



# **PicoScope® 5000 A and B Series**

Flexible Resolution Oscilloscopes

User's Guide

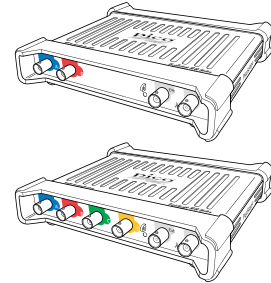
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# 1 Welcome

Thank you for buying a **PicoScope 5000 Series Flexible Resolution Oscilloscope** from Pico Technology!

The PicoScope 5000 A and B Series of Flexible Resolution Oscilloscopes from Pico Technology are a range of high-specification real-time measuring instruments that connect to the USB port of your computer and use the PicoScope software to work as oscilloscopes and spectrum analyzers. With various options of portability, resolution, deep memory, fast sampling rates and high bandwidth, these highly versatile oscilloscopes suit a wide range of applications.



The A models are high-speed portable oscilloscopes with a function generator:

PicoScope 5242A

PicoScope 5243A

PicoScope 5244A

PicoScope 5442A

PicoScope 5443A

PicoScope 5444A

The B models are as the A models, but feature an arbitrary waveform generator ([AWG](#)) and deeper memory:

PicoScope 5242B

PicoScope 5243B

PicoScope 5244B

PicoScope 5442B

PicoScope 5443B

PicoScope 5444B

Here are some of the benefits provided by the PicoScope 5000 A and B Series oscilloscopes:

- **Programmability:** The PicoScope 5000A SDK lets you write your own programs, in your chosen programming language, to control all the features of the scope. Using the API functions, you can develop your own programs to collect and analyze data from the oscilloscope. Refer to the *PicoScope 5000 Series (A API) Programmer's Guide* for more information.
- **Long-term support:** Software upgrades and beta versions are available to download from our [website](#). You can also call or email our technical specialists for support, or visit our [support forum](#). All of these services are available free of charge for the lifetime of the product.
- **Five-year warranty:** Your oscilloscope is covered for five years from the date of purchase against manufacturing faults.

For further information on the PicoScope 5000 A and B Series oscilloscopes, see the [model comparison tables](#) in this manual and the specifications tables in the *PicoScope 5000 Series data sheet*, available on our [website](#).

## 2 Introduction

### 2.1 Safety information

To prevent possible electrical shock, fire, personal injury, or damage to the product, carefully read this safety information before attempting to install or use the product. In addition, follow all generally accepted safety practices and procedures for working with and near electricity.

The product has been designed and tested in accordance with the European standard publication EN 61010-1: 2010, and left the factory in a safe condition. The following safety descriptions are found throughout this guide:









A **WARNING** identifies conditions or practices that could result in injury or death.

A **CAUTION** identifies conditions or practices that could result in damage to the product or equipment to which it is connected.

Each of these safety instructions applies to all of the PicoScope 5000 Series oscilloscopes covered by this User's Guide, unless otherwise specified.

#### 2.1.1 Symbols

These safety and electrical symbols may appear on the product and throughout this guide.

Symbol	Description
	Direct current
	Alternating current
	Earth (ground) terminal
	Chassis ground terminal
	Possibility of electric shock
	Caution
	Static awareness. Static discharge can damage part(s).
<b>CAT</b>	IEC 61010 overvoltage category
	Do not dispose of this product as unsorted municipal waste

The terminal can be used to make a measurement ground connection. The terminal is NOT a safety or protective earth.

The ground terminals of connectors marked with this symbol are all connected together, and connected to the host PC via the screen of the USB cable.

Appearance on the product indicates a need to read this Safety and operation instruction.

## 2.1.2 Product usage



### WARNING

To prevent injury or death, use the product only as instructed and use only accessories supplied or recommended. Protection provided by the product may be impaired if used in a manner not specified by the manufacturer.

## 2.1.3 Maximum input ranges

Observe all terminal ratings and warnings marked on the product.

The table below indicates the full scale measurement range and overvoltage protection range for each oscilloscope model. The full scale measurement ranges are the maximum voltages that can be accurately measured by the instrument. The overvoltage protection ranges are the maximum voltages that will not damage the instrument.



### WARNING

To prevent electric shock, do not attempt to measure voltages outside the specified full scale measurement range below.

Model	Full scale measurement range	Overvoltage protection (voltages that will not damage)	
		<a href="#">Input channels / External trigger</a>	<a href="#">Signal generator</a>
All PicoScope 5000 A and B Series oscilloscopes	±20 V	±100 V pk max.	±20 V pk max.



### WARNING

Signals exceeding the voltage limits in the table below are defined as "hazardous live" by EN 61010. To prevent electric shock, take all necessary safety precautions when working on equipment where hazardous live voltages may be present.

Signal voltage limits of EN 61010		
±70 V DC	33 V AC RMS	±46.7 V pk max.

### WARNING

The PicoScope 5000 Series oscilloscopes are not designed to measure hazardous live signals as defined by EN 61010. To prevent electric shock, do not attempt to measure voltages outside of the limits shown in the table above or the specified full scale measurement range, whichever is lower.

### WARNING

To prevent injury or death, the oscilloscope must not be directly connected to the mains (line power). To measure mains voltages, use a differential isolating probe specifically rated for mains use, such as the TA041 listed on the Pico website.



### CAUTION

Exceeding the overvoltage protection range on any connector can cause permanent damage to the oscilloscope and other connected equipment.

## 2.1.4 Grounding



### WARNING

The oscilloscope's ground connection through the USB cable is for measurement purposes only. The oscilloscope does not have a protective safety ground.

### WARNING

Never connect the ground input (chassis) to any electrical power source. To prevent personal injury or death, use a voltmeter to check that there is no significant AC or DC voltage between the oscilloscope ground and the point to which you intend to connect it.



### CAUTION

Applying a voltage to the ground input is likely to cause permanent damage to the oscilloscope, the attached computer, and other equipment.

### CAUTION

To prevent measurement errors caused by poor grounding, always use the high-quality USB cable supplied with the oscilloscope.

## 2.1.5 External connections



### WARNING

To prevent injury or death, when supplied use only the power cord and adaptor supplied with the product. These are approved for the voltage and plug configuration in your country.

### Power supply options and ratings

Model	USB 2.0 cable		External DC power supply		
	Single-headed	Double-headed	Voltage (V)	Current (A)	Power (W)
2-channel models		✓	N/A	N/A	N/A
4-channel models	✓	✓	5 V	1.5 A pk	7.5 W

For instructions on connecting your oscilloscope, see [Installation](#).



### CAUTION

Take care to avoid mechanical stress or tight bend radii for all connected leads, including all coaxial leads and connectors. Mishandling will cause deformation of sidewalls, and will degrade performance and measurement accuracy.

## 2.1.6 Environment



### WARNING

To prevent injury or death, do not use in wet or damp conditions, or around explosive gas or vapor.



### CAUTION

To prevent damage, always use and store your oscilloscope in appropriate environments.

	Storage	Operating
Temperature	-20 °C to +60 °C	0 °C to +40 °C (+20 °C to +30 °C for quoted accuracy)
Humidity	5% to 95% RH (non-condensing)	5% to 80% RH (non-condensing)
Altitude	2000 m (maximum)	
Pollution degree	2 (maximum)	

## 2.1.7 Care of the instrument

The product contains no user-serviceable parts. Repair, servicing and calibration require specialized test equipment and must only be performed by Pico Technology or an approved service provider. There may be a charge for these services unless covered by the Pico five year warranty.



### WARNING

To prevent injury or death, do not use the product if it appears to be damaged in any way, and stop use immediately if you are concerned by any abnormal operations.

### WARNING

To prevent electric shock, do not tamper with or disassemble the oscilloscope, case parts, connectors or accessories.

### WARNING

When cleaning the product, use a soft cloth and a solution of mild soap or detergent in water. To prevent electric shock, do not allow liquids to enter the oscilloscope casing, as this will compromise the electronics or insulation inside.

## 2.2 Conformance

### 2.2.1 FCC notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to **Part 15 Subpart B of the FCC Rules**. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference which the user will be required to correct at their own expense.

### 2.2.2 CE notice

The PicoScope 5000 A and B Series oscilloscopes meet the intent of **Electromagnetic Compatibility (EMC) Directive 2014/30/EU** and have been tested to **EN 61326-1:2013 Class A Emissions and Immunity** standard.

The oscilloscopes also meet the intent of **Low Voltage Directive (LVD) 2014/35/EU** and have been designed to the **BS EN 61010-1:2010** (safety requirements for electrical equipment for measurement, control, and laboratory use) standard.

## 2.3 Software license conditions

**Grant of license.** The material contained in this release is licensed, not sold. Pico Technology Limited ('Pico') grants a license to the person who installs this software, subject to the conditions listed below.

**Access.** The licensee agrees to allow access to this software only to persons who have been informed of and agree to abide by these conditions.

**Usage.** The software in this release is for use only with Pico products or with data collected using Pico products.

**Copyright.** Pico claims the copyright of and reserves the rights to all material (software, documents etc) contained in this release.

**Liability.** Pico and its agents shall not be liable for any loss or damage, howsoever caused, related to the use of Pico equipment or software, unless excluded by statute.

**Fitness for purpose.** No two applications are the same, so Pico cannot guarantee that its equipment or software is suitable for a given application. It is therefore the user's responsibility to ensure that the product is suitable for the user's application.

**Mission-critical applications.** Because the software runs on a computer that may be running other software products, and may be subject to interference from these other products, this license specifically excludes usage in 'mission-critical' applications, for example life-support systems.

**Viruses.** This software was continuously monitored for viruses during production. However, the user is responsible for virus checking the software once it is installed.

**Support.** No software is ever error-free, but if you are dissatisfied with the performance of this software, please contact our technical support staff.



## 2.4 Trademarks

*Pico Technology Limited* and *PicoScope* are trademarks of Pico Technology Limited, registered in the United Kingdom and other countries.

*PicoScope* and *Pico Technology* are registered in the U.S. Patent and Trademark Office.

*Linux* is the registered trademark of Linus Torvalds, registered in the U.S. and other countries.

*Mac* and *OS X* are trademarks of Apple Inc., registered in the U.S. and other countries.

*Windows* is a registered trademark or trademark of Microsoft Corporation, registered in the U.S. and other countries.

## 2.5 Warranty

Pico Technology **warrants** upon delivery, and for a period of 5 years unless otherwise stated from the date of delivery, that the Goods will be free from defects in material and workmanship.

Pico Technology shall not be liable for a breach of the warranty if the defect has been caused by fair wear and tear, willful damage, negligence, abnormal working conditions or failure to follow Pico Technology's spoken or written advice on the storage, installation, commissioning, use or maintenance of the Goods or (if no advice has been given) good trade practice; or if the Customer alters or repairs such Goods without the written consent of Pico Technology.

## 2.6 Minimum system requirements

To ensure that your PicoScope 5000 Series oscilloscope operates correctly, you must have a computer with at least the minimum system requirements 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.

	Specification
<b>Operating system</b>	Windows 7, Windows 8, Windows 10*. 32 bit and 64 bit versions. Beta software is also available for Linux and OS X operating systems.
<b>Processor</b>	As required by the operating system
<b>Memory</b>	
<b>Free disk space</b>	
<b>Ports</b>	<a href="#">USB 3.0</a> or <a href="#">USB 2.0</a> port(s)

\* PicoScope version 6.11 and PicoSDK are compatible with Windows XP SP3 and Vista SP2 in addition to the Windows versions listed above. For best performance we recommend Windows 7 or later.

## 3 Pack contents

A PicoScope 5000 A or B Series oscilloscope is supplied with the following items:

- Standard USB cable (4-channel scopes only)
- Double-headed USB cable
- AC adaptor (4-channel scopes only)
- Software and Reference CD
- Quick Start Guide
- Two or four probes (see [model comparison tables](#) for probe details)

## 4 Installation

Please note the various power supply options below. Full instructions are in the Quick Start Guide supplied with your oscilloscope.

### Powering 2-channel scopes

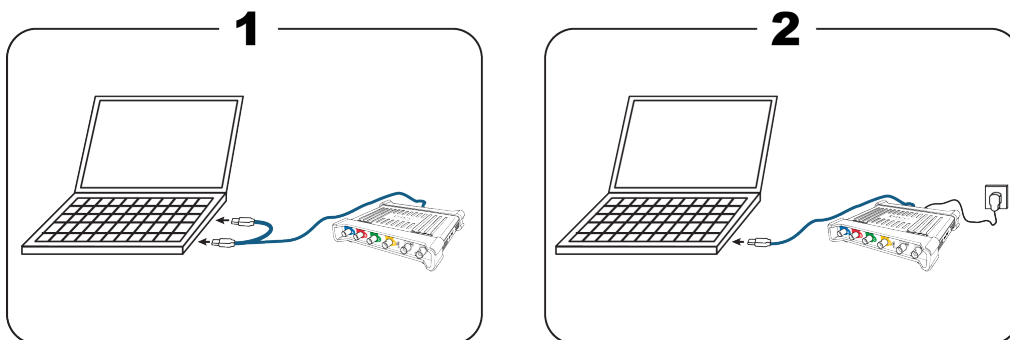
Connect your PicoScope 5000 Series 2-channel oscilloscope to two free, powered USB ports on the PC or USB hub using the double-headed USB cable supplied (see image 1 below).

### Powering 4-channel scopes

When using one or two channels of the 4-channel PicoScope 5000 Series oscilloscopes, you have two options for power.

1. If your computer or USB hub does not have two free, powered USB ports, connect your PicoScope 5000 Series oscilloscope to the PC or hub using the single-headed USB cable supplied. Plug the power adaptor into the mains and connect the DC cable to the [DC power socket](#) on the rear of the oscilloscope (see image 2 below).
2. If your computer or USB hub has two free, powered USB ports, connect your PicoScope 5000 Series oscilloscope to two ports on the PC or hub using the double-headed USB cable supplied (see image 1 below).

When using three or four channels on the 4-channel PicoScope 5000 Series oscilloscopes, connect your oscilloscope to the PC or hub using the single-headed USB cable supplied. Plug the power adaptor into the mains and connect the DC cable to the [DC power socket](#) on the rear of the oscilloscope (see image 2 below).



**Note:** If you connect or disconnect the AC adaptor while the oscilloscope is in operation it will restart automatically and any unsaved data will be lost.

### Checking the installation

Once you have installed the PicoScope software and connected the oscilloscope to the PC, start the software. The software should now display any signal connected to the scope inputs. If you have a probe connected to your oscilloscope, you should see a small 50 or 60 Hz signal in the oscilloscope window when you touch the probe tip with your finger.

## 5 Product information

### 5.1 Model comparison tables

For full specifications and further information, refer to the [PicoScope 5000 Series page](#) on our website or to the *PicoScope 5000 Series data sheet*, available on our website and on your Software and Reference CD.

#### 2-channel models

Model	Maximum bandwidth	Buffer memory*		Waveform output	Probes supplied
		8-bit mode	12-bit mode or higher		
PicoScope 5242A	60 MHz	16 MS	8 MS	Func. Gen.	2 x 60 MHz
PicoScope 5242B	60 MHz	32 MS	16 MS	Func. Gen. and AWG	2 x 60 MHz
PicoScope 5243A	100 MHz	64 MS	32 MS	Func. Gen.	2 x 150 MHz
PicoScope 5243B	100 MHz	128 MS	64 MS	Func. Gen. and AWG	2 x 150 MHz
PicoScope 5244A	200 MHz	256 MS	128 MS	Func. Gen.	2 x 250 MHz
PicoScope 5244B	200 MHz	512 MS	256 MS	Func. Gen. and AWG	2 x 250 MHz

\* Shared between active channels

#### 4-channel models

Model	Maximum bandwidth	Buffer memory*		Waveform output	Probes supplied
		8-bit mode	12-bit mode or higher		
PicoScope 5442A	60 MHz	16 MS	8 MS	Func. Gen.	4 x 60 MHz
PicoScope 5442B	60 MHz	32 MS	16 MS	Func. Gen. and AWG	4 x 60 MHz
PicoScope 5443A	100 MHz	64 MS	32 MS	Func. Gen.	4 x 150 MHz
PicoScope 5443B	100 MHz	128 MS	64 MS	Func. Gen. and AWG	4 x 150 MHz
PicoScope 5444A	200 MHz	256 MS	128 MS	Func. Gen.	4 x 250 MHz
PicoScope 5444B	200 MHz	512 MS	256 MS	Func. Gen. and AWG	4 x 250 MHz

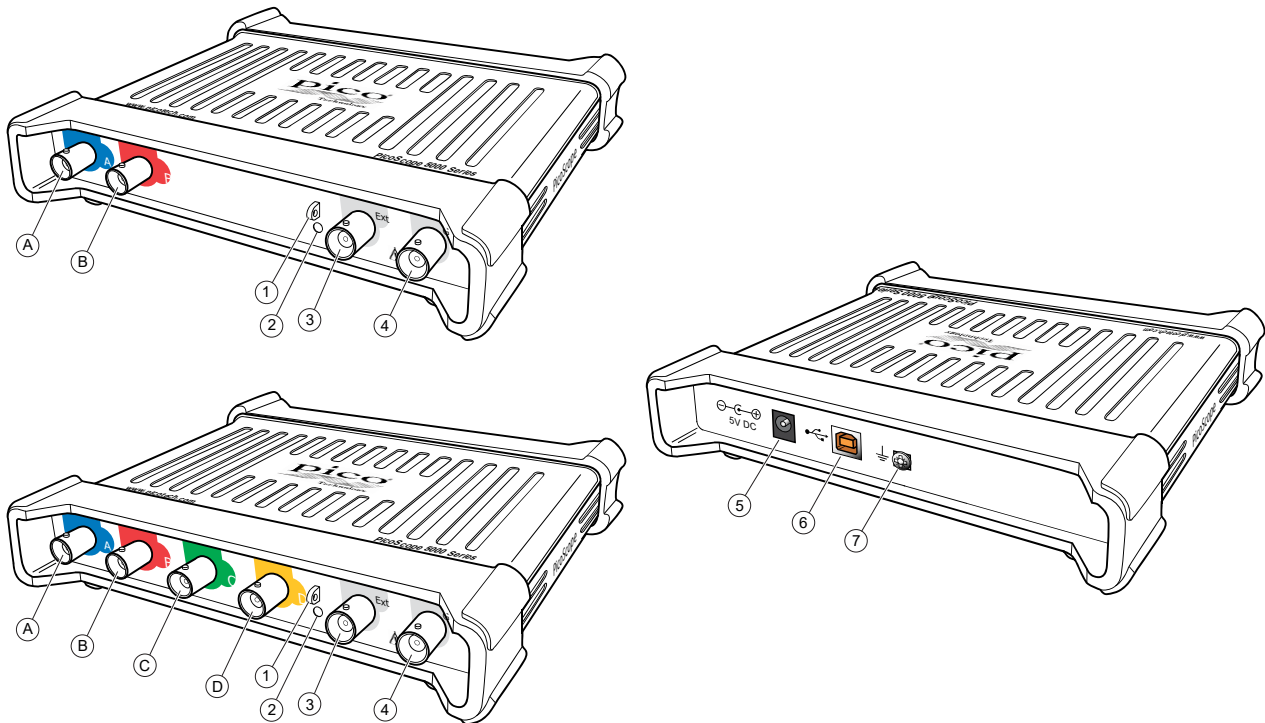
\* Shared between active channels

#### How maximum sampling rate varies by resolution and the number of channels in use

Resolution	Maximum sampling rate with number of channels in use			
	Any 1 channel	Any 2 channels	Any 3 channels	All channels
8-bit	1 GS/s	500 MS/s	250 MS/s	250 MS/s
12-bit	500 MS/s	250 MS/s	125 MS/s	125 MS/s
14-bit	125 MS/s	125 MS/s	125 MS/s	125 MS/s
15-bit	125 MS/s	125 MS/s	-	-
16-bit	62.5 MS/s	-	-	-

## 5.2 Connector diagrams

### PicoScope 5000 A and B Series oscilloscopes



A. Input channel A

B. Input channel B

C. Input channel C

D. Input channel D

1. [Probe compensation](#) output

2. LED: red when scope is connected but not operating. Flashes green when the oscilloscope is capturing data.

3. [External trigger](#) input

4. [Signal generator](#) output

5. DC power socket: for use with the AC adaptor supplied. See [Installation](#) for details.

6. [USB 2.0](#) port: connects to your PC using the Hi-Speed USB cable supplied. See [Installation](#) for powering options.

7. Ground terminal: Some laptop power supplies can produce electrical noise which may interfere with your measurements. If this occurs, you can connect the earth terminal to an external ground point (for example, on the system you are testing) to provide a ground reference for the scope. This can help prevent external noise from interfering with your measurements. Alternatively you can run the laptop using battery power.

## 5.3 Connector information

### Standard oscilloscope connectors

The PicoScope 5000 A and B Series Flexible Resolution Oscilloscopes have input channels with standard BNC connectors and standard input impedance. They are therefore compatible with most oscilloscope probes including 10:1 and switched 1:1/10:1 types.

The probes supplied with the PicoScope 5000 A and B Series oscilloscopes have been trimmed specifically for use with the scopes they are supplied with. For optimum performance, please use the probes supplied. Although other oscilloscope probes can be used, the specified performance cannot be guaranteed. You can order replacement probes matched to your PicoScope device from Pico Technology.

### Signal generator (Gen) output

The **Gen** connector is the output of the oscilloscope's built-in [signal generator](#), which can generate waveforms for a number of built-in functions. On the B models, the signal generator also produces user-defined arbitrary waveforms. Connect a BNC cable between this output and one of the channel inputs to send a signal to that channel.

- If you are using the PicoScope 6 program, refer to the *PicoScope 6 User's Guide* for information on how to configure the signal generator.
- If you are writing your own software, refer to the *PicoScope 5000 Series (A API) Programmer's Guide*.
- You can find both of these documents on your Software and Reference CD, or download the most recent versions for free from [www.picotech.com/downloads](http://www.picotech.com/downloads).

### External trigger (Ext) input

The **Ext** input can be used as a trigger source. It is selected using the trigger drop-down menu in the PicoScope software, or using a function call if you are writing your own software.

The [external trigger](#) input uses dedicated circuitry with a software-configurable threshold to detect a trigger signal. This has the advantage of freeing the analog channels for viewing signals. The external trigger input has the same characteristics as a scope channel so that a supplied probe can be trimmed on one of the channels and then used with the **Ext** input to give best vertical accuracy. If trigger timing accuracy is critical, we recommend using one of the main input channels as the trigger source. These channels use digital triggering (accurate to one sample period) and have a vertical resolution of 1 least significant bit.

## 5.4 Probe compensation

We recommend that you compensate each oscilloscope probe before using it with your PicoScope. Compensation instructions specific to the probe are included in the leaflet supplied with the probe.

### Connecting a probe for compensation

1. Plug the probe's BNC connector into the appropriate input channel on the scope.
2. Fit the spring hook (supplied with the probe) on the probe tip.
3. Attach the spring hook to the [probe compensation output](#) located on the front panel.
4. Attach the ground lead (supplied) to the probe and connect the crocodile clip to the ground shell of one of the scope's BNC inputs.
5. Run the PicoScope software. Set the input [coupling](#) to AC and then click **Auto Setup**, which ensures that the correct [input range](#) and [collection time](#) are selected.
6. Follow the compensation (or 'trimming') instructions in the probe leaflet.

**Note:** if the probe is moved to a different scope channel, the compensation procedure must be repeated.

## 6 Glossary

**API.** Application Programming Interface. A set of function calls that give programmers access to the PicoScope 5000 A and B Series driver.

**AWG.** Arbitrary waveform generator (PicoScope 5000B models only). A circuit that can generate a waveform of almost any shape, as defined by the user.

**Bandwidth.** The range of input frequencies over which the measured signal amplitude is no more than 3 decibels below its true value.

**Block mode.** A sampling mode in which the computer prompts the oscilloscope to collect a block of data into its internal memory before stopping the oscilloscope and transferring the whole block into computer memory. This mode of operation is effective when the input signal being sampled is high frequency. **Note:** To avoid aliasing effects, the maximum input frequency must be less than half the sampling rate.

**Buffer memory.** The buffer memory is used by the oscilloscope to store data temporarily. This allows the oscilloscope to sample data independently of the speed at which it can transfer data to the computer. The size of the buffer memory is measured in samples.

**Collection time.** The time represented by the horizontal axis of the PicoScope display. On traditional oscilloscopes, this function is often known as the timebase.

**Coupling control.** To switch from AC coupling to DC coupling, or vice versa, select AC or DC from the control on the oscilloscope toolbar of the PicoScope software application. The AC setting filters out any DC component of the input signal, and is suitable for viewing small AC signals superimposed on a DC or slowly-changing offset. In this mode you can measure the peak-to-peak amplitude of an AC signal but not its absolute value. Use the DC setting for measuring the absolute value of a signal.

**Driver.** A program that controls a piece of hardware. The driver for the PicoScope 5000 A and B Series oscilloscopes is supplied in the form of a 32-bit or 64-bit Windows DLL, `ps5000a.dll`. This is used by the PicoScope software, and by user-designed applications, to control the oscilloscopes.

**External trigger.** This is the BNC connector marked **Ext** on the PicoScope 5000 A and B Series oscilloscopes. It can be used as a trigger source but not as a waveform input. See also [Connector information](#).

**Flexible resolution oscilloscope.** The instrument formed by connecting a PicoScope 5000 A and B Series oscilloscope to a computer running the PicoScope software application.

**Input range.** The range of input voltages that the oscilloscope can measure. For example, a voltage range of  $\pm 20$  V means that the oscilloscope can measure voltages between  $-20$  V and  $+20$  V. Input voltages outside this range will not be measured correctly, but will not damage the instrument as long as they remain within the protection limits stated in the specifications.

**Maximum sampling rate.** A figure indicating the maximum number of samples the oscilloscope can acquire per second. Maximum sample rates are usually given in MS/s (megasamples per second) or GS/s (gigasamples per second.) The higher the sampling rate of the oscilloscope, the more accurate the representation of the high-frequency details in a fast signal.

**MS/s.** Megasamples per second. Used to quantify the sampling rate of an oscilloscope.

**PicoScope software.** This software product accompanies all our oscilloscopes. Along with your PicoScope device, it turns your PC into an oscilloscope and spectrum analyzer. You can download free updates and beta versions of the software from [www.picotech.com/downloads](http://www.picotech.com/downloads).



**Signal generator.** A built-in circuit that generates signals suitable for driving an external device under test. Its output is the BNC connector marked **Gen** on the oscilloscope. See also [Connector information](#).

**USB 1.1.** An early version of the USB standard, found on some older PCs. PicoScopes will operate slowly using a USB 1.1 port; performance will be greatly improved by using the recommended USB 2.0 or 3.0 port.

**USB 2.0.** A USB 2.0 port uses signaling speeds of up to 480 megabits per second and is backwards-compatible with USB 1.1.

**USB 3.0.** A USB 3.0 port uses signaling speeds of up to 5 gigabits per second and is backwards-compatible with USB 2.0 and USB 1.1.

**Vertical resolution.** A value, in bits, indicating the precision with which the oscilloscope converts input voltages to digital values. The resolution enhancement function in PicoScope can improve the effective vertical resolution.

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