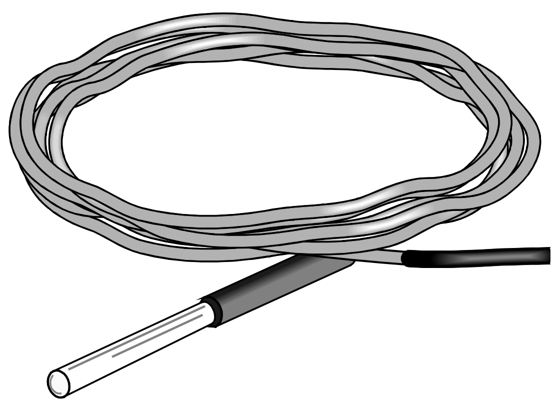
INSTRUCTION MANUAL

Model 108 Temperature Probe

Revision: 3/14



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Model 108 Temperature Probe

1. Introduction

The 108 temperature probe uses a thermistor to measure temperature in air, soil, and water. It is compatible with all current dataloggers except the CR200(X) series and CR9000(X).

2. Cautionary Statements

Santoprene® rubber, which composes the black outer jacket of the 108 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.

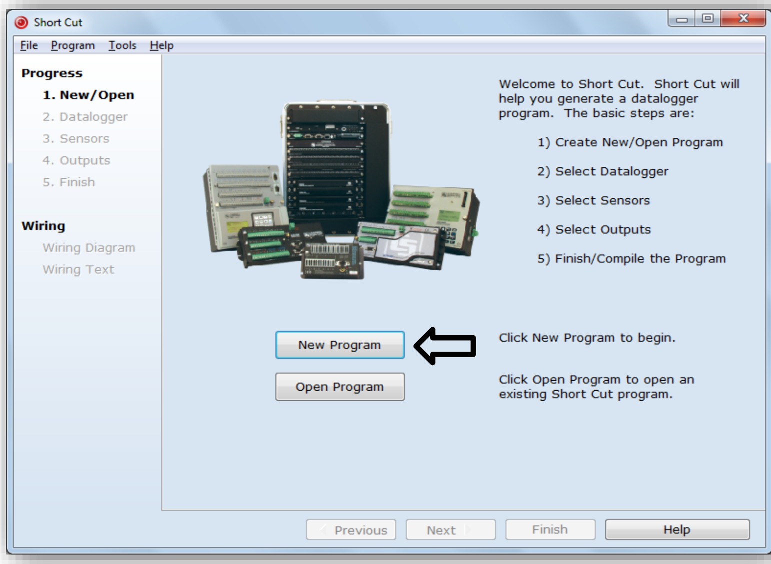
4. Quickstart

Short Cut is an easy way to program your datalogger to measure the 108 probe and assign datalogger wiring terminals. Use the following procedure to get started.

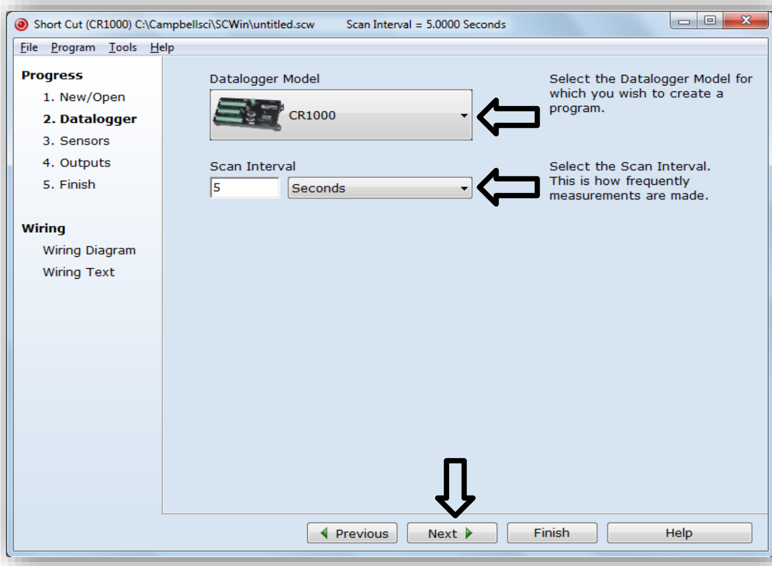
1. Install *Short Cut* by clicking on the install file icon. Get the install file from either *www.campbellsci.com*, the ResourceDVD, or find it in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ* software.

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

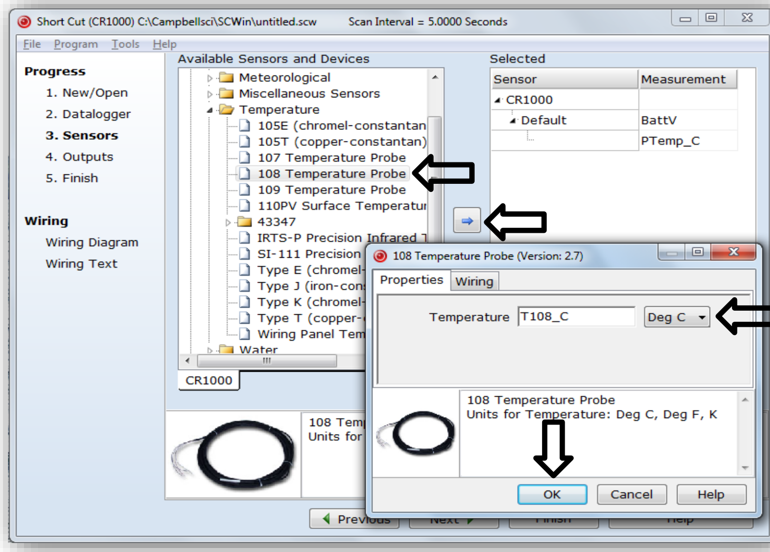
3. When *Short Cut* opens, select **New Program**.



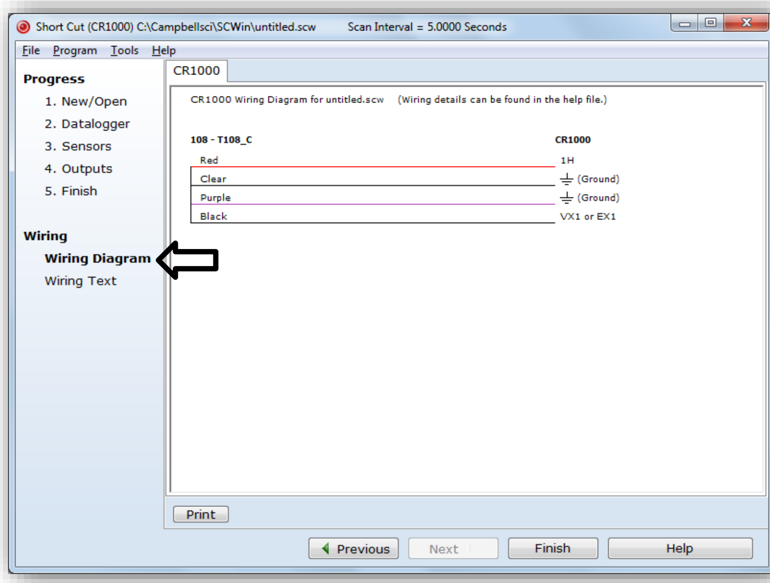
4. Select **Datalogger Model** and **Scan Interval** (default of **5** seconds is OK for most applications). Click **Next**.



5. Under the **Available Sensors and Devices** list, select the **Sensors | Temperature** folder. Select **108 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, and 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 108 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 108 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), CR510, CR500, CR23X, 21X, and CR7(X).

Sensor Element:	Measurement Specialties 100K6A1iA thermistor
Survival Range:	–50 to 100 °C
Measurement Range:	–5 to 95 °C
Time Constant in Air:	200 ± 10 seconds
Maximum Cable Length:	1000 ft
Accuracy[1]	
Worst case:	±0.3 °C (–3 to 90 °C) ±0.7 °C (–5 to 95 °C)
Interchangeability Error:	±0.10 °C (0 to 70 °C) ±0.14 °C at –5 °C ±0.25 °C at 85 °C ±0.35 °C at 95 °C
CRBasic Therm108() Steinhart-Hart Equation Error:	≤ ±0.01 °C

Edlog Polynomial (P55) Linearization Error:	<±0.5 °C (–5 to 95 °C) <±0.1 °C (–3 to 90 °C)

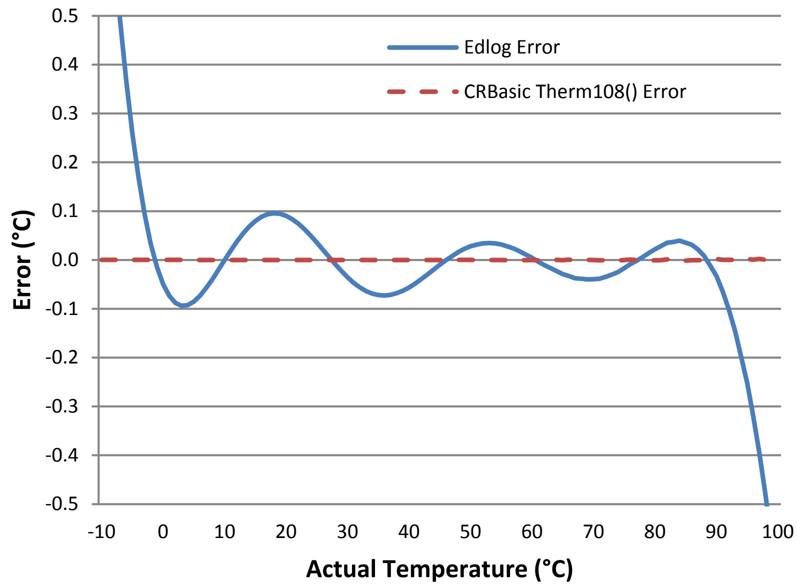


FIGURE 6-1. Linearization error, where error is the difference between actual and datalogger-computed temperature.

[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 the CRBasic instruction **Therm108()** (CRBasic dataloggers), or the error of the polynomial equation used in the Edlog **Polynomial (P55)** instruction (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.
- 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 A.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 108 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 108 probe measurement and linearization of the thermistor output are provided in Section 8.2, *Measurement and Output Linearization*.

7.2.1 CRBasic

The **Therm108()** measurement instruction programs CRBasic dataloggers (CR800-series, CR1000, CR3000, CR5000) to measure the 108 probe. It supplies a 2500 mV excitation, makes a half-bridge measurement, and converts the result to temperature using the Steinhart-Hart equation (see Section 8.2, *Measurement and Output Linearization*, for more information):

```
Therm108(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 **AC Half Bridge (P5)** measurement instruction programs Edlog dataloggers (CR10(X), CR510, CR500, CR23X, 21X, and CR7(X)) to measure the 108 probe. It makes a half-bridge measurement, and the **Polynomial (P55)** instruction converts the result to temperature using a fifth-order polynomial (see Section 8.2, *Measurement and Output Linearization*, for more information):

```
1:  AC Half Bridge (P5)
    1: 1        Reps
    2: 23       25 mV 60 Hz Rejection Range
    3: 1        SE Channel
    4: 1        Excite all reps w/Exchan 1
    5: 1000     mV Excitation
    6: 1        Loc [ T108_C    ]
    7: 200      Multiplier
    8: 0        Offset

2:  Polynomial (P55)
    1: 1        Reps
    2: 1        X Loc [ T108_C    ]
    3: 1        F(X) Loc [ T108_C    ]
    4: -26.97   C0
    5: 69.635   C1
    6: -40.66   C2
    7: 16.573   C3
    8: -3.455   C4
    9: 0.301    C5
```

Variations:

- Temperature reported as °F – add a multiplier (**P37)** of **1.8** and an offset (**P34)** of **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, sensors should be located 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. Sensors 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 108 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 on a tripod or tower:

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

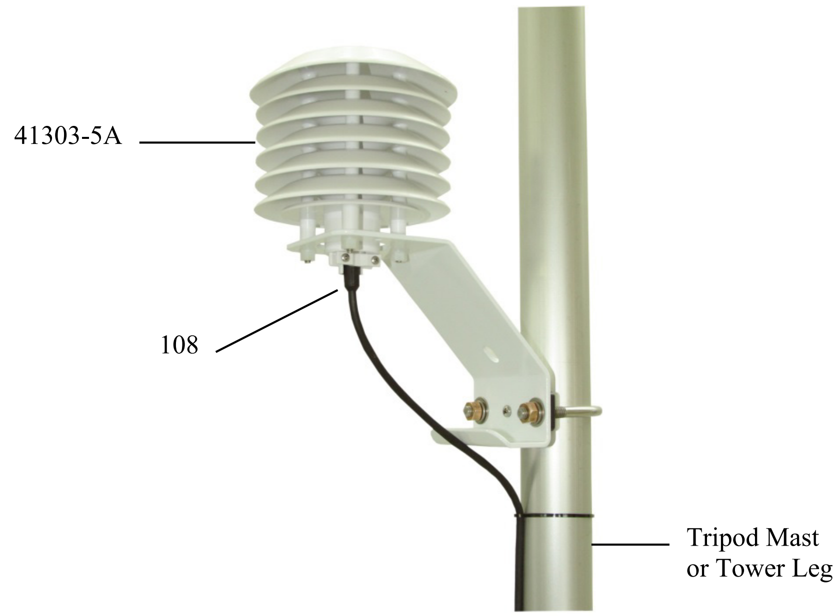


FIGURE 7-1. 108 and 41303-5A Radiation Shield on a tripod mast

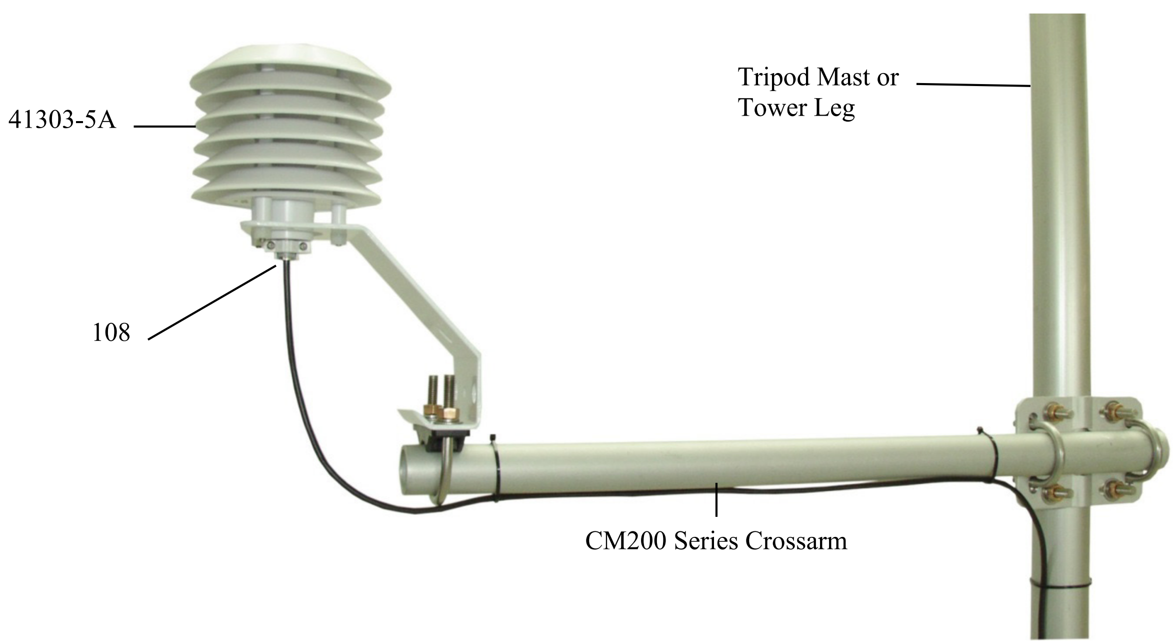


FIGURE 7-2. 108 and 41303-5A Radiation Shield on a CM200 Series Crossarm

The 108 is held within 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 sensor 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/tower using cable ties.

7.4 Water Temperature Installation

The 108 can be submerged to 15 m (50 ft) or 21 psi. The 108 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

The 108 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

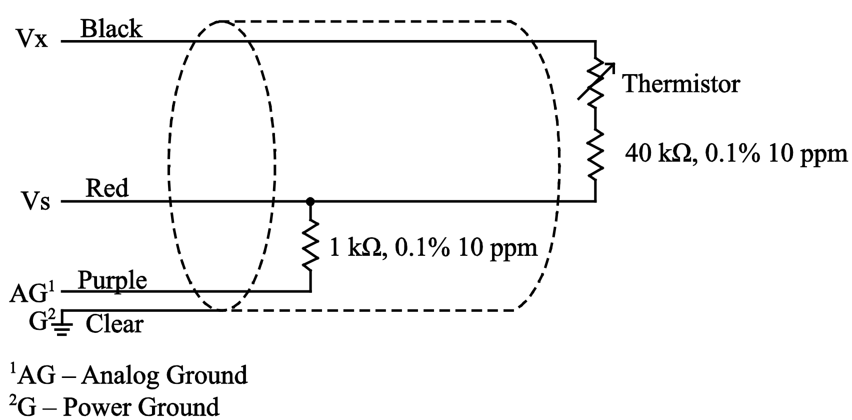


FIGURE 8-1. 108 thermistor probe schematic

8.2 Measurement and Output Linearization

Campbell Scientific dataloggers measure the 108 probe thermistor and convert the result to temperature. With reference to the previous FIGURE 8-1, *108 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 and 40 kΩ fixed resistors as described in the following equation:

$$Vs/Vx = 1000 / (Rs + 40000\ \Omega + 1000\ \Omega)$$

Solving for Rs:

$$Rs + 41000\ \Omega = 1000 \bullet (Vx/Vs)$$

$$Rs = 1000 \bullet (Vx/Vs) – 41000\ \Omega$$

TABLE 8-1, *108 Measurement Details,* and TABLE 8-2, *108 Temperature Calculation,* describe how measurement results Vs/Vx and Rs are converted to temperature by Campbell Scientific dataloggers.

TABLE 8-1. 108 Measurement Details

Datalogger Model	**Measurement Instruction**	**Excite mV**	**mV Input Range**	**Result**	**Scaling**	**Equation Applied to Scaled Result**
CR800 CR1000 CR3000 CR5000	CRBasic **Therm108()**					Steinhart-Hart (automatically applied)
CR500 CR510 CR10 CR10X	Edlog **AC Half Bridge (P5)**	1000	25	Vs/Vx	Multiply by 200‡	5th order polynomial (use **Polynomial (P55)**)
21X CR7(X) CR23X	Edlog **AC Half Bridge (P5)**	2000	50	Vs/Vx	Multiply by 200‡	5th order polynomial (use **Polynomial (P55)**)

†Fixed series resistance is subtracted before applying Steinhart-Hart.
‡ Multiplier of 200 scales Vs/Vx for the polynomial fit.

TABLE 8-2. 108 Temperature Calculation

CRBasic Dataloggers[1]

Therm108() instruction measures the ratio Vs/Vx, calculates the thermistor resistance Rs, and converts Rs to temperature using the Steinhart-Hart equation[2]:

$$T = 1 / (A + (B \bullet \ln(Rs))) + (C \bullet ((\ln(Rs)))\ ^\wedge\ 3) – 273.15$$

where:

T = temperature in degrees Celsius

A = 8.271111E–4

B = 2.088020E–4

C = 8.059200E–8

Edlog Dataloggers[3]

AC Half Bridge (P5) instruction measures the ratio Vs/Vx. **Polynomial (P55)** instruction converts the measurement result Vs/Vx * 200 to temperature using a 5th order polynomial:

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

where:

T = temperature in Celsius

X = (Vs/Vx) • 200

C0 = –26.97

C1 = 69.635

C2 = –40.66 C3 = 16.573 C4 = –3.455 C5 = 0.301
[1]CRBasic dataloggers are CR800, CR1000, CR3000, and CR5000. [2]Coefficients provided by the thermistor manufacturer. [3]Edlog dataloggers are CR10(X), CR510, CR500, 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

```
Therm108(T108_C,1,1,Vx1,0,_60Hz,1.0,0.0)
```

Edlog

```
1:  AC Half Bridge (P5)
  1:   1         Reps
  2:   23        25 mV 60 Hz Rejection Range ;CR23X:50 mV; 21X,CR7:50 mV slow range
  3:   1         SE Channel
  4:   1         Excite all reps w/Exchan 1
  5:   1000      mV Excitation              ;CR23X,21X,CR7: 2000 mV
  6:   1         Loc [ T108_C  ]
  7:   200       Multiplier
  8:   0         Offset
```

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

```
Therm108(T108_C,1,1,1,20000,_60Hz,1.0,0.0)
```

Edlog

If the 108 probe has cable lengths of more than 300 feet, use the **Excite-Delay (SE) (P4)** instruction with a 20 ms delay to measure the temperature, as shown in the following Edlog code.

```
01:  Excite-Delay (SE) (P4)
  1:   1          Rep
  2:   3          ±25 mV slow range      ;CR23X,21X,CR7: 50 mV
  3:   9          IN Chan
  4:   3          Excite all reps w/EXchan 3
  5:   2          Delay (units .01sec)
  6:   1000       mV Excitation          ;CR23X,21X,CR7: 2000 mV
  7:   11         Loc [:Temp_C    ]
  8:   .2         Mult                   ;CR23X,21X,CR7: 0.1
  9:   0          Offset

02:  Polynomial (P55)
  1:   1          Reps
  2:   11         X Loc [ Tmp108C    ]
  3:   11         F(X) Loc [ Tmp108C    ]
  4:   -26.97     C0
  5:   69.635     C1
  6:   -40.66     C2
  7:   16.573     C3
  8:   -3.455     C4
  9:   .301       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**, **–9999**, or **–273.**

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 **NAN** or **–26.**

Verify the black wire is connected to the switched excitation channel 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 108 probe requires minimal maintenance. For air temperature measurements, check the radiation shield monthly to make sure the radiation shield is clean and free from debris. Periodically check cabling for signs of damage and possible moisture intrusion.

9.3 Calibration

Calibration of the 108 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 108 probe placed in a calibration chamber at 0 °C outputs 0.1 °C. An ***Offset*** argument of ***–0.15*** is required for Edlog dataloggers because at 0 °C, the polynomial calculates a temperature of –0.05 °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 108 temperature probe once a second and
'stores the average temperature every 60 minutes.

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

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

'Declare the variable for the temperature measurement
Public T108_C

'Define a data table for 60-minute averages
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,0)
  Average(1,T108_C,IEEE4,False)
EndTable

BeginProg
  Scan(1,Sec,1,0)
    'Measure the temperature
    Therm108(T108_C,1,1,Vx1,0,_60Hz,1.0,0)
    '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 108 temperature probe once a second
;and stores the average temperature every 60 minutes.

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


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

1:  AC Half Bridge (P5)
  1:   1         Reps
  2:   23        25 mV 60 Hz Rejection Range
  3:   1         SE Channel
  4:   1         Excite all reps w/Exchan 1
  5:   1000      mV Excitation
  6:   1         Loc [ T108_C    ]
  7:   200       Multiplier
  8:   0         Offset

2:  Polynomial (P55)
  1:   1         Reps
  2:   1         X Loc [ T108_C    ]
  3:   1         F(X) Loc [ T108_C    ]
  4:   -26.97    C0
  5:   69.635    C1
  6:   -40.66    C2
  7:   16.573    C3
  8:   -3.455    C4
  9:   0.301     C5

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 [ T108_C    ]
```

Appendix C. Conversion of Thermistor Resistance or Voltage Ratio to Temperature

TABLE C-1. Voltage Ratio, Resistance, and Temperature[1]				
Actual Temperature (°C)	100K6A1iA Thermistor Resistance (Ω)	P5 Edlog Instruction = Vs/Vx * 200	P55 Edlog Instruction Output (°C)	CRBasic Therm108() Output (°C)
-10	612407	0.31	-9.02	-10.00
-9	578366	0.32	-8.20	-9.00
-8	546408	0.34	-7.37	-8.00
-7	516394	0.36	-6.51	-7.00
-6	488196	0.38	-5.63	-6.00
-5	461695	0.40	-4.74	-5.00
-4	436779	0.42	-3.83	-4.00
-3	413346	0.44	-2.91	-3.00
-2	391300	0.46	-1.97	-2.00
-1	370551	0.49	-1.01	-1.00
0	351017	0.51	-0.05	0.00
1	332620	0.54	0.93	1.00
2	315288	0.56	1.91	2.00
3	298954	0.59	2.91	3.00
4	283555	0.62	3.91	4.00
5	269034	0.65	4.91	5.00
6	255335	0.67	5.93	6.00
7	242408	0.71	6.94	7.00
8	230206	0.74	7.96	8.00
9	218684	0.77	8.98	9.00
10	207801	0.80	10.00	10.00
11	197518	0.84	11.02	11.00
12	187799	0.87	12.04	12.00
13	178610	0.91	13.05	13.00
14	169921	0.95	14.07	14.00
15	161700	0.99	15.08	15.00
16	153921	1.03	16.09	16.00
17	146558	1.07	17.09	17.00
18	139586	1.11	18.10	18.00
19	132983	1.15	19.09	19.00
20	126727	1.19	20.09	20.00
21	120799	1.24	21.08	21.00
22	115179	1.28	22.07	22.00
23	109850	1.33	23.06	23.00
24	104795	1.37	24.05	24.00
25	100000	1.42	25.04	25.00
26	95449	1.47	26.02	26.00
27	91129	1.51	27.01	27.00
28	87027	1.56	27.99	28.00
29	83131	1.61	28.98	29.00
30	79430	1.66	29.96	30.00

31	75913	1.71	30.95	31.00
32	72569	1.76	31.94	32.00
33	69390	1.81	32.94	33.00
34	66367	1.86	33.93	34.00
35	63491	1.91	34.93	35.00
36	60755	1.97	35.93	36.00
37	58150	2.02	36.93	37.00
38	55670	2.07	37.93	38.00
39	53309	2.12	38.94	39.00
40	51060	2.17	39.94	40.00
41	48917	2.22	40.95	41.00
42	46875	2.28	41.96	42.00
43	44929	2.33	42.97	43.00
44	43073	2.38	43.98	44.00
45	41303	2.43	44.99	45.00
46	39615	2.48	46.00	46.00
47	38005	2.53	47.01	47.00
48	36467	2.58	48.02	48.00
49	35000	2.63	49.02	49.00
50	33599	2.68	50.03	50.00
51	32262	2.73	51.03	51.00
52	30984	2.78	52.03	52.00
53	29763	2.83	53.03	53.00
54	28596	2.87	54.03	54.00
55	27481	2.92	55.03	55.00
56	26415	2.97	56.03	56.00
57	25395	3.01	57.02	57.00
58	24420	3.06	58.02	58.00
59	23487	3.10	59.01	59.00
60	22594	3.14	60.00	60.00
61	21740	3.19	61.00	61.00
62	20922	3.23	61.99	62.00
63	20138	3.27	62.98	63.00
64	19388	3.31	63.98	64.00
65	18670	3.35	64.97	65.00
66	17981	3.39	65.97	66.00
67	17322	3.43	66.96	67.00
68	16689	3.47	67.96	68.00
69	16083	3.50	68.96	69.00
70	15502	3.54	69.96	70.00
71	14945	3.57	70.96	71.00
72	14410	3.61	71.97	72.00
73	13897	3.64	72.97	73.00
74	13405	3.68	73.98	74.00
75	12932	3.71	74.98	75.00
76	12478	3.74	75.99	76.00
77	12043	3.77	77.00	77.00
78	11625	3.80	78.01	78.00
79	11223	3.83	79.01	79.00
80	10837	3.86	80.02	80.00
81	10466	3.89	81.03	81.00
82	10109	3.91	82.04	82.00
83	9767	3.94	83.04	83.00
84	9437	3.97	84.04	84.00
85	9121	3.99	85.04	85.00
86	8816	4.01	86.03	86.00

87	8523	4.04	87.02	87.00
88	8241	4.06	88.01	88.00
89	7970	4.08	88.99	89.00
90	7708	4.11	89.97	90.00
91	7457	4.13	90.94	91.00
92	7215	4.15	91.90	92.00
93	6982	4.17	92.86	93.00
94	6758	4.19	93.80	94.00
95	6541	4.21	94.75	95.00
96	6333	4.23	95.68	96.00
97	6132	4.24	96.60	97.00
98	5939	4.26	97.52	98.00
99	5753	4.28	98.42	99.00
100	5573	4.29	99.32	100.00
[1]Data from Measurement Specialties™				

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