



# PT-104<sup>®</sup>

PRT temperature data logger

User's Guide

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# 1 Welcome

Thank you for buying a PT-104 from Pico Technology!

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

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

## **Software Development Kit**

You can download a free Software Development Kit (SDK) from [www.picotech.com/downloads](http://www.picotech.com/downloads). This enables you to write your own applications to control the PT-104. Pico also maintains repositories of example code on [GitHub](#). Refer to the [PT-104 Data Logger Programmer's Guide](#) for further information.

## 2 General information

### 2.1 Safety information



#### CAUTION

For safety information, please read the Quick Start Guide supplied with the data logger. For the most recent version of the Quick Start Guide, please download it from our website [here](#).

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 harmonized standard publication EN 61010-1: 2010+A1:2019 (Safety requirements for electrical equipment for measurement, control and laboratory use) and EN 61010-2-030: 2010 (Requirements for testing and measuring circuits). The product left the factory in a safe condition.

For more information, please refer to your product's UKCA and EU declaration of conformity.

### 2.2 Software licence 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.

**Upgrades.** We provide upgrades, free of charge, from [www.picotech.com](http://www.picotech.com). We reserve the right to charge for updates or replacements sent out on physical media.

## 2.3 Pack contents

Please check that your PT-104 pack (order code PP682) contains the following items:

Quantity	Reorder code	Description
1	PP682	PT-104 Data Logger
1	DO112	USB Installation Guide
1	MI106	USB lead
1	TA076	Ethernet patch cable

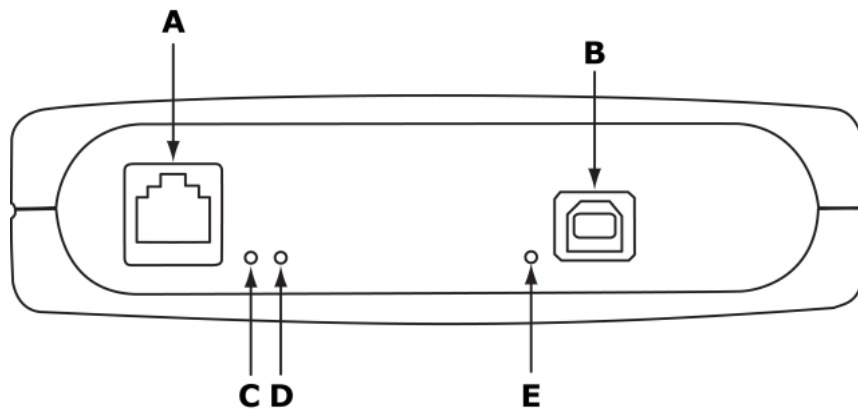
## 2.4 Minimum system requirements

To ensure that your PT-104 operates correctly, you must have a computer with at least the minimum system requirements as shown in the following table. The performance of the data logger will be better with a more powerful PC, and will benefit from a multi-core processor.

	Specification
Operating system	Windows, Linux (64-bit), macOS and Raspberry Pi OS Click <a href="#">here</a> for the latest software release notes and OS support.
Processor	As required by the operating system
Memory	
Free disk space	
Ports	USB port or Ethernet connection (Windows only)

## 3 Getting started

### 3.1 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.

### 3.2 Checking the installation

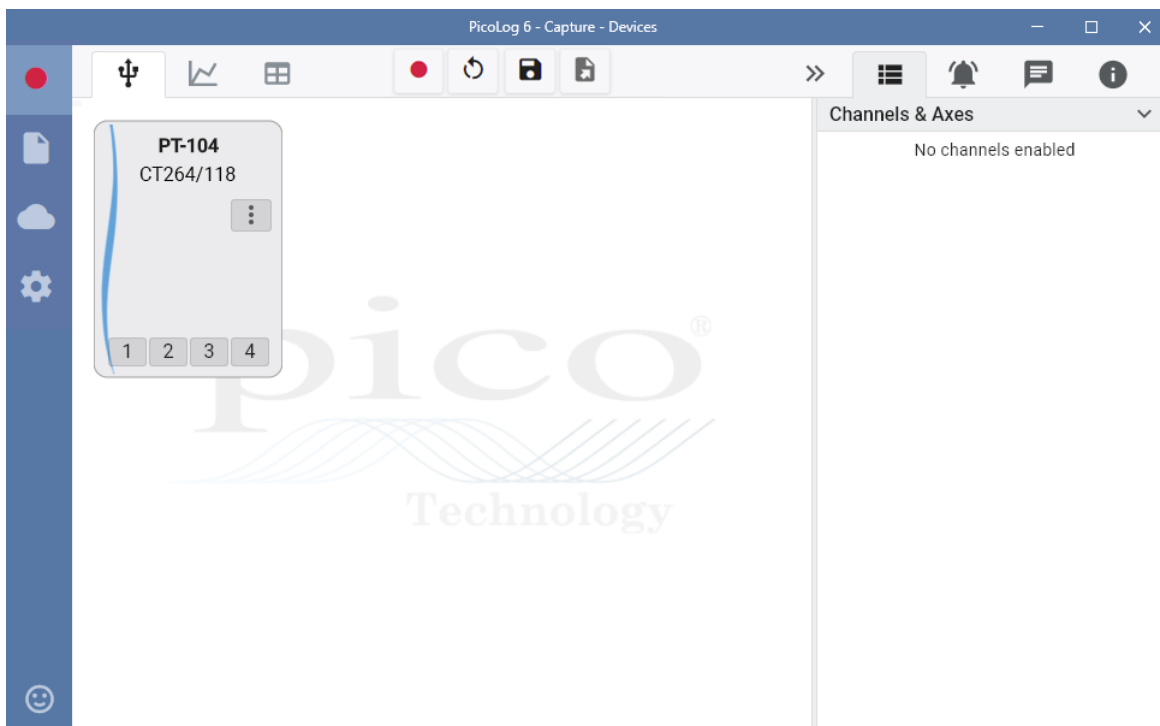
Before you connect the PT-104 to your computer for the first time, you must download and install the PicoLog software which is available free from [www.picotech.com/downloads](http://www.picotech.com/downloads).

1. When you have connected the data logger to a USB port on your PC, click the PicoLog icon on your PC desktop to start the software:

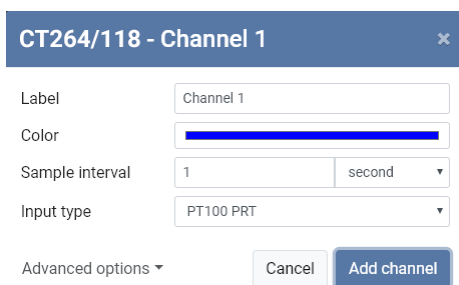


PicoLog icon

2. The PT-104 will appear in the Devices tab:



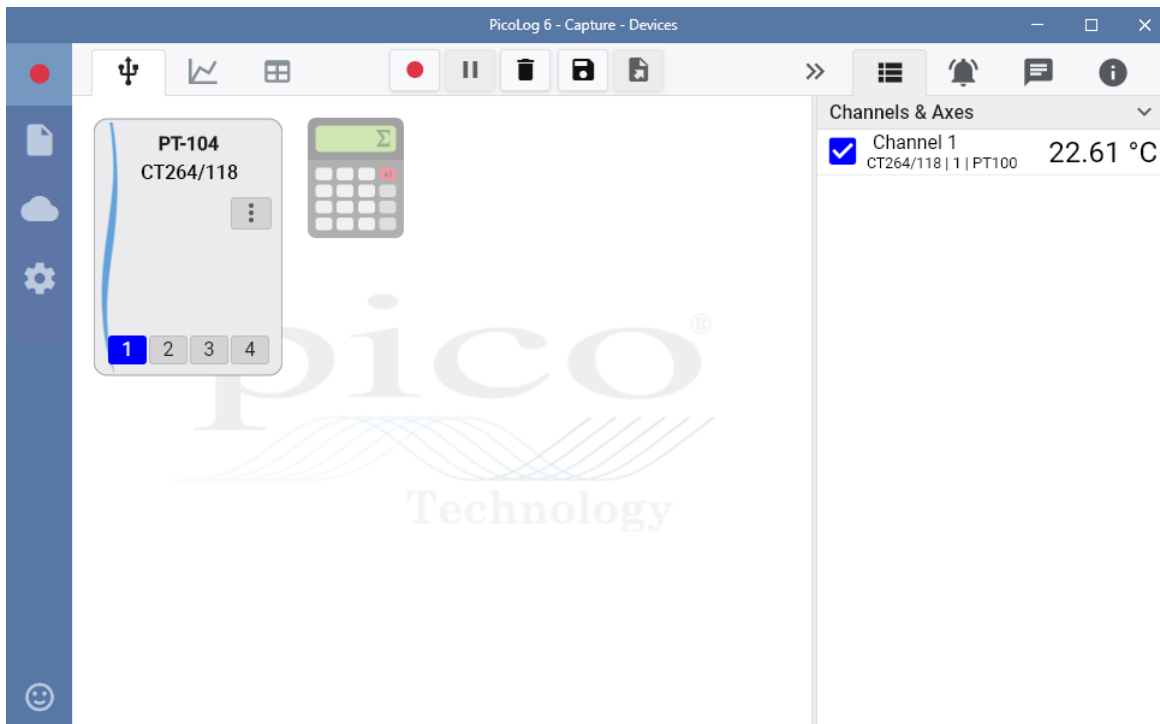
3. Connect a temperature sensor (you will not see a temperature reading unless a sensor is connected because the input is open circuit) and configure its channel by selecting it in the graphic. This will display a channel setup dialog box. You can type in a channel **Label** and choose a channel **Color**, **Sample interval** and **Input type** (sensor or other measurement). You also have an advanced option to set **Custom scaling**:



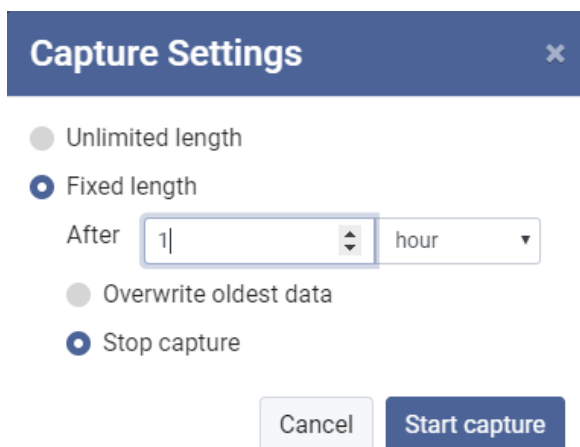
4. Click Add channel. The selected channel (in this case, channel 1) on the PT-104 will be highlighted in a color corresponding to the plot line Color chosen.

To make the configuration of multiple channels easier you can hold Ctrl (Windows and Linux) or cmd (macOS) and click on the channels to be configured. Then release Ctrl (or cmd) and click one of the channels, or press Enter, to display the channel setup dialog box.

5. The Maths channel configurator will appear in the Devices tab as a small calculator. The sensor channel will be displayed in the Channels & axes column on the right of the screen and also the Start recording, Pause, Delete, Save and Export buttons will be available:



6. To start recording, click the red **Start recording** button and then choose a capture setting of either **Unlimited** or **Fixed** length from the pop up dialog box. Don't forget to ensure there is sufficient PC storage capacity:

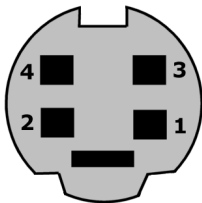




### 3.3 Connection: PRT inputs

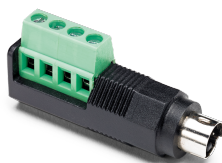
The PT-104 is compatible with PT100 and PT1000 type [platinum resistance thermometers](#) (PRTs). Connect each one of these devices to the unit as follows.

#### Pin Connections to the PT-104 4-pin Mini-DIN socket



Pin	PT100, PT1000 or Resistance 4-Wire	PT100, PT1000 or Resistance 3-Wire	PT100, PT1000 or Resistance 2-Wire
1	White	Connect to pin 3	Connect to pin 3
2	Red	Red	Red
3	White	White	White
4	Red	Red	Connect to pin 2

#### Single-channel screw terminal adaptor



You can interface third-party sensors not fitted with the 4-pin mini-DIN connector and you can measure resistance using the PP660 screw terminal adaptor. This adaptor has 4 breakout terminals and occupies a single channel of the PT-104.

## 3.4 Connection: Ethernet port

### Setup

Ethernet connection is only available with Windows operating systems.

Before connecting to the 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. In the **Devices** tab view, click the three dots on the PT-104:



3. Select **Device information** to view the dialog:

**PT-104 - CT264/118** ×

Driver version	2.0.0.459
Calibration date	7 Aug 2014
Hardware version	1
Hardware variant	PT104 (USB)
Sample interval	

☒ Enable Ethernet on this device

IP Address

192 . 168 . 0 . 5

Port

6249

☒ Automatically connect to this device

Cancel

Save changes

4. Ensure **Enable Ethernet on this device** is checked to show the Ethernet settings (**IP Address** and **Port**)
5. 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.
6. Click **Save changes**.
7. You can now either continue to use the 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 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 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 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 PT-104 directly to the network port on your computer. Most Ethernet ports on PCs and switches support Auto MDI-X (automatic cross-over). If your Ethernet ports do not, you may need to use an Ethernet cross-over cable (not supplied).

**Power over Ethernet (PoE)**

The 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.

## 4 Background information

### 4.1 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 linearize 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 linearization is done automatically with software.

The linearization equation is:

$$R_t = R_0 (1 + At + Bt^2 + C(t - 100)t^3)$$

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

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

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

$$\text{(above 0 °C)} 0$$

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  $\Omega$  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  $\pm 0.3$  °C at 0 °C. For increased accuracy, you can use BS1904 class A ( $\pm 0.15$  °C) or tenth-DIN sensors ( $\pm 0.03$  °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 color 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.

## 5 Conformance

### 5.1 FCC notice

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

### 5.2 CE and UKCA notices

This PicoScope data logger meets the intent of the CE EMC directive 2014/30/EU and UKCA SI 2016/1091 EMC Regulations.

This logger also meets the intent of the CE Low Voltage Directive 2014/35/EU and UKCA SI 2016/1101 Electrical Equipment (Safety) Regulations.

For more information, please refer to your product's UKCA and EU declaration of conformity, available for download [here](#).

## 6 Glossary

**Ethernet.** The most widely installed local area network (LAN) technology. **Ethernet** is a link layer protocol in the TCP/IP stack, describing how networked devices can format data for transmission to other network devices on the same network segment, and how to put that data out on the network connection.

**Local area network (LAN).** A network that connects computers and other devices in a relatively small area.

**USB.** Universal Serial Bus. This is an industry standard enabling peripherals to connect to hosts such as personal computers, for example. The PT-104 is compatible with any USB port from USB 1.1 upwards.

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