



PicoScope 5000 Series

PC Oscilloscopes

User's Guide



Contents

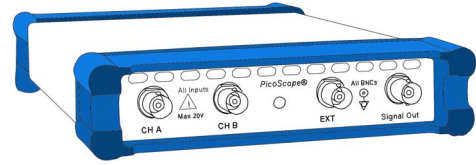
1 Welcome	1
2 Introduction	2
1 Using this guide	2
2 Safety symbols	3
3 Safety warning	3
4 FCC notice	4
5 CE notice	4
6 Software licence conditions	4
7 Trademarks	5
8 Warranty	5
9 Company details	5
3 Product information	6
1 What's in the product pack?	6
2 System requirements	6
3 Installation instructions	7
4 Connections	8
1 AUXIO connector	9
2 Signal Out connector	9
5 Specifications	10
4 Glossary	11
Index	13



1 Welcome

Thank you for buying a Pico Technology product!

The PicoScope 5000 Series of PC Oscilloscopes from Pico Technology is a range of compact units designed to replace traditional bench-top oscilloscopes costing many times the price.




Here are some of the benefits provided by your new PicoScope 5000 Series PC Oscilloscope:

- **Portability:** Take the unit with you and plug it in to any Windows PC.
- **Performance:** Fast sampling up to 1 GS/s, probe-tip bandwidth of 250 MHz, large buffer with up to 128 M samples, fast USB 2.0 interface.
- **Flexibility:** Use it as an oscilloscope, spectrum analyser or high-speed data acquisition interface.
- **Programmability:** The PicoScope 5000 series API 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. The PicoScope 5000 Series scope unit contains the special hardware you need and nothing more.
- **Convenience:** The software makes full use of the large display, storage, user interface and networking built in to your PC.

2 Introduction

2.1 Using this guide

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

The abbreviations MS/s and GS/s are used in this guide to mean megasamples per second and gigasamples per second respectively.

Further information

If you wish to write your own software to control the oscilloscope, see the *PicoScope 5000 Series Programmer's Guide*, available for download from our website.

2.2 Safety symbols

The following symbols appear on the front panel of the PicoScope 5000 Series PC 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 warning

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.

Maximum input range. PicoScope 5000 Series PC Oscilloscopes are designed to measure voltages in the range -20 V to +20 V. The A, B and EXT inputs are protected to ± 100 V, whilst the AUXIO input can accept 0 V to 10 V. Contact with voltages outside the protection range may cause permanent damage to the unit.

Mains voltages. Pico Technology products are not designed for use with mains voltages. To measure mains, use a differential isolating probe specifically designed for a high source voltage.

Safety grounding. PicoScope 5000 Series PC Oscilloscopes connect directly to the ground of a computer through the USB cable provided to minimise interference.

As with most oscilloscopes, avoid connecting 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. Failure to check may cause damage to your computer or injury to yourself and others.

The product does not have a protective safety ground.

Repairs. The oscilloscope contains no user-serviceable parts. Repair or calibration of the oscilloscope requires specialised test equipment and must be performed by Pico Technology.

Cooling fan. The unit contains a low-noise cooling fan that expels air through the holes in the back of the unit (shown in the [Connections](#) section). Do not block these holes, as this might cause the unit to overheat. Do not insert anything in the holes, as this could damage the unit or cause injury.

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](#) .

2.5 CE notice

The PicoScope 5000 Series PC Oscilloscopes meet the intent of the EMC directive 89/336/EEC and have been designed to EN61326-1 (1997) Class A Emissions and Immunity standard.

PicoScope 5000 Series PC Oscilloscopes also meet the intent of the Low Voltage Directive and have been designed to meet the BS EN 61010-1:2001 IEC 61010-1:2001 (safety requirements for electrical equipment, 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 products or with data collected using Pico 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 licence is that it excludes usage in mission-critical applications such as life-support systems.

2.7 Trademarks

Windows is a registered trademark or trademark of Microsoft Corporation in the USA and other countries. Delphi is a registered trademark of Borland Software Corporation.

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.

2.8 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, 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

Address: Pico Technology
James House
Colmworth Business Park
St Neots
Cambridgeshire
PE19 8YP
United Kingdom

Phone: +44 (0) 1480 396 395

Fax: +44 (0) 1480 396 296

Email:

Technical Support: support@picotech.com

Sales: sales@picotech.com

Web site: www.picotech.com

3 Product information

3.1 What's in the product pack?

Your PicoScope 5000 Series PC Oscilloscope kit contains the following items:

Reorder code	Quantity	Description
PR088	1	PicoScope 5203 scope unit (PicoScope 5203 kit only)
PR089	1	PicoScope 5204 scope unit (PicoScope 5204 kit only)
MI145	2	Compensated x1/x10 switchable 250 MHz oscilloscope probe
MI106	1	USB cable, for connection to the USB 1.1 or USB 2.0 port on your PC
PS006	1	Universal power adaptor with UK, US, EU and Australasian plugs
DI042	1	5000 Series software CD
DO115	1	USB Oscilloscope Installation Guide
MI144	1	Carry case

3.2 System requirements

To ensure that your [PicoScope 5000 Series](#) PC 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, Windows Vista or Windows 7; 32-bit or 64-bit		
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
Do not connect your [PicoScope 5000 Series](#) scope device to the PC before you have installed the Pico software.
If you do, Windows might not recognise the scope device correctly.

Procedure

- Follow the instructions in the Installation Guide included with your product package.
- Connect your PC Oscilloscope to the PC using the USB cable supplied.
- Select one of the mains plugs supplied with your power adaptor, according to your location, and fit it to the adaptor.
- Plug the power adaptor supplied with the unit into the mains. Plug the output lead of the adaptor into the scope unit.

Checking the installation

Once you have installed the software and connected the PC 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 50 or 60 hertz signal in the oscilloscope window when you touch the probe tip with your finger.

Moving your PicoScope PC Oscilloscope to another USB port

● Windows XP SP2

When you first installed the PicoScope 5000 Series PC 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 5000 series PC Oscilloscope" message. The PC Oscilloscope is then ready for use.

3.4 Connections

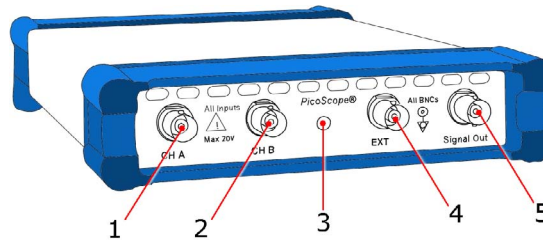
Standard oscilloscope connectors

[PicoScope 5000 Series](#) ^[1] PC Oscilloscopes have BNC oscilloscope connectors. The inputs have an impedance of 1 M Ω , so they are compatible with all standard scope probes including x10 attenuated types. To ensure that you obtain the rated bandwidth from the scope, use the compensated high-frequency probes supplied with it.

Connector diagrams

Front panel

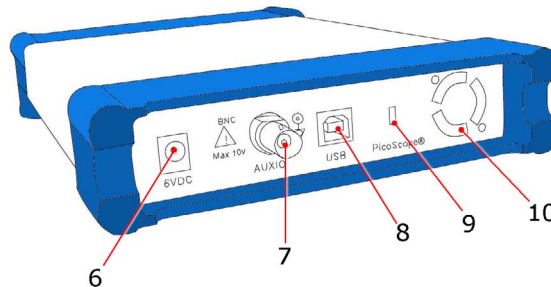
PicoScope 5203
PicoScope 5204



1. Input channel A
2. Input channel B
3. LED: shows when the oscilloscope is sampling data
4. [External trigger input](#) ^[1]
5. [Signal generator output](#) ^[9]

Rear panel

PicoScope 5203
PicoScope 5204

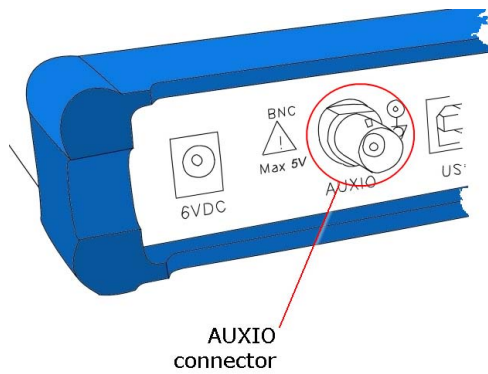


6. Power socket: for use with the AC adaptor supplied with the unit
7. [Auxiliary input / output.](#) ^[9] Used as an auxiliary trigger input and output.
8. USB 2.0 port
9. Kensington Security Slot. Allows you to attach a standard notebook security cable to the scope.
10. Cooling holes. There is a low-noise fan inside the unit that blows air through these holes.
Do not block the cooling holes or insert any objects through them, as this could damage the unit or cause injury.

3.4.1 AUXIO connector

The auxiliary input / output connector on the rear panel can be used for two different purposes: -

- When PicoScope 6 is running it functions as a trigger input.
- Programmers can use the API to configure it as a trigger input or output. (See the *PicoScope 5000 Series Programmer's Guide* for details.)

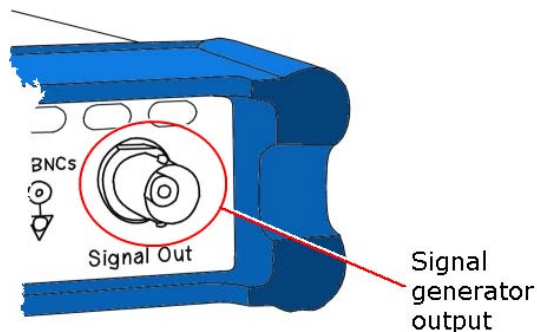


AUXIO signal specifications

Refer to the [Specifications](#) ¹⁰¹ table.

3.4.2 Signal Out connector

This signal output connector on the front panel carries the output of the unit's built-in signal generator, which can generate a number of built-in waveforms as well as arbitrary waveforms from a user-defined table of data.



Signal generator output specifications

Refer to the [Specifications](#) ¹⁰¹ table.

3.5 Specifications

Variant	PicoScope 5203	PicoScope 5204
Number of channels	2	
Vertical resolution ^[12]	8 bits	
Analog bandwidth ^[11]	250 MHz at probe tip	
Maximum sampling rate ^[11] (real time)		
One channel in use	1 GS/s	
Two channels in use	500 MS/s	
Maximum sampling rate (repetitive signals)	20 GS/s	
Buffer size ^[11]	32 MS	128 MS
	If two channels in use, buffer shared between channels.	
Inputs		
Input characteristics	BNC, 1 M Ω in parallel with about 15 pF	
Coupling	Selectable AC/DC	
Voltage ranges ^[12]	± 100 mV, ± 200 mV, ± 500 mV, ± 1 V, ± 2 V, ± 5 V, ± 10 V, ± 20 V	
Accuracy	3%	
Overload protection	± 100 V	
Timebase		
Range	5 ns/div to 100 s/div	
Accuracy	50 ppm	
Signal generator output ^[9]		
Standard waveforms	Sine, square, triangle, ramp (up/down), sin (x)/x, Gaussian, half sine, white noise	
Arbitrary waveform buffer	8192 samples	
Sample rate	125 MS/s	
Output characteristics	BNC, 50 Ω	
Resolution	12 bits	
Amplitude	± 250 mV to ± 2 V	
Offset	± 1 V	
Maximum range	± 2.5 V	
External trigger ^[11]		
Threshold	Variable up to ± 20 V	
Resolution	9.8 mV	
Input characteristics	BNC, 1 M Ω	
Bandwidth	150 MHz	
Overload protection	± 100 V	
Auxiliary input/output ^[9]		
Input impedance	100 k Ω	
Output impedance	600 Ω	
Output level	0 V (low), 3.3 V (high)	
Input voltage range	0 V to 10 V	
Input threshold	1.65 V (nominal)	
Operating environment		
Temperature range	0°C to 40°C for normal operation 20°C to 30°C for quoted accuracy	
Humidity	5% to 80% RH, non-condensing	
Storage environment		
Temperature range	-20°C to +60°C	
Humidity	5% to 95% RH, non-condensing	
PC connection	USB 2.0 Compatible with USB 1.1	
Power supply	6 V \pm 5% @ 2.5 A max.	
Protection	Auto shutdown on excess or reverse voltage	
AC adaptor	Universal adaptor supplied	
Dimensions	170 mm x 255 mm x 40 mm (6.7" x 10.0" x 1.6")	
Weight	0.9 kg (31.7 oz)	
Compliance	European EMC and LVD standards ^[4] FCC Rules Part 15 Class A ^[4]	

4 Glossary

AC/DC switch. To switch from AC coupling to DC coupling, or vice versa, select AC or DC from the control on the PicoScope 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.

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.

Device Manager. Device Manager is a Windows program that displays the current hardware configuration of your computer. On Windows XP or Vista, right-click on '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 PicoScope 5000 Series PC Oscilloscopes is supplied in the form of a 32-bit Windows DLL, `ps5000.dll`. This is used by the PicoScope software, and by user-designed applications, to control the oscilloscopes.

ETS. Equivalent Time Sampling. Constructs a picture of a repetitive signal by accumulating information over many similar wave cycles. This allows the oscilloscope to create a composite cycle that has more samples, and therefore better time resolution, than a single cycle. Note: cannot be used for one-shot signals.

External trigger. The BNC socket marked EXT on the PicoScope 5000 Series PC Oscilloscopes. It can be used as a trigger input.

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. "GS/s" is an abbreviation for gigasamples (1,000,000,000 samples) per second.

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](#)^[12] of the oscilloscope.

PC Oscilloscope. A virtual instrument formed by connecting a PicoScope 5000 Series scope unit to a computer running the PicoScope software.

PicoScope 5000 Series. Pico Technology's fifth generation of PC Oscilloscopes.

PicoScope software. A software product that accompanies all Pico PC Oscilloscopes. It turns your PC into an oscilloscope, spectrum analyser, and meter display.

Signal generator. Generates a waveform and outputs it on the BNC socket marked Signal Out on the oscilloscope. This output can be used to drive a test signal through a BNC cable into one of the scope's input channels. The PicoScope software and the API allow the generator to output regular waveforms, such as sine and square waves, or arbitrary waveforms defined by the user.

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.

Trigger bandwidth. The external trigger input is less sensitive to very high-frequency input signals than to low-frequency signals. The trigger bandwidth is the frequency at which a trigger signal will be attenuated by 3 decibels.

USB 1.1. Universal Serial Bus (Full Speed). This is a standard port used to connect external devices to PCs. A typical USB 1.1 port supports a data transfer rate of 12 megabits per second, so is much faster than an RS232 COM port.

USB 2.0. Universal Serial Bus (High Speed). This is a standard port used to connect external devices to PCs. A typical USB 2.0 port supports a data transfer rate 40 times faster than USB 1.1 when used with a USB 2.0 device, but can also be used with USB 1.1 devices.

Vertical resolution. A value, in bits, indicating the precision with which the oscilloscope converts input voltages to digital values. [Oversampling](#)^[1†] (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 of ± 100 V.

Index

A

- Accuracy 10
- Analog bandwidth 10
- Arbitrary waveform generator 9
- AUXIO connector 8, 9, 10

B

- Bandwidth (analog) 10
- BNC connector 8
- Buffers
 - size 10

C

- Calibration 3
- CE notice 4
- Company information 5
- Compliance 10
- Connections 8
- Contact details 5

D

- Dimensions 10
- Disk space 6

E

- EMC Directive 4
- External trigger 8, 10

F

- FCC notice 4

G

- Grounding 3

I

- Input range, maximum 3, 10
- Inputs 10
- Installation 7

L

- LED 8
- Low Voltage Directive 4

M

- Mains voltages 3

O

- Operating environment 10
- Operating system 6
- Oscilloscope probe 8
- Outputs 10
- Overload protection 10

P

- PC connection 10
- Pico Technical Support 5
- PicoScope 5000 Series 1
- PicoScope software 7
- Power socket 8
- Power supply 10
- Processor 6

R

- Repairs 3
- Resolution, vertical 10

S

- Safety
 - symbols 3
 - warning 3, 4
- Sampling rate 10
- Scope probe 8
- Signal generator 8, 10
 - output 9
- Signal Out connector 9
- Software licence conditions 4
- Specifications 10
- Storage environment 10
- System memory 6
- System requirements 6

T

- Technical support 5
- Test equipment 3
- Trademarks 5
- Trigger
 - bandwidth 10
 - external 8, 10
 - input 9

U

- USB 6
 - changing ports 7

V

- Vertical resolution 10
- Voltage ranges 10

W

- Warranty 5
- Weight 10
- Windows, Microsoft 6



Pico Technology

James House
Colmworth Business Park
ST. NEOTS
Cambridgeshire
PE19 8YP
United Kingdom
Tel: +44 (0) 1480 396 395
Fax: +44 (0) 1480 396 296
<%WEBADDRESS%>

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