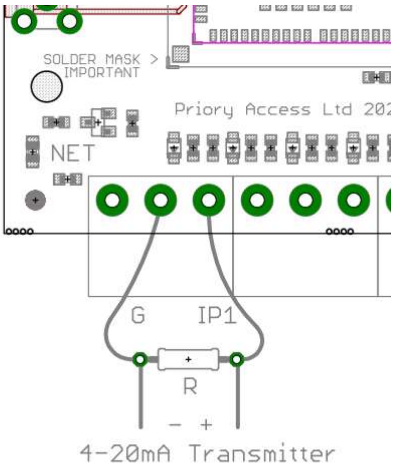
**Revision:** 1.01
https://iot-portal.com Yes
https://iot-portal.com/app Yes
**Mobile:** Yes
**Desktop:** Yes

### Using 4-20mA Current Loops with IoT Portal Communicators

Each analogue input on the iot-portal.com dialler/communicator can be used with a 4-20mA transmitter and sensor. The Live Screen includes controls to scale and offset the resultant voltage reading to the desired value and unit. This allows users to read off a value from the View Screen or Live Screen without conversion.
Trigger thresholds are also converted allowing users to input values directly without first converting the into voltages.

### Wiring

Resistors should be connected between the input terminal and GND. The below shows a resistor connected to input 1 on a Priory Access DR5 PCB. The -ve side of the transmitter should be connected to GND and the +ve side to IP1. The resistor should be 250 to 500 ohms however, any known value in range can be used.




### Scaling and Offset

In order for the measured voltage to read an appropriate value for the quantity being measured, the voltage over the resistor must be scaled and offset according to the following formula:

$$y = A(v) + C$$

$$display = A * Volts + C$$

A is the scaling value and C is the offset.

For 4-20mA applications the Live Screen can calculate these values based on known measurements at 4mA and 20mA.

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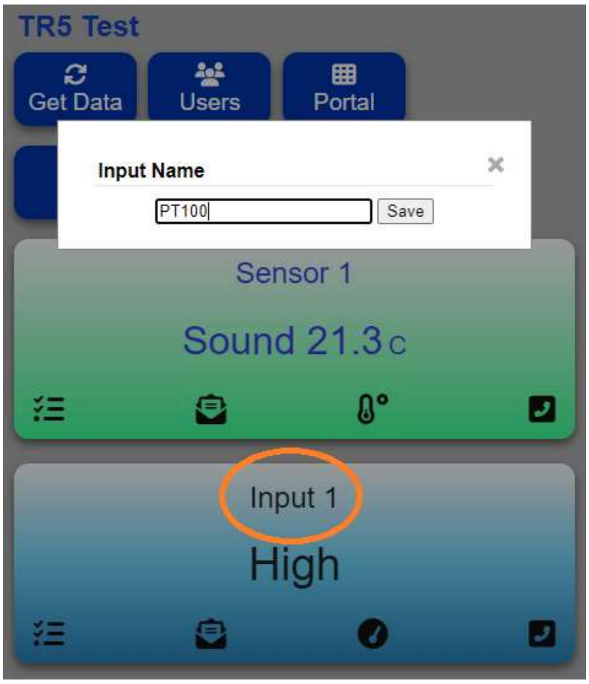
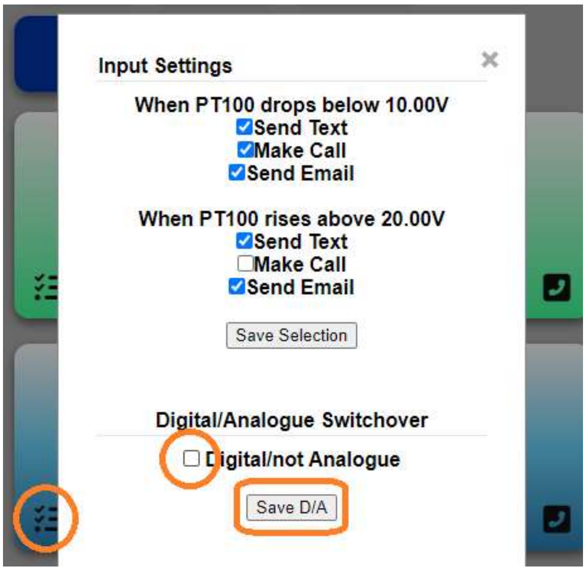
### Example

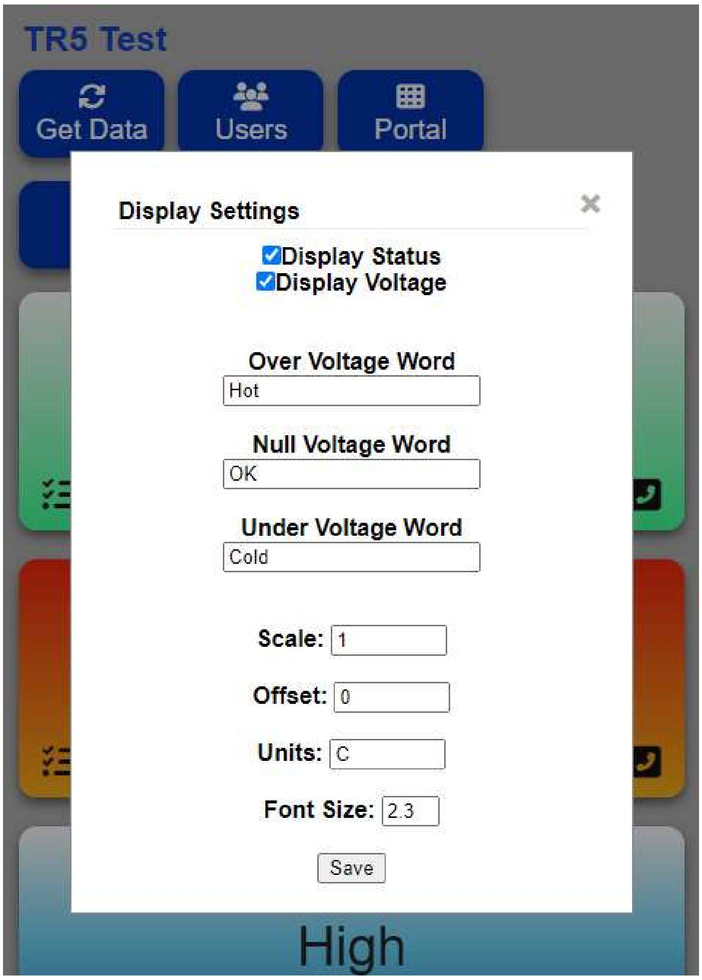
A PT100 temperature probe is used to measure temperatures from 0C to 100C. They are typically connected to a 4-20mA transmitter giving 4mA output at 0C and 20mA output at 100C.
A resistor of 500ohms is typically used to convert the current into a voltage.
In the example we use a TR5 dialler with a DS1820B temperature sensor connected to the 1-wire input as a reference. The PT100/4-20mA Transmitter is connected to Input 1.

Firstly, the name of Input 1 was changed to PT100 by clicking the current name 'Input 1'.




The input is then changed to analogue by clicking the checklist icon and unticking the '**Digital/not Analogue**' checkbox.



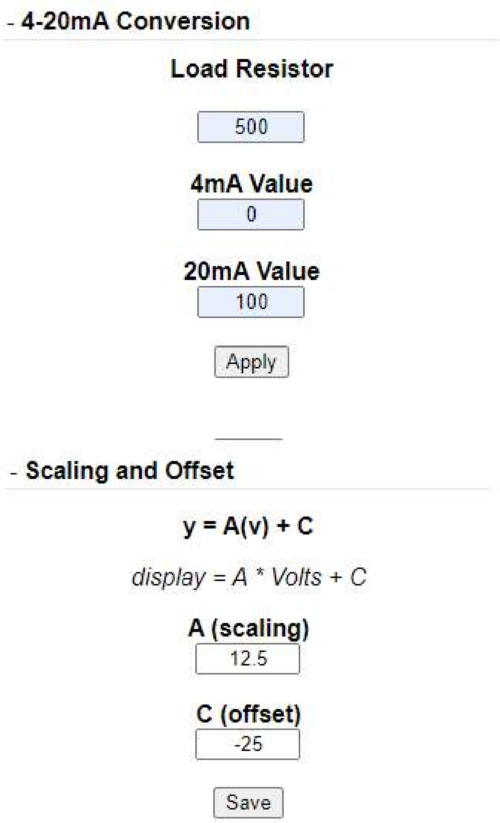



Clicking the text in the centre of the display will bring up the display settings modal.

The 'Display Voltage' checkbox is clicked to ensure the *voltage* (which will be translate into Celsius) is displayed on the input card. Additionally, the 'Units' character is changed to 'C' for Celsius and the High/Low words are changed to 'Hot' and 'Cold' respectively.

The Font Size can also be changed to ensure all of the text fits.

The scale and offset values are set using the 4-20mA conversion. Click the 'Volts' icon on the Input 1 card to reveal the 4-20mA Conversion section.




The 4mA and 20mA values should be entered in the appropriate boxes along with the Load Resistor value (in this case 500ohms).

In the case of the PT100 the chosen transmitter has been calibrated by the manufacturer to supply 4mA when the PT100 is at 0C and 20mA when the PT100 is at 100C.

The load resistor value was chosen to be 500 by the author. The input is accurate between 0-20V and can read voltage up to 36V. The maximum voltage over the 500ohm resistor is 10V:

$V_{max}$ = 500 x 0.02 = 10V

This gives a good dynamic range in the most accurate range of the input.

The 'Apply' button will fill in the Scaling and Offset section. This should be checked followed by clicking 'Save'.

### Calibration/Trimming

Typically, the system would be trimmed at its limits. However, if an accurate reference point is known, this can be used to trim the system.

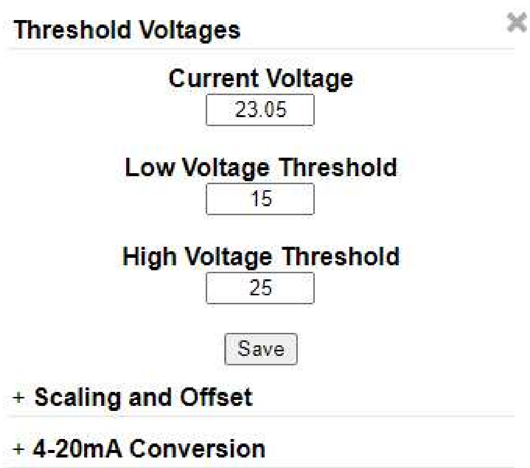
Using the DS1820B, we can set the two sensors to match by adjusting the 'Offset' value.

**The two sensors were mechanically stuck together**


The difference in temperature is 2.05C. This can be added to the Offset value to ensure both sensors match.

### Setting Upper and Lower Thresholds

The post-scaled values (i.e. in this case temperatures in Celsius) should be used instead of terminal voltages.




…but why does the card stay in an active colour? You may also need to adjust the hysteresis values.

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### Adjusting Hysteresis

Hysteresis is a measure of one-wayness in a system. Hysteresis is implemented on the analogue inputs through software which allows for a controllable and repeatable hysteresis amount. It is essential to add stability to the input when it is operating close to the threshold value.

By default, each input has 0.5V of hysteresis. When an input is in the active state, the hysteresis value is added to the low voltage threshold and subtracted to the high voltage threshold. It is easiest to understand the effect of hysteresis with an example.

Assume an input drops from 10.1V to 9.9V crossing a low voltage threshold of 10V. This will create an input low event for that input. Should the input rise to 10V, without hysteresis minor variations in voltage and measurements would create an unstable condition that could repeatedly trigger the input.

With the default 0.5V of hysteresis, the low voltage threshold would rise from 10V to 10.5V thus, the input voltage would have to rise above 10.5V before the input could be triggered again. This creates stability when operating around the threshold values.

In the above example, using the PT100, the scaling value was calculated by the portal to be 12.5. This would translate to the hysteresis value also being multiplies by 12.5 which equates to 6.25C.

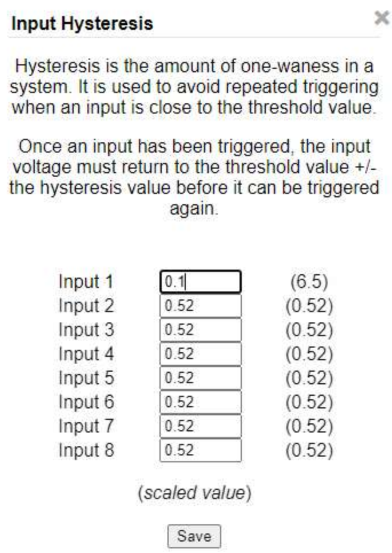
Therefore, with the low threshold value of 15C and upper threshold value of 25C, the input will only trigger one time and will always remain within the hysteresis loop.

LOW: 15C (threshold) + 6.25C (hysteresis) = 21.25C
HIGH: 25C (threshold) + 6.25C (hysteresis) = 18.75C

The above thresholds overlap in such a way that the input cannot be triggered.

Unless the thresholds are over 12.5C apart (6.25C x 2 => 0.5V x 2) the hysteresis values should be adjusted. This requires firmware v8.01R029 or v8.02R015 or later firmware.


**WARNING: The minimum voltage hysteresis should be 0.1V (1.25C in the example)!**
**The hysteresis value is specified in Volts only (i.e. not scaled)!**
To adjust the hysteresis value, go to the Live Screen, click Tools and then click the hysteresis button.




Setting the hysteresis value for input 1 to 0.1V gives a hysteresis value of 1.25C. This requires a minimum separation between high and low states of >2.5C.

### Limitations

The inputs have a voltage range of 0-36V. ADC has a resolution of 10bits (i.e. 1024 steps). Therefore, the minimum voltage step is approximately 0.035V
The accuracy of the input voltage divider is 1%.
In the PT100 example, an accuracy of about 1C would be as good as the standard input can provide.

Inputs are not calibrated by the factory. We recommend a dedicated 1-wire sensor for precision measurements.

Firmware v8.01R029 or v8.02R015 or later is required to change hysteresis values.

### Security

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### Threats to Existing Installations and Recommended Testing

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