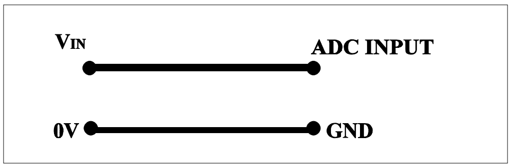
Measuring voltages using the ADC terminal block

Direct inputs

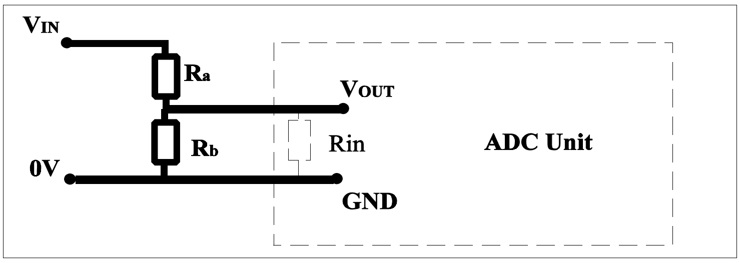
All channels can be fed directly into the ADC unit using the terminal board.



Ensure the voltages are within the input range of the ADC unit.

Measuring voltages greater than the ADC input range

The terminal board can be used to measure voltages greater than 2.5 volts by incorporating a simple potential divider circuit.



There are positions on the terminal board for resistors Ra and Rb. ***NOTE*** There is a thin track on the terminal board under position Ra which must be cut with a sharp knife before the potential divider will work.

The following equation is used to calculate the values of Ra and Rb:-

$$\text{Vout} = \text{Vin} \times \frac{\text{Rb}}{\text{Ra} + \text{Rb}}$$

Technical Note
To prevent errors in the measured voltages caused by loading of the source voltage, the combined resistance of Ra and Rb should be much greater than the output resistance of the voltage source.

Technical Note - see equation on right
If the chosen value of Rb is greater than 10KΩ, and you need high accuracy, then it is neccessary to take into account the ADCs input resistance otherwise measurement errors will occur.

$$\text{Rb equivalent} = \frac{\text{Rb} \times \text{Rin}}{\text{Rb} + \text{Rin}}$$

If you are unsure of the output resistance of the source voltage then use large values for Ra and Rb.

Rin values for ADC11 & ADC16	
ADC16	= 1 Meg Ohm
ADC11	= over 2.5 Meg Ohm

Noise

There are three common situations when noise or noiselike problems can occur.

The voltage being measured is noisy (try fitting a capacitor as described below).
RF interference is 'picked up' at high impedance points (smaller values of Ra and Rb may help).
noise is present on the earth connections or the signal 0V line should not be connected to mains earth.

If noise caused by either 1 or 2 above is a problem then a capacitor can be added to try and filter out the noise.

Resistor Ra must be fitted
Fit a capacitor in position Rb (in parallel with Rb if necessary)

The approximate capacitor value can be calculated using the equation :-

$$\text{Cap Value} = \frac{1}{2\prod f \times R}$$

Where R is Ra or the smaller of Ra and Rb

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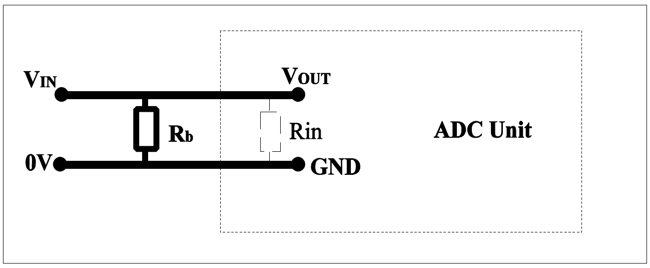
Measuring other parameters using the ADC terminal block

Measuring current

For relatively small currents a simple shunt resistor can be used to convert the current into a voltage which the ADC can then measure.



The resistor value required can be calculated as shown below :-

$$R_b = \frac{2.5V}{I_{max}}$$

Warning
Under no circumstances use this method for measuring mains currents - Seek Advice

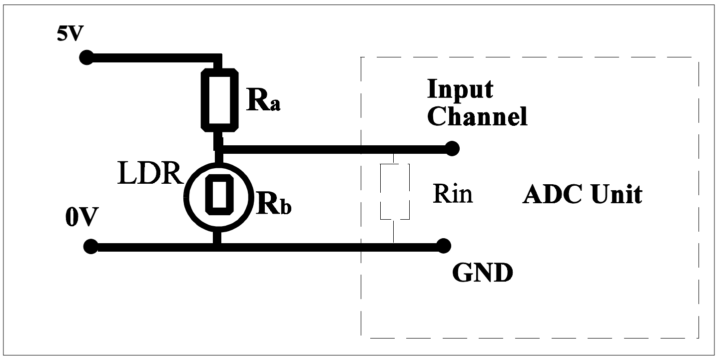
See terminal block diagram for position of Rb

Measuring Light Level

A light dependant resistor (LDR) can be used in conjunction with a fixed resistor to measure light level.

A suitable LDR sensor can be obtained from Maplin (part number AZ83E).
A resistor Ra of around 1Meg is suitable.

You can use either the Digital Output or the +5V output to supply the circuit

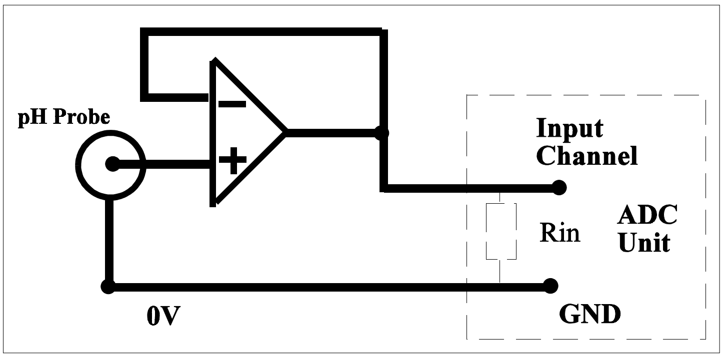


Measuring pH

The circuit shown on the right can be used with any standard pH probe.

pH probe (Pico part number DD011)

The Op-Amp needs to have a very high input impedance - an LT1114 is suitable.
(Maplin part number AGB37)



Technical Note
Using this method you will have to calibrate the probe using two or three solutions of known pH (these solutions are known as buffer solutions). Beware - the measured pH of a liquid can vary widely with temperature

A much simpler and more complete way to measure pH is available in the Pico DrDAQ unit which has an optimised version of the above circuit built in and also the ability to use temperature sensor to compensate for the pH variations due to the temperature of the liquid. (Pico part number DD000)

Measuring Temperature

Note
If several temeprature sensors are required, the TC08 thermocouple unit is often a much simpler solution since thrmocouples plug directly into the TC08 and the software automatically converts the thermocouple voltages to temperature. Eight thermocouples can be used with each TC08.

Alternatively, consider the TH03 or PT100 signal conditioner

With a suitable sensor and some interfacing circuitry, temperatures can be measured with considerable accuracy.

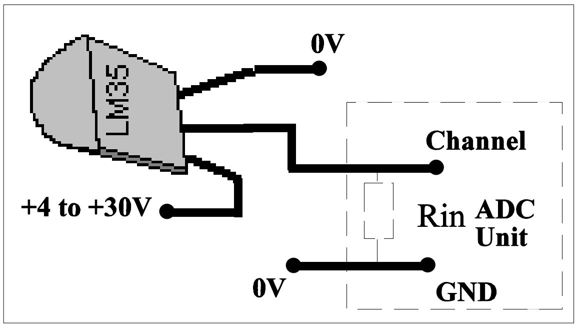
This technical note describes how to interface three common sensor types to the ADC unit using the terinal block.

The three sensor tyes covered here are :-

- LM35 Semiconductor Integrated Circuit Sensor,
- Precision Thermistor,
- Thermocouple (using AD595 IC)

LM35 IC (Maplin part number UF52G) - This is the easiest of the three devices to connect to the ADC units.

The LM35 IC is a precision integrated temperature sensor with combined signal conditioner supplied in a three pin TO92 style package.



The device includes the electronics required to convert the temperature to a linear voltage of 10mV/°C.

It requires a relatively stable supply voltage of between 4 and 30V.
The terminal board supply can be used.

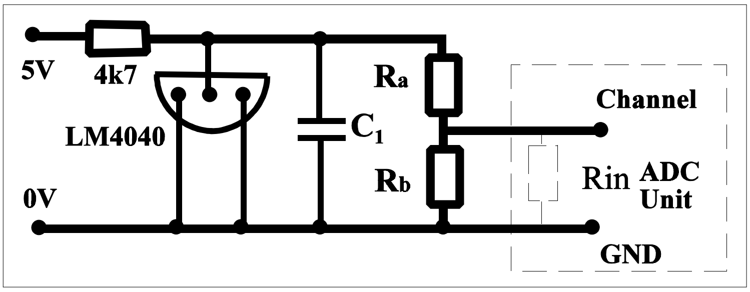
ADC Channels for Position Q1	
ADC16	= Channel 8
ADC11	= Channel 1

The LM35 can be fitted to the terminal board in the position labeled Q1.

To convert the voltage to temperature a scaling equation can be used in PicoLog. Set the scaling equation to :- **X*100**

Precision Thermistor

This is the next easiest method requiring the use of a precision thermistor.



A suitable precision thermistor can be obtained from RS (or Electromail) under part number 151-243.

The 5V supply can be taken from the terminal block. It is converted to a stable and precise 2.5V using the LM4040 voltage reference device (Maplin part number ARC81).

This stable voltage is used in conjunction with a known value resistor to calculate the resistance of the thermistor. This method requires a lookup table to allow PicoLog to convert the voltages into equivalent temperatures. The Lookup table is generated from the thermistor manufacturers data sheet and can be found in the appendix.

The thermistor above is a NTC (negative temperature coefficient) type and should be fitted in position Rb.
Resistor Ra is a precision metal file type with a value of 49k9 and a tolerance of 0.1%.
Capacitor C1 should be 1uF or greater with at least a 3V voltage rating.

A graph of the values in the lookup table show the maximum resolution is approx 0.1°C at 40°C for the ADC11.

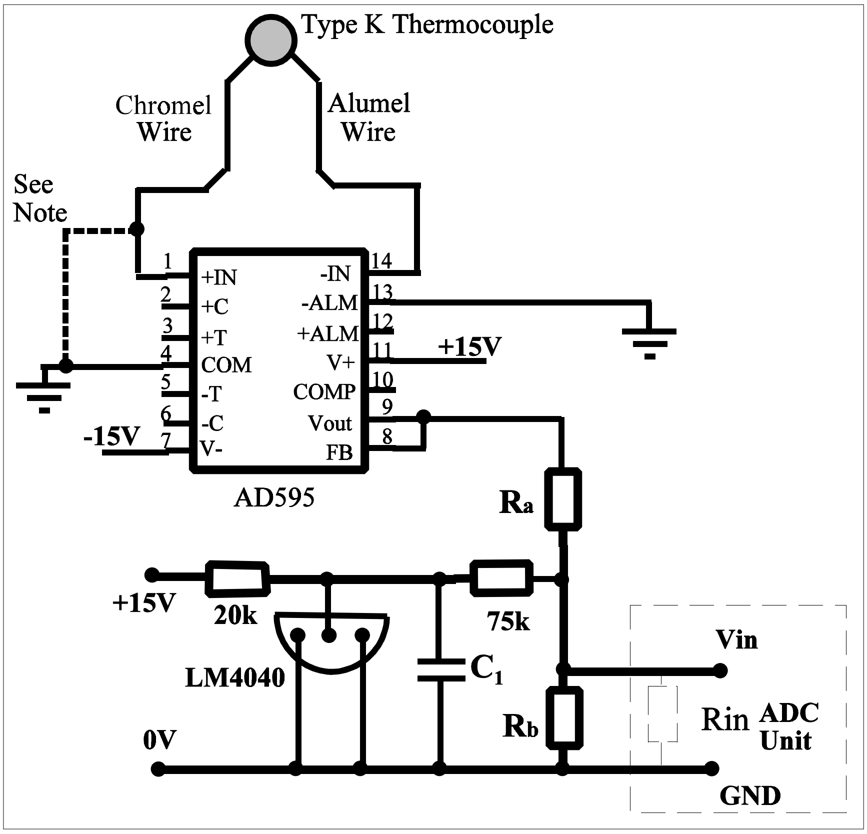
Thermocouple using AD595 IC (RS or Electromail Part Number 301-779)

The AD595 IC is an integrated thermocouple instrumentation amplifier with built-in cold junction compensation. This is not the simplest of ways to measure temperature and great care should be taken with the circuitry. A lookup table must be used in PicoLog since the AD595 output voltage is not linear with temperature (see appendix for table).

Note
A separate external DC power supply is required to supply the AD595. The voltages available on the terminal board should not be used.

For full details about the AD595, see the Analog Devices website.
www.analog.com

The circuit shown below works over the temperature range +1250 to -200°C.



Component Values

Ra = 44.2k 0.1% metal file type.
Rb = 11k 0.1% metal file type.
C1 = 1uF or greater with at least 3V voltage rating.
The 75k Resistor should also be 0.1% metal film type.

Technical Note
The dashed line in the circuit above is required for the bias current return and should be connected as shown. If the thermocouple tip connot be connected to mains earth then consult the AD595 data sheet for further information

Appendix1

Precision Thermistor Lookup Table

Temp	ADC Voltage
-30	2.441
-20	2.392
-10	2.311
0	2.189
10	2.016
20	1.794
25	1.668
30	1.535
40	1.264
50	1.006
60	0.779
70	0.593
80	0.446
90	0.334
100	0.251
110	0.189
120	0.143
130	0.109
140	0.084
150	0.065

AD595 Lookup Table

Temp	ADC Voltage	Temp	ADC Voltage	Temp	ADC Voltage
-200	0.003	240	0.693	760	1.658
-180	0.018	260	0.729	780	1.695
-160	0.036	280	0.765	800	1.731
-140	0.057	300	0.802	820	1.767
-120	0.081	320	0.856	840	1.803
-100	0.107	340	0.875	860	1.838
-80	0.135	360	0.912	880	1.874
-60	0.164	380	0.949	900	1.909
-40	0.196	400	0.984	920	1.944
-20	0.229	420	1.024	940	1.979
-10	0.246	440	1.061	960	2.014
0	0.263	460	1.098	980	2.049
10	0.281	480	1.136	1000	2.083
20	0.298	500	1.173	1020	2.117
25	0.307	520	1.211	1040	2.151
30	0.316	540	1.249	1060	2.185
40	0.334	560	1.286	1080	2.221
50	0.352	580	1.324	1100	2.253
60	0.371	600	1.361	1120	2.286
80	0.407	620	1.399	1140	2.319
100	0.444	640	1.436	1160	2.352
120	0.480	660	1.474	1180	2.384
140	0.516	680	1.511	1200	2.417
160	0.552	700	1.548	1220	2.449
180	0.587	720	1.585	1240	2.480
200	0.622	740	1.621	1250	2.496
220	0.657	750	1.640		