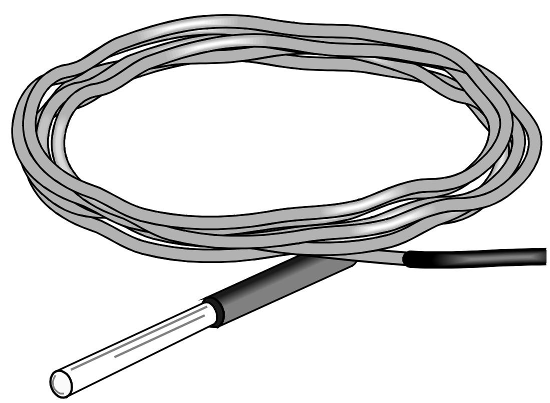
INSTRUCTION MANUAL

Model 107 Temperature Probe

Revision: 3/14



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Tables

Model 107 Temperature Probe

1. Introduction

The 107 Temperature Probe uses a thermistor to measure temperature in air, soil, and water. It is compatible with all Edlog and CRBasic dataloggers except the CR200(X) and CR9000(X). See Section 6, *Specifications*, for a complete list of compatible dataloggers.

2. Cautionary Statements

Santoprene® rubber, which composes the black outer jacket of the 107 cable, will support combustion in air. It is used because of its resistance to temperature extremes, moisture, and UV degradation. It is rated as slow burning when tested according to U.L. 94 H.B. and passes FMVSS302. However, local fire codes may preclude its use inside buildings.

3. Initial Inspection

- Check the packaging and contents of the shipment. If damage occurred during transport, immediately file a claim with the carrier. Contact Campbell Scientific to facilitate repair or replacement.

- Check model information against the shipping documents to ensure the expected products and the correct lengths of cable are received. Model numbers are found on each product. On cables and cabled items, the model number is usually found at the connection end of the cable. Report any shortages immediately to Campbell Scientific.

4. Quickstart

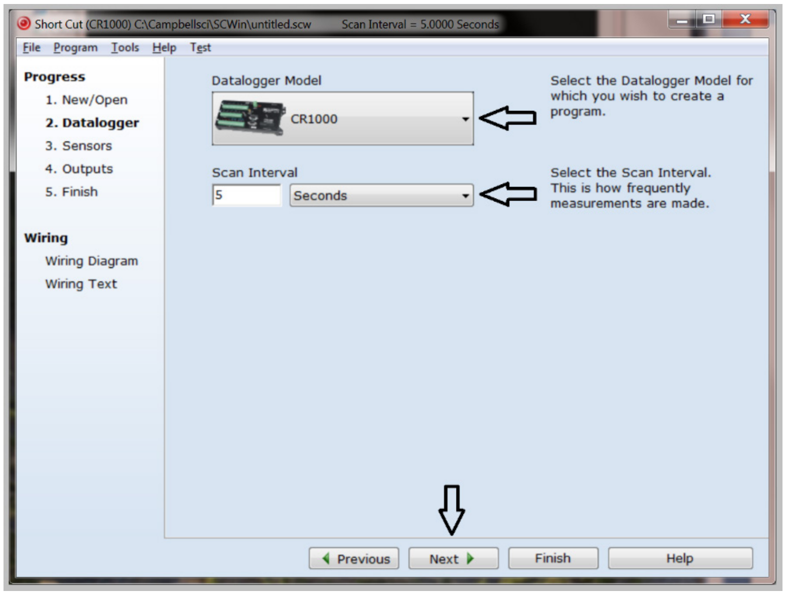
Short Cut is an easy way to program your datalogger to measure the 107 probe and assign datalogger wiring terminals. Use the following procedure to get started.

1. Install *Short Cut* by clicking on the install file icon. Get the install file from either *www.campbellsci.com*, the ResourceDVD, or find it in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ* software.

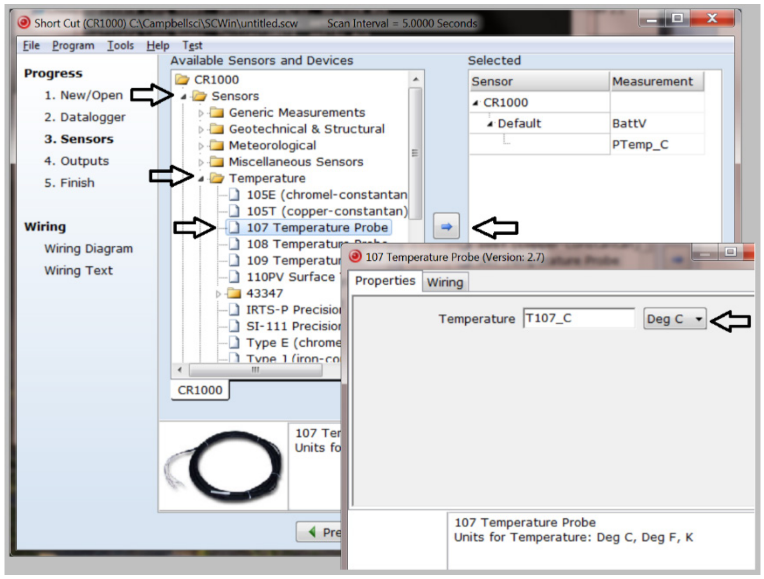
2. The *Short Cut* installation should place a shortcut icon on the desktop of your computer. To open *Short Cut*, click on this icon.

3. When *Short Cut* opens, select **New Program**.

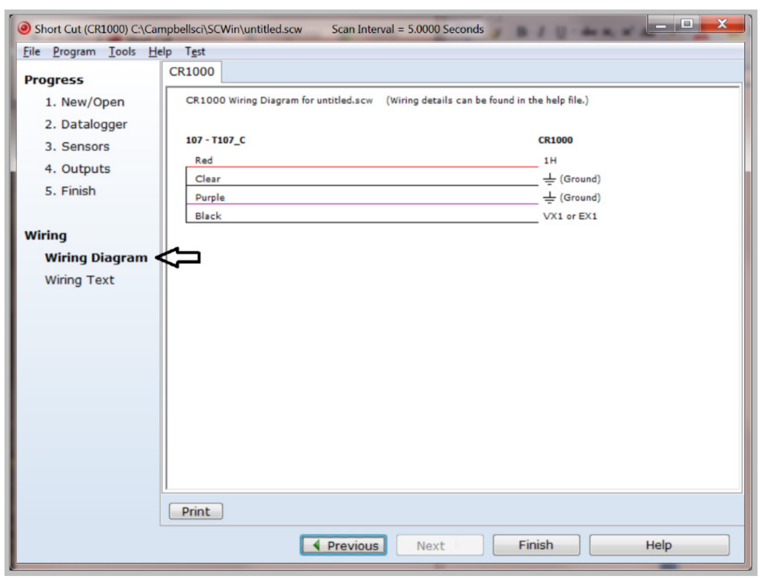
4. Select **Datalogger Model** and **Scan Interval** (default of **5** seconds is OK for most applications). Click **Next**.



5. Under the **Available Sensors and Devices** list, select the **Sensors** | **Temperature** folder. Select **107 Temperature Probe**. Click  to move the selection to the **Selected** device window. Data defaults to degree Celsius. This can be changed by clicking the **Deg C** box and selecting **Deg F**, for degrees Fahrenheit, or **K** for Kelvin.



6. After selecting the sensor, click at the left of the screen on **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed out now or after more sensors are added.



7. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Contents | Programming Steps**.

8. If *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* is running on your PC, and the PC to datalogger connection is active, you can click **Finish** in *Short Cut* and you will be prompted to send the program just created to the datalogger.

9. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 6, check the output of the sensor in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

The 107 is a rugged probe that accurately measures air, soil, or water temperature in a variety of applications. The sensor consists of a thermistor encapsulated in an epoxy-filled aluminum housing. This design allows the probe to be buried or submerged in water to 15 m (50 ft) or 21 psi. When measuring air temperature, a 41303-5A radiation shield is normally used to mount the 107 and limit solar radiation loading. See *Specifications* for a complete list of compatible dataloggers.

6. Specifications

Features

- Measures air, soil, or water temperature
- Compatible with AM16/32-series multiplexers
- Easy to install or remove
- Durable
- Compatible with Campbell Scientific CRBasic dataloggers CR800 series, CR1000, CR3000, and CR5000. Also compatible with Edlog dataloggers CR10(X), CR500, CR510, CR23X, 21X, and CR7(X).

Sensor Element: Measurement Specialties 100K6A1iA thermistor

Survival Range: –50 to 100 °C
Measurement Range: –35 to 50 °C

Time Constant in Air: 30 to 60 s in a wind speed of 5 m/s

Maximum Cable Length: 1000 ft

Accuracy[1]

Worst case: ±0.4 °C (–24 to 48 °C)
±0.9 °C (–35 to 50 °C)

Interchangeability Error: ±0.10 °C (0 to 50 °C)
±0.20 °C at –10 °C
±0.30 °C at –20 °C
±0.40 °C at –30 °C
±0.50 °C at –40 °C

CRBasic Therm107()

Steinhart-Hart Equation Error: ≤ ±0.01 °C (–35 to 50 °C)

Edlog Temp (107) (P11)

Polynomial Linearization Error: <±0.1 °C (–24 to 48 °C)
<±0.5 °C (–35 to 50 °C)

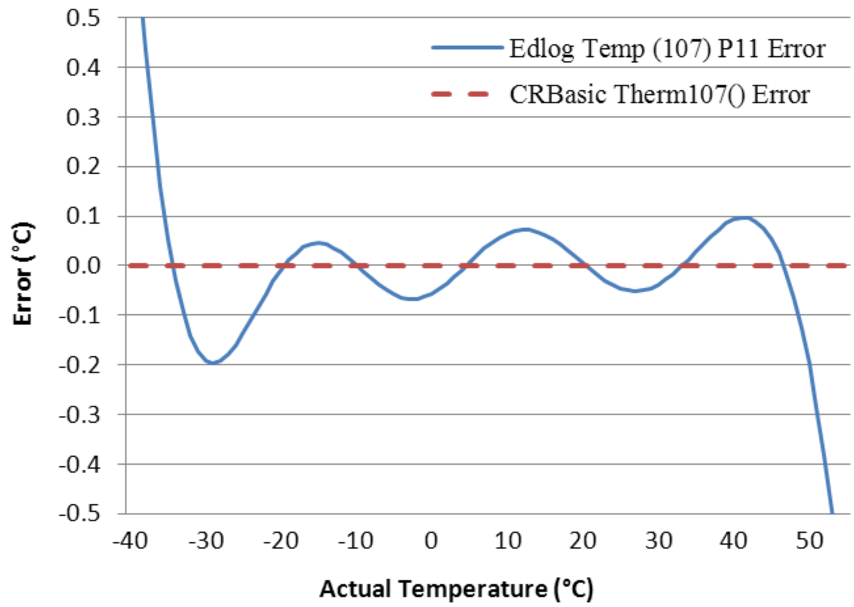


FIGURE 6-1. Linearization error, where error is the difference between actual and datalogger computed temperature.

[1]The overall probe accuracy is a combination of the thermistor interchangeability specification, the precision of the bridge resistors, and the error of the Steinhart-Hart equation used in CRBasic instruction **Therm107()** (CRBasic dataloggers), or the error of the polynomial fit used in Edlog instruction **Temp (107) (P11)** (Edlog dataloggers). The major error component is the interchangeability specification of the thermistor. For the range of 0 to 50 °C, the interchangeability error is predominantly offset and can be determined with a single point calibration. The offset can be entered in the measurement instruction ***Offset*** parameter. Bridge resistors have 0.1% tolerance with a 10 ppm temperature coefficient.

Probe Length: 10.4 cm (4.1 in)

Probe Diameter: 0.762 cm (0.3 in)

Weight with 10 ft Cable: 136 g (5 oz)

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.1, *Wiring to Datalogger*, and Section 7.2, *Datalogger Programming*. *Short Cut* does this work for you. See Section 4, *Quickstart*, for a *Short Cut* tutorial.

7.1 Wiring to Datalogger

TABLE 7-1. Wire Color, Function, and Datalogger Connection		
Wire Color	**Wire Function**	**Datalogger Connection Terminal**
Black	Voltage-excitation input	**EX**, **VX** (voltage excitation)
Red	Analog-voltage output	**SE** (single-ended, analog-voltage input)
Purple	Bridge-resistor lead	**AG** or ⏚ (analog ground)
Clear	EMF shield	**G** (power ground)

7.2 Datalogger Programming

Short Cut is the best source for up-to-date datalogger programming code. Programming code is needed,

- when creating a program for a new datalogger installation.
- when adding sensors to an existing datalogger program.

If your data acquisition requirements are simple, you can probably create and maintain a datalogger program exclusively with *Short Cut*. If your data acquisition needs are more complex, the files that *Short Cut* creates are a great source for programming code to start a new program or add to an existing custom program.

NOTE *Short Cut* cannot edit programs after they are imported and edited in *CRBasic Editor*.

A *Short Cut* tutorial is available in Section 4, *Quickstart*. If you wish to import *Short Cut* code into either *Edlog* or *CRBasic Editor* to create or add to a customized program, follow the procedure in Appendix B.1, *Importing Short Cut Code into a Program Editor*. Programming basics for CRBasic and Edlog dataloggers are provided in the following sections. Complete program examples for select dataloggers can be found in Appendix B, *Example Programs*.

If the 107 probe is to be used with long cable lengths or in electrically noisy environments, consider employing the measurement programming techniques outlined in Section 8.3, *Electrically Noisy Environments*, and Section 8.4, *Long Cable Lengths*.

Details of 107 probe measurement and linearization of the thermistor output are provided in Section 8.2, *Measurement and Output Linearization*.

7.2.1 CRBasic

The **Therm107()** measurement instruction programs CRBasic dataloggers (CR800-series, CR1000, CR3000, CR5000) to measure the 107 probe. It supplies a 2500 mV excitation, makes a half-bridge resistance measurement, and converts the result to temperature using the Steinhart-Hart equation (see Section 8.2, *Measurement and Output Linearization*, for more information):

```
Therm107(Dest,Reps,SEChan,VxChan,SettlingTime,Integ,Mult,Offset)
```

Variations:

- Temperature reported as °C — set **Mult** to **1** and **Offset** to **0**
- Temperature reported as °F — set **Mult** to **1.8** and **Offset** to **32**
- Ac mains noise filtering — set **Integ** to **_60Hz** or **_50Hz** (see Section 8.3, *Electrically Noisy Environments*)
- Compensate for long cable lengths — Set **SettlingTime** to **20000** (see Section 8.4, *Long Cable Lengths*)

7.2.2 Edlog

The **Temp(107) (P11)** measurement instruction programs Edlog dataloggers (CR10(X), CR510, CR500, CR23X, 21X, and CR7(X)) to measure the 107 probe. It makes a half-bridge resistance measurement and converts the result to temperature using a fifth-order polynomial (see Section 8.2, *Measurement and Output Linearization*, for more information):

```
1:  Temp (107) (P11)
    1:1         Reps
    2:1         SE Channel
    3:21        Excite all reps w/E1, 60Hz, 10ms delay
    4:1         Loc [ T107_C    ]
    5:1.0       Multiplier
    6:0.0       Offset
```

NOTE Parameter ***3: Ex Channel Option*** specifies the excitation channel to be used for the measurement. Option ***21***, which applies a 60 Hz noise filter to the measurement, is normally used. See the Edlog help system for information about other options.

Variations:

- Temperature reported as °C — set **Multiplier** to **1** and **Offset** to **0**
- Temperature reported as °F — set **Multiplier** to **1.8** and **Offset** to **32**
- Ac mains noise filtering — see Section 8.3, *Electrically Noisy Environments*
- Compensate for long cable lengths — see Section 8.4, *Long Cable Lengths*

7.3 Air Temperature Installation

For air temperature measurements, locate probes over an open level area at least 9 m (EPA) in diameter. The surface should be covered by short grass or the natural earth surface where grass does not grow. Probes should be located at a distance of at least four times the height of any nearby obstruction, and at least 30 m (EPA) from large paved areas. Sensors should be protected from thermal radiation, and adequately ventilated.

Standard air temperature measurement heights:

- 1.25 to 2.0 m (WMO)
- 2.0 m (EPA)
- 2.0 m and 10.0 m temperature difference (EPA)

When exposed to sunlight, the 107 should be housed in a 41303-5A or 41303-5B six-plate solar radiation shield. The louvered construction of the shields allows air to pass freely through, thereby keeping the probe at or near ambient temperature. The white shields reflect solar radiation. The 41303-5A attaches to a crossarm, mast, or user-supplied pipe with a 2.5 to 5.3 cm (1.0 to 2.1 inch) outer diameter. The 41303-5B attaches to a CM500-series pole or a user-supplied pole with a 5.1 cm (2.4 inch) outer diameter.

Tools required for installing a radiation shield to a tripod or tower include:

- 1/2 inch open end wrench
- small screw driver provided with datalogger
- small Phillips screwdriver
- UV resistant cable ties
- small pair of diagonal-cutting pliers

FIGURE 7-1. 107 and 41303-5A Radiation Shield on a tripod mast

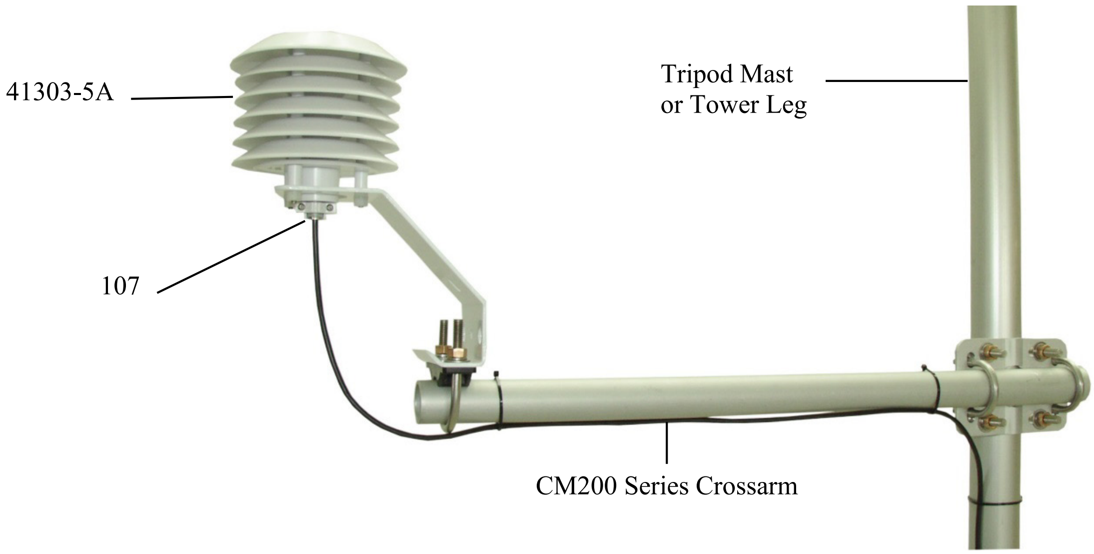


FIGURE 7-2. 107 and 41303-5A Radiation Shield on a CM200 Series Crossarm

The 107 is held within the radiation shield by a mounting clamp on the bottom plate of the 41303-5A (FIGURE 7-2). Loosen the two mounting clamp screws, and insert the probe through the clamp and into the shield. Tighten the screws to secure the sensor in the shield, and route the sensor cable to the instrument enclosure. Secure the cable to the tripod or tower using cable ties.

7.4 Water Temperature Installation

107 probes can be submerged to 15 m (50 ft) or 21 psi. The 107 is not weighted, so a weighting system should be added, or the probe secured to a fixed submerged object such as a piling.

7.5 Soil Temperature Installation

The 107 tends to measure the average temperature over its length, so it should generally be buried such that the measurement tip is horizontal to the soil surface at the desired depth.

One or two coils of cable should also be buried in a shallow installation. Burial of some cable mitigates the effect of solar heating of the above ground cable on the temperature measurement.

Placement of the cable inside a rugged conduit may be necessary for long cable runs, especially in locations subject to digging, mowing, traffic, use of power tools, or lightning strikes.

The maximum burial depth for soil that could become saturated with water is dictated by the maximum water pressure allowed for the sensor, which is 21 psi.

8. Operation

8.1 Sensor Schematic

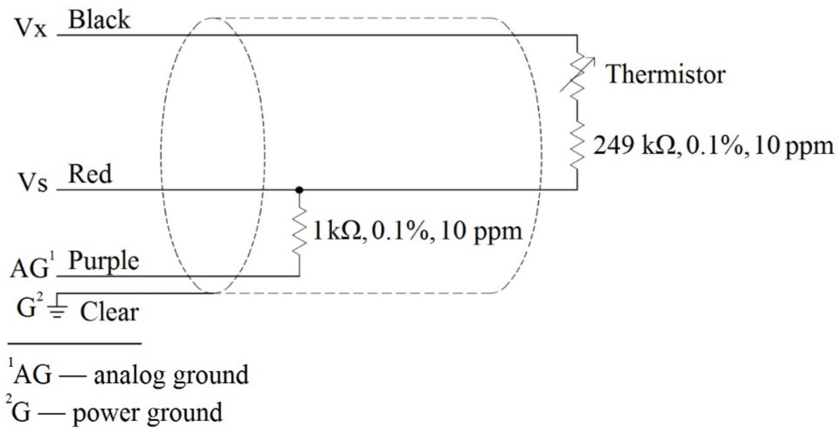


FIGURE 8-1. 107 thermistor probe schematic

8.2 Measurement and Output Linearization

Campbell Scientific dataloggers measure the 107 probe thermistor and convert the result to temperature. With reference to the previous FIGURE 8-1, *107 thermistor probe schematic*, a precise excitation voltage is applied at the Vx line and the voltage drop across the 1 kΩ resistor is measured at the Vs line.

The ratio of measured voltage (Vs) to excitation voltage (Vx) is related to thermistor resistance (Rs), and the 1 kΩ ohm and 249 kΩ fixed resistors as described in the following equations:

$$Vs/Vx = 1000 / (Rs + 249000\ \Omega + 1000\ \Omega)$$

Solving for Rs:

$$Rs + 250000\ \Omega = 1000 \bullet (Vx/Vs)$$

$$Rs = 1000 \bullet (Vx/Vs) - 249000$$

TABLE 8-1, *107 Measurement Details,* and TABLE 8-2, *107 Temperature Calculation,* describe how measurement results Vs/Vx and Rs are converted to temperature by Campbell Scientific dataloggers.

TABLE 8-1. 107 Measurement Details

Datalogger Model	Measurement Instruction	Excite mV	Result	Scaling	Equation Applied to Scaled Result
CR800 CR1000 CR3000 CR5000	CRBasic **Therm107()**				Steinhart-Hart (automatically applied)
CR10 CR10X CR500 CR510 CR23X	Edlog **Temp(107)(P11)**	2000	Vs/Vx	Multiply by 800‡	Fifth-order polynomial (automatically applied)
21X CR7(X)	Edlog **Temp(107)(P11)**	4000	Vs/Vx	Multiply by 800‡	Fifth-order polynomial (automatically applied)

† Fixed series resistance is subtracted before applying Steinhart-Hart.
‡ Multiplier of 800 scales Vs/Vx for the polynomial fit.

TABLE 8-2. Temperature Calculation

CRBasic Dataloggers[1]

Therm107() instruction measures the ratio Vs/Vx, calculates the thermistor resistance Rs, and converts Rs to temperature using the Steinhart-Hart equation[2]:

$$T = 1 / (A + (B \cdot \ln(Rs))) + (C \cdot ((\ln(Rs))) ^ 3) - 273.15$$

where:

T = temperature in Celsius
A = 8.271111E–4
B = 2.088020E–4
C = 8.059200E–8

Edlog Dataloggers[3]

Temp(107) (P11) instruction measures the ratio Vs/Vx and coverts it to temperature using a fifth-order polynomial:

$$T = C0 + C1 \cdot X + C2 \cdot X^2 + C3 \cdot X^3 + C4 \cdot X^4 + C5 \cdot X^5$$

where:

X = (Vs/Vx) • 800
C0 = –53.4601
C1 = 9.0807
C2 = –0.83257
C3 = 0.052283
C4 = –0.0016723
C5 = 0.00002211

See Appendix C, *Thermistor Resistance Table*.

[1]CRBasic dataloggers are CR800, CR1000, CR3000, and CR5000.
[2]Coefficients provided by the thermistor manufacturer.
[3] Edlog dataloggers are CR10(X), CR500, CR510, CR23X, 21X, and CR7.

8.3 Electrically Noisy Environments

EMF noise emanating from the ac mains power grid can be a significant source of measurement error. 60 Hz noise is common in the United States. 50 Hz noise is common in Europe and other regions. Depending on the datalogger model, this noise can usually be filtered out.

The following code examples filter 60 Hz noise. The key parameters are in bold type.

CRBasic

```
Therm107(T107_C,1,1,Vx1,0,_60Hz,1.0,0.0)
```

Edlog (except CR10, 21X, and CR7)

```
x:  Temp (107) (P11)
  1:          1       Reps
  2:          1       SE Channel
  3:         21       Excite all reps w/E1, 60Hz, 10ms delay
  4:          1       Loc [ Air_Temp  ]
  5:          1.0     Multiplier
  6:          0.0     Offset
```

Edlog (CR10, 21X, and CR7)

CR10, 21X, and CR7 dataloggers do not have **60Hz** or **50Hz** integration options for the excitation channel. When using these dataloggers in electrically noisy environments, use the **AC Half Bridge (P5)** instruction, which incorporates ac noise rejection in input voltage range options. After the measurement, convert the result to temperature using **Polynomial (P55)**. The following example shows the use of the **P5** and **P55** instructions:

```
x:  AC Half Bridge (P5)
  1:          1       Reps
  2:         22       7.5 mV 60 Hz Rejection Range   ;21X,CR7: 50 mV slow range
  3:          1       SE Channel
  4:          1       Excite all reps w/Exchan 1
  5:       2000       mV Excitation                  ;21X,CR7: 4000 mV
  6:          1       Loc [ Air_Temp  ]
  7:        800       Mult
  8:          0       Offset

x:  Polynomial (P55)
  1:          1       Reps
  2:          1       X Loc [ Air_Temp  ]
  3:          1       F(X) Loc [ Air_Temp  ]
  4:        -53.46    C0
  5:         90.807   C1
  6:        -83.257   C2
  7:         52.283   C3
  8:        -16.723   C4
  9:          2.211   C5
```

8.4 Long Cable Lengths

Long cable lengths may require longer than normal analog measurement settling times. Settling times are increased by adding a measurement delay to the datalogger program.

CRBasic

For CRBasic dataloggers, the 60 Hz and 50 Hz integration options include a 3 ms settling time; longer settling times can be entered into the ***Settling Time*** parameter. The following example uses a 20000 µs settling time.

```
Therm107(T107_C,1,1,1,20000,_60Hz,1.0,0.0)
```

Edlog

The 60 Hz and 50 Hz rejection options for the CR10X, CR510, and CR23X include a delay to accommodate long cable lengths.

When using the CR10, 21X, and CR7 dataloggers, if the 107 probe has cable lengths of more than 300 feet, use the **Excite-Delay (SE) (P4)** instruction with a 20 ms delay to measure temperature, as shown in the following Edlog code. The CR10, 21X, and CR7 dataloggers have no programming provision for compensating for long cables and filtering 60 Hz or 50 Hz noise simultaneously.

```
1:  Excite-Delay (SE) (P4)
  1:          1       Reps
  2:          2       7.5 mV Slow Range
  3:          9       SE Channel
  4:          3       Excite all reps w/Exchan 3
  5:          2       Delay (units 0.01 sec)
  6:       2000       mV Excitation                 ;21X,CR7: 4000 mV
  7:          1       Loc [ Air_Temp  ]
  8:           .4     Mult                          ;21X,CR7: 0.2
  9:          0       Offset

2:  Polynomial (P55)
  1:          1       Reps
  2:          1       X Loc [ Air_Temp  ]
  3:          1       F(X) Loc [ Air_Temp  ]
  4:     -53.46       C0
  5:      90.807      C1
  6:     -83.257      C2
  7:      52.283      C3
  8:     -16.723      C4
  9:       2.211      C5
```

9. Troubleshooting and Maintenance

NOTE All factory repairs and recalibrations require a returned material authorization (RMA) and completion of the "Declaration of Hazardous Material and Decontamination" form. Refer to the *Assistance* page at the beginning of this manual for more information.

9.1 Troubleshooting

Symptom: Temperature is reported as **NAN**, **-INF**, or **-9999.**

Verify the red wire is connected to the correct single-ended analog input channel as specified by the measurement instruction, and the purple wire is connected to datalogger ground.

Symptom: Temperature is reported as **–86** (°C) or **–53** (°F).

Verify the black wire is connected to the switched excitation channel as specified by the measurement instruction.

Symptom: Incorrect temperature is reported.

Verify the multiplier and offset arguments in the measurement instructions are correct for the desired units (Section 7.2, *Datalogger Programming*). Check the cable for signs of damage and possible moisture intrusion.

Symptom: Unstable temperature is reported.

Most likely a result of electromagnetic interference. Try using the 60 or 50 Hz integration options, and/or increasing the settling time as described in Section 8.3, *Electrically Noisy Environments*, and Section 8.4, *Long Cable Lengths*. Make sure the clear shield wire is connected to datalogger ground, and the datalogger is properly grounded.

9.2 Maintenance

The 107 probe requires minimal maintenance. For air temperature measurements, check the radiation shield monthly to make sure it is clean and free from debris. Periodically check cabling for signs of damage and possible moisture intrusion.

9.3 Calibration

Calibration of the 107 probe is not necessary unless the application requires removal of the thermistor interchangeability offset described in Section 6, *Specifications*. If performing the one point calibration with an Edlog datalogger, be aware of this precaution:

The value of the offset must be chosen so that the probe outputs the temperature calculated by the polynomial, not the actual calibration temperature. For example, a 107 probe placed in a calibration chamber at 0 °C outputs 0.1 °C. An ***Offset*** argument of ***–0.16*** is required for Edlog dataloggers because at 0 °C, the polynomial calculates a temperature of –0.06 °C (Appendix C, *Conversion of Thermistor Resistance or Voltage Ratio to Temperature*).

10. Attributions and References

Santoprene® is a registered trademark of Exxon Mobile Corporation.

EPA installation standard: *Quality Assurance Handbook for Air Pollution Measurement Systems – Volume IV: Meteorological Measurements Version 2.0*

WMO standard: *WMO No. 8, Seventh edition, 6 Aug 2008 Guide to Meteorological Instruments and Methods of Observation*

Appendix A. Importing Short Cut Code

This tutorial shows:

- How to import a *Short Cut* program into a program editor for additional refinement.
- How to import a wiring diagram from *Short Cut* into the comments of a custom program.

A.1 Importing Short Cut Code into a Program Editor

Short Cut creates files that can be imported into either *CRBasic Editor* or *Edlog* program editor. These files normally reside in the C:\campbellsci\SCWin folder and have the following extensions:

- .DEF (wiring and memory usage information)
- .CR1 (CR1000 datalogger code)
- .CR8 (CR800 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)
- .DLD (contain code for CR10(X), CR23X, CR500, CR510, 21X, or CR7(X) dataloggers)

The following procedures show how to import these files for editing.

A.1.1 CRBasic Datalogger

Use the following procedure to import *Short Cut* code into *CRBasic Editor* (CR1000, CR800, CR3000, CR5000 dataloggers).

1. Create the *Short Cut* program following the procedure in Section 4, *Quickstart*. Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.

2. Open *CRBasic Editor*.

3. Click **File | Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has a ".CR1", ".CR8", ".CR3", or ".CR5" extension, for CR1000, CR800, CR3000, or CR5000 dataloggers, respectively. Select the file and click **Open**.

4. Immediately save the file in a folder different from \Campbellsci\SCWin, or save the file with a different file name.

NOTE Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

5. The program can now be edited, saved, and sent to the datalogger.

6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading "-Wiring for CRXXX–" into the CRBasic program, usually at the head of the file. After pasting, edit the information such that a **'** character (single quotation mark) begins each line. This character instructs the datalogger compiler to ignore the line when compiling the datalogger code.

A.1.2 Edlog

Use the following procedure to import *Short Cut* code into the *Edlog* program editor (CR10(X), CR500, CR510, CR23X, 21X, and CR7(X) dataloggers).

1. Create the *Short Cut* program following the procedure in Section 4, *Quickstart*. Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.

2. Open *Edlog*.

3. Click **File | Document DLD File**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has a ".DLD" extension. Select the file and click **Open**. The .dld file, which is a type of ASCII machine code, is imported, documented, and, when saved, given a ".CSI" extension.

4. Immediately save the file in a folder different from \Campbellsci\SCWin, or save the file with a different file name.

NOTE Once the file is edited with *Edlog*, *Short Cut* can no longer be used to edit the program. Change the name of the program file or move it, or *Short Cut* may overwrite it.

5. The program can now be edited, saved, and sent to the datalogger.

6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading "-Wiring for CRXXX–" into the Edlog program, usually at the head of the file. After pasting, edit the information such that a **;** (semicolon) begins each line, which instructs the datalogger compiler to ignore the line when compiling the datalogger code.

Appendix B. Example Programs

B.1 Example CRBasic Program

This example can be used directly with CR800 series, CR1000, CR3000, and CR5000 dataloggers.

```
'Program measures one 107 temperature probe once a second and
'stores the average temperature every 60 minutes.

'Wiring Diagram
'==============
'107 Probe
'
'  Wire
'  Color      Function                       CR1000
'  -----      ---------                      ------
'  Black      Voltage-excitation input       VX1 or EX1
'  Red        Analog-voltage output          SE1
'  Purple     Bridge-resistor ground         AG*
'  Clear      Shield                         G*

'*AG = Analog Ground (represented by ground symbol on CR1000 wiring panel

'Declare the variables for the temperature measurement
Public T107_C

'Define a data table for 60 minute averages:
DataTable(Table1,True,-1)
    DataInterval(0,60,Min,0)
    Average(1,T107_C,IEEE4,0)
EndTable

BeginProg
    Scan(1,Sec,1,0)
        'Measure the temperature
        Therm107(T107_C,1,1,Vx1,0,_60Hz,1.0,0.0)
        'Call Data Table
        CallTable(Table1)
    NextScan
EndProg
```

B.2 Example Edlog Program

This example can be used directly with CR10X dataloggers. With minor adaptations, it can also be used with CR10, CR500, CR510, CR23X, and CR7X dataloggers. More adaptation will be needed with the 21X and CR7 dataloggers. Contact a Campbell Scientific application engineer for help with any datalogger program.

```
;{CR10X}

;Program measures one 107 temperature probe once a second
;and stores the average temperature every 60 minutes.

;Wiring Diagram
;==============
;107 Probe
;
;  Wire
;  Color      Function                      CR10X
;  -----      --------                      ------
;  Black      Voltage-excitation input      E1
;  Red        Analog-voltage output         SE1
;  Purple     Bridge-resistor ground        AG
;  Clear      Shield                        G


*Table 1 Program
  01: 1.0000     Execution Interval (seconds)

1:  Temp (107) (P11)
  1:  1          Reps
  2:  1          SE Channel
  3:  21         Excite all reps w/E1, 60Hz, 10ms delay
  4:  1          Loc [ T107_C    ]
  5:  1.0        Multiplier
  6:  0.0        Offset

3:  If time is (P92)
  1:  0          Minutes (Seconds --) into a
  2:  60         Interval (same units as above)
  3:  10         Set Output Flag High (Flag 0)

4:  Set Active Storage Area (P80)
  1:  1          Final Storage Area 1
  2:  101        Array ID

5:  Real Time (P77)
  1:  1220       Year,Day,Hour/Minute (midnight = 2400)

6:  Average (P71)
  1:  1          Reps
  2:  1          Loc [ T107_C    ]
```

Appendix C. Resistance or Voltage Ratio to Temperature

TABLE C-1. Voltage Ratio, Resistance, and Temperature[1]

Actual Temperature (°C)	100K6A1iA Thermistor Resistance	P11 Edlog Instruction X = Vs/Vx * 800	P11 Edlog Instruction Output	CRBasic Therm107() Output
-40	4071186	1.85	-39.19	-40.00
-39	3798837	1.98	-38.39	-39.00
-38	3546330	2.11	-37.56	-38.00
-37	3312107	2.25	-36.71	-37.00
-36	3094743	2.39	-35.84	-36.00
-35	2892930	2.55	-34.95	-35.00
-34	2705469	2.71	-34.03	-34.00
-33	2531260	2.88	-33.09	-33.00
-32	2369292	3.05	-32.14	-32.00
-31	2218639	3.24	-31.17	-31.00
-30	2078448	3.44	-30.19	-30.00
-29	1947934	3.64	-29.20	-29.00
-28	1826376	3.85	-28.19	-28.00
-27	1713112	4.08	-27.18	-27.00
-26	1607529	4.31	-26.16	-26.00
-25	1509065	4.55	-25.14	-25.00
-24	1417202	4.80	-24.11	-24.00
-23	1331461	5.06	-23.08	-23.00
-22	1251401	5.33	-22.06	-22.00
-21	1176615	5.61	-21.03	-21.00
-20	1106727	5.90	-20.01	-20.00
-19	1041391	6.19	-18.99	-19.00
-18	980285	6.50	-17.97	-18.00
-17	923112	6.82	-16.96	-17.00
-16	869600	7.15	-15.96	-16.00
-15	819493	7.48	-14.95	-15.00
-14	772557	7.82	-13.96	-14.00
-13	728575	8.18	-12.96	-13.00
-12	687344	8.53	-11.97	-12.00
-11	648680	8.90	-10.98	-11.00
-10	612407	9.28	-10.00	-10.00
-9	578366	9.66	-9.01	-9.00
-8	546408	10.05	-8.03	-8.00
-7	516394	10.44	-7.04	-7.00
-6	488196	10.84	-6.05	-6.00
-5	461695	11.24	-5.06	-5.00
-4	436779	11.65	-4.06	-4.00
-3	413346	12.06	-3.07	-3.00
-2	391300	12.47	-2.07	-2.00
-1	370551	12.89	-1.06	-1.00
0	351017	13.31	-0.06	0.00
1	332620	13.73	0.95	1.00
2	315288	14.15	1.96	2.00
3	298954	14.57	2.98	3.00

4	283555	14.99	3.99	4.00
5	269034	15.41	5.01	5.00
6	255335	15.83	6.02	6.00
7	242408	16.25	7.03	7.00
8	230206	16.66	8.05	8.00
9	218684	17.07	9.06	9.00
10	207801	17.47	10.06	10.00
11	197518	17.88	11.07	11.00
12	187799	18.27	12.07	12.00
13	178610	18.66	13.07	13.00
14	169921	19.05	14.07	14.00
15	161700	19.43	15.06	15.00
16	153921	19.81	16.05	16.00
17	146558	20.17	17.04	17.00
18	139586	20.53	18.03	18.00
19	132983	20.89	19.02	19.00
20	126727	21.24	20.01	20.00
21	120799	21.58	20.99	21.00
22	115179	21.91	21.98	22.00
23	109850	22.23	22.97	23.00
24	104795	22.55	23.96	24.00
25	100000	22.86	24.95	25.00
26	95449	23.16	25.95	26.00
27	91129	23.45	26.95	27.00
28	87027	23.74	27.95	28.00
29	83131	24.01	28.95	29.00
30	79430	24.28	29.96	30.00
31	75913	24.55	30.97	31.00
32	72569	24.80	31.98	32.00
33	69390	25.05	33.00	33.00
34	66367	25.29	34.01	34.00
35	63491	25.52	35.03	35.00
36	60755	25.74	36.04	36.00
37	58150	25.96	37.06	37.00
38	55670	26.17	38.07	38.00
39	53309	26.38	39.08	39.00
40	51060	26.57	40.09	40.00
41	48917	26.76	41.10	41.00
42	46875	26.95	42.10	42.00
43	44929	27.13	43.09	43.00
44	43073	27.30	44.08	44.00
45	41303	27.46	45.05	45.00
46	39615	27.62	46.02	46.00
47	38005	27.78	46.98	47.00
48	36467	27.93	47.94	48.00
49	35000	28.07	48.87	49.00
50	33599	28.21	49.80	50.00
51	32262	28.34	50.72	51.00
52	30984	28.47	51.62	52.00
53	29763	28.60	52.51	53.00
54	28596	28.72	53.38	54.00
55	27481	28.83	54.24	55.00
[1]Data from Measurement Specialties™				

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 (Beijing) Co., Ltd.
8B16, Floor 8 Tower B, Hanwei Plaza
7 Guanghua Road
Chaoyang, Beijing 100004
P.R. CHINA
www.campbellsci.com • info@campbellsci.com.cn

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)
14532 – 131 Avenue NW
Edmonton AB T5L 4X4
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. (CSL France)
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Ltd. (CSL Germany)
Fahrenheitstraße 13
28359 Bremen
GERMANY
www.campbellsci.de • info@campbellsci.de

Campbell Scientific Spain, S. L. (CSL Spain)
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.