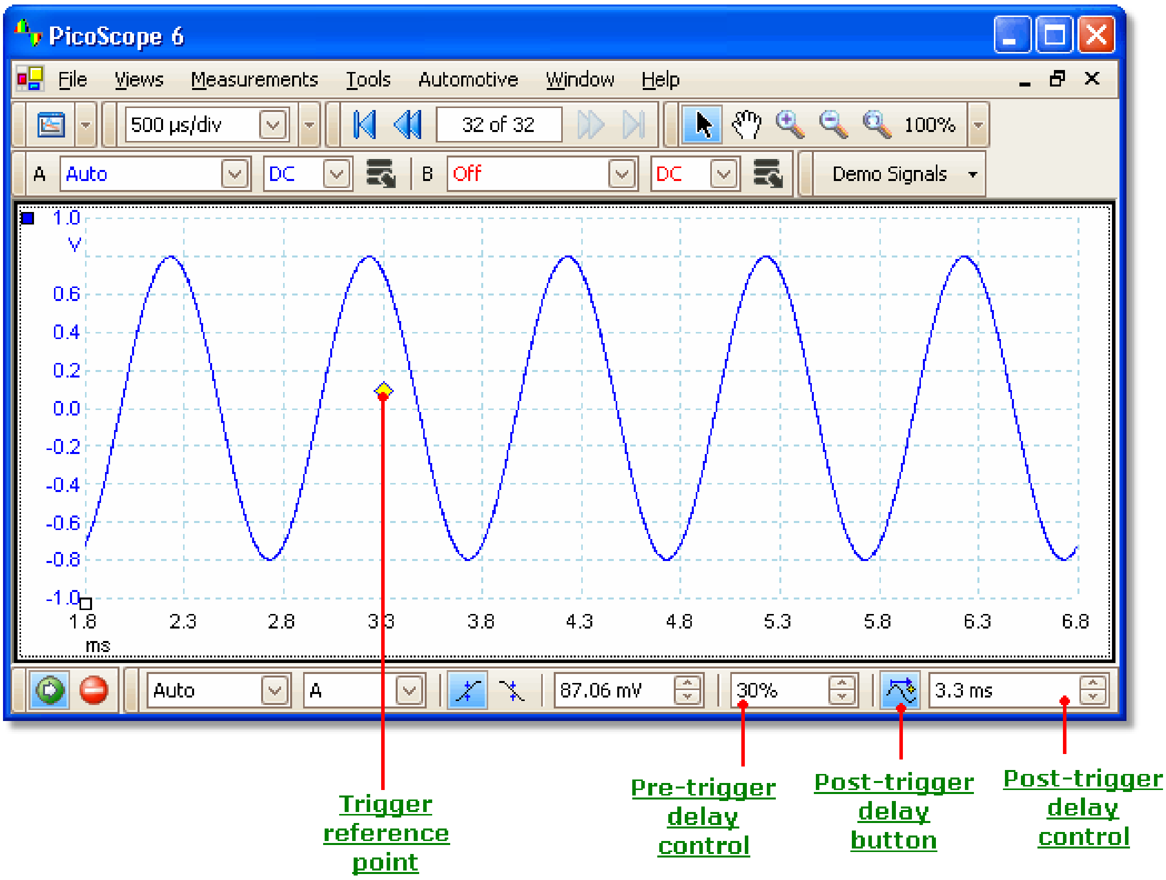
To create a spectrum view, 16 PicoScope uses a Fast Fourier Transform to compute the spectrum of a block of sampled data. A block of sampled data has a beginning and an end, and these sharp boundaries have an effect on the computed spectrum, creating unwanted artefacts such as ripple and gain errors. To reduce these artefacts, the signal can be smoothed so it tapers off to zero at the start and end of the block. A number of different types of smoothing, called window functions, can be applied depending on the type of signal and the purpose of the measurement. The rectangular window is simply the unsmoothed, truncated version of the data.

The Window Functions control in the Spectrum Options dialog 72 lets you select one of the standard window functions for spectrum analysis. The following table shows some of the figures of merit used to compare window functions.

Window	Main peak width (bins @ -3 dB)	Highest side lobe (dB)	Side lobe roll-off (dB/octave)	Notes
Blackman	1.68	-58	18	often used for audio work
Gaussian	1.33 to 1.79	-42 to -69	6	gives minimal time and frequency errors
Triangular	1.28	-27	12	also called Bartlett window
Hamming	1.30	-41.9	6	also called raised sine-squared; used in speech analysis
Hann	1.20 to 1.86	-23 to -47	12 to 30	also called sine-squared; used for audio & vibration
Blackman-Harris	1.90	-92	6	general-purpose
Flat-top	2.94	-44	6	negligible pass-band ripple; used mainly for calibration
Rectangular	0.89	-13.2	6	maximal sharpness; used for short transients

9.3 Trigger timing (part 1)

The pre-trigger time control and post-trigger delay control functions are described individually under "Triggering toolbar", 80 but the interaction between the two controls is also important to understand. Here is a screen shot of a scope view 14 with post-trigger delay enabled:



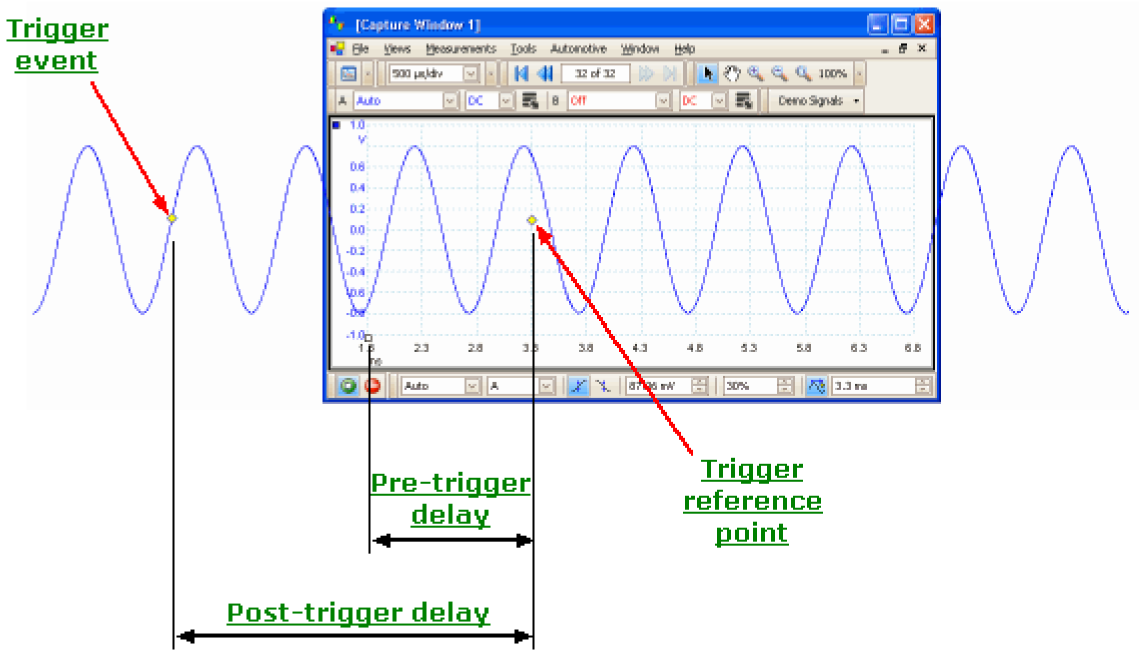
Note 1. The trigger reference point (◇) does not lie on the waveform. This is because the post-trigger delay is set to 3.3 ms, which means that the trigger occurred 3.3 ms before the reference point, somewhere off the left-hand edge of the scope view. 14 The time axis is aligned so that the trigger reference point is at 3.3 ms.

Note 2. The pre-trigger delay is set to 30%, which makes the trigger reference point appear 30% of the way across the scope view from the left-hand edge.

Note 3. PicoScope limits the trigger-to-reference-point delay to a multiple of the total capture time. Once you have reached this limit, the program will not let you increase the pre-trigger delay, and if you increase the post-trigger delay, PicoScope will reduce the pre-trigger delay to stop the total exceeding the limit. The multiple is typically 100 in most trigger modes, and 1 in ETS 112 mode.

9.4 Trigger timing (part 2)

"Trigger timing (part 1) 109" introduced the concepts of pre-trigger delay 80 and the post-trigger delay 80. This diagram below shows how they are related.



The pre-trigger delay positions the scope view 14 in relation to the trigger reference point so that you can choose how much of the waveform should be before the reference point, and how much after it.

The post-trigger delay is like the delayed trigger of a conventional oscilloscope. PicoScope waits for this time after the trigger event before drawing the trigger reference point. Scope devices have a limit to the number of sampling intervals that can elapse between the trigger event and the end of the capture, so the software may adjust the pre-trigger delay to keep within this limit.

Tip

If you have set up a post-trigger delay, you can click the post-trigger delay button while the scope is running whenever you want to switch between viewing the trigger event and the trigger reference point.

9.5 Keyboard shortcuts

You can activate most of PicoScope's functions using the menu system, but some functions also have keyboard shortcuts. These can save time on tasks that you repeat often.

Ctrl-C	Copy the current view113 or note34 to the Windows clipboard. You can then switch to another application and paste the contents of the clipboard as a picture. The method for doing this varies, but many applications use the Ctrl-V key or a "Paste" button.
Ctrl-D	Hand tool. Use to pan the waveform when zoomed in. Equivalent to the "Hand tool" button on the Zooming and Scrolling toolbar.86
Ctrl-I	Zoom-in tool. Click on the waveform to zoom in. Equivalent to the "Zoom-in tool" button on the Zooming and Scrolling toolbar.86
Ctrl-M	Marquee zoom tool. Click on the waveform and drag to draw a box (a marquee), and PicoScope will zoom in to make the box fill the view. Equivalent to the "Marquee zoom tool" button on the Zooming and Scrolling toolbar.86
Ctrl-O	Zoom-out tool. Click on the waveform to zoom out. Equivalent to the "Zoom-out tool" button on the Zooming and Scrolling toolbar.86
Ctrl-S or Esc	Cancel a zoom or pan mode and restore the pointer to a standard selection tool. Equivalent to the "Normal selection tool" button on the Zooming and Scrolling toolbar.86
Ctrl-U	Zoom to 100% scale. Restores a view to its normal state. Equivalent to the "Zoom to 100% scale" button on the Zooming and Scrolling toolbar.86
Page Up	Load the previous waveform file (*.psdata) in the same directory as the currently loaded file.
Page Down	Load the next waveform file (*.psdata) in the same directory as the currently loaded file.
Space	Starts and stops the scope device.

9.6 Glossary

AC coupling. In this mode, the scope device rejects very low signal frequencies below about 1 hertz. This allows you to use the full resolution of the scope to measure a.c. signals accurately, ignoring any d.c. offset. You cannot measure the signal level with respect to ground in this mode.

AWG. An arbitrary waveform generator (AWG) is a circuit that can generate a waveform of almost any shape. It is programmed with a data file, supplied by the user, which defines the output voltage at a number of equally spaced points in time. The circuit uses this data to reconstruct the waveform with a specified amplitude and frequency.

Axis. A line marked with measurements. PicoScope shows one vertical axis for each channel that is enabled in a view, giving measurements in volts or other units. Each view also has a single horizontal axis, which is marked in units of time for a scope view, or units of frequency for a spectrum view.

Channel. A scope device has one or more channels, each of which can sample one signal. High-speed scope devices typically have one BNC connector per channel.

DC coupling. In this mode, the scope device measures the signal level relative to signal ground. This shows both d.c. and a.c. components.

ETS. Equivalent Time Sampling. A method of increasing the effective sampling rate of the scope. In a scope view, the program captures several cycles of a repetitive signal, then combines the results to produce a single waveform with higher time-resolution than a single capture. For accurate results, the signal must be perfectly repetitive and the trigger must be stable.

Graticule. The horizontal and vertical dashed lines in every view. These help you estimate the amplitude and time or frequency of features on the waveform.

Grid. The arrangement of viewports. The number of grid rows and the number of grid columns can each be either 1, 2, 3 or 4.

In focus. PicoScope can display several views, but only one view is in focus at any time. When you click a toolbar button, it will usually affect only the view that is in focus. To bring a view into focus, click on it.

Probe. An accessory that attaches to your oscilloscope and picks up a signal to be measured. Probes are available to pick up any form of signal, but they always deliver a voltage signal to the oscilloscope. PicoScope has built-in definitions of standard probes, but also allows you to define custom probes.

Progressive mode. Normally, PicoScope redraws the waveform in a scope view many times every second. At timebases slower than 200 ms/div, however, it switches to progressive mode. In this mode, PicoScope updates the scope view continuously as each capture progresses, rather than waiting for a complete capture before updating the view.

Resolution enhancement. Collecting samples at a faster rate than requested, then combining the excess samples by averaging. This technique can increase the effective resolution of a scope device when there is a small amount of noise on the signal. (More details.) 20

Ruler. A vertical or horizontal dashed line that can be dragged into place on a waveform in a view. PicoScope displays the signal level, time value or frequency value of all rulers in the Ruler Legend box.

Scope device. A box of electronics that, with the help of the PicoScope software, turns your computer into a PC Oscilloscope.

Standard deviation. A statistical measure of the spread of a set of samples. The standard deviation of the set $y_0 \cdots y_{n-1}$ is defined as:

$$SD = \sqrt{\sum_{i=0}^{n-1} (y_i - \bar{y})^2},$$

where $\bar{y}$ is the arithmetic mean of all the samples. The units of the standard deviation value are the same as those of the original samples.

Tool tip. A label that appears when you move the mouse pointer over some parts of the PicoScope screen, such as buttons, controls and rulers.

Trigger. The part of an oscilloscope that monitors an incoming signal and decides when to begin a capture. Depending on the trigger condition that you set, the scope may trigger when the signal crosses a threshold, or may wait until a more complex condition is satisfied.

Vertical resolution. The number of bits that the scope device uses to represent the signal level. This number is fixed by the design of the device, but a greater *effective* number can be obtained in some cases by using resolution enhancement 20.

View. A presentation of data from a scope device. A view may be a scope view or a spectrum view.

Viewport. The views in the PicoScope window 13 are arranged in a grid, 112 and each rectangular area in the grid is called a viewport.

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