Optimum Instruments Inc.

Innovations in Data Collection

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Connecting a 4 - 20mA sensor to the Model 400

Introduction

A wide variety of sensors available today have as their output a standard 4-20mA current signal. These type of sensors include pressure transducers, temperature transmittters, level meters, flow meters and many others. The following document covers the connection of a two, three, or four wire 4-20mA sensor to a Model 400 precision input.

Shunt Resistors

Since the Model 400 datalogger reads and records voltages (and not current) on its precision inputs, the output of a current signal device must be converted to a voltage. This is done with a precision 100Ω shunt resistor. A 100Ω resistor will, with a 4-20mA current source, produce voltages in the 0.4V (4mA) to 2.0V (20mA) range. As an option, a 125Ω precision resistor can be used to produce voltages in the 0.5V (4mA) to 2.5V (20mA) range. However, as 2.5V is the top of the input's measurable voltage scale, currents in excess 20mA will simply be read on the input as a full scale voltage when using a 125Ω shunt resistor.
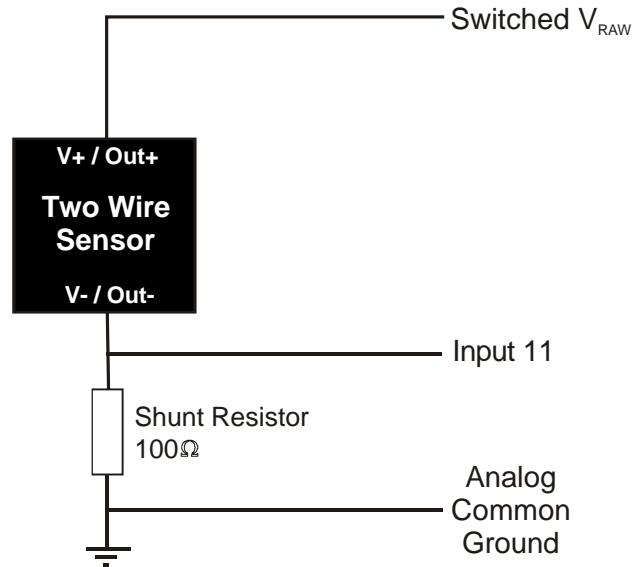
Wiring and Connections

4-20mA sensing devices are available in two, three or four wire configurations. Where mentioned below in the following sub-sections, "Switched V_{RAW}" is the second from the right terminal position on the Model 400's green plug-in power terminal connector (see "" below).


Figure 1: Power terminal connector

Two Wire

In the two-wire configuration, the V+/ Out+ wire is connected to the Model 400's "Switched V_{RAW}" terminal. The other wire of the sensor (V- / Out -) is connected to a precision input. In the diagram shown in Figure 2, the sensor is connected to input 11. The shunt resistor is connected between the input and Analog Common Ground (Alg. Comm.). During operation, the Model 400 will provide power (equal to the power it is being powered with) to the "Switched V_{RAW}" terminal just prior to taking a reading on its inputs to activate the sensor.

Optimum Instruments Inc.
#201, 3124 Parsons Road, Edmonton, AB, Canada, T6N 1L6
For more info call (780) 450-0591 or FAX (780) 440-2515
Email: optimum@optinst.com

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1000IE-09/03

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Switched V$_{RAW}$

V+ / Out+

Two Wire Sensor

V- / Out-

Input 11

Shunt Resistor 100Ω

Analog Common Ground

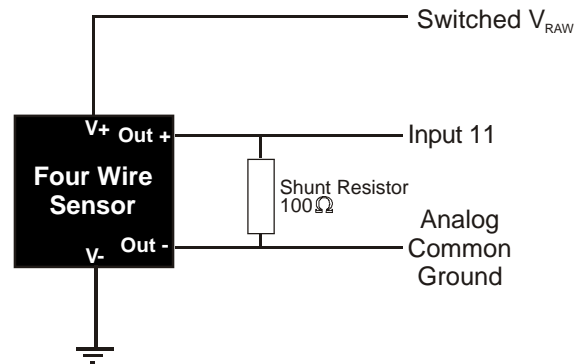**Figure 2: Two wire sensor wiring diagram**

Three Wire

With the three-wire version of the 4 – 20 mA sensor, the "V+" wire is connected to the Model 400's "Switched V$_{RAW}$" terminal. The sensor's "Out+" wire is connected to the precision input on the Model 400 and the "V- / Out-" wire is connected to the Analog Common Ground terminal (Alg. Comm.). Again, the shunt resistor is connected between the Model 400's precision input and ground to create the measurable voltage for the input.

Switched V$_{RAW}$

V+

Three Wire Sensor

Out +

V- / Out-

Input 11

Shunt Resistor 100 Ω

Analog Common Ground
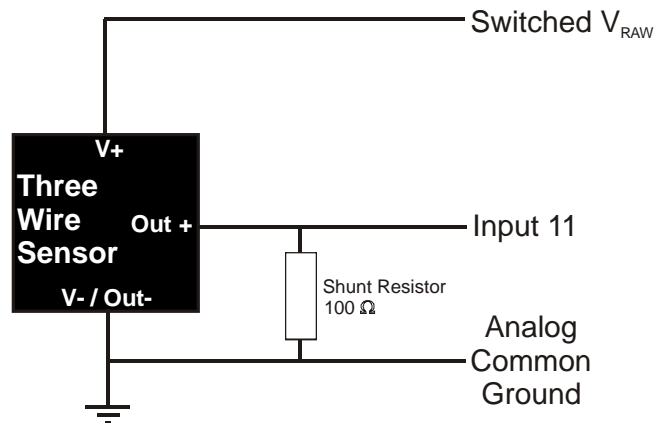
Figure 3: Three wire sensor wiring diagram

Four Wire

A four-wire sensor will have the "V+" and "V-" wires connected to the "Switched V$_{RAW}$" terminal and the Analog Common Ground terminal (Alg. Comm.) respectively. The other two wires will supply the 4-20 mA signal. The positive current signal wire (Out +) will connect to the Model 400's precision input, and the negative current signal wire (Out -) will connect to the analog common ground terminal (Alg. Comm.). As above, the shunt resistor is connected between the Dolphin's precision input and ground.
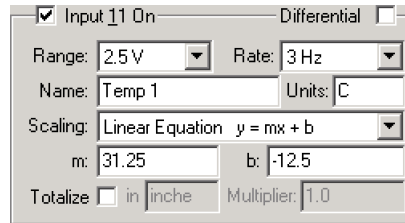
Figure 4: Four wire sensor wiring diagram

A bit about grounding

There are a few small differences with respect to the analog common ground terminal and the power source ground terminal next to the "Switched V_{RAW}" output. If high precision is desired from the 4-20mA sensing device, and some noise is tolerable on the other input channels, use the analog common ground terminal for grounding. On the other hand, if high precision is desired on all the other channels and some imprecision (introduced by the Model 400 circuitry) is tolerable on the 4-20mA channel, then it is suggested that you use the power source ground. In some cases, additional circuitry may be required. If you are uncertain about the grounding requirements for your 4-20mA sensing device, contact a technician at Optimum Instruments for more information.

How do I configure a Model 400 Input?

Once you have ensured that the 4-20 mA sensor is wired correctly to the Model 400, you will want to enable and configure the input that the sensor is connected to by using the Data Dolphin software. As an example, precision input 11 on the Model 400 has been correctly configured in the following procedure to convert the current output from a temperature sensor (0 - 50°C) into a temperature measurement, in degrees centigrade. Follow the example in the following procedure to configure the Model 400's input for your 4-20 mA sensor.
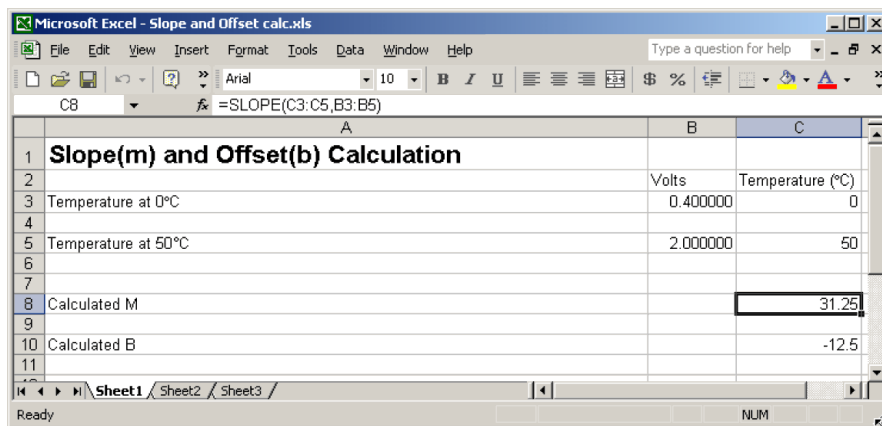
1. Power-up the Model 400 and the sensor. Connect your Model 400 to the serial port of your computer, and load the Data Dolphin software on your computer, and establish a direct, on-site connection to the Model 400 (see "Model 400 Software manual").
2. Open the Dolphin Setup window by clicking the Setup button on the Model 400 software's toolbar.
3. Click on the "Precision Inputs" tab to view the Precision Inputs configuration page. Load the precision input settings from the Model 400 into the Data Dolphin software by clicking on the "Load from Dolphin" button. The Model 400 precision input settings should load into the controls of the inputs sections on this page. If the settings did not load (the Status bar in the Data Dolphin software reads "No response from data logger") check your cable and power connections and repeat this step
4. Now, determine which input you have connected the sensor to. Each section on this page contains the configuration controls for a single precision input eg. The controls in the section marked "Input 11" configure the Model 400's precision input 11, marked "In + Alg 11" on its screw terminal. Note that the settings for inputs 15-18 are displayed by clicking on the "Show Inputs 15-18" button. Once you have determined which input you have connected your sensor to, ensure that the input is enabled (the "On" checkbox has a check), and properly named (i.e. "Temp 1"). The voltage range should be 2.5V, the "Rate" combo box should have 3 Hz selected, and the type of scaling used should be linear equation.

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Figure 5: Precision input configuration

5. To calculate the final m and b values, open a spreadsheet in Microsoft Excel and enter the depth and the corresponding input voltages into two separate columns. An example spreadsheet is shown in below. These entries assume that the voltage read at the input, with a 100Ω resistor and the sensor at 0°C, is 0.4V. Also assumed is that when full scale temperature (50°C) is applied to the sensor, it will output 20 mA, which will be read at the input as 2.0V

Figure 6: Slope and offset calculation with Excel

6. Click on the cell where you want the slope value to appear, and type the following into the formula bar:

     =SLOPE(**<range of depth values>**,**<range of voltage values>**)

    The format for the range of depth and voltage values is in the spreadsheet formula format, such as C3:C5, where C3 is the first cell in the range, and C5 is the last. Hit return, and the value that appears in this cell is the final slope (m) value.

7. Finally, click on the cell where you want the offset value to appear, and enter the following formula into the formula bar:

     =INTERCEPT(**<range of depth values>**,**<range of voltage values>**)+ **<distance from depth sensor to the invert of pipe>**

    Hit the return button to calculate the offset (b).

8. Enter the slope (m) and offset (b) values into the textboxes as shown in step 4. Click the apply button to program the input's settings into the Model 400.

9. The Model 400 input is now correctly programmed for the 4-20 mA sensor. If possible, confirm that the sensor is working correctly by exposing it to known conditions, and verifying its reading in the Data Dolphin software's Status window. In our example, this would correspond to exposing our temperature sensor to a known temperature, and verifying that this temperature is displayed in the Data Dolphin software's Status window.