



USB PT-104

Platinum RTD Converter

User's Guide



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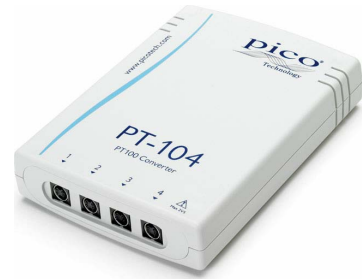
1 Introduction

1.1 Overview

The USB PT-104 is a four-channel, high-resolution temperature converter for use with PT100 and PT1000 type [platinum resistance thermometers](#) (PRTs). It can be used to measure temperature, resistance and voltage.

In PT100, PT1000 and resistance modes, the unit can use a two, three or four-wire circuit. Four-wire measurement gives the greatest accuracy.

In voltage mode, the input connector can be treated as a [differential input](#) with ground, or as two [single-ended inputs](#).



Programmer's Guide

All the software that you need for everyday use of the USB PT-104 is supplied with the unit. For more advanced applications, you can write your own software. Information on programming is published in a separate guide:

- [USB PT-104 Programmer's Guide \(usbpt104pg.en.pdf\)](#)

1.2 Safety warnings



We strongly recommend that you read the general safety information below before using your product for the first time. If the equipment is not used in the manner specified then the protection provided may be impaired. This could result in damage to your computer and injury to yourself and others.

DO NOT exceed the maximum input range. The USB PT-104 is designed to measure voltages in the range 0 to +2.5 V. Any voltages in excess of ± 30 V may cause permanent damage to the unit.

DO NOT use in contact with mains (line) voltages. This product is not designed for use on circuits carrying mains voltages. Take great care when measuring temperatures near mains (line-powered) equipment. If in doubt, use a meter to check that there is no hazardous AC or DC voltage on the equipment. If a sensor is accidentally connected to a mains voltage, you risk damage to the converter and your computer, and your computer chassis may become live resulting in injury to yourself and others.

DO NOT exceed the maximum input voltage range of the device. Incorrect configuration or use of the device to measure voltages outside this range can be hazardous.

DO NOT rely upon the product's ground connection as a protective safety earth. If there is any possibility of contact with hazardous voltages, the equipment under test must be safely earthed.

DO NOT attempt to repair the unit. The unit contains no user-serviceable parts. Repair or calibration of the unit requires specialised test equipment and must be performed by Pico Technology or its authorised distributors.

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2 Product information

2.1 Pack contents

Your USB PT-104 pack (order code PP682) should contain the following items:

Quantity	Reorder code	Description
1	PP682	Platinum RTD data logger
1	DO112	USB Installation Guide
1	MI106	USB lead
1	DI025	Software and Reference CD
1	TA076	Ethernet patch cable

2.2 Specifications

	Temperature	Resistance	Voltage
Sensor	PT100*, PT1000	N/A	N/A
Range	-200 to +800 °C	0 to 375 Ω* 0 to 10 k	0 to 115 mV 0 to 2.5 V*
Linearity	20 ppm	20 ppm	20 ppm
Accuracy @25°C	0.01 °C*	20 ppm*	0.2% (0 to 2.5 V) 2% (0 to 115 mV)
Temperature coefficient	5 ppm/°C	5 ppm/°C	100 ppm/°C
RMS Noise (using filter)	0.01 °C	10 ppm	10 ppm
Resolution	0.001 °C	1 mΩ	0.156 μV
Conversion Time Per Channel	720 ms		
Number of inputs	4		
Connectors	4-pin mini-DIN		
Input impedance	>> 1 MΩ		
Overvoltage protection	±30 V		
Output	USB or Ethernet		
Power	Powered by USB or Ethernet		
Environment	20°C to 30°C for stated accuracy; 0°C to 70°C overall; 20% to 90% relative humidity		
Dimensions	W 135 x L 184 x H 36 mm (5.31 x 7.24 x 1.42 in.)		
Software	PicoLog data logging software. Drivers for Windows XP SP2/Vista/Windows 7. Examples for C/C++, Delphi, Excel, LabVIEW, Visual Basic, Agilent-VEE.		
Ethernet port	Conforms to IEEE 802.3 10Base-T. Compatible with 10/100/1000Base-T networks. Conforms to IEEE 802.3af Power-over-Ethernet (PoE).		
USB port	Conforms to USB 2.0 Full-Speed (12 Mbps)		
*Quoted accuracy is for options marked			

2.3 Installing the driver

The driver is installed automatically when you install the PicoLog software. Alternatively, you can download the driver from our website at <http://www.picotech.com>.

2.4 Connection: USB port

To use the USB PT-104, connect its USB port to a USB port on your computer using the cable provided.

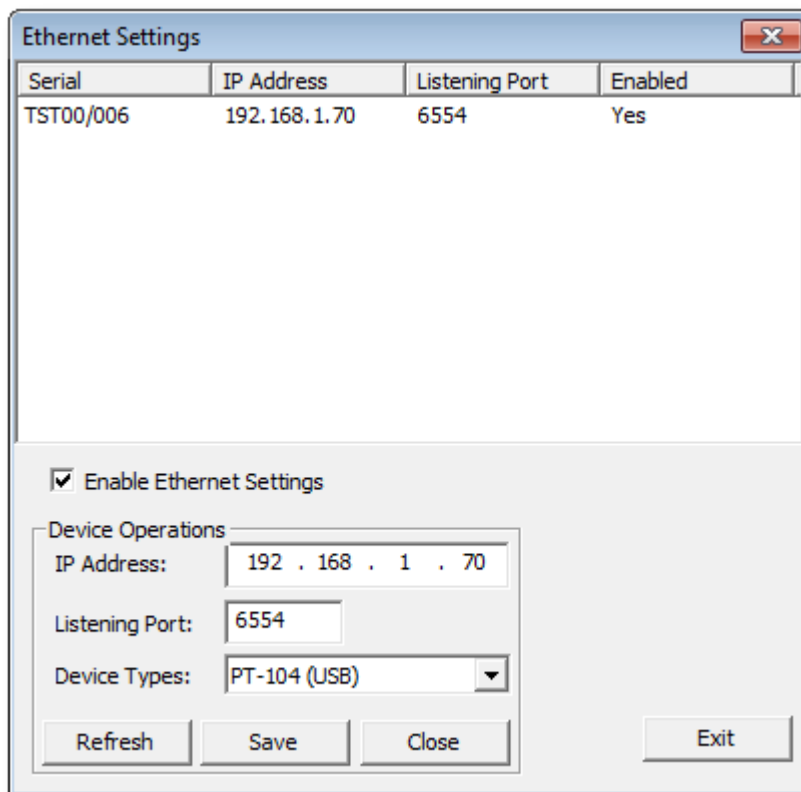
The first time you connect the device, Windows will install the driver and then tell you that the device is ready for use. You can then run PicoLog to start making measurements.

2.5 Connection: Ethernet port

Setup utility

Before connecting to the USB PT-104's Ethernet port, you must first configure the Ethernet settings. Proceed as follows:

1. Connect the unit to your computer using the USB port.
2. Run the *Ethernet Settings* utility. There is a shortcut to this utility in the *Pico Technology* program group under the Windows *Start* menu.
3. Set the *Device Types* control to "PT-104 (USB)".
4. The serial number of your device should appear in the device list. Click the device once to select it.
5. Set the *Enable Ethernet Settings* check box.
6. Enter the IP address and port that you wish to give the device. You may need to ask your network manager for an IP address that does not conflict with existing devices on the network.



7. Click *Save* and then *Exit*.
8. Power down the device by unplugging the USB cable.
9. Power up the device, either by connecting the USB port to a USB host, or by connecting the Ethernet port to a Power-over-Ethernet power source. This causes the USB PT-104 to update its configuration.
10. You can now either continue to use the USB PT-104 as a USB device, or unplug the USB cable and reconnect the device using its Ethernet port.

Power-saving tip



If you wish to stop using the USB PT-104 in Ethernet mode, you can use the *Ethernet Settings* utility to disable its Ethernet port. This reduces the power consumption of the device when used in USB mode.

Ethernet and USB



Do not use the USB PT-104 in USB mode when it is being powered by Power-over-Ethernet (PoE). This could cause the unit to radiate electromagnetic energy outside the limits permitted by FCC and EU regulations, and could also cause it to produce spurious measurements. It will not, however, cause permanent damage to the unit.

LAN connection

To use the USB PT-104 on a local-area network (LAN), connect it to your network switch or network router using the Ethernet cable provided.

Direct connection

You can also connect the USB PT-104 directly to the network port on your computer. For this connection, you will need to use an Ethernet crossover cable (not supplied).

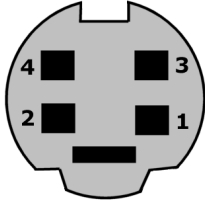
Power over Ethernet (PoE)

The USB PT-104 can obtain its power from the Ethernet port as a Powered Device (PD) according to the PoE standard. To use this feature, you must connect the unit to Power Sourcing Equipment (PSE) such as a network switch, router or power injector that also supports the PoE standard. Any standard Ethernet cable up to 100 m (about 328 ft) in length can be used.

2.6 Connection: PRT inputs

The USB PT-104 is compatible with PT100 and PT1000 type [platinum resistance thermometers](#) (PRTs). Connect each one of these devices to the unit as follows.

Pin Connections to the USB PT-104 Mini-DIN socket



Pin	PT100, PT1000 or Resistance 4-Wire	PT100, PT1000 or Resistance 3-Wire	PT100, PT1000 or Resistance 2-Wire	Differential voltage
1	White	Connect to pin 3	Connect to pin 3	Do not connect
2	Red	Red	Red	V -
3	White	White	White	V +
4	Red	Red	Connect to pin 2	Gnd

Single-ended voltage connection

Single-ended mode allows you to double the number of channels from 4 to 8. It is supported by the driver, so you can use it in your own applications. It is not, however, supported by PicoLog.

Connector	Channel	Pin
1	1	3
	5	2
2	2	3
	6	2
3	3	3
	7	2
4	4	3
	8	2

Note on Differential Voltage Mode

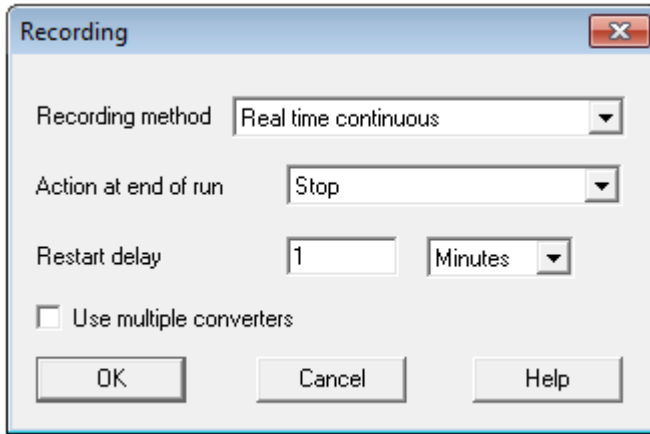
The maximum input voltage range of the USB PT-104 is 2.5 V. Any voltage in excess of ± 30 V on any input pin may cause permanent damage to the unit.

In Differential Voltage Mode, the input connector should be treated as a differential input with reference to ground. Both inputs (V+ and V-) must be zero volts or above (it does not matter which input has the higher voltage) and must remain within the input range. A ground reference connection is also required for correct operation. The ground connection of each mini-DIN socket consists of a 100 Ω resistor to mains earth/ground through the USB cable outer braiding and the PC chassis.

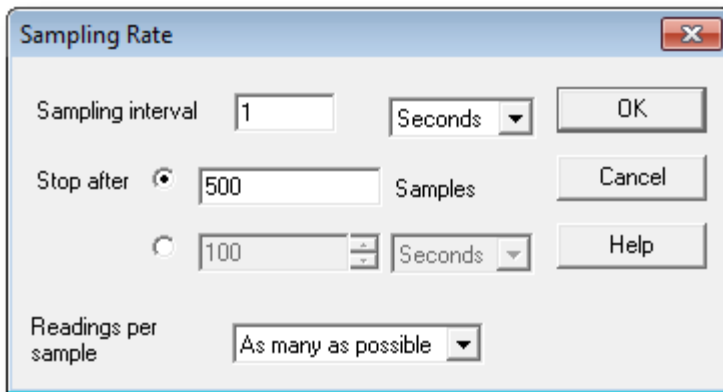
2.7 Setting up

Set up the USB PT-104 as follows:

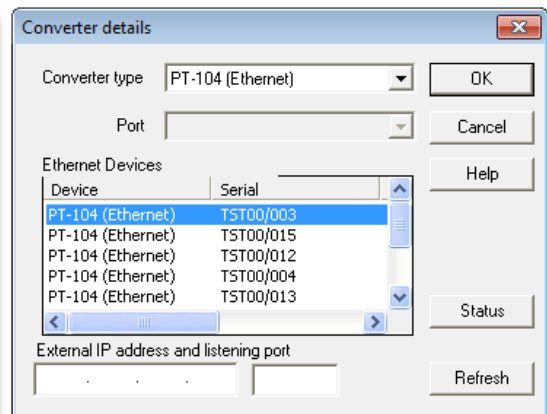
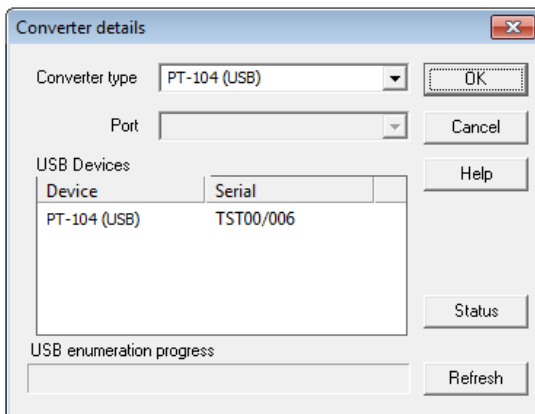
1. From the File menu in PicoLog Recorder, select New settings. The Recording dialog box appears:



2. Click OK. The Sampling Rate dialog box appears:



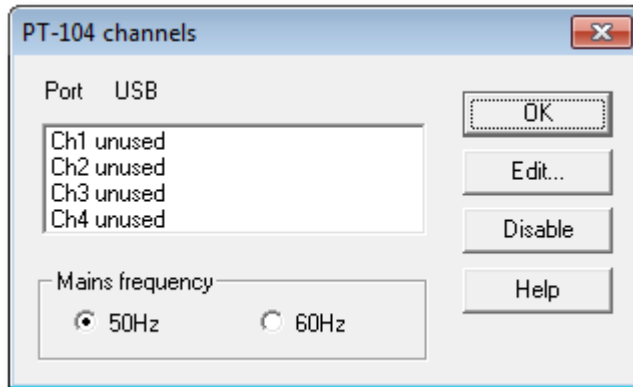
3. Click OK. The Converter details dialog box appears.
4. From the Converter type drop-down list, select either PT-104 (USB) or PT-104 (Ethernet). The dialog box will then show the converter list, as in the following examples:



5. USB connection: Select the device with the correct type and serial number, and click OK.

Ethernet connection: Any USB PT-104 devices visible to your computer on your local network will appear in the list. Select the device with the correct type and IP address, and click OK. If your device does not appear in the list, type its IP address and port number in the boxes below the list.

When you click OK, the USB PT-104 channels window will appear:

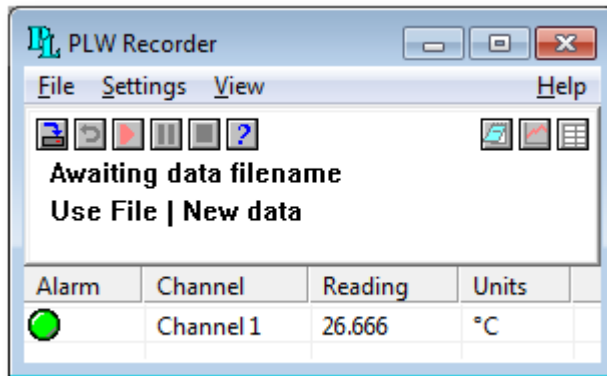


6. In the USB PT-104 channels window, double-click on Ch1 unused. The Edit USB PT-104 Channel dialog box appears:

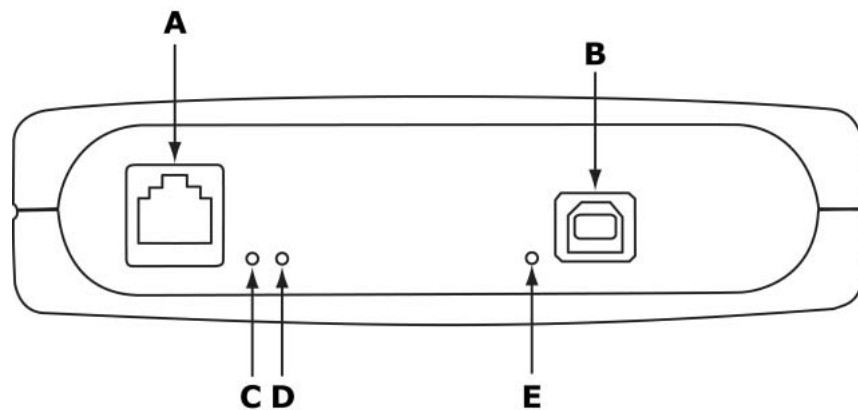


7. Type in a name for the channel, if required.
8. Select the data type required i.e temperature, resistance or voltage.
9. Select circuit - for PT100, PT1000 and Resistance data types only.

10. Now click OK. Readings from the USB PT-104 should appear in the monitor window:



2.8 The back panel



A: [Ethernet port](#)

B: [USB port](#)

C: Ethernet Data indicator - Flashes to indicate Ethernet data transfer.

D: Ethernet Link indicator - On when Ethernet port connected to an active device.

E: Power/Status indicator - On when power is applied. Flashes to indicate conversion in progress.

3 Background information

3.1 Platinum resistance thermometers (PRTs)

PRTs (Platinum Resistance Thermometers) offer excellent accuracy over a wide temperature range (from -200 °C to 850 °C). Sensors are interchangeable between different manufacturers, and are available in various accuracy ratings in packages to suit most applications. Unlike thermocouples, it is not necessary to use special cables to connect to the sensor.

The principle of operation is to measure the resistance of a platinum element. The most common type (PT100) has a resistance of 100 Ω at 0 °C and 138.4 Ω at 100 °C.

The relationship between temperature and resistance is approximately linear over a small temperature range. For example, if you assume that it is linear over the 0 °C to 100 °C range, the error at 50 °C is 0.4 °C. For precision measurement, it is necessary to linearise the resistance to give an accurate temperature. The most recent definition of the relationship between resistance and temperature is International Temperature Standard 90 (ITS-90). This linearisation is done automatically with software.

The linearisation equation is:

$$R_t = R_0 (1 + A \cdot t + B \cdot t^2 + C \cdot (t-100) \cdot t^3)$$

$$A = 3.9083 \times 10^{-3}$$

$$B = -5.775 \times 10^{-7}$$

$$C = (\text{below } 0^\circ\text{C}) -4.183 \times 10^{-12}$$

$$(\text{above } 0^\circ\text{C}) 0$$

For a PT100 sensor, a 1 °C temperature change will cause a 0.384 Ω change in resistance, so even a small error in measurement of the resistance (for example, the resistance of the wires leading to the sensor) can cause a large error in the measurement of the temperature. For precision work, sensors have four wires - two to carry the sense current, and two to measure the voltage across the sensor element. It is also possible to obtain three-wire sensors, although these operate on the (not necessarily valid) assumption that the resistance of each of the three wires is the same.

The current through the sensor will cause some heating. For example, a sense current of 245 μA through a 100 Ω resistor generates 6 μW of heat. If the sensor element is unable to dissipate this heat, it reports an artificially high temperature. This effect can be reduced by either using a large sensor element, or by making sure that it is in good thermal contact with its environment.

Using a 1 mA sense current gives a signal of only 100 mV. Because the change in resistance for a degree Celsius is very small, even a small error in the measurement of the voltage across the sensor produces a large error in the temperature measurement. For example, a 100 μV voltage measurement error would give a 0.4 °C error in the temperature reading. Similarly, a 1 μA error in the sense current would give a 0.4 °C temperature error.

Because of the low signal levels, it is important to keep any cables away from electric cables, motors, switchgear and other devices that may emit electrical noise. Using screened cable, with the screen grounded at one end, may help to reduce interference. When using long cables, it is necessary to check that the measuring equipment is capable of handling the resistance of the cables. Most equipment can cope with up to 100 Ω per core.

The type of probe and cable should be chosen carefully to suit the application. The main issues are the temperature range and exposure to fluids (corrosive or conductive) or metals. Clearly, normal solder junctions on cables should not be used at temperatures above about 170 °C.

Sensor manufacturers offer a wide range of sensors that comply with BS1904 class B (DIN 43760). These sensors offer an accuracy of ± 0.3 °C at 0 °C. For increased accuracy, you can use BS1904 class A (± 0.15 °C) or tenth-DIN sensors (± 0.03 °C). Companies like Isotech can provide standards with 0.001°C accuracy. Please note that these accuracy specifications relate to the SENSOR ONLY. It is necessary to add on any error in the measuring system as well.

Related standards are IEC751 and JISC1604-1989. IEC751 also defines the colour coding for PRT sensor cables: the one or two wires attached to one end of the sensor are red, and the one or two wires at the other end are white.



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