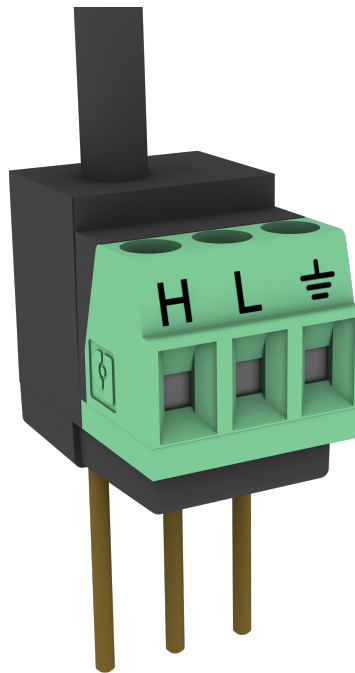




3WHB10K

3-Wire Half Bridge Terminal Input Module



Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. Quotations for repairs can be given on request. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.



Campbell Scientific Ltd,
80 Hathern Road,
Shepshed, Loughborough, LE12 9GX, UK
Tel: +44 (0) 1509 601141
Fax: +44 (0) 1509 270924
Email: support@campbellsci.co.uk
www.campbellsci.co.uk

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area: 1 in² (square inch) = 645 mm²

Length: 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

Mass: 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

Pressure: 1 psi (lb/in²) = 68.95 mb

Volume: 1 UK pint = 568.3 ml
1 UK gallon = 4.546 litres
1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a “#” symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.



Campbell Scientific Ltd, 80 Hathern Road, Shepshed, Loughborough, LE12 9GX,
UK Tel: +44 (0) 1509 601141 Fax: +44 (0) 1509 270924
Email: support@campbellsci.co.uk
www.campbellsci.co.uk

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.eu or by telephoning +44(0) 1509 828 888 (UK). 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

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- 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, or 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.

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.

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.

Table of contents

1. Function	1
2. Specifications	2
3. Wiring	2
4. Programming examples	4
4.1 GRANITE 9/10 program example	5
4.2 GRANITE 6/CR6 program example	6
4.3 CR1000X program example	6
4.4 CR1000 program example	7
4.5 CR9000X program example	7
5. 100 Ohm PRT in 3-wire half bridge	8
5.1 Excitation voltage	8
5.2 Calibrating a PRT	9
5.3 Compensation for wire resistance	9

1. Function

A terminal input module (TIM) connects directly to a data logger or GRANITE analogue input module. It provides completion resistors for resistive bridge measurements, voltage dividers, and precision current shunts. The 3WHB10k is used in 3-wire half bridge measurements and includes a 10 k Ω completion resistor.

NOTE:

The GRANITE 6 and CR6 include the fixed resistor and current excitation required to complete the half-bridge circuit without a terminal input module. However, the GRANITE 6 and CR6 are still compatible with a terminal input module and may be used with one, should the application require it.

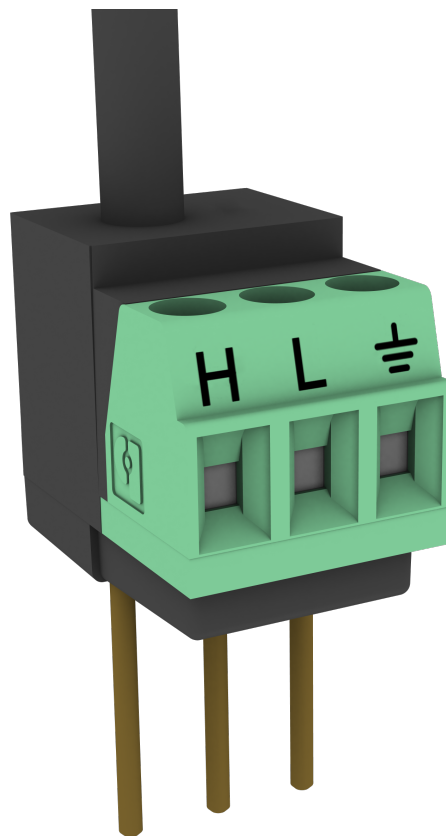


Figure 1-1. Terminal input module

2. Specifications

10 k Ω completion resistor

Tolerance @ 25 °C: $\pm 0.01\%$

Maximum temperature coefficient $\pm 0.8 \text{ ppm}/^\circ\text{C}$

Power rating @ 70 °C: 0.25 W

Compliance: View compliance documents at:
www.campbellsci.eu/3whb10k 

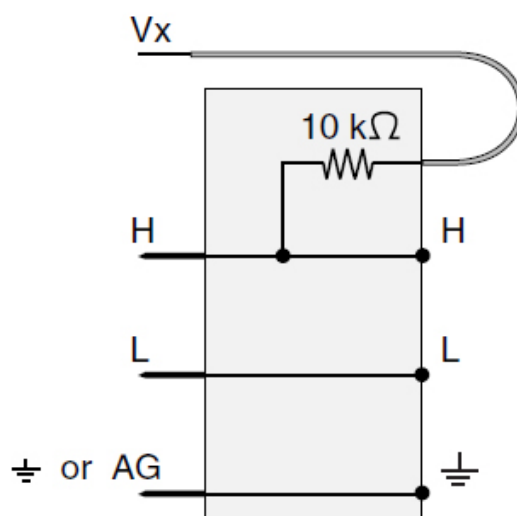


Figure 2-1. Schematic

3. Wiring

The terminal input module is connected to adjacent **H** and **L** terminals. When making 3-wire half bridge measurements, the 3WHB10K performs two single-ended measurements. The sense wires from the platinum resistance thermometer (PRT) attach to the 3WHB10K. The black excitation wire is connected to an excitation terminal. In the following example, the 3WHB10K is connected

to the **1H** and **1L** terminals, using them for two single-ended measurements. The excitation wire is connected to excitation terminal **VX1** ([Figure 3-1](#) [p. 3]).

Often, sensors only have two wires. Use the 3WHB10K as a fixed, known resistor to measure them. Wire a jumper between the **H** and **L** terminals on the 3WHB10K to allow the sensor to receive excitation voltage. Without the jumper, the sensor will not function. See [Figure 3-1](#) (p. 3).

When using a 2-wire sensor with the 3WHB10K, use the [BrHalf\(\)](#) (or [CDM_BrHalf\(\)](#)) instruction in place of the [BrHalf3W\(\)](#) (or [CDM_BrHalf3W\(\)](#)) instruction. The parameters of the [BrHalf3W\(\)](#) and [BrHalf\(\)](#) instructions are identical; so, only the instruction name needs to be changed in the [Programming examples](#) (p. 4) example programs.

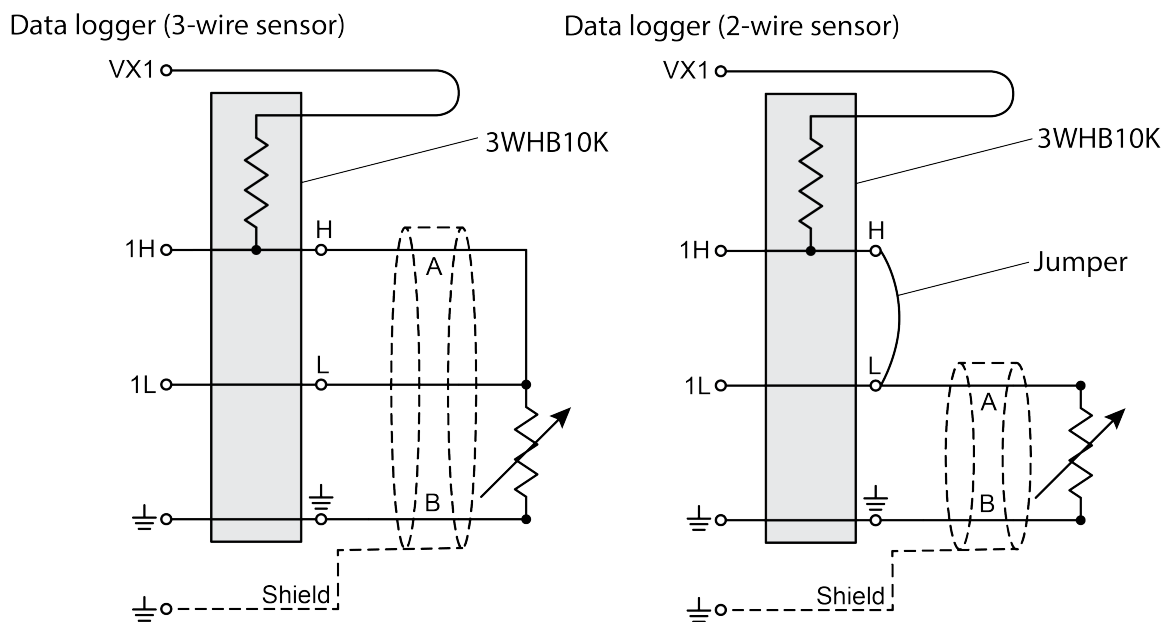


Figure 3-1. 3-wire half bridge used to measure PRT

Table 3-1: 3WHB10K connections to Campbell Scientific data loggers

Function	Label/Wire	GRANITE analogue input module	GRANITE 6, CR6	CR3000, CR1000X, CR800, CR850, CR1000	CR9000X
Excitation	Black wire	X1	U5	VX1	Excitation 1
V1 high reference	H	1H	U1	1H	1H
V1 low sense	L	1L	U2	1L	1L
Ground	G	⏏	⏏	⏏	⏏

¹ The GRANITE 9 and GRANITE 10 do not directly make analogue measurements. Instead, they use analogue input modules such as the VOLT 108 or VOLT 116. When making a half-bridge measurement, the terminal input module is connected to the analogue input module, which is then connected to the GRANITE 9 or GRANITE 10.

4. Programming examples

The following examples show the two instructions necessary to 1) make the measurement and 2) calculate the temperature. The result of the half bridge measurement as shown is R_s/R_0 , the input required for the PRT algorithm to calculate temperature.

If using a calibrated sensor, the exact measurement of R_0 will be known. Use this value to increase the accuracy of the `PRTCalc()` instruction by inserting the following equation between the `BrHalf4W()` and `PRTCalc()` instructions in the example programs.

$$Rs_R0 = Rs_R0*100/R0$$

where $R0$ is the sensor resistance at 0 °C

The following examples are based on a maximum sensor resistance of 100 Ω at 0 °C. The excitation voltages used were chosen with the assumption that the temperature would not exceed 50 °C. Calculation of optimum excitation voltage is discussed in [Excitation voltage](#) (p. 8).

4.1 GRANITE 9/10 program example

The GRANITE 9 and GRANITE 10 require the use of an analogue input module, such as the VOLT 108, when making a half-bridge measurement.

CRBasic Example 1: GRANITE 9/10 3-wire half bridge example

```
'3-wire half bridge example
'GRANITE 9 and GRANITE 10 data loggers (with a VOLT 108)

'Declare Variables and Units
Public Temp_C_3wire
Public Rs_R0

'Define Data Tables
DataTable(Hourly,True,-1)
    DataInterval(0,60,Min,10)
    Average(1,Temp_C_3wire,IEEE4,False)
EndTable

'Main Program
BeginProg
    'Configure the VOLT 108 Module and assign it CPI address 'CPI_BUSA+1'
    CPIAddModule(VOLT108,10," ",CPI_BUSA+1)
    'Main Scan
    Scan(5,Sec,1,0)
    'Half Bridge, 3-wire measurements on the VOLT 108
    CDM_BrHalf3W(VOLT108,CPI_BUSA+1,Rs_R0,1,mV1000,1,1,1,3200,True,500,60,1,0)
    'PRT temperature calculation
    PRTCalc (Temp_C_3wire,1,Rs_R0,0,1.0,0)
    'Call Data Tables and Store Data
    CallTable Hourly
    NextScan
EndProg
```

4.2 GRANITE 6/CR6 program example

The GRANITE 6 and CR6 include the fixed resistor and current excitation required to complete the half-bridge circuit without a terminal input module. However, the GRANITE 6 and CR6 are still compatible with a terminal input module and may be used with one, should the application require it.

CRBasic Example 2: GRANITE 6/CR6 3-wire half bridge example

```
'GRANITE 6/CR6 data logger 3-wire half bridge using a terminal input module
```

```
Public Rs_R0, Temp_C

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

BeginProg
  Scan (1,Sec,0,0)
  BrHalf3W (Rs_R0,1,mV1000,U1,U4,1,2500,True ,0,250,100,0)
  PRTCalc (Temp_C,1,Rs_R0,0,1,0)
  CallTable Hourly
  NextScan
EndProg
```

4.3 CR1000X program example

CRBasic Example 3: CR1000X 3-wire half bridge example

```
'CR1000X-series data logger 3-wire half bridge
```

```
Public Rs_R0, Temp_C

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

BeginProg
  Scan (1,Sec,0,0)
  BrHalf3W (Rs_R0,1,mV1000,1,Vx1,1,3200,True ,0,250,100,0)
  PRTCalc (Temp_C,1,Rs_R0,0,1,0)
  CallTable Hourly
  NextScan
EndProg
```

4.4 CR1000 program example

CRBasic Example 4: CR1000 3-wire half bridge example

```
'CR1000-series data logger 3-wire half bridge

Public Rs_R0, Temp_C

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

BeginProg
    Scan (1,Sec,0,0)
        BrHalf3W (Rs_R0,1,mV2500,1,Vx1,1,2500,True,0,250,100,0)
        PRTCalc (Temp_C,1,Rs_R0,0,1,0)
        CallTable Hourly
    NextScan
EndProg
```

4.5 CR9000X program example

CRBasic Example 5: CR9000X 3-wire half bridge example

```
'CR9000X data logger 3-wire half bridge

Public Rs_Ro, Temp_F

DataTable (Temp_F,1,-1)
    DataInterval (0,60,Min,0)
    Sample (1,Temp_F,FP2)
EndTable

BeginProg
    Scan (1,mSec,0,0)
        BrHalf3W (Rs_Ro,1,mV1000,5,1,6,1,1,3200,True,30,40,100,0)
        PRTCalc (Temp_F,1,Rs_Ro,0,1.8,32)
        CallTable Temp_F
    NextScan
EndProg
```

5. 100 Ohm PRT in 3-wire half bridge

The advantages of the 3-wire half bridge over other measurements that correct for wire resistance such as a 4-wire half bridge, are that it only requires 3 wires going to the sensor and takes 2 single-ended terminals, whereas the 4-wire half bridge requires 4 wires and 2 differential channels.

The result of the 3-wire half bridge instruction is equivalent to the ratio of the PRT resistance, R_s to the resistance of the 10 k fixed resistor, R_f .

$$\frac{R_s}{R_f}$$

The `PRTCalc()` instruction computes the temperature (°C) for a DIN 43760 standard PRT from the ratio of the PRT resistance at the temperature being measured (R_s) to its resistance at 0 °C (R_0). Thus, a multiplier of R_f/R_0 is used with the 3-wire half bridge instruction to obtain the desired intermediate, $R_s/R_0 = (R_s/R_f \times R_f/R_0)$. If R_f and R_0 are equal, the multiplier is 1.

The fixed resistor must be thermally stable. The 0.8 ppm/°C temperature coefficient would result in a maximum error of 0.035 °C at 125 °C. This measurement is ratiometric (R_s/R_f) and does not rely on the absolute values of either R_s or R_f .

The properties of the 10 kΩ resistor do not affect the result. The purpose of this resistor in the circuit is to limit current.

5.1 Excitation voltage

When determining the excitation voltage, it is important to consider the maximum excitation current the sensor can experience without self-heating. This is typically less than 0.35 mA. Refer to the manufacturer's sensor data sheet for the specific value.

Once the maximum excitation current is known, the excitation voltage is then calculated.

$$V_x = I_x (R_f + R_{Smax})$$

Where:

R_f = PRT completion resistor value

R_{Smax} = Maximum sensor resistance based on the maximum expected temperature to be measured

Using the typical 0.35 mA maximum excitation current, the maximum excitation voltage for the sensor when R_{Smax} is 100 Ω is:

$$V_x = 0.35 \text{ mA} (10 \text{ k}\Omega + 100 \text{ }\Omega) = 3.54 \text{ V}$$

When R_{Smax} is 1.25 k Ω , this changes to:

$$V_x = 0.35 \text{ mA} (10 \text{ k}\Omega + 1.25 \text{ k}\Omega) = 3.94 \text{ V}$$

5.2 Calibrating a PRT

The greatest source of error in a PRT is likely to be that the resistance at 0 °C deviates from the nominal value. Calibrating the PRT in an ice bath can correct this offset and any offset in the fixed resistor in the terminal input module.

The result of the 3-wire half bridge is:

$$\frac{V_2}{V_1} = \frac{I \bullet R_s}{I \bullet R_f} = \frac{R_s}{R_f}$$

With the PRT at 0 °C, $R_s = R_0$. Thus, the above result becomes R_0/R_f , the reciprocal of the multiplier required to calculate temperature, R_f/R_0 . By making a measurement with the PRT in an ice bath, errors in both R_s and R_0 can be accounted for.

To perform the calibration, connect the PRT to the data logger and program the data logger to measure the PRT with the 3-wire half bridge as shown in the example section (multiplier = 1). Place the PRT in an ice bath (@ 0 °C; $R_s = R_0$). Read the result of the bridge measurement. The reading is R_s/R_f , which is equal to R_0/R_f since $R_s = R_0$. The correct value of the multiplier, R_f/R_0 , is the multiplier used divided by this reading. For example, if, with a 100 Ω PRT, the initial reading is 0.9890, the correct multiplier is: $R_f/R_0 = 100/0.9890 = 101.11$.

5.3 Compensation for wire resistance

The 3-wire half bridge compensates for wire resistance by assuming that the resistance of wire A is the same as the resistance of wire B (Figure 3-1 [p. 3]). The maximum difference expected in wire resistance is 2%, but is more likely to be on the order of 1%. The resistance of R_s calculated with `BrHa1f3W()`, is actually R_s plus the difference in resistance of wires A and B.

For example, assume that a 100 Ω PRT is separated from the data logger by 500 feet of 22 AWG wires. The average resistance of 22 AWG wire is 16.5 Ω per 1000 feet, which would give each 500-foot wire a nominal resistance of 8.3 Ω . Two percent of 8.3 Ω is 0.17 Ω . Assuming that the greater resistance is in wire B, the resistance measured for the PRT ($R_0 = 100 \text{ }\Omega$) in the ice bath would be

100.17 Ω , and the resistance at 40 °C would be 115.71. The measured ratio R_s/R_0 is 1.1551; the actual ratio is $115.54/100 = 1.1554$. The temperature computed by [PRTCalc\(\)](#) from the measured ratio would be about 0.1 °C lower than the actual temperature of the PRT. This source of error does not exist in a 4-wire half bridge where a differential measurement is used to directly measure the voltage across the PRT.



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