



PicoLog[®] 1000 Series

USB Data Loggers

User's Guide

PicoLog 1000

Small Terminal Board



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1 Introduction

1.1 Overview

The PicoLog 1000 Series PC Data Loggers are medium-speed, multichannel voltage-input devices for sampling analog data using a PC. This manual describes the physical properties of the loggers.



The following PicoLog 1000 Series Data Loggers are available:

Version	Resolution	Channels
PicoLog 1012	10 bits	12
PicoLog 1216	12 bits	16

These devices are designed for use with the PicoLog data logging software and the PicoScope oscilloscope software. You can also use the PicoLog API supplied to develop your own programs to collect and analyze data. See the *PicoLog 1000 Series Programmer's Guide* for details of the API.

http://www.elseo.sk/product.php?id_product=2127

1.2 Safety warning

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 or others.

Maximum input range

The inputs of the PicoLog 1000 Series loggers are protected against overvoltages up to ± 30 V. Input voltages beyond this range may cause permanent damage to the unit.

Mains voltages

Pico products are not designed for use with mains voltages. To measure mains we recommend the use of a differential isolating probe specifically designed for such measurements.

Safety grounding

The ground of every unit is connected directly to the ground of your computer via the interconnecting cable provided. This is done to minimize interference. If the PC (especially laptops) is not grounded, reading stability cannot be guaranteed and it may be necessary to manually ground the equipment.

As with most oscilloscopes and data loggers, you should take care to avoid connecting the inputs of the unit to any equipment which may be at an unsuitable voltage. If in doubt, use a voltmeter to check that there is no hazardous AC or DC voltage. Failure to check may cause damage to the product and/or computer and could cause injury to yourself or others.

You should assume that the product does not have a protective safety earth. Incorrect configuration and/or use on voltages outside the maximum input range can be hazardous.

Cleaning

The unit may be cleaned externally using a cloth dampened slightly with water. Do not use any other solvents or abrasive cleaning materials.

Repairs

The unit contains no user-serviceable parts. Repair or calibration of the unit requires specialized test equipment and may be performed only by Pico Technology or its authorized distributors.

1.3 Legal information

The material contained in this release is licensed, not sold. Pico Technology grants a license to the person who installs this software, subject to the conditions listed below.

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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 scale. 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. We reserve the right to charge for updates or replacements sent out on physical media.

1.4 Trademarks

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PicoScope and **Pico Technology** are registered in the U.S. Patent and Trademark Office.

Windows and **Excel** are registered trademarks or trademarks of Microsoft Corporation in the USA and other countries.

1.5 Accessories

The following items are supplied in all packages:

Standard items	Part no.
PicoLog 1000 Series PC Data Logger	PP543 (PicoLog 1012) PP544 (PicoLog 1216)
USB cable	MI106
Software and Reference CD-ROM	DI025
USB Installation Guide	DO112

The following additional items are supplied in some packages (see our [website](#) for details):

Additional items	Part no.
Small Terminal Board	PP545
Small Terminal Board User's Guide	DO161

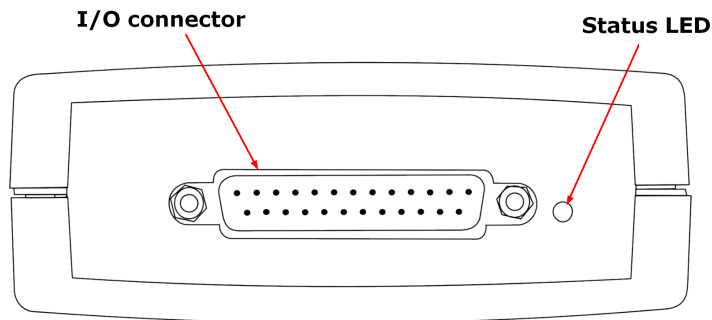
The Small Terminal Board makes connecting wires to the Data Logger much easier. Instead of soldering wires to a 25-way D-type plug, you can simply insert prepared wire ends into the screw terminals on the terminal board. The board also contains solder pads to allow you to fit resistors that divide the input voltage to each channel by a known ratio, thereby expanding the measuring range by the same ratio. For example, if you divide the input voltage by 4, then the effective input range of the Data Logger is increased from 2.5 V to 10 V on that channel.

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1.6 Connecting the logger

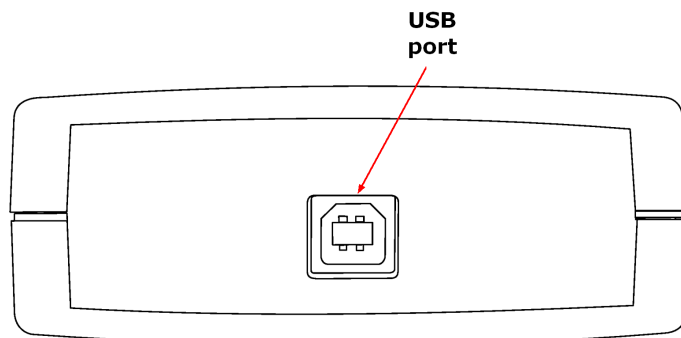
Before you connect your logger, you must install the software supplied on the CD.

To connect the PicoLog logger, plug the cable provided into any available USB port on your PC.



I/O connector: for the pin-numbering of the I/O connector, see [I/O connector pins](#). The Pico PP545 Small Terminal Board is specially designed to connect to this socket to allow you to make connections to individual wires easily without soldering. If you need to use a ribbon cable to connect your signals to this socket, use the shortest possible length to avoid introducing too much crosstalk between the signals.

Status LED: this flashes while the device is capturing data. The flash rate depends on the sampling rate.



USB port: use the USB cable supplied to connect this to the PC that is running the Pico software. A PC with a USB 2.0 port or faster is recommended for best performance.

1.7 Getting started

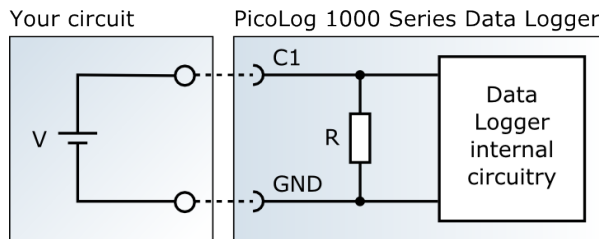
To check that the unit is working, start the PicoScope program by clicking the PicoScope icon on your desktop:



You should immediately see a signal trace on the screen. As the inputs are high-impedance, the trace will show noise until a defined voltage is applied to the input. If you connect a 1.5 V battery between the GND terminal and the C1 analog input (see [I/O connector pins](#)), you should see the signal jump to +1.5 V. Alternatively you can generate a test voltage using a potential divider connected between the PO output and a GND terminal.

1.8 Example circuit (voltage)

This is how to connect a simple voltage source to the Data Logger:



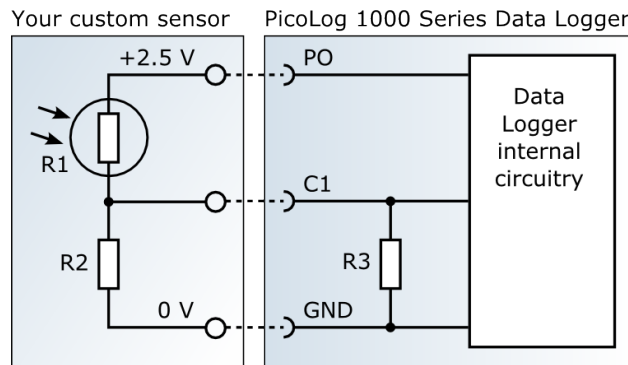
The components of the circuit are as follows:

V	Battery	Any cell, battery or transducer with a voltage output in the range 0 V to +2.5 V.
R	1 M Ω	The input resistance of the PicoLog Data Logger. You do not have access to this resistor, but you may need to know its value when designing your circuit.
C1	Channel 1	The C1 pin on the Data Logger. If you are using the Pico Small Terminal Board, use the screw terminal marked C1 .
GND	Ground	The GND pin on the data logger. If you are using the Pico Small Terminal Board, use any of the screw terminals marked GND .

Once you have built the circuit, connect it to the Data Logger, run the PicoScope 6 software and watch the trace on the display. When the voltage source is connected, the trace should rise to the level of the source voltage. When the voltage source is disconnected, the trace should fall to zero volts.

1.9 Example circuit (light)

Here is an example of a sensor circuit that you could connect to the logger.



The components of the circuit are as follows:

R1	ORP12	A light-dependent resistor of type ORP12 or similar. In the dark this acts like a fixed resistor with a high value of 1 M Ω or more, but when exposed to light its resistance drops in proportion to the brightness of the light, down to several k Ω .
R2	100 k Ω	A fixed resistor to limit the current through R ₁ .
R3	1 M Ω	The input resistance of the PicoLog Data Logger. You do not have access to this resistor, but you may need to know its value when designing your circuit.
C1	Channel 1	The C1 pin on the data logger. If you are using the Pico Small Terminal Board, use the screw terminal marked C1 .
PO	+2.5 V	The power output pin on the data logger. If you are using the Pico Small Terminal Board, use the screw terminal marked 2.5 .
GND	Ground	The GND pin on the data logger. If you are using the Pico Small Terminal Board, use any of the screw terminals marked GND .

Once you have built the circuit, connect it to the Data Logger, run the PicoScope 6 software and watch the trace on the display. When the sensor is exposed to light, the trace should rise to almost 2.5 V. When the sensor is covered, the trace should fall to a value close to 0 V.

2 Product information

2.1 Specifications

	PicoLog 1012	PicoLog 1216
Maximum sampling rate continuous streaming block mode ^[1]	100 kS/s single-channel 1 MS/s single-channel	
Buffer size	8k sample internal buffer shared by all channels; 1 million sample limit using SDK	
Analog inputs	12 ^[2]	16 ^[2]
analog bandwidth (-3 dB)	DC to 70 kHz	
input type	Single-ended, unipolar	
input voltage range	0 to +2.5 V	
linearity (at 25 °C)	1 LSB	
resolution	10 bits	12 bits
accuracy	1%	0.5%
overload protection	±30 V to ground	
input coupling	DC	
input impedance	1 MΩ	
Digital outputs (D0...D3)	2	4 ^[2]
Digital outputs (PWM) period duty cycle	None	1 100 μs to 1800 μs adjustable from 0% to 100% in 1% steps
Digital outputs (all) logic low voltage logic high voltage current limiting	100 mV (typical) 3.3 V 1 kΩ resistors in series with outputs	
Power output for sensors	2.5 V @ 10 mA, current-limited	
Ground fault current protection	0.9 A thermal self-resetting fuse	
I/O connector	25-way D female	
Environmental operating conditions for quoted accuracy general operation relative humidity	20°C to 50°C for quoted accuracy 0°C to 70°C overall 5% to 80% RH	
Compliance	CE (EMC) class A emissions & immunity FCC emissions	
PC connection	USB	
Dimensions	45 mm x 100 mm x 140 mm (1.77" x 3.94" x 5.51")	
Weight	< 200 g (7.05 oz)	

Notes:

- Block mode is supported by PicoScope and the PicoLog 1000 Series API. The PicoLog software will allow a Fast Block capture with one PicoLog 1000 Series device connected to the PC.
- Except in [USB ADC-11 compatibility mode](#) (see [I/O connections table](#))

2.2 I/O connector pins

The I/O connector is the 25-way connector on the front of the unit. Pin numbers and signal names are as follows. See [Specifications](#) for further details of input and output characteristics.

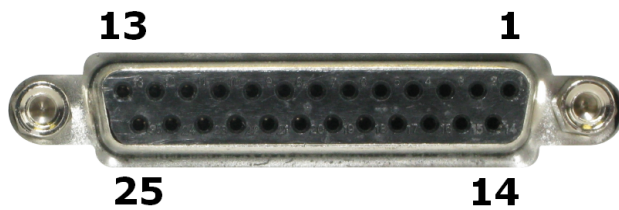
Pin no.	Pin name	Function	Characteristics	PicoLog 1012	PicoLog 1216	ADC-11 ¹
Shell	GND	Ground	0.15 A resettable fuse ²	Y	Y	Y
1	DO1	Digital out	3.3 V	Y	Y	Y
2	GND	Ground	0.9 A resettable fuse ²	Y	Y	Y
3	C1	Analog in	0 to +2.5 V	Y	Y	Y
4	C2					
5	C3					
6	C4					
7	C5					
8	C6					
9	C7					
10	C8					
11	C9					
12	C10					
13	C11	Digital out	3.3 V	Y	Y	Y
14	DO2			NC		NC
15	DO3			Y		Y
16	DO4			Y		Y
17	PO			Y		Y
18	PWM	PWM output	3.3 V	NC	Y	NC
19	GND	Ground	0.9 A resettable fuse ²	Y	Y	
20	GND			Y	Y	
21	C12	Analog in	0 to +2.5 V	Y	Y	
22	C13			NC		
23	C14					
24	C15					
25	C16					

Note 1: These outputs are available when the unit is used in [USB ADC-11 compatibility mode](#).

Note 2: The ground pins are protected by resettable fuses. If you connect one of the ground pins to a voltage source such as a power pack, and the voltage source shares a ground connection with the USB cable to the Data Logger, then a large current will flow into the ground pin. The fuse will detect this condition and disconnect the pin before damage is caused to the Data Logger. The fuse will automatically reset itself when the voltage source is disconnected from the input pin.

Note 3: NC = not connected

The I/O connector pins are numbered as follows:



2.3 USB ADC-11 compatibility mode

The PicoLog 1000 Series data loggers may be used as replacements for the USB ADC-11, an 11-channel data logger previously available from Pico Technology. The 1000 Series units have all the functions of the USB ADC-11 and some extra functions, such as extra [digital outputs](#), a [PWM output](#) and a sensor power output. They also have a faster USB interface and more advanced driver software.

If you use a 1000 Series unit with old versions of PicoScope and PicoLog that were released before April 2009, then it will automatically emulate a USB ADC-11. You can continue to use the unit as an USB ADC-11 if you wish, or you can upgrade your software to enable the extra functions of the new unit.

3 Glossary

Accuracy. The closeness between measured values and true values. This is more usually expressed as the error, as a percentage of full scale, between the measured value and the true value.

ADC. Analog to Digital Converter. An ADC samples analog signals and converts them to digital data for storage and processing. It is an essential component of a data logger.

Analog bandwidth. The range of input frequencies over which the measured signal power is at least half its true value. This corresponds to a drop in amplitude of about 29%.

Duty cycle. For a square wave signal, the proportion of the time that the signal spends at the high level divided by the period of the signal, expressed as a percentage. Thus, a symmetrical square wave has a duty cycle of 50%.

Input impedance. The impedance of the input channels of the logger with the input disconnected. Impedance is the total opposition (due to resistance, capacitance and inductance) offered to the flow of an alternating current.

Linearity. The ideal output of an ADC is a linear function of its analog input. Linearity is a measure of the worst-case deviation from this ideal characteristic.

Maximum sampling rate. A figure indicating the maximum number of samples the ADC is capable of acquiring per second. Maximum sample rates are usually given in S/s (samples per second). The higher the sampling rate of the AI accurately it can represent the high-frequency details in a signal.

Overload protection. The maximum voltage that can be applied across the inputs of the ADC without causing damage to it.

PWM. Pulse-width modulation. A way of conveying analog information by means of a single binary signal. The PWM output from the PicoLog 1000 Series units is a square wave between 0 volts and +3.3 volts, with variable duty cycle. The average voltage of the signal is the peak voltage, 3.3 volts, multiplied by the duty cycle.

Resolution. A value, in bits, indicating the number of distinct input levels that the [ADC](#) can turn into digital values.

USB. Universal Serial Bus. This is a standard port that enables you to connect external devices to PCs. A full-speed USB 2.0 port operates at up to 480 megabits per second. The PicoLog 1000 Series is also compatible with any USB port from USB 1.1 upwards.



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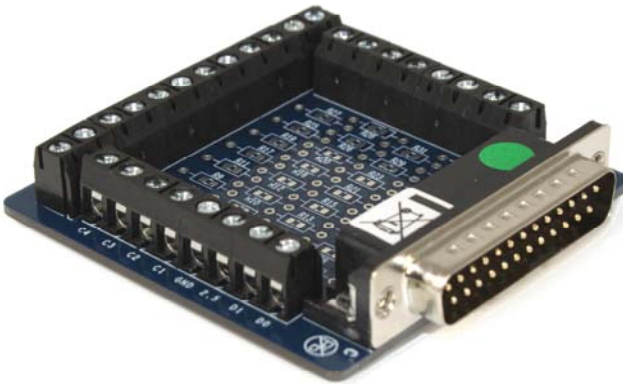
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PicoLog 1000 Small Terminal Board

User's Guide



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1 Overview

1.1 Introduction

The Small Terminal Board (PP545) is an accessory for the PicoLog 1012 and 1216 Data Loggers. The screw terminals allow sensor wires to be attached to the data logger without soldering. The terminal board also has locations where you can fit resistors to extend the input ranges of the logger.



Figure 1 - Small Terminal Board

1.2 Specifications

Dimensions	66 x 72 x 17 mm (approx. 2.6 x 2.83 x 0.67 in.)
Weight	50 g nominal (approx. 1.76 oz)
Terminal wire size	0.6-1.6 mm (14-22 AWG)

1.3 Connecting the Terminal Board to the Data Logger

You can plug the Terminal Board directly into the analog connector on the PicoLog Data Logger, or you can use a standard 25-way male-D to female-D parallel cable to connect the two units.

Using a cable will increase the noise and crosstalk between channels. If you make your own cable, you can minimise this problem by using a signal/ground twisted pair for each channel.

1.4 Terminals and solder pads

The table below shows the purpose of each of the screw terminals and resistor locations on the Terminal Board. For details of the inputs and outputs of the data logger, see the PicoLog 1012 and 1216 User’s Guide.

Marking on Terminal Board	Description
C1...C16 *	Analog input channels 1 to 16 *
D0...D3	Digital outputs
GND	Circuit ground
2.5	2.5 volt power output for sensors
PWM	Pulse-width modulated output
R1, R3, R5 etc.	Locations for 0805 or leaded series resistors in analog inputs (see Figure 5). Before you fit a resistor in one of these sites, you must cut the track under the component (see Figure 6).
R2, R4, R6 etc.	Solder pads for 0805 or leaded shunt resistors between each analog input and GND (see Figure 5).

* The PicoLog 1216 has channels 1 to 16.
 The PicoLog 1012 has channels 1 to 12.

Table 1 - Terminals and resistor sites

2 Making measurements

2.1 Measuring voltages up to +2.5 V

For voltage sources from 0 V to +2.5 V, you can connect directly to any analog input channel. With this method, there is no need to fit any additional components to the Terminal Board.

Figure 2 shows analog channel 1, but the connections are similar for the other channels.

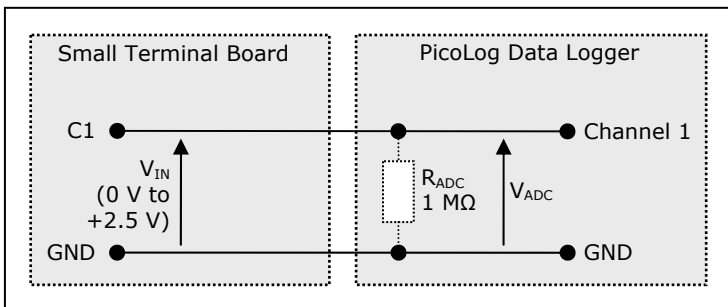


Figure 2 - Direct input to channel

2.2 Measuring voltages above +2.5 V

For voltages above +2.5 V, use a voltage divider connection. You must cut one track on the Terminal Board and fit two 0805 surface-mount, or axial leaded, resistors for each channel that you wish to use in this way.

Figure 3 shows the voltage divider circuit for analog channel 1, but the connections are similar for the other channels.

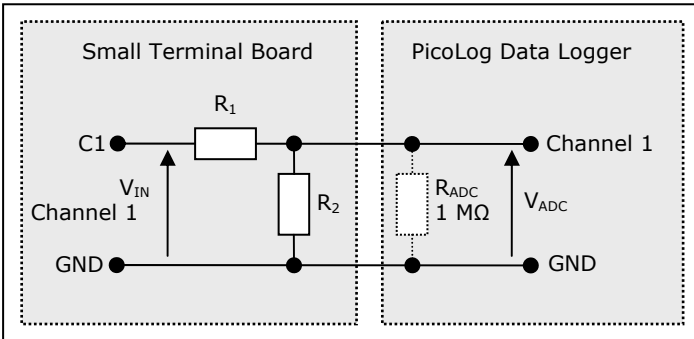


Figure 3 - Voltage divider

The voltage that the ADC sees, V_{ADC} , depends on V_{IN} and the values of R_1 and R_2 , and is given by the following equation:

$$V_{ADC} = \frac{V_{IN} \cdot R_2}{R_1 + R_2}$$

Choose values of R_1 and R_2 so that V_{ADC} is approximately +2.5 V when V_{IN} is at its highest.

To minimise errors in the measured voltage, V_{ADC} , caused by loading of the source voltage V_{IN} , ensure that the combined resistance of $R_1 + R_2$ is much greater than the resistance of the voltage source. If you are unsure of the resistance of the voltage source, use large values for R_1 and R_2 such that $R_1 + R_2$ is about 10 kΩ.

If you have chosen a value for R_2 that is greater than 10 kΩ and you need high accuracy, then you will need to take into account the ADC's input resistance R_{ADC} , which is in parallel with R_2 . Use the following formula to obtain a value for the parallel equivalent resistance of R_2 and R_{ADC} , R_p :

$$R_p = \frac{R_2 \cdot R_{ADC}}{R_2 + R_{ADC}}$$

where $R_{ADC} = 1 \text{ M}\Omega$, and then use R_p instead of R_2 in the previous formula.

2.3 Offsetting and scaling the sensor signal

Example using a 2.5 V input

It is possible to offset and scale the ± 5.0 V signal from your sensor. There is a +2.5 V, 10 mA source available on the PicoLog Data Logger.

Assuming you are using channel 1, add a 20 k Ω surface mount or leaded resistor in position R1 (cutting the link as in Figure 6). Add a second 20 k Ω surface mount or leaded resistor in position R2. Finally, to give the correct offset and final scaling you must add a 10 k Ω leaded resistor in position R33. These three resistors will scale the ± 5 V output of your sensor to a signal at the logger varying from 0 V to +2.5 V.

The scaling function of PicoLog can convert this reduced and offset range back to the original voltage reading by mathematically subtracting 1.25 V and multiplying the remainder by 4. To compensate for any residual errors, the actual scaling offset and multiplier can be slightly varied to give exact readings by doing a simple calibration, if required.

If required, all 16 channels can be offset in this way. The above values allow use up to the full analogue bandwidth of the PicoLog of 70 kHz but the input impedance is reduced from 1 M Ω to about 27 k Ω .

If a higher input impedance is required, replace R1 with 1 M Ω , do not fit R2 at all and for the R33 use 500 k Ω (two 1 M Ω in parallel). This will give an input impedance of over 1 M Ω but the frequency response will fall to about 1 kHz.

In both cases, when no input is connected, the DC voltage will float up to 1.66 V. As long as the output impedance of the sensor you are feeding to the input of the PicoLog is much lower than input impedance of the circuit above, the DC level is pulled to the correct value upon connection.

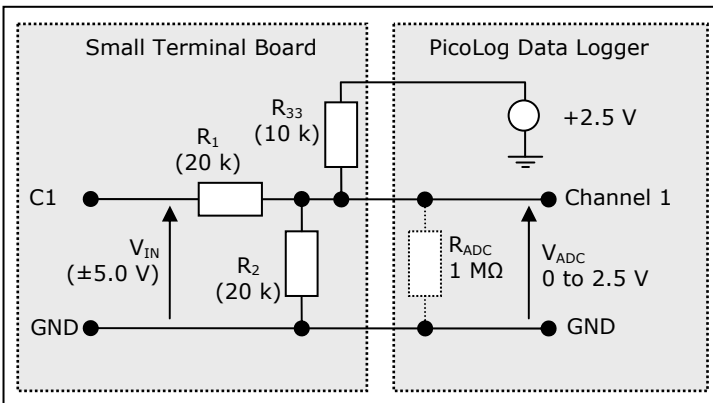


Figure 4 – Offsetting and scaling the signal

2.4 Resistor connections

The resistors on the Small Terminal Board are connected as shown in Figure 5.

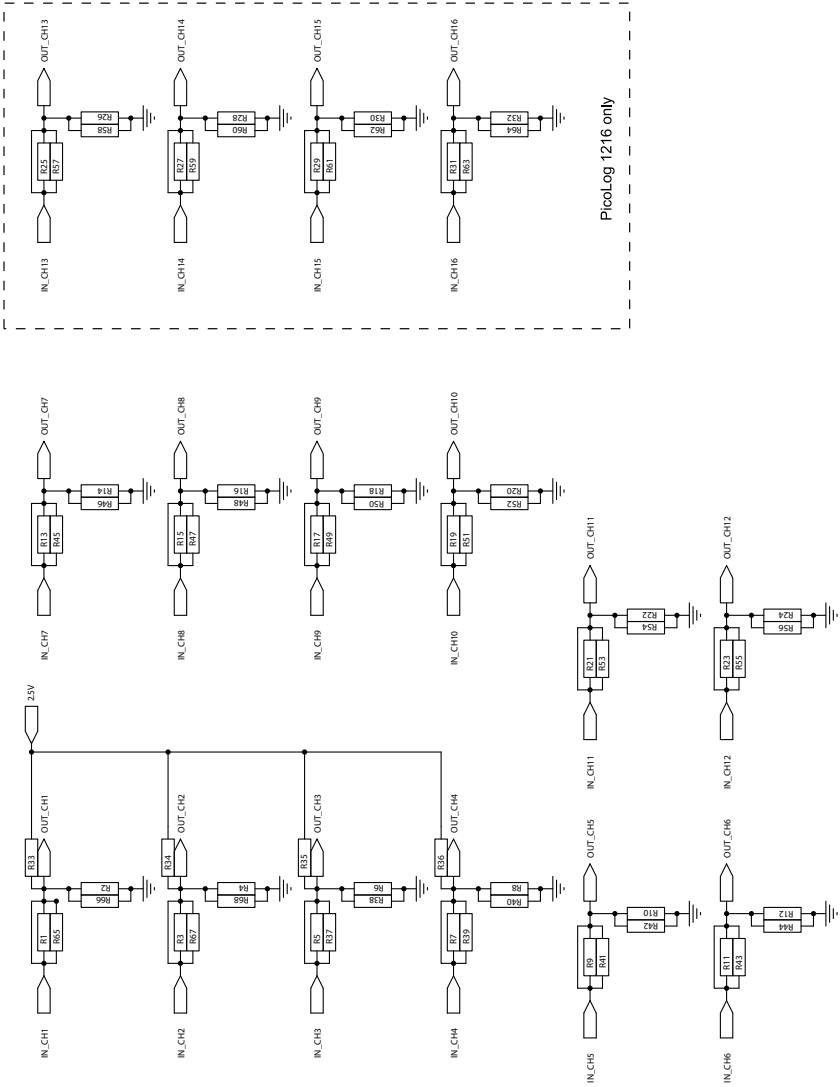


Figure 5 - Voltage divider resistor sites

The location for each series resistor (R1 and so on) is bypassed by a copper link. You must cut this link (see Figure 6) before fitting the resistor.

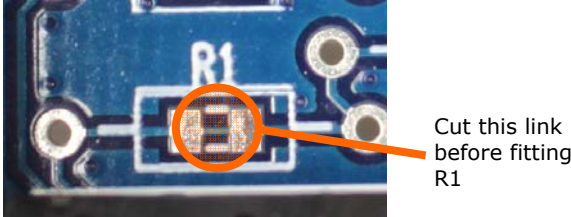


Figure 6 - Location of copper link under R1

The following noise problems are often associated with potential divider circuits:

<p>1. Noise from source voltage</p>	<p>Try fitting a capacitor as described below.</p>
<p>2. RF interference picked up at high-impedance points</p>	<p>Smaller values for R₁ and R₂ may help</p>
<p>3. Noise on the earth connections</p>	<p>The signal 0 V line is connected to mains earth. Try to avoid this situation.</p>

Should either 1 or 2 above occur and you want to try a capacitor, ensure that you have fitted resistor R₁ and cut the corresponding track beneath the resistor. Fit the capacitor in place of or in parallel with R₂, as necessary. Use the following formula for C, the value of the capacitor:

$$C = \frac{1}{2\pi f R}$$

where R is R₁ or the smaller of R₁ and R₂, and f is the highest signal frequency in hertz.

2.5 Measuring current

You can use measure current towards ground by using a simple shunt resistor to convert the current into a voltage before measuring with the ADC.

Figure 7 shows the circuit for analog channel 1, with shunt resistor R_2 . A similar circuit can be used for the other channels.

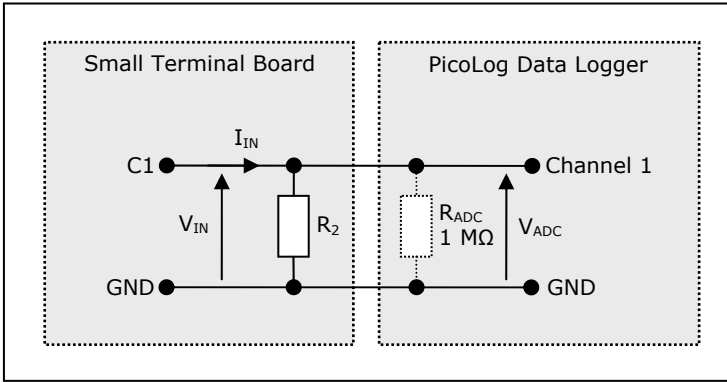


Figure 7 - Shunt resistor circuit

You will need to calculate the resistor value R_2 from the following equation:

$$R_2 = \frac{2.5\text{ V}}{I_{MAX}}$$

where I_{MAX} is the highest current you want to measure.

Warning!

Under no circumstances use this method for measuring mains (house) currents. The Small Terminal Board is not designed to be connected to the mains. Attempting to do so could result in serious property damage and personal injury.

Issues:

- 1) 14.5.09. New for PicoLog 1012 & 1216.
- 2) 11.2.11. New SMT design.
- 3) 04.1.13. Title changed

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