PicoScope 6000 Series
PC Oscilloscopes

User's Guide

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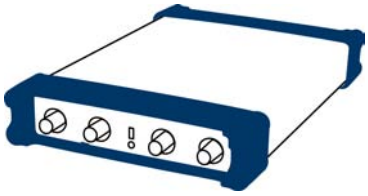
1 Welcome

Thank you for buying a PicoScope 6000 Series oscilloscope from Pico Technology!



The PicoScope 6000 Series scopes have comparable features and specifications to traditional bench-top oscilloscopes, but are more economical and take up only a fraction of the space.

Here are some of the benefits provided by your new PicoScope 6000 Series oscilloscope:

- Portability: Take the unit with you and plug it in to any Windows PC.
- Performance: 5 GS/s sampling, 350 MHz bandwidth and 1 GS buffer.
- Flexibility: Use it as an oscilloscope, spectrum analyzer or high-speed data acquisition interface.
- Programmability: The PicoScope 6000 Series SDK lets you write your own programs, in your chosen programming language, to control all the features of the scope.
- 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 6000 Series scope 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.

2 Introduction

2.1 Using this guide

You will sometimes see a symbol like this: 2 This is the cross-reference symbol, and it indicates the number of a page on which you can find more information about a topic.

2.2 Safety symbols

The following symbols appear on the front panel of the PicoScope 6000 Series oscilloscope.

Symbol 1: Warning triangle

This symbol indicates that a safety hazard exists on the indicated connections if correct precautions are not taken. Read all safety documentation associated with the product before using it.

Symbol 2: Equipotential

This symbol indicates that the outer shells of the indicated BNC connectors are all at the same potential (shorted together). You must therefore take necessary precautions to avoid applying a potential across the return connections of the indicated BNC terminals. Such a potential could cause a large current to flow, resulting in damage to the product or connected equipment, or both.

2.3 Safety warnings

We strongly recommend that you read the general safety information below before using your oscilloscope for the first time. Safety protection built in to equipment may cease to function if the equipment is used incorrectly. This could cause damage to your computer, or lead to injury to yourself and others.

DO NOT exceed the overload protection range. The product is designed to measure signals within the ranges stated in the "Voltage ranges" section of the Specifications table 9. The inputs can withstand the wider range of voltages stated in the "Overload protection" section of the same table 9. Contact with voltages outside the overload protection range may cause permanent damage to the unit.

DO NOT connect to mains voltages. The product is not designed for use with mains voltages (also known as line voltages, or house current). To measure mains voltages, use a differential isolating probe specifically rated for mains use.

DO NOT rely on the scope's ground as a safety ground. The product connects directly to the ground of a computer through the USB cable provided. This ground is for signalling and shielding, and is not a safety ground.

DO NOT connect the ground input to any potential other than ground. If in doubt, use a meter to check that there is no significant AC or DC voltage between the ground input of the oscilloscope and the point to which you intend to connect it. Connecting the ground input to a voltage source may cause damage to the scope and the computer, and injury to yourself and others.

2.4 FCC notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 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 warning 2.

2.5 CE notice

The product meets the intent of the EMC directive 89/336/EEC and has been tested to EN61326-1:2006 Class A Emissions and Immunity standard.

The product also meets the intent of the Low Voltage Directive and has been designed to meet the BS EN 61010-1:2001 IEC 61010-1:2001 Safety requirements for electrical equipment for measurement, control, and laboratory use standard.

2.6 Software licence conditions

The material contained in this software release is licensed, not sold. Pico Technology Limited grants a licence 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 Ltd. claims the copyright of, and retains the rights to, all material (software, documents etc.) contained in this release. You may copy and distribute the PicoScope and PicoLog software and drivers with no modifications, additions or omissions. You may copy and modify the SDK example programs.

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 licence is that it excludes usage in mission-critical applications such as 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 web site at www.picotech.com. We reserve the right to charge for updates or replacements sent out on physical media.

2.7 Trademarks

Trademarks. Windows is a trademark of Microsoft Corporation in the United States and other countries. Pico Technology and PicoScope are internationally registered trademarks of Pico Technology Ltd.

Pico Technology 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.

2.8 Warranty

Pico Technology warrants upon delivery, and for a period of 5 years 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, wilful 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.

2.9 Company details

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Sales:	sales@picotech.com
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3 Product information

3.1 What do I get?

You can buy the PicoScope 6000 Series oscilloscopes with or without a set of 4 high-impedance 10:1 probes. Here are the contents of the 4 available product packs:

Code	Description	Product packs			
		PP628	PP629	PP630	PP631
-	PicoScope 6402 oscilloscope with 32 MS memory	1	1		
-	PicoScope 6403 oscilloscope with 1 GS memory			1	1
TA101	500 MHz 10:1 compensated oscilloscope probes (350 MHz system bandwidth when used with PicoScope 6000 Series scopes)		4		4
TA102	2-footed probe stand		1		1
MI106	Hi-Speed USB cable, for connection to the USB port on your PC	1	1	1	1
PS010	AC adapter with mains cable (line cord)	1	1	1	1
DI025	Pico Technology software and reference CD	1	1	1	1
DO115	USB Oscilloscope Installation Guide	1	1	1	1
MI251	Carrying case	1	1	1	1

3.2 System requirements

To ensure that your PicoScope 6000 Series 11 oscilloscope 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 software will increase with more powerful PCs, including those with multi-core processors.

Item	Absolute minimum	Recommended minimum	Recommended full specification
Operating system	Windows XP SP2, Vista or 7 (32-bit and 64-bit versions)		
Processor	As required by Windows	300 MHz	1 GHz
Memory		256 MB	512 MB
Free disk space (Note 1)		1 GB	2 GB
Ports	USB 1.1 compliant port	USB 2.0 compliant port	

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.

3.3 Installation instructions

> IMPORTANT
> Always install the Pico software before connecting your PicoScope 6000 Series oscilloscope to the PC. This ensures that Windows will correctly recognize the oscilloscope.

Procedure

- Follow the instructions in the USB Oscilloscope Installation Guide included with your product package.
- Connect the AC adapter (supplied) to a power socket using the appropriate cable (also supplied), and connect the DC output of the AC adapter to the "DC Power" socket on the back of the oscilloscope.
- Connect the oscilloscope to the PC using the USB cable supplied.

Checking the installation

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

Moving the PicoScope PC Oscilloscope to another USB port

- Windows XP SP2

When you first installed the oscilloscope by plugging it into a USB port, Windows associated the Pico driver with that port. If you later move the oscilloscope to a different USB port, Windows will display the "New Hardware Found Wizard" again. When this occurs, just click "Next" in the wizard to repeat the installation. If Windows gives a warning about Windows Logo Testing, click "Continue Anyway". As all the software you need is already installed on your computer, there is no need to insert the Pico Software CD again.

- Windows Vista and Windows 7

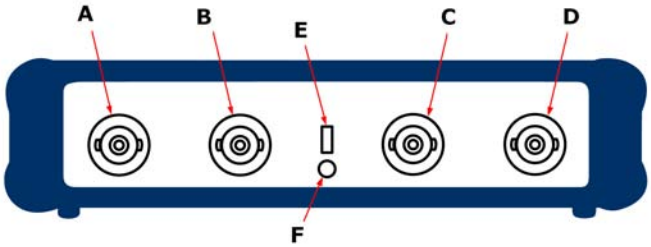
The process is automatic. When you move the device from one port to another, Windows displays an "Installing device driver software" message and then a "PicoScope 6000 Series oscilloscope" message. The oscilloscope is then ready for use.

3.4 Connections

Standard oscilloscope connectors

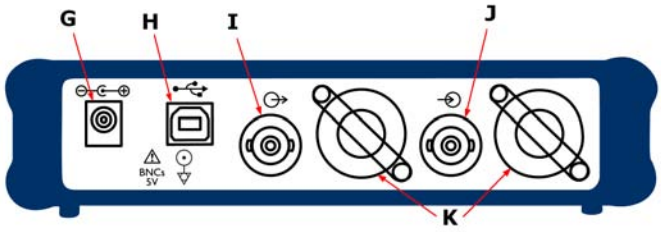
The PicoScope 6000 Series 11 oscilloscopes have standard BNC input and output connectors. The channel inputs have switchable impedances of 50 Ω or 1 MΩ. In high-impedance mode, they are compatible with all standard scope probes including 10:1 attenuated types. To ensure that you obtain the rated bandwidth from the scope, we recommend that you use the compensated high-frequency probes supplied with it.

Connector diagrams



Front panel
PicoScope 6000 Series

A. Input channel A 9
B. Input channel B 9
C. Input channel C 9
D. Input channel D 9
E. Probe calibration output 9
F. LED: shows when the oscilloscope is sampling data



Rear panel
PicoScope 6000 Series

G. DC power socket 10: for use with the AC adaptor supplied with the unit
H. USB 2.0 port 10: connects to your PC using the Hi-Speed USB cable supplied
I. SIGNAL OUT connector 10: carries the output of the arbitrary waveform generator and signal generator
J. AUX IN connector 9: carries the auxiliary (AUX) trigger and reference clock inputs
K. Ventilation holes. Do not block the air intake holes or insert any objects through them, as this could damage the unit and cause injury.

3.5 Specifications

Model number	PicoScope 6402	PicoScope 6403
Vertical section		
Number of channels	4	
Analog bandwidth 11	350 MHz (-3 dB) with TA101 probe or direct 50 Ω input	
Rise time	1.0 ns (10% to 90%)	
Connectors	BNC female	
Input coupling 11	AC or DC, independently switchable	
Input impedance	1 MΩ || 15 pF (AC or DC) or 50 Ω (DC only), independently switchable	
Voltage ranges 12	±50 mV†, ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V*, ±20 V* *1 MΩ input only †250 MHz bandwidth	
Sensitivity	10 mV/div to 4 V/div at x1 zoom	
Bandwidth limiter	20 MHz @ -3 dB, single-pole, software-selectable	
Input offset (position) adjustment	50 mV to 200 mV ranges: ±0.5 V 500 mV to 2 V ranges: ±2.5 V 5 V range, 50 Ω input: ±0.5 V 5 V range, 1 MΩ input: ±20 V 10 V to 20 V ranges: ±20 V	
DC accuracy	3% of full scale	
Overload protection	±100 V DC+AC peak on 1 MΩ inputs 5.5 V RMS on 50 Ω inputs	
Acquisition		
Vertical resolution 11	8 bits (up to 12 in resolution enhance mode)	
Maximum sampling rate 11 (real-time) One channel in use Two channels in use Three or four channels in use	 5 GS 11/s 2.5 GS/s 1.25 GS/s	
Maximum streaming data rate	13 MS/s (PC-dependent)	
Buffer size 11	32 MS 11	1 GS 11
	shared between enabled channels	
Maximum buffer segments	32 k	1 M
Timebase ranges 11	1 ns/div to 200 s/div (real-time sampling)	
Timebase accuracy	5 ppm	
Triggering		
Trigger types	Single edge, dual edge, hysteresis, level, window, pulse width, runt pulse, delayed, dropout, logic	
Trigger modes	None, Single, Repeat, Auto, Rapid	
Trigger level	Adjustable over whole of selected voltage range	
Maximum trigger rate	Up to 10,000 waveforms in a 10 ms burst	
Re-arm time	Less than 1 µs on fastest timebase	
Trigger sources	Ch A to Ch D, AUX	
Maximum trigger delay	Pre-trigger: 100% of capture size Post-trigger: 4 billion samples	
Spectrum analyzer		
Frequency range	DC to 350 MHz	
Display modes	Magnitude, average, peak hold	
Windowing functions	Rectangular, Gaussian, triangular, Blackman, Blackman-Harris, Hamming, Hann, flat-top	
Number of FFT points	Selectable from 128 to 1 million in powers of 2	
Probe calibration output		
Signal	1 kHz square wave, 2 V pk-pk, 600 Ω	
Overload protection	±5 V	
AUX input		
Connector	BNC female	
Impedance	50 Ω	
Coupling	DC	
Bandwidth (-3 dB)	25 MHz	

Model number	PicoScope 6402	PicoScope 6403
Threshold adjustment range	±1 V	
External clock input	Reference frequency 5 MHz to 25 MHz	
Protection range	±5 V	
Function generator and arbitrary waveform generator (AWG)		
Frequency range	DC to 20 MHz	
Standard waveforms	Sine, square, triangle, ramp, (sin x)/x, Gaussian, half-sine, white noise, DC level	
Amplitude flatness	3 dB	
DAC resolution	12 bits	
AWG sample rate	200 MS/s	
AWG buffer size	16,384 samples	
DC accuracy	1%	
Amplitude range	±250 mV to ±2 V	
Offset adjustment	±1 V (max. combined output ±2.5 V)	
Impedance	50 Ω	
Connector	BNC female	
Overload protection	±5 V	
Math channels		
Functions	–x, x+y, x–y, x*y, x/y, sqrt(x), x^y, exp(x), ln(x), log(x), abs(x), norm(x), sign(x), sin(x), cos(x), tan(x), arcsin(x), arccos(x), arctan(x), sinh(x), cosh(x), tanh(x), Pi	
Operands	A to D (input channels), T (time), reference waveforms	
CAN bus decoding		
Baud rate	10 kb/s to 1 Mb/s	
Threshold voltage	Adjustable	
Polarity	CAN H, CAN L	
Mask limit testing		
Horizontal resolution	1000 to 10,000 points, adjustable	
Statistics	Pass/fail, failure count, total count	
Display		
Interpolation	Linear or (sin x)/x	
Persistence modes	Digital color, analog intensity, custom, or none	
Environmental conditions		
Operating environment Temperature range Humidity	 0 °C to 40 °C operational 20 °C to 30 °C for stated accuracy 5% to 80% RH, non-condensing	
Fan speed	Automatic, to reduce noise	
Storage environment Temperature range Humidity	 -20 °C to +60 °C 5% to 95% RH, non-condensing	
IP rating	IP 20	
Miscellaneous		
PC connection	Hi-Speed USB 2.0	
Power supply	External AC to 12 V 3.5 A DC adapter and cables (cords) included	
Dimensions	170 mm x 255 mm x 40 mm (6.7" x 10.0" x 1.6") including connectors and plastic end caps	
Weight	1.15 kg (approx. 2 lb 9 oz)	
Compliance	Europe: EMC EN61326, LVD EN61010-1, RoHS, WEEE USA: FCC Rules Part 15 Class A 3	
Languages supported	Full: English, French, Italian, German, Spanish Partial: Simplified Chinese, Hungarian, Dutch	

4 Glossary

Analog bandwidth. The input frequency at which the measured signal amplitude is 3 decibels below the true signal amplitude.

Buffer size. The size of the oscilloscope buffer memory, measured in samples. The buffer allows the oscilloscope to sample data faster than it can transfer it to the computer.

Coupling. To switch between AC coupling and DC coupling in PicoScope, select AC or DC from the control on the toolbar. The AC setting filters out very low-frequency components of the input signal, including DC, 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.

Device Manager. Device Manager is a Windows program that displays the current hardware configuration of your computer. On Windows XP or Vista, right-click 'My Computer,' choose 'Properties', then click the 'Hardware' tab and the 'Device Manager' button.

Driver. A program that controls a piece of hardware. The driver for the oscilloscopes is supplied in the form of a 32-bit Windows DLL, `ps6000.dll`. This is used by the PicoScope software, and by user-designed applications, to control the oscilloscopes.

GS. Gigasamples (1,000,000,000 samples).

Maximum sampling rate. A figure indicating the maximum number of samples the oscilloscope can acquire 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. Megasamples (1,000,000 samples).

Oversampling. Oversampling is taking measurements more frequently than the requested sample rate, and then combining them to produce the required number of samples. If, as is usually the case, the signal contains a small amount of noise, this technique can increase the effective vertical resolution 11 of the oscilloscope.

PC Oscilloscope. A virtual instrument formed by connecting a PicoScope oscilloscope to a computer running the PicoScope software.

PicoScope 6000 Series. A range of 8-bit USB oscilloscopes from Pico Technology, with a sampling rate of 5 GS/s, a bandwidth of 350 MHz and buffer sizes up to 1 GS.

PicoScope software. A software product that accompanies all PicoScope oscilloscopes. It turns your PC into an oscilloscope, spectrum analyzer and multimeter.

Timebase. The timebase controls the time interval that each horizontal division of a scope view represents. There are ten divisions across the scope view, so the total time across the view is ten times the timebase per division.

USB 2.0. Universal Serial Bus. This is a standard port used to connect external devices to PCs. The port supports a data transfer rate of up to 480 megabits per second, so is much faster than the RS-232 COM ports found on older PCs.

Vertical resolution. A value, in bits, indicating the precision with which the oscilloscope converts input voltages to digital values. Oversampling 11 (see above) can improve the effective vertical resolution.

Voltage range. The range of input voltages that the oscilloscope can measure. For example, a voltage range of ±100 mV means that the oscilloscope can measure voltages between -100 mV and +100 mV. Input voltages outside this range will not damage the instrument as long as they remain within the protection limits stated in the Specifications 9 table.

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