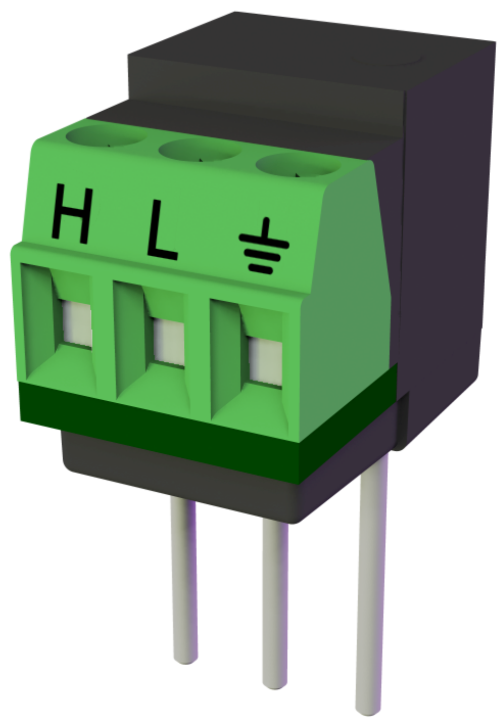
INSTRUCTION MANUAL

CURS100 100 Ohm Current Shunt Terminal Input Module

Revision: 7/13



Warranty

"PRODUCTS MANUFACTURED BY CAMPBELL SCIENTIFIC, INC. are warranted by Campbell Scientific, Inc. ("Campbell") to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless otherwise specified in the corresponding Campbell pricelist or product manual. Products not manufactured, but that are re-sold by Campbell, are warranted only to the limits extended by the original manufacturer. Batteries, fine-wire thermocouples, desiccant, and other consumables have no warranty. Campbell's obligation under this warranty is limited to repairing or replacing (at Campbell's option) defective products, which shall be the sole and exclusive remedy under this warranty. The customer shall assume all costs of removing, reinstalling, and shipping defective products to Campbell. Campbell will return such products by surface carrier prepaid within the continental United States of America. To all other locations, Campbell will return such products best way CIP (Port of Entry) INCOTERM® 2010, prepaid. This warranty shall not apply to any products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for installation services performed by Campbell such as programming to customer specifications, electrical connections to products manufactured by Campbell, and product specific training, is part of Campbell's product warranty. CAMPBELL EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Campbell is not liable for any special, indirect, incidental, and/or consequential damages."

Assistance

Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit *www.campbellsci.com* to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. 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

For all returns, the customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.com/repair*. A completed form must be either emailed to *repair@campbellsci.com* or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Table of Contents

PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.

Figures

CURS100 100 Ohm Current Shunt Terminal Input Module

1. Introduction

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 (for example, 4 to 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 (CR800, CR850, CR1000, CR3000, CR5000, CR9000X, CR9000, 21X, CR23X).

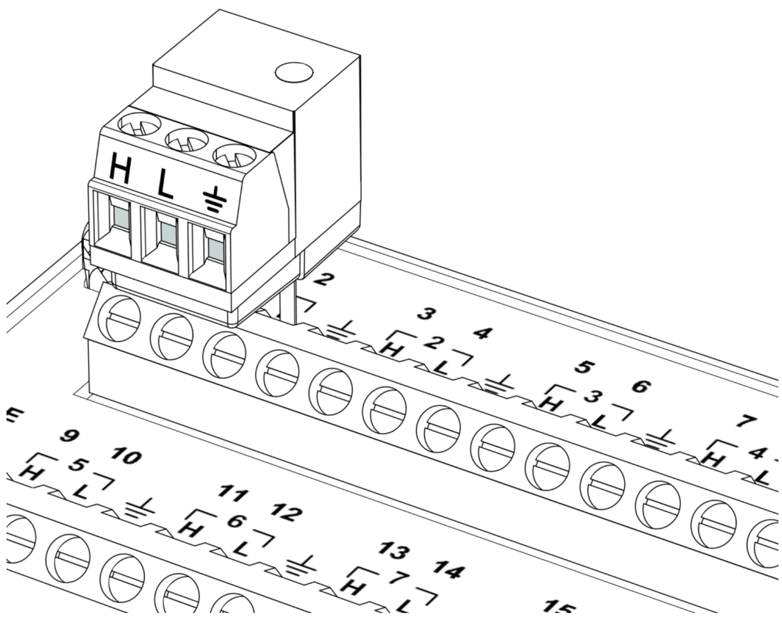


FIGURE 1-1. CURS100 terminal input module

2. Specifications

100 Ohm Shunt Resistor

Tolerance @ 25°C:	±0.01%
Temperature coefficient:	±0.8 ppm / ºC
Power rating:	0.25 W

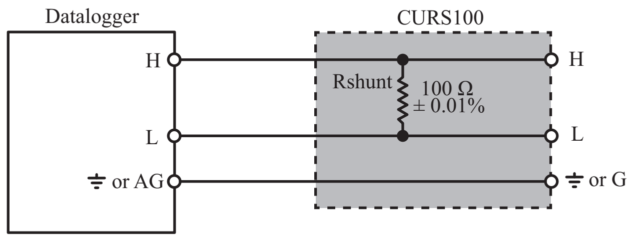


FIGURE 2-1. CURS100 schematic

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, CR800, CR850, CR1000, CR3000, CR5000, or CR9000(X) or AG on CR10(X)).

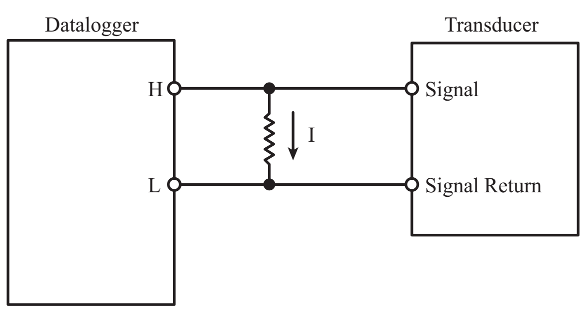
3. Measurement Concepts

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 the 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 long lead lengths.

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. Use **VoltDiff()** for the CRBasic dataloggers (for example, CR1000, CR5000, or CR9000(X)). Use Instruction 2 for Edlog dataloggers (for example, CR10X). The differential voltage measurement measures the difference in voltage between the low and high terminals. The CURS100 connects the resistor between the high and the low terminals.

3.2 Completing the Current Loop Circuit

As shown in FIGURE 2-1, the 100 Ω sense resistor in the CURS100 is not connected to the adjacent ground pin that connects into the datalogger signal ground (⏚ or AG). Hence, an additional connection must be made in order to complete the loop, which is commonly done by connecting the CURS100 L terminal to a datalogger G (power ground) terminal with a jumper wire (FIGURE 3-1). Connecting the L terminal to the adjacent ground (⏚ or G) terminal on the CURS100 will result in unwanted return currents flowing into the datalogger signal ground (⏚ or AG), which could induce undesirable offset errors in low-level, single-ended measurements. The ground (⏚ or G) terminal on the CURS100 can be used to connect cable shields to ground.

Completing the loop by connecting voltages other than ground is possible as long as the datalogger voltage input limits are not exceeded. These input limits specify the voltage range, relative to datalogger ground, which both H and L input voltages must be within in order to be processed correctly by the datalogger. The input limits are ±2.5 V for the CR10(X) and ±5 V for the CR800, CR850, CR1000, CR3000, CR5000, and CR9000(X). Hence, when measuring currents up to 50 mA with the CURS100, a connection to datalogger ground is necessary in order for the resulting (50 mA) × (100 Ω) = 5 V signal to comply with the ±5 V input limits for the CR800, CR850, CR1000, CR3000, CR5000, and CR9000(X) dataloggers.

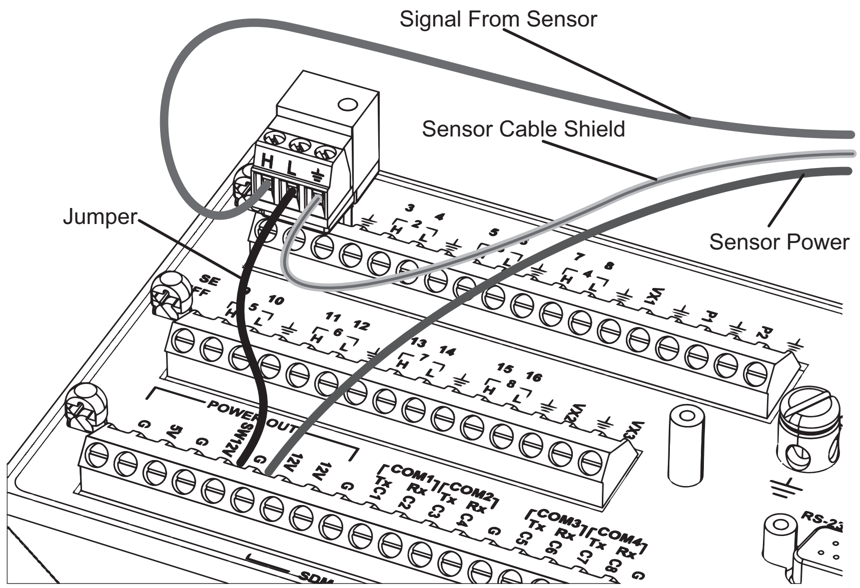


FIGURE 3-1. CURS100 L terminal connected to a datalogger G terminal using a jumper wire.

NOTE Normally the L terminal on the CURS100 should be connected to a datalogger G terminal (power ground) with a jumper wire (FIGURE 3-1). Connecting the L terminal to the adjacent ground (⏚ or G) terminal on the CURS100 can result in unwanted return currents on the datalogger signal ground, which could induce undesirable offset errors in low-level, single-ended measurements. The G terminal on the CURS100 can be used to connect cable shields to ground.

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.

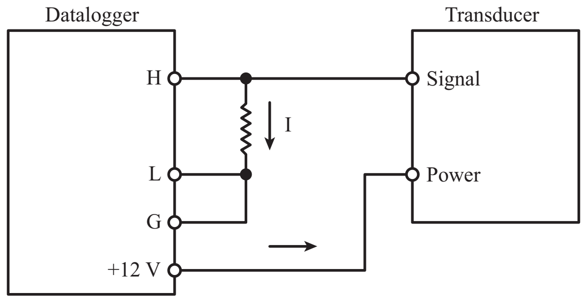


FIGURE 4-1. 2-wire with datalogger power

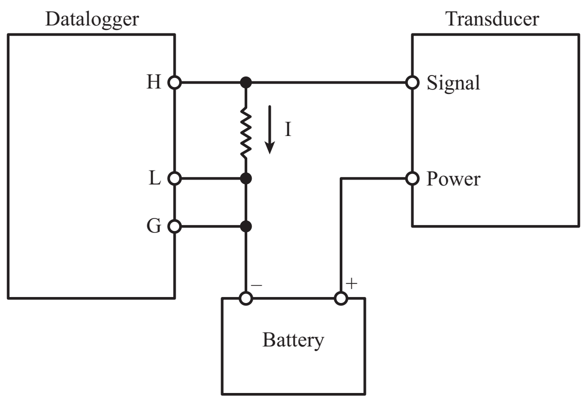


FIGURE 4-2. 2-wire with external power

4.1.1 Possible Ground Loop Problems

The resistor must be grounded at the datalogger to ensure that measurements are 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 (for example, 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 voltage drop across the resistor on the voltage applied to the transducer.

For example, suppose a 4 to 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.

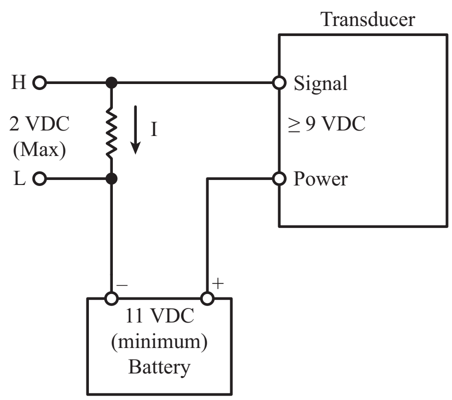


FIGURE 4-3. 2-wire supply voltage

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.

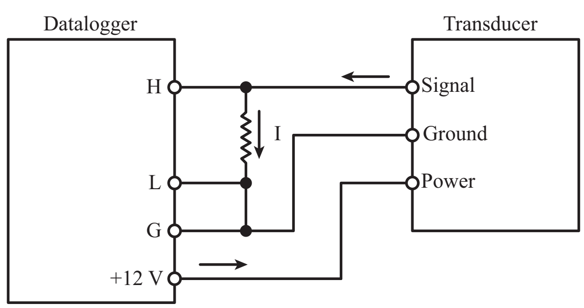


FIGURE 4-4. 3-wire with datalogger power

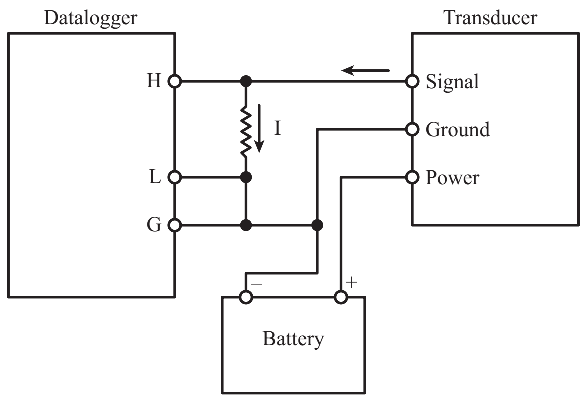


FIGURE 4-5. 3-wire with external power

4.3 Four-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.

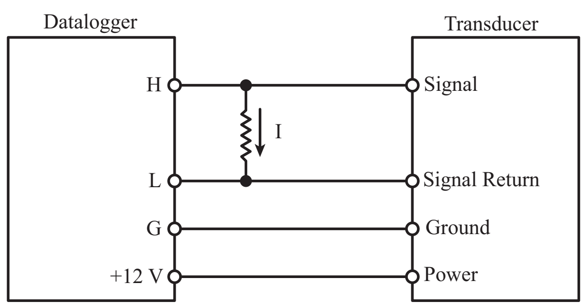


FIGURE 4-6. 4-wire with datalogger power

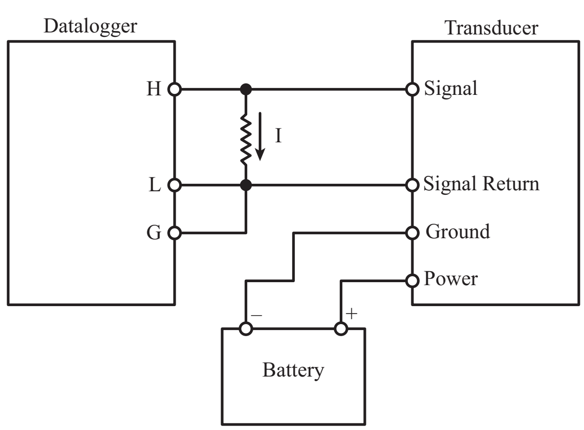


FIGURE 4-7. 4-wire with external power

5. Sensor and Programming Example

In this example, the input voltage range, and the multiplier and offset values 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 CR1000, CR9000(X), CR10(X), and 21X dataloggers; programming for the CR800, CR850, CR3000, and CR5000 is virtually identical to the CR1000.

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 its maximum voltage at 20 mA.

$V = 100 \text{ ohms} \times 0.02 \text{ A} = 2 \text{ V}$

An output of 2 volts is measured on the ±2500 mV range on the CR800, CR850, CR1000, and CR10(X), or on the ±5000 mV range on the 21X, CR3000, CR5000, or CR9000(X).

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 where the sensor specifications are as follows:

Transducer range — 200 to 700 psi

Transducer output range — 4 to 20 mA

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:

$V = I \times R$

$V = 0.004 \times 100$

$V = 0.4 \text{ V or } 400 \text{ mV}$

and at 700 psi is:

V = 0.020 × 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

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

m = multiplier (slope) = 0.3125 and

b = the offset (intercept) = 75.0.

5.3 CR1000 Program Example

```
'CR1000 program example for sensor with 4-20mA output.

'Assuming a flow meter that outputs a 4-20mA signal representing 0 - 100 gal/min,
'the voltage across the resistor at 0 gal/min = 4mA * 100 ohms = 400mV,
'and at 100 gal/min is 20mA * 100 ohms = 2000mV.  The change in mV is
'2000mV - 400mV = 1600mV for 0 - 100 gal/min flow rate.

'The measurement result (X) for the VoltDiff instruction is mV.  The
'multiplier to convert mV to gal/min is: mV * 100gal/min / 1600mV = 0.0625,
'the offset is 400mV * .0625 = -25.0.

Public Measure

DataTable (Hourly,True,-1)
    DataInterval (0,60,Min,0)
    Average (1,Measure,IEEE4,0)
EndTable
```

```
BeginProg
Scan (1,Sec,1,0)
      'Generic 4-20 mA Input measurement Measure:
      VoltDiff (Measure,1,mV2500,1,True,0,_60Hz,0.0625,-25.0)
      CallTable (Hourly)
NextScan
EndProg
```

5.4 CR9000(X) Program Example

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

5.5 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
```

5.6 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
```

Campbell Scientific Companies

Campbell Scientific, Inc. (CSI)
815 West 1800 North
Logan, Utah 84321
UNITED STATES
www.campbellsci.com • info@campbellsci.com

Campbell Scientific Africa Pty. Ltd. (CSAf)
PO Box 2450
Somerset West 7129
SOUTH AFRICA
www.csafrica.co.za • cleroux@csafrica.co.za

Campbell Scientific Australia Pty. Ltd. (CSA)
PO Box 8108
Garbutt Post Shop QLD 4814
AUSTRALIA
www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific do Brasil Ltda. (CSB)
Rua Apinagés, nbr. 2018 ─ Perdizes
CEP: 01258-00 ─ São Paulo ─ SP
BRASIL
www.campbellsci.com.br • vendas@campbellsci.com.br

Campbell Scientific Canada Corp. (CSC)
11564 - 149th Street NW
Edmonton, Alberta T5M 1W7
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Centro Caribe S.A. (CSCC)
300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA
www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Ltd. (CSL)
Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM
www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Ltd. (France)
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Spain, S. L.
Avda. Pompeu Fabra 7-9, local 1
08024 Barcelona
SPAIN
www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or international representative.