CURS100 100 OHM CURRENT SHUNT TERMINAL INPUT MODULE
INSTRUCTION MANUAL

REVISION: 4/00

Warranty and Assistance

The **CURS100 100 OHM CURRENT SHUNT TERMINAL INPUT MODULE** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.

CAMPBELL SCIENTIFIC, INC.

815 W. 1800 N.
Logan, UT 84321-1784
USA
Phone (435) 753-2342
FAX (435) 750-9540
www.campbellsci.com

Campbell Scientific Canada Corp.
11564 -149th Street
Edmonton, Alberta T5M 1W7
CANADA
Phone (780) 454-2505
FAX (780) 454-2655

Campbell Scientific Ltd.
Campbell Park
Hathern Road
Shepshed, Leics. LE12 9RP
ENGLAND
Phone (44)-50960-1141
FAX (44)-50960-1091

CURS100 100 Ohm Current Shunt Terminal Input Module

1. Function

Terminal input modules connect directly to the datalogger's input terminals to provide completion resistors for resistive bridge measurements, voltage dividers, and precision current shunts. The CURS100 converts a current signal (e.g., 4-20 mA) to a voltage that is measured by the datalogger. The 100 ohm resistor used for the current shunt allows currents up to 25 mA to be read on a ±2500 mV range (CR10, CR10X) and currents up to 50 mA to be read on a ±5000 mV range (21X, CR23X, CR7, CR5000, CR9000).

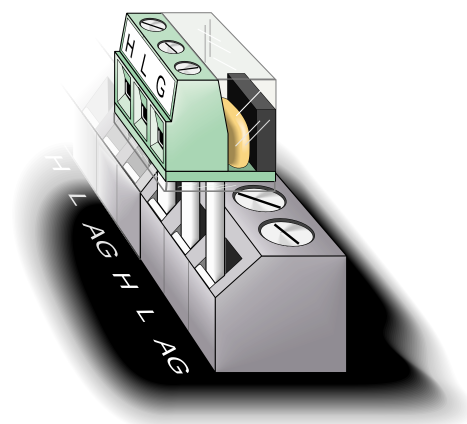


FIGURE 1-1. Terminal Input Module

2. Specifications

TABLE 2-1. Resistor Specifications

100 Ohm Shunt Resistor	
Tolerance @ 25 °C	±0.01%
Temperature coefficient	8 ppm/ºC
Power rating	0.25 W

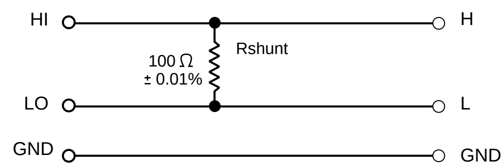


FIGURE 2-1. CURS100 Schematic

The CURS100 has three pins: high, low, and ground; these pins are the correct spacing to insert directly into the datalogger's high, low, and ground terminals (⏚ on 21X, CR23X, CR7, CR5000, or CR9000 or AG on CR10(X)).

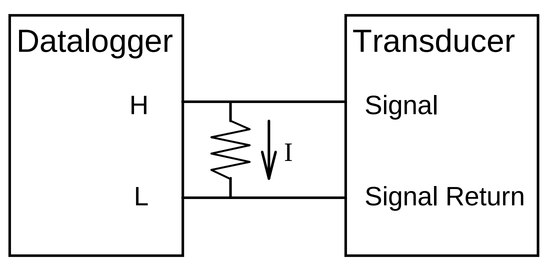
3. Measurement Concepts

Transducers that have current as an output signal consist of three parts: a sensor, a current transducer (quite often integrated with the sensor), and a power supply. The power supply provides the required power to the sensor and transducer. The sensor signal changes with the phenomenon being measured. The current transducer converts the sensor signal into a current signal. The current output changes in a known way with the phenomenon being measured.

An advantage of current loop transducers over voltage output transducers is the current signal remains constant over very long leads.

Two disadvantages with current loop transducers are as follows. First, most transducers require constant current from the power supply, adding cost and size. Secondly, the conditioned output quality may not be as good as a similar unconditioned sensor being measured directly by a datalogger.

The output of the transducer is wired so the current must flow through the 100 ohm resistor in the CURS100.



Ohm's law describes how a voltage (V) is generated by the signal current (I) through a completion resistor (R):

$V=I\ (R)$.

This voltage is measured by the datalogger.

3.1 Differential Measurement

The voltage across the completion resistor is measured with the differential voltage measurement Instruction 2 (VoltDiff on the CR5000 or CR9000). The differential voltage measurement measures the difference in voltage between the low and high terminals. The CURS100 connects the resistor between the high and low terminals.

3.2 Common-Mode Range

In order to make a voltage measurement, the voltage at the channel inputs must be within the datalogger's common mode range. The common mode range is the voltage range, relative to ground within which both inputs of a differential channel must lie in order for the differential measurement to be made. The common mode range is ± 2.5 volts for the CR10(X) and ± 5 volts for the 21X, CR23X, CR5000, CR9000, and CR7.

NOTE One side of the completion resistor is attached to the datalogger's earth ground (G for the CR10(X), CR23X, and CR5000 and ⏚ for the 21X, CR7, and CR9000) to keep the measurement within the datalogger's common mode range.

3.3 Ground Offset on Single-Ended Measurements

When current flows through the ground path on the datalogger, the actual voltage at the different ground terminals will be slightly different. The small offset voltages between the ground points are caused because there is resistance (albeit small) in the ground path and current flowing through a resistance results in a voltage drop. The offsets in ground voltage cause offsets in single-ended voltage measurements.

3.3.1 CR10(X), CR23X, CR5000

These dataloggers were designed with separate analog ground (AG on CR10X ⏚ on CR23X and CR5000) and ground (G) terminals. Ground (G) terminals are used for power and shield connections where there is likely to be current flowing. Ground is connected directly to earth ground (a grounding rod) to provide a path to earth for transient voltages. By avoiding the use of analog ground as a current path, analog ground terminals will stay at the same ground potential and not cause offsets in single-ended measurements.

NOTE All ground connections on these dataloggers should be made at a G terminal. Do NOT use the CURS100's ground terminal which connects to analog ground.

3.3.2 21X, CR7, CR9000

The 21X, CR7, and CR9000 dataloggers do not have a separate analog ground. The 21X may have a slightly higher ground path resistance than the CR7 or CR9000. When current is allowed to flow in the ground path, the offset voltages on single-ended measurements can be as high as several millivolts. The more current signals measured, the larger this offset voltage can become. To reduce the amount of current flowing in the 21X ground path, it is recommended that a separate power supply be used to power current transducers.

4. Transducer Wiring

Current transducers differ mainly in how they are powered and in the relative isolation of the current output. In this section the transducers are grouped by the total number of wires the transducer uses to obtain power and output the current.

4.1 Two-Wire Transducers

In a two wire transducer the power supply is in series within the current loop. The transducer regulates the amount of current that flows; the current drawn from the battery is exactly the current used as a signal.

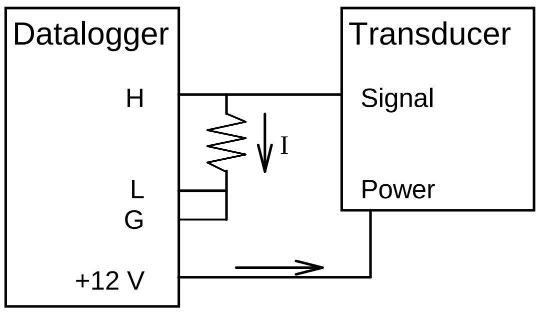


FIGURE 4-1. 2-Wire w/ Datalogger Power

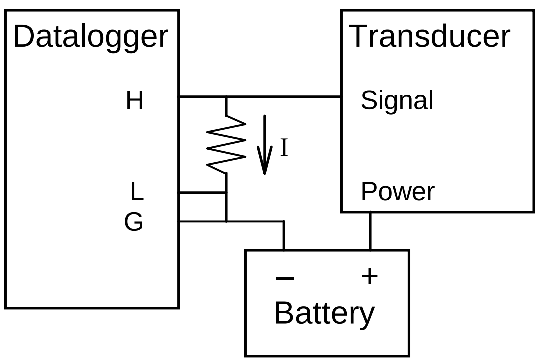


FIGURE 4-2. 2-Wire w/External Power

4.1.1 Possible Ground Loop Problems

The resistor must be grounded at the datalogger to ensure that the measurement is within common mode range. The signal (or low) output on the transducer is higher than the datalogger ground by the voltage drop across the resistor. A ground-loop error may occur if the signal output is not electrically isolated but is connected to the sensor's case. If such a sensor is in contact with earth ground (i.e., a pressure transducer in a well or stream) an alternative path for current flow is established through earth ground to the datalogger earth ground. This path is in parallel with the path from the signal output through the resistor; hence not all the current will pass through the resistor and the measured voltage will be too low.

4.1.2 Minimum Supply Voltage

When the power supply is in the current loop, as is the case in a 2 wire transducer, it is necessary to consider the effect of the voltage drop across the resistor on the voltage applied to the transducer.

For example, suppose a 4-20 mA transducer requires at least 9 volts to operate correctly and the system is powered by a 12 volt battery. The voltage the transducer sees is the battery voltage minus the voltage drop in the rest of the current loop. At 20 mA output, the voltage drop across the 100 ohm resistor is 2 volts. When the battery is at 12 volts, this leaves 10 volts for the transducer and everything is fine. However, if the battery voltage drops to 11 volts, a 20 mA current will leave just 9 volts for the transducer. In this case, when the battery drops below 11 volts, the output of the transducer may be in error.

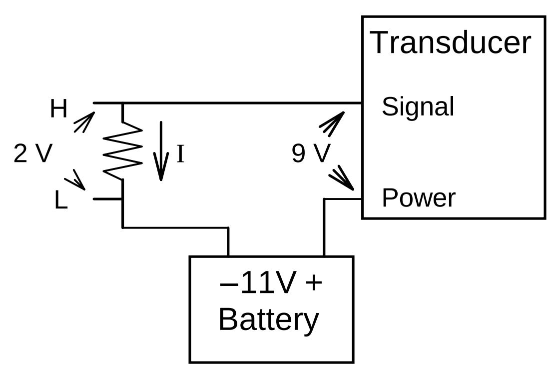


FIGURE 4-3. 2-Wire Supply Voltage

4.2 Three-Wire Transducers

A three wire current loop transducer has the power supply connected directly to the transducer. The voltage of the power supply is the voltage applied to the transducer. The current output returns to power ground. Datalogger ground is connected to sensor ground and the current output by the sensor must pass through the resistor before going to ground.

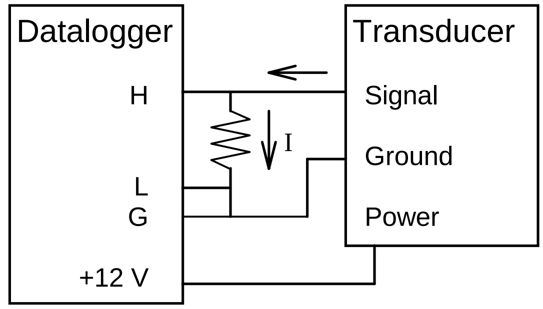


FIGURE 4-4. 3-Wire w/Datalogger Power

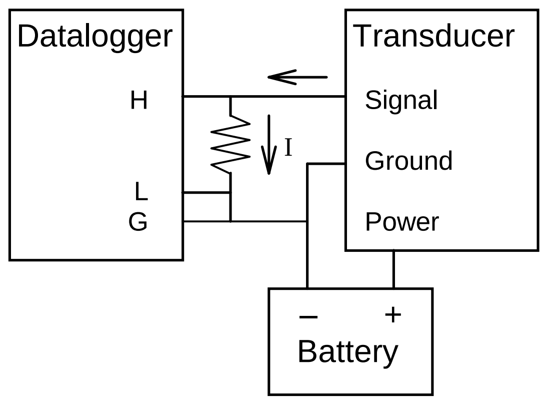


FIGURE 4-5. 3-Wire w/External Power

4.3 4-Wire Transducers

A four wire transducer has separate wires for power input and ground and for signal output and ground. The signal ground may or may not be internally tied to the power ground. Some transducers have completely isolated outputs.

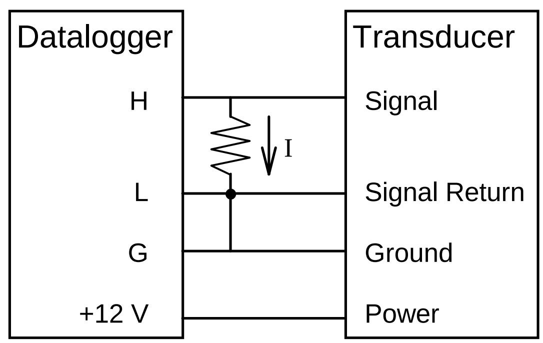


FIGURE 4-6. 4-Wire w/Datalogger Power

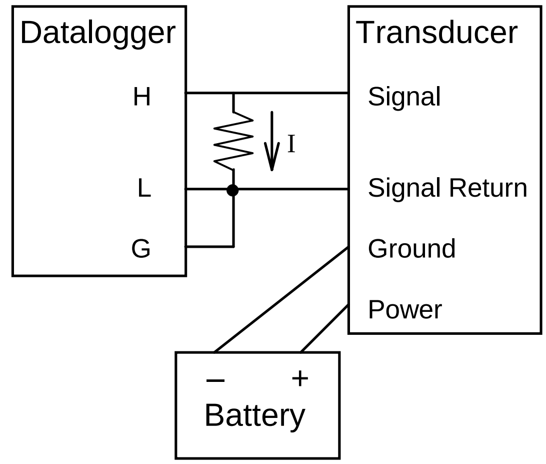


FIGURE 4-7. 4-Wire w/External Power

5. Sensor and Programming Example

In the following example, the input voltage range and multiplier and offset are calculated for a 4 to 20 mA output pressure transducer. Examples showing the differential measurement made on channel 1 are then given for the CR10(X), 21X, CR7, and CR9000 dataloggers.

5.1 Voltage Range

The voltage range on which to make the measurement should be the smallest range that will accommodate the maximum signal the sensor will output. Using the smallest possible range will give the best resolution.

The voltage across the resistor, V, is equal to the resistance (100 ohms) multiplied by the current, I.

V = 100 I

The maximum voltage occurs at the maximum current. Thus, a 4 to 20 mA transducer will output it's maximum voltage at 20 mA.

V = 100 ohms x 0.02 A = 2 V

An output of 2 volts is measured on the ±2500 mV range on the CR10(X) or on the ±5000 mV range on the 21X, CR7, or CR9000.

5.2 Calculating Multiplier and Offset—An Example

The multiplier and the offset are the slope and y-intercept of a line and are computed with Ohm’s law and a linear fit.

For example, measure a current loop transducer that detects pressure with the CR10(X) where the sensor specifications are as follows:

Transducer range --	200 to 700 psi
Transducer output range --	4 to 20 mA
CR10(X) range --	±2500 mV

The transducer will output 4 mA at 200 psi and 20 mA at 700 psi. Using Ohm's law, the voltage across the resistor at 200 psi is

V = I x R

V = 0.004 x 100

V = 0.4 V or 400 mV

and at 700 psi is

V = 0.020 x 100

V = 2.0 V or 2000 mV

Since the datalogger measures in mV, the multiplier (or slope) must be in units of psi/mV. Therefore, the y values have the units psi and the x values mV.

The equation of a line is

$(y - y_1) = m (x - x_1)$

Solve the equation for m that is the slope of the line (or multiplier).

$$m = \frac{700\,psi - 200\,psi}{2000mV - 400mV} = 0.3125\frac{psi}{mV}$$

Now replace the known values to determine the intercept (or offset). Where y = m(x)+b

$$200\,psi = 0.3125\frac{psi}{mV} \cdot 400mV + b$$
$$b = 200 - 0.3125 \cdot 400 = 75\,psi$$

m = multiplier (slope) = 0.3125 and

b = the offset (intercept) = 75.0.

5.3 CR10(X) Program Example

```
1:  Volt (Diff) (P2)
  1:          1        Reps
  2:         25        ± 2500 mV 60 Hz Rejection Range
  3:          1        DIFF Channel
  4:          1        Loc [ Press_psi ]
  5:          0.3125   Mult
  6:         75        Offset
```

5.4 CR23X Program Example

```
1:  Volt (Diff) (P2)
  1:          1        Reps
  2:         25        ± 5000 mV, 60 Hz Reject, Fast Range
  3:          1        DIFF Channel
  4:          1        Loc [ Press_psi ]
  5:          0.3125   Mult
  6:         75        Offset
```

5.5 CR7 Program Example

```
1:  Volt (Diff) (P2)
  1:          1        Reps
  2:          8        ± 5000 mV Slow Range
  3:          1        In Card
  4:          1        DIFF Channel
  5:          1        Loc [ Press_psi ]
  6:          0.3125   Mult
  7:         75        Offset
```

5.6 CR9000 Program Example

```
VoltDiff(Press_psi, 1, mV5000, 5, 1, 1, 0, 0, 0.3125, 75)
```