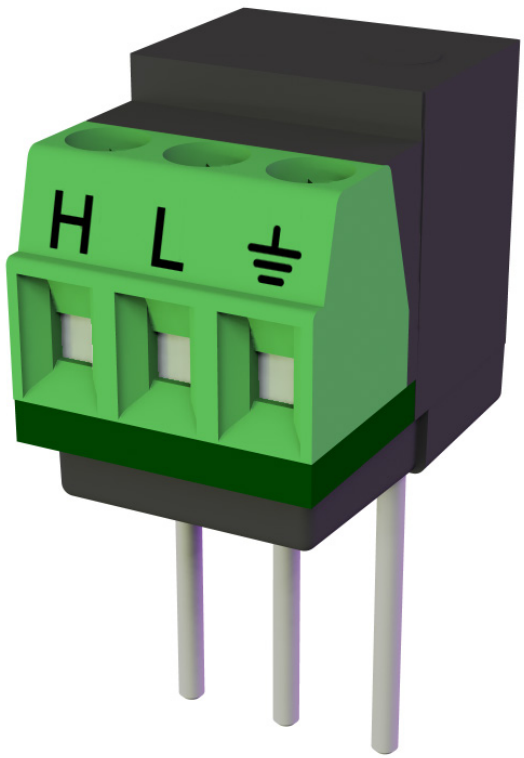
Product Manual

Measurement & Control Peripheral

CURS100

100 Ohm Current Shunt Terminal Input Module



Revision: 11/2022

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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

CRBasic Example

CURS100 100 Ohm Current Shunt Terminal Input Module

1. Introduction

Terminal input modules connect directly to the data logger 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 data logger. The 100-ohm resistor used for the current shunt allows currents up to 50 mA to be read on a ±5000 mV range (CR6, CR800, CR850, CR1000, CR1000X, CR3000, CR5000, CR9000X, CR9000). The CR300 allows currents up to 25 mA with a –100 to +2500 mV range.

NOTE The CR6 (serial numbers greater than or equal to 7502), CR300-series, and CR1000X data loggers are able to do current measurements directly. While compatible with the CURS100, the CURS100 is not required to convert the current signal to a voltage. For more information, see *CRBasic Editor Help* for the **CurrentSE()** instruction.

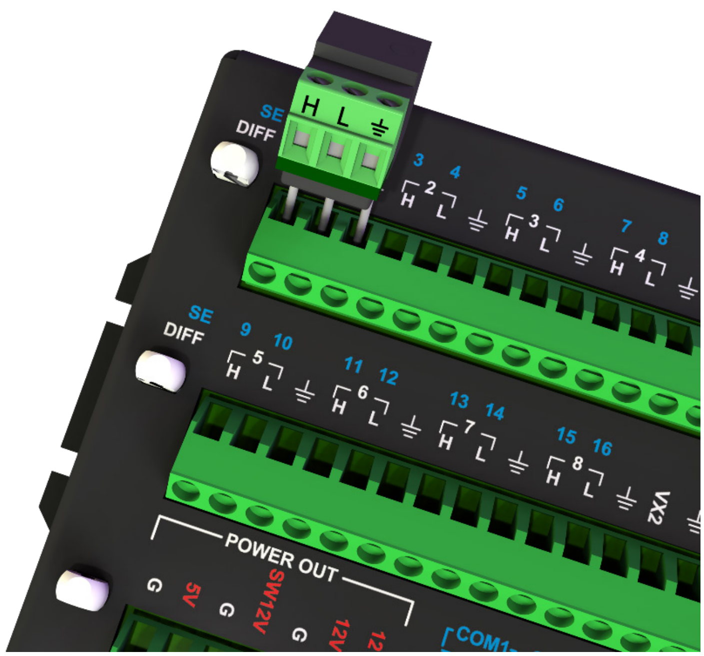


FIGURE 1-1. CURS100 terminal input module

2. Specifications

100 Ohm Shunt Resistor

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

Compliance: View compliance documents at: *www.campbellsci.com/curs100*

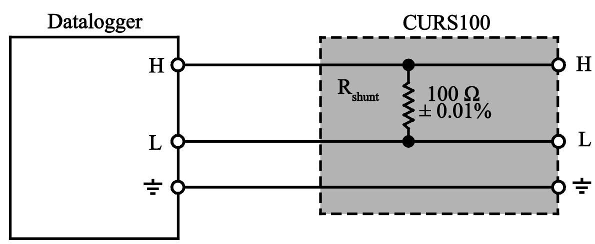


FIGURE 2-1. CURS100 schematic

The CURS100 has three pins: high, low, and ground. These pins have the correct spacing to insert directly into the data logger high, low, and ground terminals (⏚ on CR6, CR300, CR800, CR850, CR1000, CR1000X, CR3000, CR5000, or CR9000(X)).

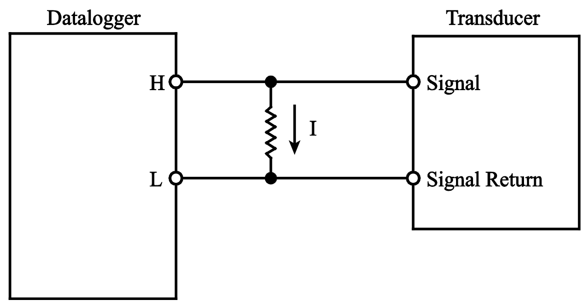
3. Measurement Concepts

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

An advantage of current loop transmitters over voltage output transmitters is the current signal remains constant over long wire lengths.

Current loop transmitters also have disadvantages. Most transmitters require constant current from the power supply, adding cost and size. Also, the conditioned output quality may not be as good as a similar unconditioned sensor being measured directly by a data logger.

The output of the transmitter 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 data logger.

3.1 Differential Measurement

The voltage across the completion resistor is measured with the differential voltage measurement. Use **VoltDiff()** for the CRBasic data loggers (for example, CR6, CR1000, CR1000X, CR5000, or CR9000(X)). 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 data logger signal ground (⏚). 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 data logger **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 data logger signal ground (⏚), 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 data logger voltage input limits are not exceeded. These input limits specify the voltage range, relative to data logger ground, which both H and L input voltages must be within in order to be processed correctly by the data logger. The input limits are ±5 V for the CR6, CR800, CR850, CR1000, CR1000X, CR3000, CR5000, and CR9000(X). Hence, when measuring currents up to 50 mA with the CURS100, a connection to data logger 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 CR6, CR800, CR850, CR1000, CR1000X, CR3000, CR5000, and CR9000(X) data loggers. The CR300 is limited to 25 mA with a –100 to +2500 mV range.

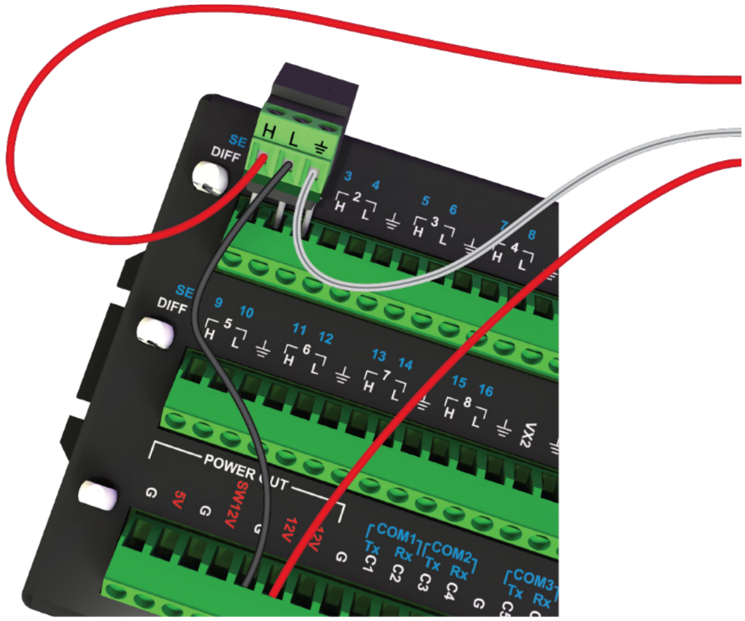


*FIGURE 3-1. CURS100 L terminal connected to a data logger **G** terminal using a jumper wire.*

NOTE Normally the **L** terminal on the CURS100 should be connected to a data logger **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 data logger 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. Transmitter Wiring

Current transmitters differ mainly in how they are powered and in the relative isolation of the current output. This sections groups the transmitters by the total number of wires the transmitter uses to obtain power and output the current.

4.1 Two-Wire Transmitters

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

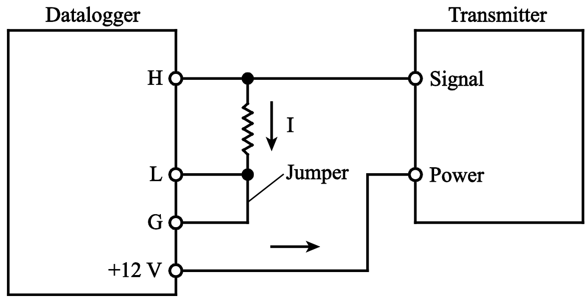


FIGURE 4-1. 2-wire with data logger power

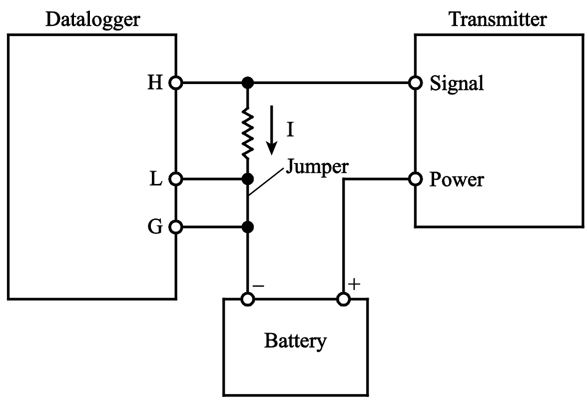


FIGURE 4-2. 2-wire with external power

4.1.1 Possible Ground Loop Problems

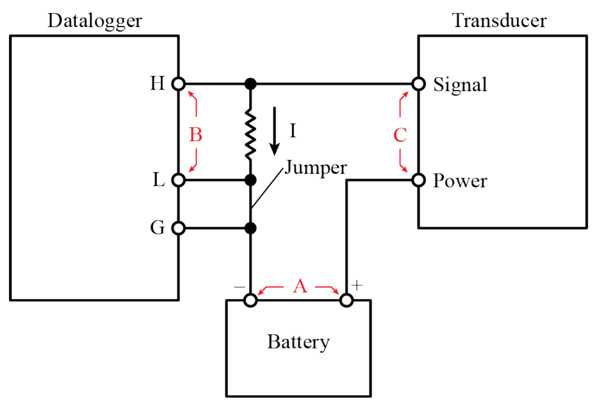
The resistor must be grounded at the data logger to ensure that measurements are within common mode range. The signal (or low) output on the transmitter is higher than the data logger ground by the voltage drop across the resistor. A ground-loop error may occur if the signal output is not electrically isolated but is connected to the sensor case. If such a sensor is in contact with earth ground (for example, a pressure transmitter in a well or stream), an alternative path for current flow is established through earth ground to the data logger 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 transmitter, it is necessary to consider the effect of voltage drop across the resistor on the voltage applied to the transmitter.

For example, suppose a 4 to 20 mA transmitter requires at least 9 volts to operate correctly and the system is powered by a 12-volt battery. The voltage the transmitter 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 transmitter and everything is fine. However, if the battery voltage drops to 11 volts, a 20-mA current will leave just 9 volts for the transmitter. In this case, when the battery drops below 11 volts, the output of the transmitter may be in error.

FIGURE 4-3 illustrates how the voltage available to a transducer (C) is directly related to the voltage available from the battery (A).



Battery Level (A)	Datalogger (B)	Transducer (C)
13 Vdc	2 Vdc	11 Vdc
12 Vdc	2 Vdc	10 Vdc
11 Vdc	2 Vdc	9 Vdc
10 Vdc	2 Vdc	8 Vdc

FIGURE 4-3. Voltage drop in a 2-wire transducer with external power

4.2 Three-Wire Transmitters

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

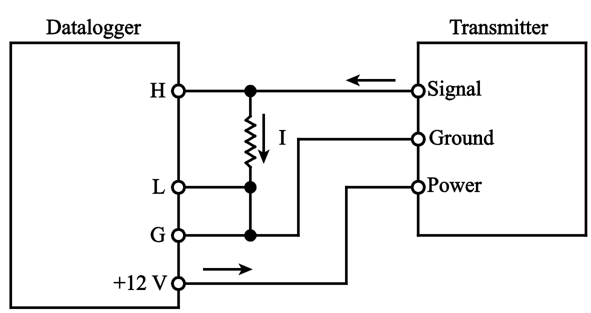


FIGURE 4-4. 3-wire with data logger power

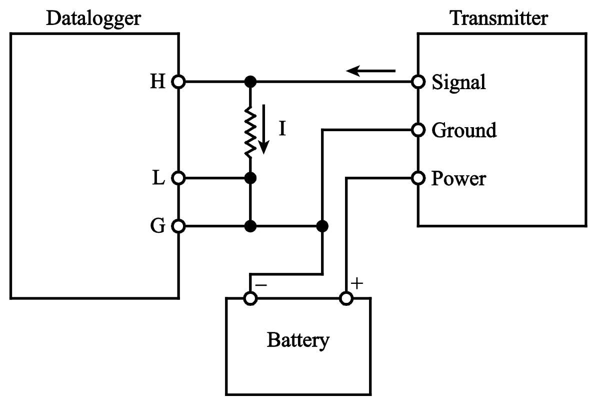


FIGURE 4-5. 3-wire with external power

4.3 Four-Wire Transmitters

A four-wire transmitter 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 transmitters have completely isolated outputs.

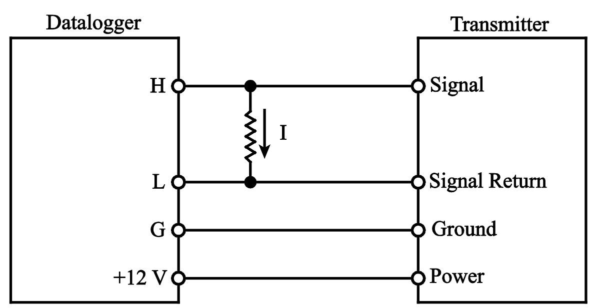


FIGURE 4-6. 4-wire with data logger power

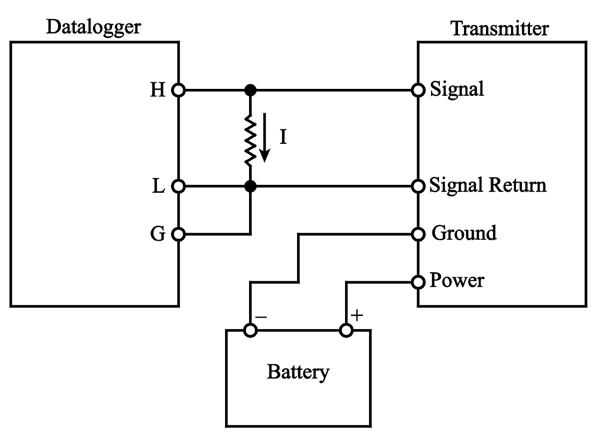


FIGURE 4-7. 4-wire with external power

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 transmitter. Examples showing the differential measurement made on Terminal 1 are then given for the CR1000X and CR9000(X) data loggers; programming for the CR6, CR300, CR800, CR850, CR1000, CR3000, and CR5000 is virtually identical to the CR1000X.

5.1 Voltage Range

Select the smallest voltage range that encompasses the maximum output signal from the sensor. Using the smallest possible range will provide 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 transmitter will output its maximum voltage at 20 mA.

V = 100 ohms • 0.02 A = 2 V

An output of 2 volts is measured on the ±2500 mV range on the CR800, CR850, and CR1000 or on the ±5000 mV range on the CR6, CR1000X, CR3000, CR5000, or CR9000(X). The 2 volt output is measured on the –100 to +2500 mV range of the CR300.

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 transmitter that detects pressure where the sensor specifications are as follows:

Transmitter range –	200 to 700 psi
Transmitter output range –	4 to 20 mA

The transmitter 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 • R

V = 0.004 • 100

V = 0.4 V or 400 mV

and at 700 psi is:

V = 0.020 • 100

V = 2.0 V or 2000 mV

Since the data logger 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).

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

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

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

m = multiplier (slope) = 0.3125 and

b = the offset (intercept) = 75.0.

5.3 CR1000X Program Example

CRBasic Example 5-1. CR1000X Program Example for Sensor with 4 to 20 mA Output

```
'CR1000X Series

'CR1000X program example for sensor with 4-20 mA 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 = 0 - 400mV * 0.0625 = -25.0

'Declare Variables and Units
Public BattV
Public PTemp_C
Public Measure

Units BattV=Volts
Units PTemp_C=Deg C
Units Measure=mV

'Define Data Tables
DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,Measure,IEEE4,False)
EndTable

DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable
```

```
'Main Program
BeginProg
  'Main Scan
  Scan(5,Sec,1,0)
    'Default CR1000X Data Logger Battery Voltage measurement 'BattV'
    Battery(BattV)
    'Default CR1000X Data ogger Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,60)
    'Generic 4-20 mA Input measurement 'Measure'
    VoltDiff(Measure,1,mV2500,1,True,0,60,0.0625,-25)
    'Call Data Tables and Store Data
    CallTable Hourly
    CallTable Daily
  NextScan
```

5.4 CR9000(X) Program Example

CRBasic Example 5-1 will work with the CR9000(X) data logger with one small change. Insert the following **VoltDiff()** command in place of the **VoltDiff()** command in the program. The program will now function with the CR9000(X). This program assumes the analog input module is installed in slot 5 for this example.

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

Limited Warranty

Products manufactured by Campbell Scientific are warranted by Campbell Scientific to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified on the corresponding product webpage. See Product Details on the Ordering Information pages at *www.campbellsci.com*. Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

Refer to *www.campbellsci.com/terms#warranty* for more information.

CAMPBELL SCIENTIFIC EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Campbell Scientific hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.

Assistance

Products may not be returned without prior authorization.

Products shipped to Campbell Scientific require a Returned Materials Authorization (RMA) or Repair Reference number and must be clean and uncontaminated by harmful substances, such as hazardous materials, chemicals, insects, and pests. Please complete the required forms prior to shipping equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page for the Global Sales and Support Network or visit *www.campbellsci.com/contact* to determine which Campbell Scientific office serves your country.

To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement 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.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

INFO

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Global Sales & Support Network

A worldwide network to help meet your needs

Campbell Scientific Regional Offices

Australia

Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

India

Location: New Delhi, DL India
Phone: 91.11.46500481.482
Email: info@campbellsci.in
Website: www.campbellsci.in

South Africa

Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Spain

Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

Thailand

Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: info@campbellsci.asia
Website: www.campbellsci.asia

UK

Location: Shepshed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA

Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com