PicoScope® 5000 A and B Series

Flexible Resolution Oscilloscopes

User's Guide

Contents

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. With the PicoScope software you can use these devices 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.
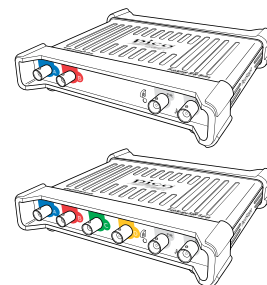
The A models are high-speed portable oscilloscopes with a function generator:

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 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:

- **Flexibility:** Whether you want 8, 12, 14, 15 or 16-bit resolution, the PicoScope 5000 Series oscilloscopes will suit your needs.
- **Portability:** Take the unit with you and plug it in to any Windows PC.
- **Performance:** Up to 1 GS/s sampling, 200 MHz bandwidth and 512 MS buffer.
- **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 are available to download from our website. You can also call our technical specialists for support. You can continue to use both of these services free of charge for the lifetime of the product.
- **Value for money:** You don't have to pay twice for all the features that you already have in your PC, as the PicoScope 5000 Series oscilloscope contains the special hardware you need and nothing more.
- **Convenience:** The software makes full use of the full-sized display, disk storage, user interface and networking built in to your PC.
- **Five-year warranty:** Your oscilloscope is covered for five years from the day of purchase against manufacturing faults. We don't charge a penny extra for this benefit.

For further information on the PicoScope 5000 A and B Series oscilloscopes, see the comparison table in this manual, and the specifications tables in the PicoScope 5000 Series data sheets available on our website.

2   Introduction

2.1   Safety information

This 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   Safety symbols

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

Symbol	Description	
— — —	Direct current.	
∿	Alternating current.	
⏚	Functional earth terminal.	This terminal is connected to chassis ground, and allows you to connect the oscilloscope to an external ground reference. This terminal is not intended to provide a protective (safety) ground.
⏚	Chassis ground terminal.	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. This symbol is used in place of the equipotential symbol which may appear on older products.
▣	Equipment protected throughout by double insulation or reinforced insulation.	
⚡	Possibility of electric shock.	
⚠	Caution.	Indicates a potential HAZARD: consult the product documentation every time you see this symbol, in order to identify the hazard and any actions needed to avoid it.
⚠	Static awareness. Static discharge can damage part(s).	
CAT	IEC 61010 overvoltage category.	
⌦	Do not dispose of this product as unsorted municipal waste.	

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.

WARNING
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 around electricity.

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 overload protection range for each oscilloscope model. The full scale measurement ranges are the maximum voltages that can be accurately measured by each instrument. The overload protection ranges are the maximum voltages that can be applied without damaging the oscilloscope.

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

Model	Full scale measurement range	Overload protection	
		Input channels / EXT trigger	**Signal generator**
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 overload 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 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)

2.1.6   Care of the instrument

The oscilloscope and its accessories contain no user-serviceable parts. Repair and servicing 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 instrument if it appears to be damaged in any way, and stop use immediately if you are concerned by any abnormal operations.

WARNING
When cleaning the oscilloscope, 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 casing, as this will cause damage to the electronics or insulation inside.

CAUTION
Do not tamper with or disassemble the oscilloscope, connectors or accessories. Internal damage will affect performance.

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 in which case the user will be required to correct the interference at his or her own expense.

For safety and maintenance information see the safety information.

2.2.2   CE notice

The PicoScope 5000 A and B Series oscilloscopes meet the intent of the **EMC directive 89/336/EEC** and have been tested to **EN 61326-1:2013 Class A Emissions and Immunity** standard.

The product also meets the intent of the **Low Voltage Directive** and has been designed to meet **BS EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use** standard.

2.3   Software license conditions

The software supplied with this product is licensed, not sold. Pico Technology Limited 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 these conditions and agree to abide by them.

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

Copyright. Pico Technology Limited claims the copyright of, and retains the rights to, all material (software, documents etc.) contained in this release. You may copy and distribute the entire release in its original state, but must not copy individual items within the release other than for backup purposes.

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

Fitness for purpose. Because no two applications are the same, Pico Technology cannot guarantee that its equipment or software is suitable for a given application. It is your responsibility, therefore, to ensure that the product is suitable for your application.

Mission-critical applications. This software is intended for use on a computer that may be running other software products. For this reason, one of the conditions of the license is that it excludes usage in mission-critical applications; for example, life-support systems.

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

Support. 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.

Upgrades. We provide upgrades, free of charge, from our website at www.picotech.com. We reserve the right to charge for updates or replacements sent out on physical media.

2.4 Trademarks

Windows is a registered trademark of Microsoft Corporation in the USA and other countries.

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

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

*   PicoScope version 6.11 and SDKs 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
- Installation Guide
- 2 or 4 x Probes (see Model Comparison table for probe details)

4   Installation

Please note the various power supply options below. Consult the appropriate section relating to the intended use of the oscilloscope and the instructions in the Installation Guide and the leaflet included with your product package.

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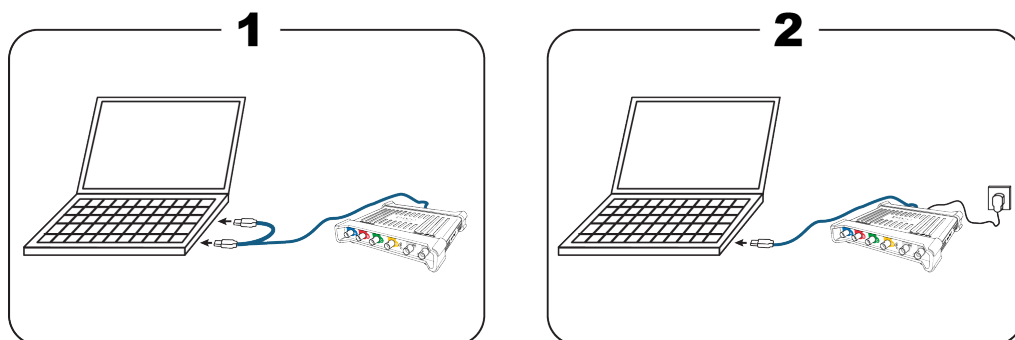
Note: If you connect or disconnect the AC adaptor while the oscilloscope is in operation it will restart automatically and any unsaved data will be lost.

Checking the installation

Once you have installed the software and connected the oscilloscope to the PC, start the PicoScope 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 hertz signal in the oscilloscope window when you touch the probe tip with your finger.

5   Product 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 x10 and switched x1/x10 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. Replacement probes matched to your PicoScope 5000 can be ordered from Pico Technology.

Signal generator (Gen) output

The **Gen** connector is the output of the oscilloscope's built-in signal generator, which can generate a number of built-in waveforms as well as user-defined arbitrary waveforms (B Models only).

- 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*.

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 **Ext** 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 **Ext** 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 LSB.

5.1 Model comparison table

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

PicoScope 2-channel models overview					
Model	**Maximum Bandwidth**	**Memory**		**Waveform Output**	**Probes Supplied**
		8-bit	**≥ 12-bit**		
5242A	60 MHz	16 MS	8 MS	Func. Gen.	2 x 60 MHz
5242B	60 MHz	32 MS	16 MS	Func. Gen. and AWG	2 x 60 MHz
5243A	100 MHz	64 MS	32 MS	Func. Gen.	2 x 150 MHz
5243B	100 MHz	128 MS	64 MS	Func. Gen. and AWG	2 x 150 MHz
5244A	200 MHz	256 MS	128 MS	Func. Gen.	2 x 250 MHz
5244B	200 MHz	512 MS	256 MS	Func. Gen. and AWG	2 x 250 MHz

PicoScope 4-channel models overview					
Model	**Maximum Bandwidth**	**Memory**		**Waveform Output**	**Probes Supplied**
		8-bit	**≥ 12-bit**		
5442A	60 MHz	16 MS	8 MS	Func. Gen.	4 x 60 MHz
5442B	60 MHz	32 MS	16 MS	Func. Gen. and AWG	4 x 60 MHz
5443A	100 MHz	64 MS	32 MS	Func. Gen.	4 x 150 MHz
5443B	100 MHz	128 MS	64 MS	Func. Gen. and AWG	4 x 150 MHz
5444A	200 MHz	256 MS	128 MS	Func. Gen.	4 x 250 MHz
5444B	200 MHz	512 MS	256 MS	Func. Gen. and AWG	4 x 250 MHz

Resolution vs sampling rate				
Resolution	**Sampling rate vs. 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
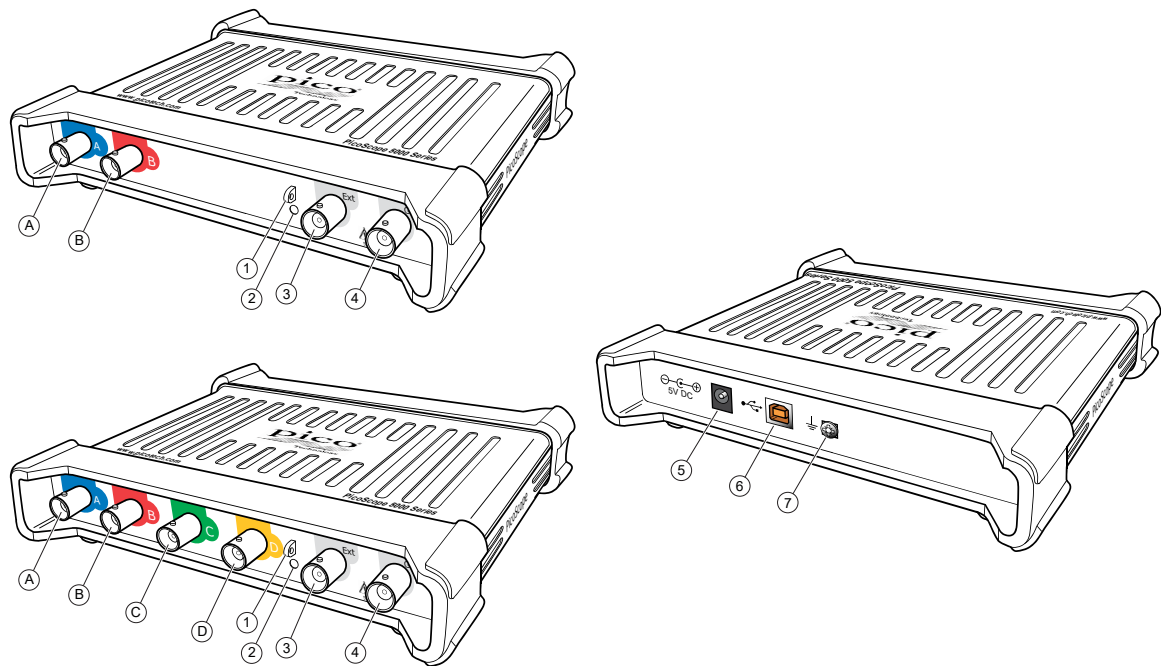
A. Input channel A

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

5.3 Moving to another USB port

The process is automatic. When you move the device from one port to another, Windows displays an "Installing device driver software" message and then a "PicoScope 5000 Series PC Oscilloscope" message. The oscilloscope is then ready for use.

5.4 Compensating probes

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 range and timebase 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.

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

Buffer size. The size of the oscilloscope buffer memory, measured in samples. In block mode, 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.

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 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.

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

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 is a software product that accompanies all our oscilloscopes. It turns your PC into an oscilloscope, spectrum analyzer, and meter display.

Signal generator. A built-in circuit that generates signals suitable for driving an external device under test. Its output is on the BNC connector marked Gen on the oscilloscope. If you connect a BNC cable between this and one of the channel inputs, you can send a signal into the channel.

Timebase. A timer that controls the speed at which the scope device captures data. At slow timebases this process is visible as PicoScope draws the trace across the scope view from left to right, but at fast timebases PicoScope draws the whole trace in a single operation. The timebase is measured in units of time (such as seconds) per division. There are ten divisions across the scope view, so the total time across the width of the view is ten times the "per division" setting.

USB 1.1. USB (Universal Serial Bus) is a standard port that enables you to connect external devices to PCs. A typical USB 1.1 port supports a data transfer rate of 12 Mbps (12 megabits per second), much faster than an RS232 port.

USB 2.0. A typical USB 2.0 port supports a data transfer rate that is 40 times faster than USB 1.1. USB 2.0 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.

Voltage range. The range of input voltages that the oscilloscope can measure. For example, a voltage range of ±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.

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