108
Temperature Probe

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MONITORING

CAMPBELL SCIENTIFIC®

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1. Introduction

The 108 Temperature Probe uses a thermistor to measure temperature in air, soil, and water. It easily interfaces with most Campbell Scientific data loggers and can be used in a variety of applications.

For Edlog data logger support, check the availability of an older manual at www.campbellsci.com/old-manuals⬏, or contact Campbell Scientific for assistance.

2. Precautions

READ AND UNDERSTAND the Safety section at the back of this manual.

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

A video that describes data logger programming using **Short Cut** is available at: www.campbellsci.com/videos/cr1000x-data logger-getting-started-program-part-3 ▶. *Short*

Cut is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com ↗. It is included in installations of *LoggerNet*, *RTDAQ*, and *PC400*.

The following procedure also describes programming with *Short Cut*.

1. Open *Short Cut* and click **Create New Program**.

2. Double-click the data logger model.

3. In the **Available Sensors and Devices** box, type 108 or find the 108 in the **Sensors > Temperature** folder. Double-click the **108 Temperature Probe**. 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.
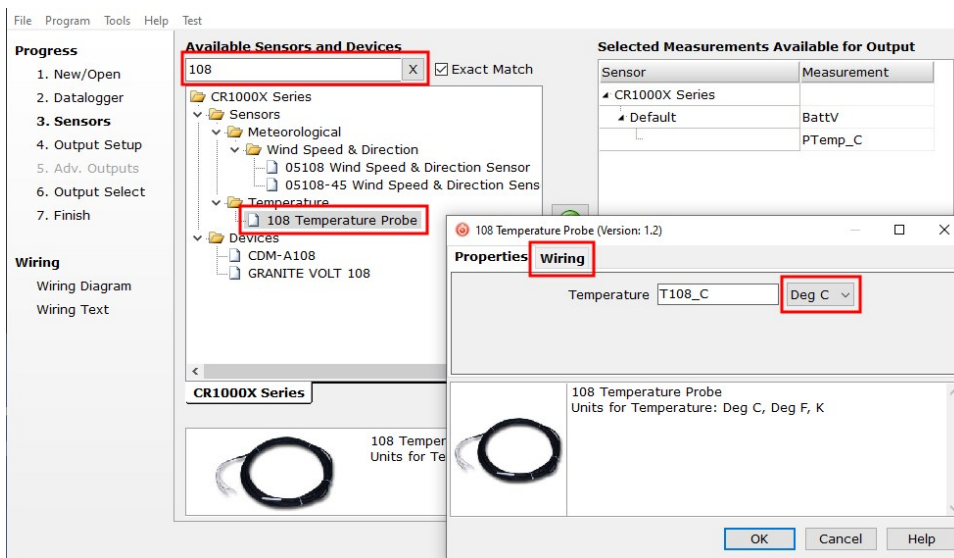
4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.
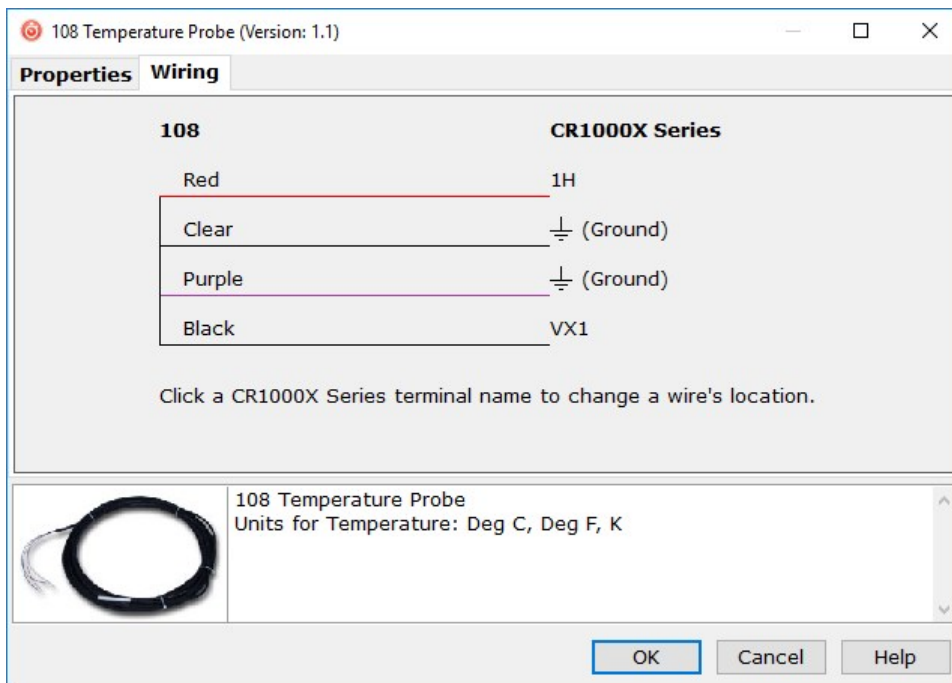
5. Repeat steps three and four for other sensors being measured. Click **Next**.

6. In **Output Setup**, type the scan rate, **Data Output Storage Intervals**, and meaningful table names.
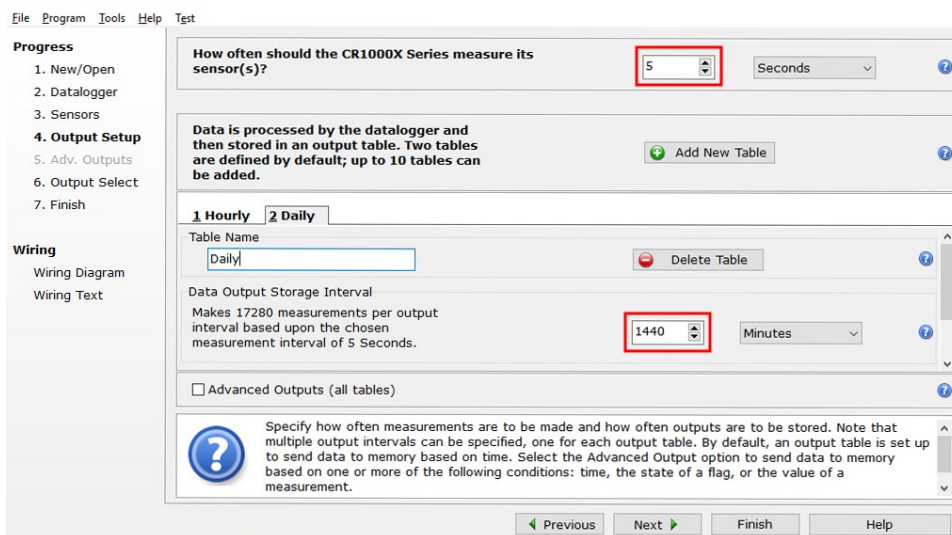
7. Select the measurement and its associated output option.
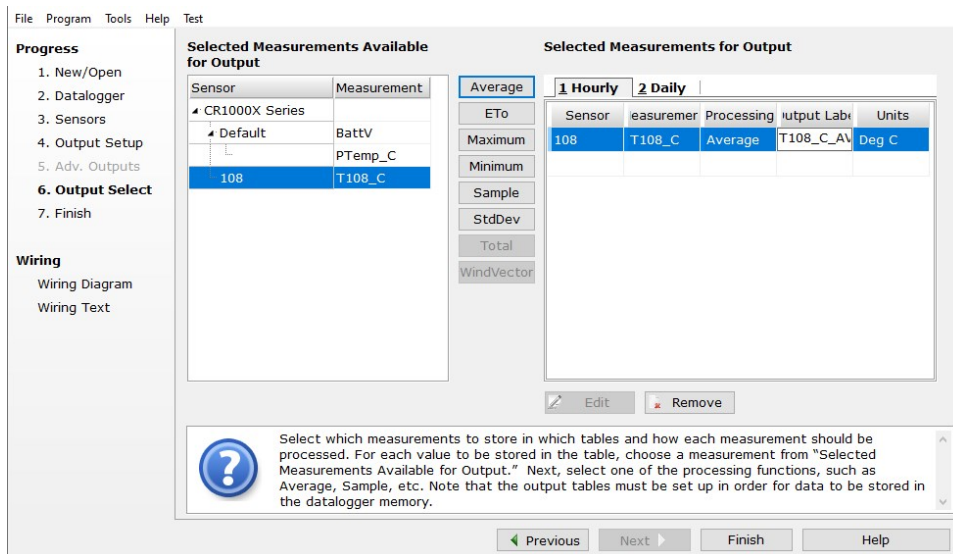
8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

9. If the sensor is connected to the data logger, check the output of the sensor in the data display in *LoggerNet*, *RTDAQ*, or *PC400* 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 six-plate radiation shield is normally used to mount the 108 and limit solar radiation loading.

Features:

- Measures air, soil, or water temperature
- Compatible with AM16/32-series multiplexers
- Easy to install or remove
- Durable

- Compatible CRBasic data loggers: CR6, CR3000, CR1000X, CR800-series, CR300-series, CR1000

6. Specifications

Sensor element:	Measurement Specialties 100K6A1iA thermistor
Survival range:	–50 to 100 °C
Measurement range:	–5 to 95 °C
Time constant in air:	200 ± 10 s
Maximum cable length:	305 m (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
Steinhart-Hart equation error:	≤ ±0.01 °C (–35 to 50 °C)
Probe weight and dimensions	
Weight with 10 ft cable:	136 g (5 oz)
Length:	10.4 cm (4.1 in)
Diameter:	0.762 cm (0.3 in)
Compliance:	View the EU Declaration of Conformity at ww.campbellsci.com/108

[1]Overall probe accuracy is a combination of thermistor interchangeability, bridge-resistor accuracy, and error of the Steinhart-Hart equation. Bridge resistors have 0.1% tolerance with a 10 ppm temperature coefficient. Interchangeability is the principle component error. If needed, an estimate of the interchangeability error for 0 to 50 °C, that can be used as the `Offset` parameter of the `Therm108()` instruction, can be determined with a 1-point or 2-point calibration.

7. Installation

If you are programming your data logger with *Short Cut*, skip Wiring to data logger (p. 6) and Data logger programming (p. 6). *Short Cut* does this work for you. See QuickStart (p. 1) for a *Short Cut* tutorial.

7.1 Wiring to data logger

Table 7-1: Wire color, function, and data logger connection		
Wire color	Wire function	Data logger connection terminal
Black	Voltage-excitation input	**U** configured for voltage excitation[1], **EX**, **VX** (voltage excitation)
Red	Analog-voltage output	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
Purple	Bridge-resistor	$\perp$ (analog ground)
Clear	EMF shield	$\perp$ (analog ground)
[1]**U** terminals are automatically configured by the measurement instruction.		

7.2 Data logger programming

Short Cut is the best source for up-to-date data logger programming code.

If your data acquisition requirements are simple, you can probably create and maintain a data logger 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 QuickStart (p. 1). If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in Importing Short Cut code into CRBasic Editor (p. 14). Programming basics are provided in the following section. A complete program example can be found in Example program (p. 15).

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 Electrically noisy environments (p. 11) and Long cable lengths (p. 11).

Details of 108 probe measurement and linearization of the thermistor output are provided in Measurement and output linearization (p. 10).

7.2.1 Therm108() instruction

The `Therm108()` measurement instruction programs CRBasic data loggers to measure this sensor. It applies a precise excitation voltage, makes a half-bridge resistance measurement, and converts the result to temperature using the Steinhart-Hart equation. See Measurement and output linearization (p. 10) for more information. `Therm108()` instruction and parameters are as follows:

```
Therm108(Dest, Reps, SEChan, VxChan, SettlingTime, Integ/f_{N1}, 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/f$_{N1}$** to the 60 Hz or 50 Hz option (see Electrically noisy environments (p. 11))
- Compensate for long cable lengths — Set **SettlingTime** to **20000** (see Long cable lengths (p. 11))

7.3 Air temperature installation

For air temperature measurements, locate probes over an open, level area at least 9 m (EPA; Attributions and references (p. 13)) 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; Attributions and references (p. 13))
- 2.0 m (EPA; Attributions and references (p. 13))
- 2.0 m and 10.0 m for temperature difference (EPA)

When exposed to sunlight, the 108 should be housed in a six-plate solar radiation shield. Six-plate shields offered by Campbell Scientific are models 41303-5A, 41303-5B, or RAD06.

The white color of these shields reflects solar radiation, and the louvered construction allows air to pass freely through, thereby keeping the probe at or near ambient temperature. The RAD06 uses a double-louvered design that offers improved sensor protection from insect intrusion and driving rain and snow. In addition, the RAD06 shield has lower self-heating in bright sunlight combined with higher temperatures (> 24 °C (75 °F)) and low wind speeds (< 2 m/s (4.5 mph)), giving a better measurement.

The 41303-5A and RAD06 attach to a crossarm, mast, or user-supplied pipe with a 2.5 to 5.3 cm (1.0 to 2.1 in) outer diameter. The 41303-5B attaches to a CM500-series pole or a user-supplied pole with a 5.1 cm (2.4 in) outer diameter.

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

- 1/2-inch open end wrench
- UV resistant cable ties
- adjustable wrench with a minimum 1-1/2 inch jaw size

FIGURE 7-1. Installing a 108 and 41303-5A Radiation Shield on a CM200-Series Crossarm

FIGURE 7-2. 108 and 41303-5A Radiation Shield on a tripod mast (left).
108 and RAD06 Radiation Shield on a CM200-Series Crossarm (right).

The 108 is held in the 41303-5A radiation shield by a mounting clamp at the bottom (FIGURE 7-1 (p. 8) and FIGURE 7-2 (p. 9) left). Loosen the mounting clamp screws, and insert the probe through the clamp. Tighten the screws to secure the sensor, and route the sensor cable to the instrument enclosure.

The 108 is held in the RAD06 radiation shield by inserting the sensor through the sensor gland at the bottom of the shield (FIGURE 7-2 (p. 9) right). Loosen the nut on the gland, and insert the probe into the shield. Tighten the nut on the sensor gland using an adjustable wrench until the sensor is securely held in place. Route the sensor cable to the instrument enclosure.

Secure the cable to the tripod or tower using cable ties.

7.4 Water temperature installation

108 probes 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 submerged object such as a piling.

7.5 Soil temperature installation

The 108 tends to measure the average temperature over its length, so burying the probe such that the measurement tip is horizontal to the soil surface at the desired depth is usually preferred. 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.

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.

8. Operation

8.1 Sensor schematic
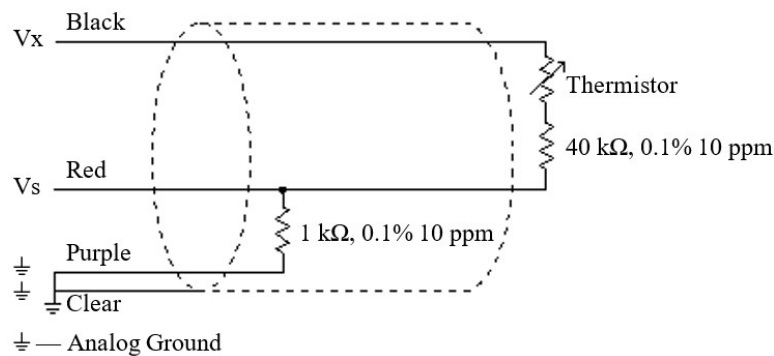
FIGURE 8-1. 108 thermistor probe schematic

8.2 Measurement and output linearization

CRBasic instruction `Therm108()` measures the 108 probe thermistor and automatically converts the result to temperature. With reference to the previous FIGURE 8-1 (p. 10), `Therm108()` applies 1000 mV excitation at the Vx line and measures the voltage drop across the 1 kΩ resistor 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 equations:

Vs/Vx = 1000 / (Rs + 40000 Ω + 1000 Ω)

Solving for Rs:

Rs + 41000 Ω = 1000 • (Vx/Vs)

Rs = 1000 • (Vx/Vs) – 41000 Ω

The relationship of Rs to temperature is tabulated in Thermistor resistance and temperature (p. 16), but is calculated by `Therm108()` using the Steinhart-Hart equation, described as follows:

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

where:

T_C = temperature in degrees Celsius (°C)

A^1 = 8.271111E–4

B^1 = 2.088020E–4

C^1 = 8.059200E–8

[1]Coefficients provided by Measurement Specialties™.

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. This noise can usually be filtered out.

The following code snip examples filter 60 Hz noise.

CR6-series data logger example:

```
Therm108(T108_C,1,U1,U10,0,60,1.0,0.0)
```

CR800-series and CR3000 data loggers example:

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

8.4 Long cable lengths

Long cable lengths (> 50 ft) may require longer than normal analog measurement settling times. Enter a longer settling time in the **SettlingTime** parameter of the **Therm108()** instruction. Campbell Scientific suggests doubling the settling time every 50 ft. The following code snip examples increase settling time by 20000 μs by placing **20000** as the argument in the **SettlingTime** parameter:

CR6-series data logger example:

```
Therm108(T108_C,1,U1,U10,20000,60,1.0,0.0)
```

CR800-series and CR3000 data loggers example:

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

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 back of this manual for more information.

9.1 Troubleshooting

Symptom: Temperature is reported as **NAN**, **–INF**, or incorrect temperature.

Verify wires are connected to the terminals specified in the `Therm108()` instruction: red to single-ended analog input (**SE** or **U**), black to switched excitation (**VX/EX** or **U**), and purple to ground (⏚).

Symptom: Incorrect temperature is reported.

Verify the `Mult` and `Offset` arguments in `Therm108()` are correct for the desired units (Data logger programming (p. 6)). Check the cable for signs of damage and possible moisture intrusion.

Symptom: Unstable temperature is reported.

Probably a result of electromagnetic interference. Try using the 50 Hz or 60 Hz options for the f_{N1} parameter, and/or increasing the settling time as described in Electrically noisy environments (p. 11) and Long cable lengths (p. 11). Ensure the clear wire is connected to data logger ground, and the data logger is properly grounded.

9.2 Maintenance

The 108 probe requires minimal maintenance. For air temperature measurements, check the radiation shield monthly to make sure it is free from dust and debris. To clean the shield, first remove the sensor. Dismount the shield. Brush all loose dirt off. If more effort is needed, use warm, soapy water and a soft cloth or brush to thoroughly clean the shield. Allow the shield to dry before remounting.

Periodically check cabling for signs of damage and possible moisture intrusion.

9.3 Calibration

If needed, an estimate of the interchangeability error for 0 to 50 °C, that can be used as the Offset parameter of the Therm108() instruction, can be determined with a 1-point or 2-point calibration. Calibration of the 108 probe is not necessary unless the accuracy needed in the sensor data requires correction of the thermistor interchangeability offset described in Specifications (p. 5).

10. Attributions and references

Santoprene® is a registered trademark of Exxon Mobile Corporation.

Measurement Specialties™ is a trademarked global designer and manufacturer of sensors and sensor-based systems.

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 into *CRBasic Editor*

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the *CRBasic Editor*. By default, these files reside in the C:\campbellsci\SCWin folder.

Import *Short Cut* program file and wiring information into *CRBasic Editor*:

1. Create the *Short Cut* program. After saving the *Short Cut* program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > **NOTE:**
   > Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the program it created.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.

3. Go into the CRBasic program and paste the wiring information into it.

4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video ▶.

Appendix B. Example program

This following example measures one 108 temperature probe once a second and stores the average temperature every 60 minutes.

CRBasic Example 1: CR1000X program that measures the 108

```
'Program measures one 108 temperature probe once a second and
'stores the average temperature every 60 minutes.

'Wiring Diagram
'==============
'  Probe
'  Wire                              Data logger
'  Color    Function                 Terminal
'  -----    --------                 ------
'  Black    Voltage-excitation input VX1/EX1
'  Red      Analog-voltage output    SE1
'  Purple   Bridge-resistor ground   Ground Symbol
'  Clear    Shield                   Ground Symbol

'Declare the variables for the temperature measurement
Public T108_C

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

EndTable

BeginProg
  Scan(1,Sec,1,0)
    'Measure the temperature
    Therm108(T108_C,1,1,Vx1,0,60,1.0,0.0)
    'Call Data Table
    CallTable(Hourly)
  NextScan
EndProg
```

Appendix C. Thermistor resistance and temperature

Table C-1: 108 thermistor resistance and temperature[1]		
Actual temperature (°C)	100K6A1iA thermistor resistance (Ω)	CRBasic Therm108() output (°C)
-10	612407	-10.00
-9	578366	-9.00
-8	546408	-8.00
-7	516394	-7.00
-6	488196	-6.00
-5	461695	-5.00
-4	436779	-4.00
-3	413346	-3.00
-2	391300	-2.00
-1	370551	-1.00
0	351017	0.00
1	332620	1.00
2	315288	2.00
3	298954	3.00
4	283555	4.00
5	269034	5.00
6	255335	6.00
7	242408	7.00
8	230206	8.00
9	218684	9.00

Table C-1: 108 thermistor resistance and temperature[1]		
Actual temperature (°C)	100K6A1iA thermistor resistance (Ω)	CRBasic Therm108() output (°C)
10	207801	10.00
11	197518	11.00
12	187799	12.00
13	178610	13.00
14	169921	14.00
15	161700	15.00
16	153921	16.00
17	146558	17.00
18	139586	18.00
19	132983	19.00
20	126727	20.00
21	120799	21.00
22	115179	22.00
23	109850	23.00
24	104795	24.00
25	100000	25.00
26	95449	26.00
27	91129	27.00
28	87027	28.00
29	83131	29.00
30	79430	30.00
31	75913	31.00
32	72569	32.00
33	69390	33.00
34	66367	34.00
35	63491	35.00

Table C-1: 108 thermistor resistance and temperature[1]		
Actual temperature (°C)	100K6A1iA thermistor resistance (Ω)	CRBasic Therm108() output (°C)
36	60755	36.00
37	58150	37.00
38	55670	38.00
39	53309	39.00
40	51060	40.00
41	48917	41.00
42	46875	42.00
43	44929	43.00
44	43073	44.00
45	41303	45.00
46	39615	46.00
47	38005	47.00
48	36467	48.00
49	35000	49.00
50	33599	50.00
51	32262	51.00
52	30984	52.00
53	29763	53.00
54	28596	54.00
55	27481	55.00
56	26415	56.00
57	25395	57.00
58	24420	58.00
59	23487	59.00
60	22594	60.00
61	21740	61.00

Table C-1: 108 thermistor resistance and temperature[1]		
Actual temperature (°C)	100K6A1iA thermistor resistance (Ω)	CRBasic Therm108() output (°C)
62	20922	62.00
63	20138	63.00
64	19388	64.00
65	18670	65.00
66	17981	66.00
67	17322	67.00
68	16689	68.00
69	16083	69.00
70	15502	70.00
71	14945	71.00
72	14410	72.00
73	13897	73.00
74	13405	74.00
75	12932	75.00
76	12478	76.00
77	12043	77.00
78	11625	78.00
79	11223	79.00
80	10837	80.00
81	10466	81.00
82	10109	82.00
83	9767	83.00
84	9437	84.00
85	9121	85.00
86	8816	86.00
87	8523	87.00

Table C-1: 108 thermistor resistance and temperature[1]		
Actual temperature (°C)	100K6A1iA thermistor resistance (Ω)	CRBasic Therm108() output (°C)
88	8241	88.00
89	7970	89.00
90	7708	90.00
91	7457	91.00
92	7215	92.00
93	6982	93.00
94	6758	94.00
95	6541	95.00
96	6333	96.00
97	6132	97.00
98	5939	98.00
99	5753	99.00
100	5573	100.00
[1]Data from Measurement Specialties™		

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.

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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.

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