107
Temperature Probe
and
10TCRT Thermocouple Reference Thermistor

User Guide

Issued 14.5.12

Guarantee

This equipment is guaranteed against defects in materials and workmanship. This guarantee applies for twelve months from date of delivery. We will repair or replace products which prove to be defective during the guarantee period provided they are returned to us prepaid. The guarantee will not apply to:

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

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

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

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

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

CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

Campbell Scientific Ltd,
Campbell Park, 80 Hathern Road,
Shepshed, Loughborough, LE12 9GX, UK
Tel: +44 (0) 1509 601141
Fax: +44 (0) 1509 601091

Email: support@campbellsci.co.uk
www.campbellsci.co.uk

PLEASE READ FIRST

About this manual

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

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2	**Mass:**	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km	**Pressure:**	1 psi (lb/in^2) = 68.95 mb
		Volume:	1 UK pint = 568.3 ml 1 UK gallon = 4.546 litres 1 US gallon = 3.785 litres

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

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

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

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

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

Recycling information

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

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

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

Campbell Scientific Ltd, Campbell Park, 80 Hathern Road, Shepshed, Loughborough, LE12 9GX, UK
Tel: +44 (0) 1509 601141   Fax: +44 (0) 1509 601091
Email: support@campbellsci.co.uk
www.campbellsci.co.uk

Contents

Figures

Tables

107 Temperature Probe

1. General

The 107 temperature probe uses a thermistor to measure temperature. The probe is designed for measuring air/soil/water temperatures. For air temperature, a 41303-5A or Met 20 radiation shield is used to mount the 107 Probe and limit solar radiation loading.

1.1 Specifications

Sensor:	BetaTherm 100K6A Thermistor
Temperature Measurement Range:	-35° to +50°C (-55 to +70°C with the CRBasic Therm107 instruction)
Thermistor Interchangeability Error*:	<±0.18°C over -25 to +50°C <±0.3°C over -55 to +70°C
Temperature Survival Range:	-55° to +100°C
CRBasic Temp107 Linearization Error:	<±0.01°C over -35°C to +50°C <±0.03°C over -55 to +70°C
P11 Polynomial Linearization Error: (old loggers)	<±0.5°C over -35°C to +50°C
Bridge resistor errors (worst case)*:	<±0.13°C over -25 to +50°C <±0.35°C over -55 to +70°C
Time Constant in Air (63%):	<80s in air at a wind speed of 1 ms^{-1}
Resolution of Measurement (CR800/1000):	<0.03°C over -35 to +50°C <0.08°C over -55 to +70°C
Maximum recommended Lead Length:	300 m

*Figures applicable to European built sensors only.

1.2 Accuracy

The overall probe accuracy is a combination of the thermistor's interchangeability specification, the datalogger accuracy, the precision of the bridge resistors and the error in linearisation. For CRBasic dataloggers in a 'worst case' example all of the errors add in one direction to yield accuracy of ±0.3ºC over the range -25ºC to +50ºC. The error is typically less than this. The major error component is the tolerance (interchangeability) specification of the thermistor, which is ±0.18ºC from -25°C to +70ºC. The interchangeability error is predominantly offset and can be determined with a single point calibration. The error can then be compensated for with the offset entered in the measurement instruction.

CRBasic dataloggers linearise the sensor output with no practical error (<0.01ºC). For older loggers which use instruction P11. The errors caused by the linearisation polynomial used are significant and are shown in Table 1 and also plotted in Figure 1. These errors are additional to those described above.

Table 1 Linearisation Errors for older dataloggers

Range ºC	Error
-40 to +56	<±1.0ºC
-38 to +52	<±0.5ºC
-23 to +48	<±0.1ºC

The errors associated with the tolerance of the thermistor are shown in Table 4. For temperatures below 0°C the manufacturer only publishes figures at 10°C intervals.

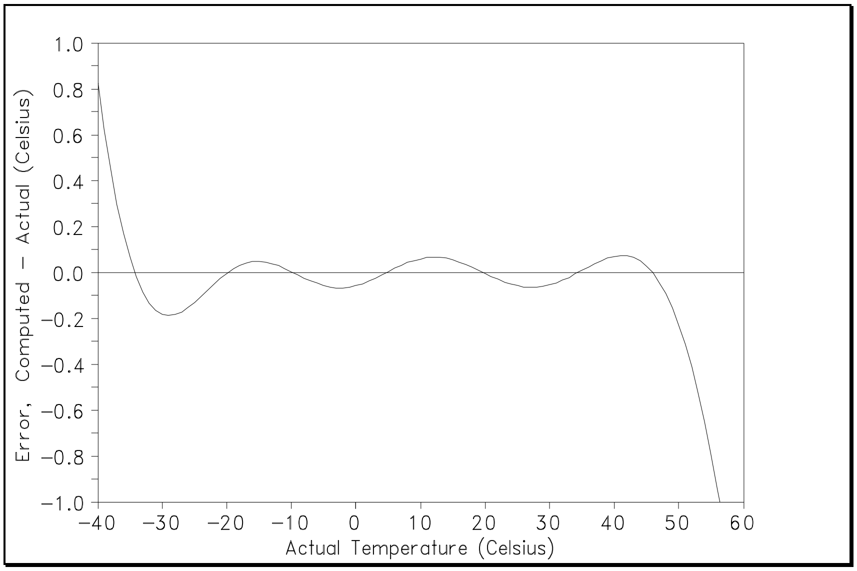

Figure 1. 107 Probe Polynomial Error Curve (applicable to instruction P11 used in older Edlog loggers only)

CAUTION The 107 Probe is a rugged sensor, manufactured to very high standards to give consistently accurate readings.
However, the probe can be damaged if subjected to severe thermal shock (for example by plunging a warm probe into very cold water). This is unlikely to occur in the field but care should be taken when checking the probe in a test situation.

2. Installation

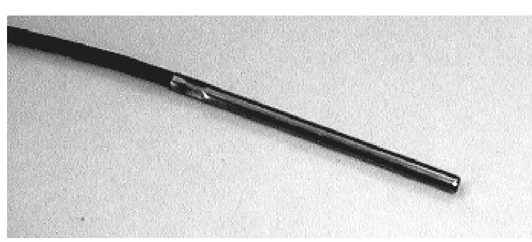

Figure 2. 107 Probe

To increase measurement accuracy and to avoid damage to the probe, please follow the guidelines shown below.

CAUTION Do not immerse the probe in substances which can degrade stainless steel.

2.1 Installation in Water

The 107 can be submerged to 10 m. Please note that the 107 is not weighted. Therefore, the installer should either add a weighting system or secure the probe to a fixed or submerged object such as piling.

If the probe is being used to measure the temperature of moving water, ensure that the probe and cable are firmly attached to a fixed object to prevent unnecessary movement of the cable which might otherwise lead to a stress fracture or abrasion of the wire.

2.2 Installation in Soil

The 107 is suitable for shallow burial only. It should be placed horizontally at the desired depth to avoid thermal conduction from the surface to the thermistor. Placement of the cable inside a rugged conduit may be advisable for long cable runs, especially in locations subject to digging, mowing, traffic, use of power tools, or lightning strikes.

CAUTION Always fully excavate the soil above a buried 107 probe before attempting to remove it. Never try to pull the probe from the soil by the wire alone as this is likely to cause damage.

2.3 Installation in Air

2.3.1 General

When measuring substances with a low thermal conductivity, such as air, the 107, in common with all such temperature probes, can suffer errors as a result of heat conduction between the tip and the connection wire. For the 107 this error can approach 0.02°C for every °C difference between the temperature of the tip and that of the cable where it is joined to the metal probe.

To minimise such errors always try to make sure that the cable temperature is as close as possible to the tip temperature. For example, when measuring air temperature using a radiation shield, try to ensure the cable is routed so that it is shaded from direct sunshine. If very high solar radiation is likely, cover the exposed length of the cable closest to the sensor with a reflective material such as a length of white tubing. To prevent cable movement in windy conditions make sure that it is fixed to both the mounting arm and the tripod/tower by using cable ties at regular intervals.

2.3.2 Using a Radiation Shield

Figure 3. 41303-5 Radiation Shield and Mounting Arm

Figure 4. Met 20 Radiation Shield

Instructions for installation into either of the shields is as follows:

Mount the shield and mounting arm onto the tower/tripod and position so that the sensor will be at approximately the required height. Tighten the U-bolts just enough to secure the arm onto the tower/tripod.

Fit the probe into the shield, reversing the sensor clamp, if necessary, to allow it to grip the body of the sensor (6mm diameter). Gently push the sensor up into the shield as far as it will go, but still allowing the plastic clamp to retain its grip on the metal body of the sensor. (If you inadvertently push the sensor body beyond the clamp, pull it back down until the clamp *fully* grips the body.)

Route the cable along the underside of the mounting arm, and secure in place by using a small cable-tie pushed through the two holes in the top plate of the arm. Try to ensure that the cable is shaded as much as possible from the sun.

Adjust for height/position, if necessary, before fully securing the sensor and mounting arm in place.

3. Wiring

The 107 schematic is shown in Figure 4. Connections to Campbell Scientific dataloggers are given in Table 2. Temperature is measured with one Single-Ended input channel and an Excitation channel. Multiple probes can be connected to the same excitation channel (the number of probes per excitation channel is physically limited by the number of lead wires that can be inserted into a single excitation terminal, approximately six).

Table 2. Connections to Campbell Scientific Dataloggers

Colour	Description	CR800 CR5000 CR3000 CR1000	CR510 CR500 CR10(X)	CR21X CR7 CR23X
Black	Excitation	Switched Excitation	Switched Excitation	Switched Excitation
Red	Temperature Signal	Single-Ended Input	Single-Ended Input	Single-Ended Input
White	Signal Ground	⏚	AG	⏚
Clear	Shield	⏚	G	⏚

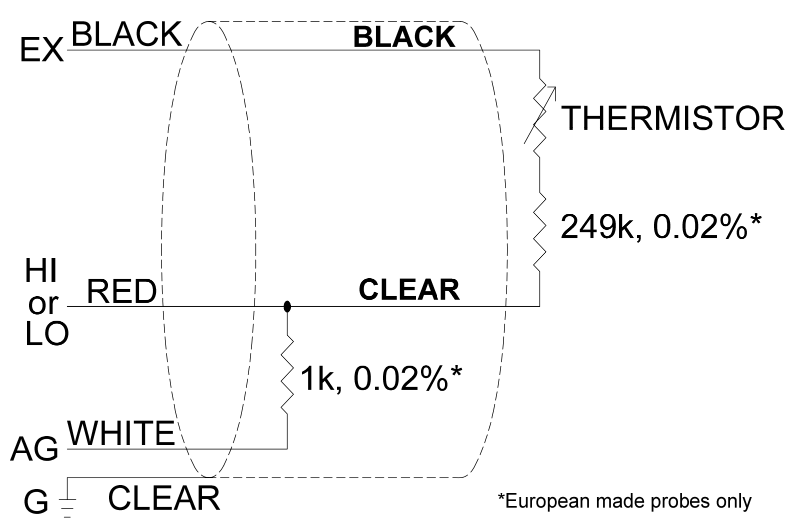

Figure 5. 107 Probe Schematic

CAUTION Extending the cable by simply adding to the existing cable will result in measurement errors (see Section 7).

4. Programming

This section is for users who write their own datalogger programs. A datalogger program to measure this sensor can be created using Campbell Scientific's Short Cut Program Builder software. You do not need to read this section to use Short Cut.

4.1 CRBasic

The Therm107 measurement instruction is used with dataloggers that are programmed with CRBasic (e.g. CR1000) to measure the 107 probe. Therm107 makes a half bridge voltage measurement, and converts the measurement result to temperature using the Steinhart-Hart equation. With a multiplier of 1 and an offset of 0, the output is temperature in degrees C. With a multiplier of 1.8 and an offset of 32, the output is temperature in degrees F.

4.2 Edlog

The Temp107 measurement instruction (P11), is used with dataloggers that are programmed with Edlog (e.g. CR10X, CR23X) to measure the 107 probe. P11 makes half bridge voltage measurement, and converts the measurement result to temperature using a fifth order polynomial. With a multiplier of 1 and an offset of 0, the output is temperature in degrees C. With a multiplier of 1.8 and an offset of 32, the output is temperature in degrees F.

4.3 Example programs

Table 3. Wiring for Example Programs

Colour	**Description**	**CR1000**	**CR10X**
Black	Excitation	EX1	E1
Red	Signal	SE1	SE1
White	Signal Ground	⏚	AG
Clear	Shield	⏚	G

Both example programs measure a 107 temperature probe every second and store a 60 minute average temperature.

4.4 Example Program for CR1000 Datalogger

```
'CR1000
'This example program measures a single 107 Thermistor probe
'once a second and stores the average temperature every 60 minutes.

'Declare the variables for the temperature measurement
Public T107_C

'Define a data table for 10 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,_50Hz,1.0,0.0)
        'Call Data Table
        CallTable(Table1)
    NextScan
EndProg
```

4.5 Example Program for CR10X Datalogger

```
;{CR10X}
*Table 1 Program
  01:  1.0000        Execution Interval (seconds)

1:  Temp (107) (P11)
  1:   1             Reps
  2:   1             SE Channel
  3:   31            Excite all reps w/E1, 50Hz, 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    ]
```

5. Cable Extension

The 107 probe incorporates a thermistor and a 249kΩ resistor in the stainless steel head, and a lkΩ bridge resistor at the opposite end of the cable (nearest to the datalogger). If long cable runs are anticipated, special 107 probes can be ordered with the extra cable added at manufacture. Some users may prefer to extend the standard 107 probe by attaching extra cable. Although this may provide a cheaper solution, there is a real danger that the accuracy of the temperature measurement will be seriously degraded unless the following points are observed:

(a) Good quality cable should be used for the extension (preferably Belden 8761 or 8451).

(b) The lkΩ bridge resistor must be relocated so as to be at the datalogger end of the extended probe cable.

(c) The cable junctions must be well soldered, and sealed to avoid water penetration.

(d) The cable screen should be continuous and earthed *only* at the datalogger.

Failure to observe these points can have serious consequences; an extension of 150m made without reference to (b) above can introduce an error of 1.5°C at 40°C. Failure to comply with (d) above can cause a ‘noisy’ signal with fluctuations in apparent temperature as great as ±3°C. Also see Sections 8 and 9 of this manual.

6. Maintenance and Calibration

The temperature sensor in the probe is designed to give long term stability. The only maintenance required is to inspect the cable sheath at regular intervals to check for cuts and abrasion. If the sheath is cut, allowing water to penetrate the cable, measurements will start to become inaccurate as the water will increase the inter-conductor capacitance. The water is also likely to corrode the cable screen and may even find its way into the datalogger enclosure.

If you are using a radiation shield clean it at regular intervals to remove spiders' webs, insects, etc. If such debris is not removed errors will occur as a result of reduced air movement through the shield.

For most applications it is unnecessary to calibrate the 107 to eliminate the thermistor offset. However, for those users that are interested, the following briefly describes calibrating the 107 probes.

A single point calibration can be performed to determine the 107 temperature offset (thermistor interchangeability).

For older loggers using instruction P11 this calibration will not remove the polynomial error. 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 is placed in a calibration chamber that is at 0°C and the probe outputs 0.1°C. The offset is -0.16, because at 0°C the polynomial calculates a temperature of -0.06°C (Table 4).

7. Measurement Details

Understanding the details in this section are not necessary for general operation of the 107 Probe with CSI's dataloggers.

7.1 Therm107 Instruction

Therm107 instruction applies a precise 2000 mV excitation voltage and measures the voltage drop across the 1K ohm resistor (Figure 4). The ratio of measured voltage (Vs) to the excitation voltage (Vx) is related to thermistor resistance (Rs), and the 1000 and 249K ohm fixed resistors as shown below:

Vs/Vx = 1000/(Rs+249000+1000)

Therm107 calculates Rs from the voltage ratio, and converts Rs to temperature using the Steinhart-Hart equation:

$T = 1/(A+B(LnRs)+C(LnRs)^3) – 273.15$

Where T is the temperature returned in degrees Celsius, and A, B, and C are coefficients provided by the thermistor manufacturer:

A = 8.271111E-4
B = 2.088020E-4
C = 8.059200E-8

7.2 Temp(107) Instruction (P11)

The Temp(107) instruction (P11) applies a precise 2VAC (4VAC with the 21X and CR7) excitation voltage and measures the voltage drop across the 1K ohm resistor (Figure 4). The ratio of measured voltage (Vs) to the excitation voltage (Vx) is related to thermistor resistance (Rs), and the 1000 and 249K ohm fixed resistors as shown below:

Vs/Vx = 1000/(Rs+249000+1000)

Instruction P11 converts the ratio Vs/Vx * 800 to temperature using a 5^{th} order polynomial. The polynomial coefficients are shown in Table 5. Thermistor resistance, and computed temperature over a -40 to +60 degree Celsius range is shown in Table 4.

Parameter 3 specifies the excitation channel to be used for the measurement, with options to increment the excitation channel for each repetition, integration options for 60 or 50Hz noise rejection, and 10 ms delay for use with long lead lengths (Sections 9 and 10):

Excitation/Integration Codes

Code	**Result**
0x	excite all rep with channel x
1x	increment chan x with each rep
2x	excite all reps with channel x, 60 Hz rejection, 10 ms delay
3x	excite all reps with channel x, 50 Hz rejection, 10 ms delay
4x	increment chan x with each rep, 60 Hz rejection, 10 ms delay
5x	increment chan x with each rep, 50 Hz rejection, 10 ms delay

Table 4 shows the thermistor resistance and datalogger output at several temperatures.

Table 4 Temperature, Resistance and Datalogger Output from P11 (older loggers)

Actual Temp. (°C)	Thermistor resistance (Ω)	Estimated Temp. (°C)	Est. - Act. (°C)	Thermistor tolerance (±°C)
-50.00	8337869	-45.68	4.32	0.28
-49.00	7743400	-45.16	3.84	
-48.00	7194826	-44.60	3.40	
-47.00	6688364	-44.02	2.98	
-46.00	6220553	-43.41	2.59	
-45.00	5788455	-42.77	2.23	
-44.00	5388878	-42.11	1.89	
-43.00	5019313	-41.42	1.58	
-42.00	4677268	-40.70	1.30	
-41.00	4360636	-39.95	1.05	
-40.00	4067212	-39.18	0.82	0.25
-39.00	3795342	-38.38	0.62	
-38.00	3543286	-37.55	0.45	
-37.00	3309422	-36.70	0.30	
-36.00	3092416	-35.83	0.17	
-35.00	2890843	-34.94	0.06	
-34.00	2703671	-34.02	-0.02	
-33.00	2529672	-33.09	-0.09	
-32.00	2367900	-32.13	-0.13	
-31.00	2217423	-31.17	-0.17	
-30.00	2077394	-30.18	-0.18	0.20
-29.00	1947006	-29.19	-0.19	
-28.00	1825568	-28.19	-0.19	
-27.00	1712400	-27.17	-0.17	
-26.00	1606911	-26.15	-0.15	
-25.00	1508530	-25.13	-0.13	
-24.00	1416745	-24.11	-0.11	
-23.00	1331059	-23.08	-0.08	
-22.00	1251079	-22.05	-0.05	
-21.00	1176328	-21.03	-0.03	
-20.00	1106485	-20.00	0.00	0.16
-19.00	1041173	-18.99	0.01	
-18.00	980100	-17.97	0.03	
-17.00	922956	-16.96	0.04	
-16.00	869458	-15.95	0.05	
-15.00	819378	-14.95	0.05	
-14.00	772463	-13.96	0.04	
-13.00	728492	-12.96	0.04	
-12.00	687276	-11.97	0.03	
-11.00	648624	-10.98	0.02	
-10.00	612366	-10.00	0.00	0.13
-9.00	578321	-9.01	-0.01	
-8.00	546376	-8.02	-0.02	
-7.00	516372	-7.04	-0.04	
-6.00	488178	-6.05	-0.05	
-5.00	461683	-5.06	-0.06	
-4.00	436773	-4.06	-0.06	
-3.00	413344	-3.07	-0.07	
-2.00	391294	-2.07	-0.07	
-1.00	370547	-1.06	-0.06	
0.00	351017	-0.06	-0.06	0.10
1.00	332619	0.95	-0.05	0.10
2.00	315288	1.96	-0.04	0.10
3.00	298959	2.97	-0.03	0.10
4.00	283558	3.99	-0.01	0.10
5.00	269041	5.00	0.00	0.10

Table 4 (cont.)

Actual Temp. (°C)	Thermistor resistance (Ω)	Estimated Temp. (°C)	Est. - Act. (°C)	Thermistor tolerance (±°C)
6.00	255337	6.02	0.02	0.10
7.00	242414	7.03	0.03	0.10
8.00	230210	8.04	0.04	0.10
9.00	218688	9.05	0.05	0.10
10.00	207807	10.06	0.06	0.10
11.00	197521	11.06	0.06	0.10
12.00	187803	12.07	0.07	0.10
13.00	178613	13.07	0.07	0.10
14.00	169924	14.06	0.06	0.10
15.00	161702	15.05	0.05	0.10
16.00	153923	16.05	0.05	0.10
17.00	146560	17.03	0.03	0.10
18.00	139588	18.02	0.02	0.10
19.00	132984	19.01	0.01	0.10
20.00	126729	19.99	-0.01	0.10
21.00	120799	20.98	-0.02	0.10
22.00	115179	21.97	-0.03	0.10
23.00	109850	22.96	-0.04	0.10
24.00	104796	23.95	-0.05	0.10
25.00	100000	24.94	-0.06	0.10
26.00	95449	25.94	-0.06	0.10
27.00	91128	26.93	-0.07	0.10
28.00	87026	27.93	-0.07	0.10
29.00	83129	28.94	-0.06	0.10
30.00	79428	29.95	-0.05	0.10
31.00	75912	30.95	-0.05	0.10
32.00	72567	31.97	-0.03	0.10
33.00	69389	32.98	-0.02	0.10
34.00	66365	33.99	-0.01	0.10
35.00	63489	35.01	0.01	0.10
36.00	60752	36.02	0.02	0.10
37.00	58149	37.04	0.04	0.10
38.00	55668	38.05	0.05	0.10
39.00	53307	39.06	0.06	0.10
40.00	51058	40.07	0.07	0.10
41.00	48915	41.07	0.07	0.10
42.00	46873	42.07	0.07	0.10
43.00	44927	43.06	0.06	0.10
44.00	43071	44.05	0.05	0.10
45.00	41301	45.03	0.03	0.10
46.00	39613	46.00	0.00	0.10
47.00	38003	46.96	-0.04	0.10
48.00	36465	47.91	-0.09	0.10
49.00	34999	48.84	-0.16	0.10
50.00	33598	49.77	-0.23	0.10
51.00	32260	50.69	-0.31	0.10
52.00	30983	51.59	-0.41	0.10
53.00	29761	52.48	-0.52	0.10
54.00	28595	53.35	-0.65	0.10
55.00	27479	54.21	-0.79	0.10
56.00	26413	55.05	-0.95	0.10
57.00	25394	55.88	-1.12	0.10
58.00	24419	56.70	-1.30	0.10
59.00	23486	57.49	-1.51	0.10
60.00	22593	58.28	-1.72	0.10

Table 5. Polynomial Coefficients

Coefficient	Value
C0	-53.4601
C1	90.807
C2	-83.257
C3	52.283
C4	-16.723
C5	2.211

8. Electrically Noisy Environments

AC power lines can be the source of electrical noise. If the datalogger is in an electronically noisy environment, the 107 temperature measurement should be measured with 50/60 Hz rejection. For CRBasic loggers, the Therm107 Integration parameter has options for 50 and 60 Hz rejection. 60 Hz and 50 Hz rejection is available as an option in the Excitation Channel parameter of Instruction 11 for the CR10X, CR510, and CR23X dataloggers. For the CR10, CR21X and CR7, the 107 should be measured with the AC half bridge (Instruction 5). For CRBasic loggers, the Therm107 Integration parameter has options for 50 and 60 Hz rejection.

Example 8-1, CR1000 measurement instruction with 50 Hz rejection:

```
Therm107(T107_C,1,1,1,0,_50Hz,1.0,0.0)
```

Example 8-2. Sample CR10(X) Instructions Using AC Half Bridge

```
1:  AC Half Bridge (P5)
  1:          1        Reps
  2:         32        7.5 mV 50 Hz Rejection Range
  3:          9        SE Channel
  4:          3        Excite all reps w/Exchan 3
  5:       2000        mV Excitation ;Use 4000 mV on 21X and CR7
  6:          1        Loc [ Air_Temp  ]
  7:        800        Mult
  8:          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. Long Lead Lengths

For CRBasic loggers, the 60 and 50 Hz integration options include a 3 ms settling time and is recommended for most applications. Longer settling times can be entered into the settling time parameter for exceptionally long cables or where a high capacitance extension cable has been added. The 60 and 50 Hz rejection options for the CR10X, CR510 and CR23X include a delay to accommodate long lead lengths. For the CR10, 21X and CR7, if the 107 has lead lengths of more than 300 feet, use the DC Half Bridge instruction (Instruction 4) with a 20 millisecond delay to measure temperatures.

The delay provides a longer settling time before the measurement is made. Do not use the 107 with long lead lengths in an electrically noisy environment.

Example 9-1. CR1000 measurement instruction with 20 mSec (20000 μSec) delay:

```
Therm107(T107_C,1,1,1,20000,_50Hz,1.0,0.0)
```

Example 9-2. CR10X Measurement Instructions Using DC Half Bridge with Delay

```
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 ;Use 4000 mV on 21X and CR7
   7:          1       Loc [ Air_Temp  ]
   8:           .4     Mult ;Use 0.2 on 21X and CR7
   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
```

10. Troubleshooting

Symptom: Temperature is NAN, -INF, -9999

Verify the red wire is connected to the correct Single-Ended analogue input channel as specified by the measurement instruction, and the white wire is connected to datalogger ground.

Symptom: Temperature is -86, -53

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

Symptom: Incorrect Temperature

Verify the multiplier and offset parameters are correct for the desired units (Section 5). Check the cable for signs of damage and possible moisture intrusion.

Symptom: Unstable Temperature

Try using the 60 or 50 Hz integration options, and/or increasing the settling time as described in Sections 9 and 10. Make sure the clear shield wire is connected to datalogger ground, and the datalogger is properly grounded.

Appendix A. The 10TCRT Thermocouple Reference Thermistor

The 10TCRT is a temperature reference for thermocouples monitored with the CR10X Measurement and Control Module. When installed, the 10TCRT lies between the two analogue input terminal strips of the CR10X. 10TCRT circuitry, measurement and specifications are equivalent to the 107 Temperature Probe. The CR10X provides a 2.0V AC excitation, makes a single-ended measurement and linearises the result with a fifth order polynomial to output the temperature in °C.

A.1 Installation

The 10TCRT is installed between the two terminal strips in the wiring panel as shown in Figure A-3. A general view of a CR10X wiring panel is shown in Figure A-1 below.

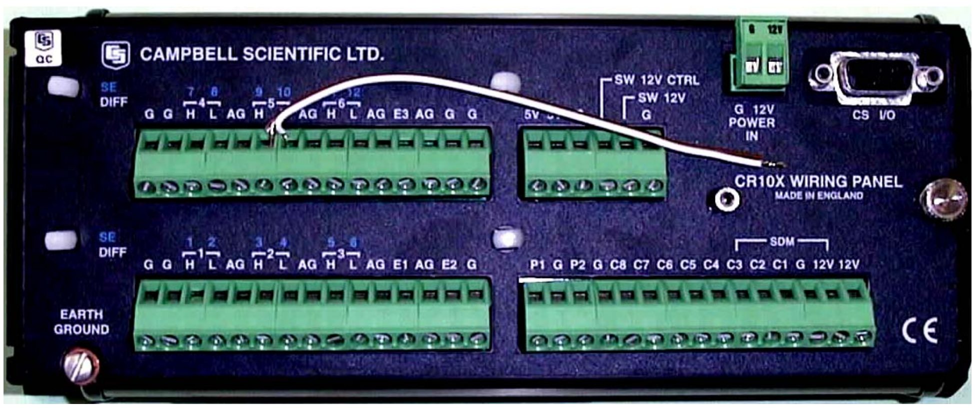

Figure A-1 General View of CR10X Wiring Panel

Note that the piece of ‘wire’ connected across differential channel 5 is, in fact, a test thermocouple. It can be removed if not required for testing purposes.

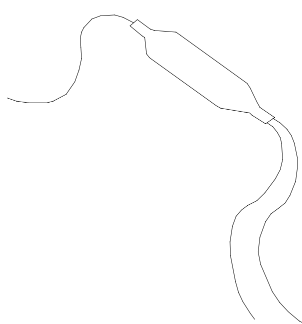

Figure A-2 10TCRT Thermocouple Reference Thermistor

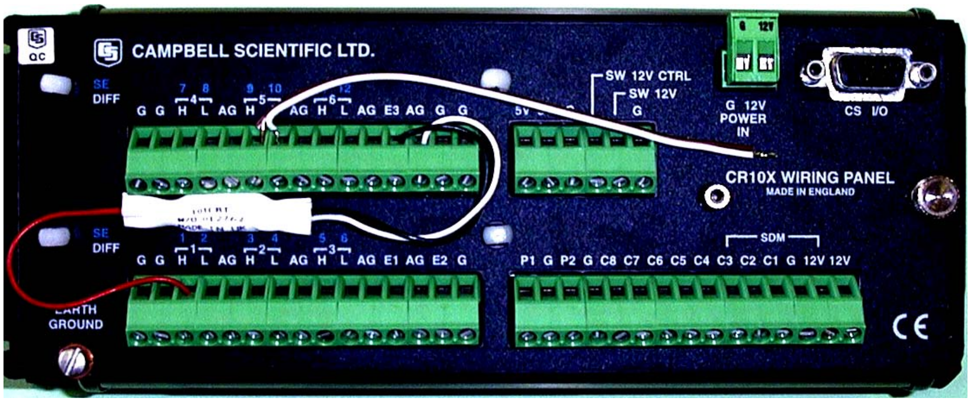

Figure A-3 Installation of the 10TCRT on the CR10X Wiring Panel

A.2 Wiring

The 10TCRT circuit is identical to that of the 107 Probe except that there is no shield wire (see Figure A-4). It is generally wired as the 107 as described in Section 3 of the manual. Wiring colours are shown in Figure A-2. Ensure that the 10TCRT is connected between the two terminal strips as shown in Figure A-3.

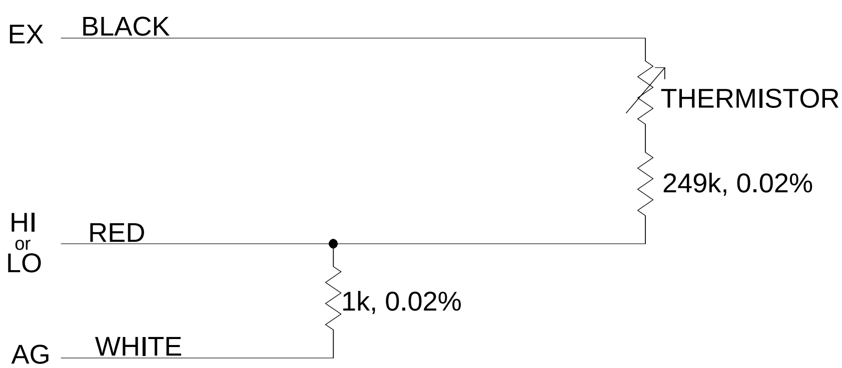

Figure A-4 10TCRT Circuit Diagram

A.3 Measurement

Please refer to Section 4, ‘Programming’.

A.3.1 Using the Same Channel for the 10TCRT and a Thermocouple

If you need to monitor a thermocouple on a differential channel where the 10TCRT is using the HI or LO side of that channel, to minimise errors due to noise carried on the thermocouple, use Instruction 11 with 50Hz rejection. For older datalogger models (without the updated Instruction P11 – see Section 7.2 of this manual) measure the output of the 10TCRT using Instruction 5, AC Half Bridge, with the 50Hz rejection integration option. The 50Hz rejection integration averages out electromagnetic noise introduced by the thermocouple connected to the 10TCRT input. See your specific datalogger manual for details of Instruction 5.

A.4 Avoiding Thermal Gradients

The 10TCRT is a thermistor probe which lies between the terminal strips on the CR10X. However, it does not make thermal contact with the strips themselves, so care must be taken to avoid large temperature differences between the reference thermistor and the terminals to which the thermocouples are connected.

When making thermocouple measurements, operate the CR10X out of direct sunlight and away from heat sources. The optional WP-COVER terminal cover can be used to minimise any thermal gradients. For older CR10 dataloggers, with a silver wiring panel, a small amount of insulation material can be placed over the terminal strips to help minimise these gradients (which are unlikely to exceed 5°C in any case).

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 • sales@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 do Brazil Ltda. (CSB)
Rua Luisa Crapsi Orsi, 15 Butantã
CEP: 005543-000 São Paulo SP BRAZIL
www.campbellsci.com.br • suporte@campbellsci.com.br

Campbell Scientific Canada Corp. (CSC)
11564 - 149th Street NW
Edmonton, Alberta T5M 1W7
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Centro Caribe S.A. (CSCC)
300N 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. (France)
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Spain, S. L.
Avda. Pompeu Fabra 7-9
Local 1 - 08024 BARCELONA
SPAIN
www.campbellsci.es • info@campbellsci.es

Campbell Scientific Ltd. (Germany)
Fahrenheitstrasse13, D-28359 Bremen
GERMANY
www.campbellsci.de • info@campbellsci.de

Please visit www.campbellsci.com to obtain contact information for your local US or International representative.