CR10XTCR THERMOCOUPLE REFERENCE

REVISION: 1/03

Warranty and Assistance

The **CR10XTCR THERMOCOUPLE REFERENCE** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

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CR10XTCR Thermocouple Reference

1. General

The Model CR10XTCR Probe contains a thermistor for measuring temperature and is used as a reference temperature for thermocouples measured with the CR10X. It is installed between the two terminal stripes in the wiring panel. After all the thermocouples are wired, the wiring panel cover is installed to minimize temperature gradients on the terminal strip.

1.1 Specifications

Temperature Measurement Range:	-35° to +50°C
Thermistor Interchangeability Error:	Typically <±0.2°C over 0°C to 60°C ±0.4 @ -35°C.
Polynomial Linearization Error:	<±0.5°C over -35°C to +50°C.

2. Accuracy — Temperature Sensor

The overall probe accuracy is a combination of the thermistor's interchangeability specification, the precision of the bridge resistors, and the polynomial error. In a "worst case" all errors add to an accuracy of ±0.4°C over the range of -24° to 48°C and ±0.9°C over the range of -38°C to 53°C. The major error component is the interchangeability specification of the thermistor, tabulated in Table 1. For the range of 0° to 50°C the interchangeability error is predominantly offset. The bridge resistors are 0.1% tolerance with a 10 ppm temperature coefficient. Polynomial errors are tabulated in Table 2 and plotted in Figure 1.

TABLE 1. Thermistor Interchangeability Specification

Temperature (°C)	Temperature Tolerance (±°C)
–40	0.40
–30	0.40
–20	0.32
–10	0.25
0 to +50	0.20

TABLE 2. Polynomial Error

-40 to +56	<±1.0°C
-38 to +53	<±0.5°C
-24 to +48	<±0.1°C

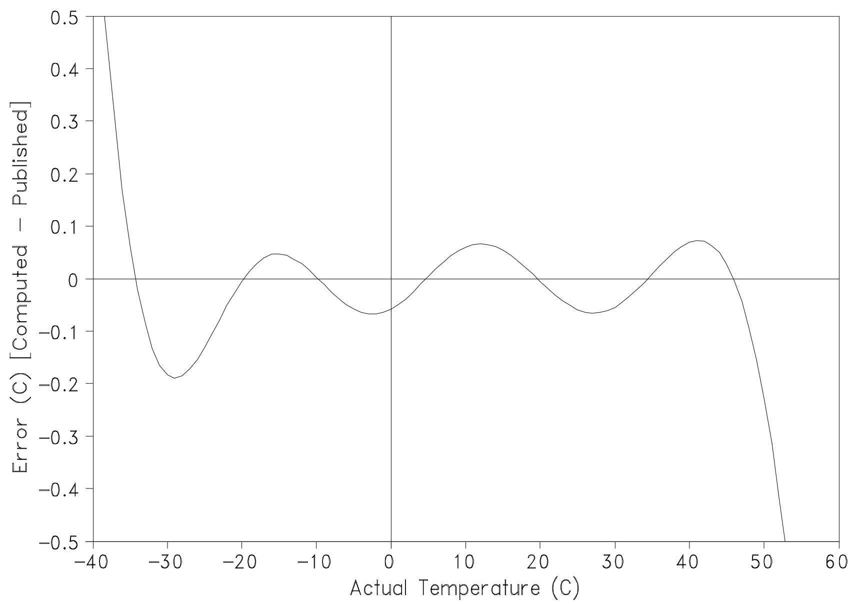

FIGURE 1. Error Produced by Polynomial Fit to Published Values

3. Installation and Wiring

The wiring diagram for the CR10XTCR is shown in Figure 1. The probe requires a single-ended analog input channel and an excitation channel. After the CR10XTCR and thermocouple are connected to the datalogger, install the wiring panel cover (Figure 2 and 3).

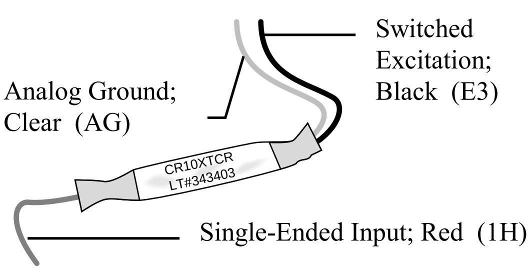

FIGURE 2. Wiring Diagram

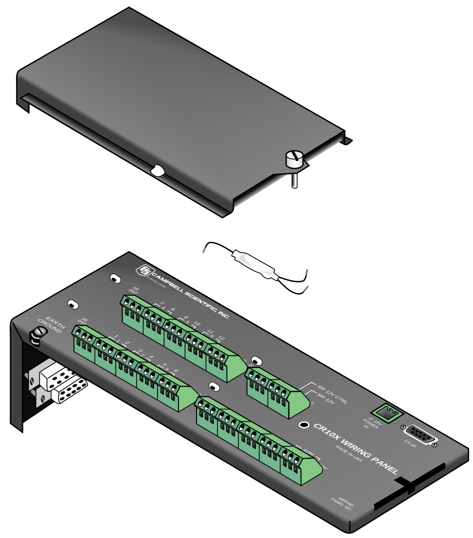

FIGURE 3. Wiring Panel, CR10XTCR, and Wiring Panel Cover

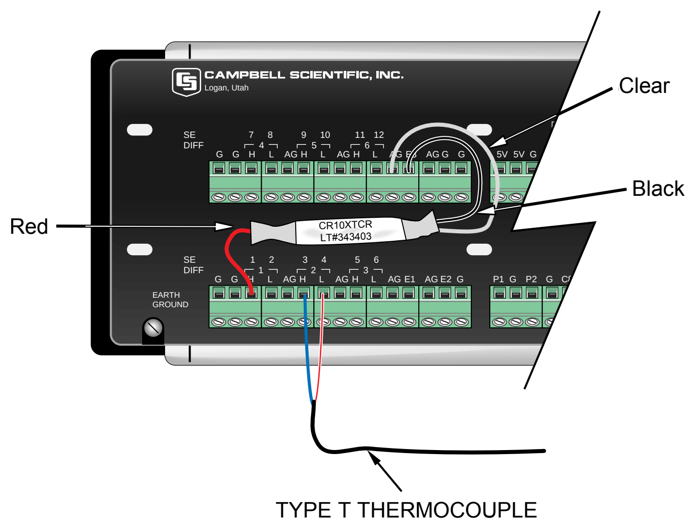

FIGURE 4. CR10XTCR Installed on the CR10X Wiring Panel

4. Programming

Instruction 11 is used to measure the CR10XTCR. Instruction 11 provides AC excitation, makes a single ended voltage measurement, and calculates temperature with a fifth order polynomial. A multiplier of 1.0 and an offset of 0.0 yields temperature in Celsius. For Fahrenheit, use a multiplier of 1.8 and an offset of 32.

CAUTION The reference temperature for thermocouples must be in degrees Celsius.

EXAMPLE 1. Sample CR10X Instructions

```
01:  Temp 107 Probe (P11)
   01: 1          Rep
   02: 1          IN Chan
   03: 3          Excite all reps w/EXchan 3
   04: 15*        Loc [:Ref_Temp]
   05: 1          Mult
   06: 0          Offset

*  Proper entries will vary with program and input location.
```

5. Instruction 11 Details

Understanding the details in this section are not necessary for general operation of the CR10XTCR with Campbell Scientific's dataloggers.

Instruction 11 outputs a precise 2 VAC excitation and measures the voltage drop due to the sensor resistance (Figure 5). The thermistor resistance changes with temperature. Instruction 11 calculates the ratio of voltage measured to excitation voltage (Vs/Vx) which is related to resistance, as shown below:

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

where Rs is the resistance of the thermistor.

See the measurement section of the datalogger manual for more information on bridge measurements.

Instruction 11 then calculates temperature using a fifth order polynomial equation correlating Vs/Vx with temperature. The polynomial coefficients are given in Table 3. The polynomial input is (Vs/Vx)*800. Resistance and datalogger output at several temperatures are shown in Table 4.

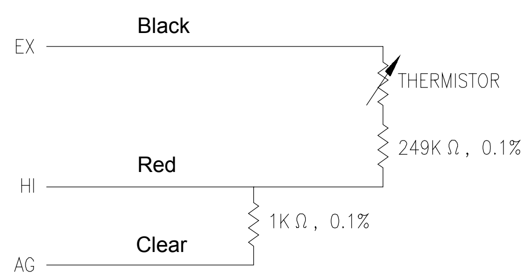

FIGURE 5. CR10XTCR Reference Temperature Schematics

TABLE 3. Temperature, Resistance, and Datalogger Output		
Temperature °C	Resistance OHMS	Output °C
-40.00	4067212	-39.18
-38.00	3543286	-37.55
-36.00	3092416	-35.83
-34.00	2703671	-34.02
-32.00	2367900	-32.13
-30.00	2077394	-30.18
-28.00	1825568	-28.19
-26.00	1606911	-26.15
-24.00	1416745	-24.11
-22.00	1251079	-22.05
-20.00	1106485	-20.00
-18.00	980100	-17.97
-16.00	869458	-15.95
-14.00	772463	-13.96
-12.00	687276	-11.97
-10.00	612366	-10.00
-8.00	546376	-8.02
-6.00	488178	-6.05
-4.00	436773	-4.06
-2.00	391294	-2.07
0.00	351017	-0.06
2.00	315288	1.96
4.00	283558	3.99
6.00	255337	6.02
8.00	230210	8.04
10.00	207807	10.06
12.00	187803	12.07
14.00	169924	14.06
16.00	153923	16.05
18.00	139588	18.02
20.00	126729	19.99
22.00	115179	21.97
24.00	104796	23.95
26.00	95449	25.94
28.00	87026	27.93
30.00	79428	29.95
32.00	72567	31.97
34.00	66365	33.99
36.00	60752	36.02
38.00	55668	38.05
40.00	51058	40.07
42.00	46873	42.07
44.00	43071	44.05
46.00	39613	46.00
48.00	36465	47.91
50.00	33598	49.77
52.00	30983	51.59
54.00	28595	53.35
56.00	26413	55.05
58.00	24419	56.70
60.00	22593	58.28

TABLE 4. Polynomial Coefficients	
Coefficient	**Value**
C0	-53.4601
C1	90.807
C2	-83.257
C3	52.283
C4	-16.723
C5	2.211

6. Electrically Noisy Environments

AC power lines can be the source of electrical noise. If the datalogger is in an electronically noisy environment, the CR10XTCR temperature measurement should be measured with the AC half bridge (Instruction 5) with the 60 Hz rejection integration option on the CR10X (see Section 13 of the datalogger manual for more information on noise). Instruction 11's fast integration will not reject 60 Hz noise.

Example 2. Sample CR10X Instructions Using AC Half Bridge

```
01:  AC Half Bridge (P5)
   01: 1            Rep
   02: 22           7.5 mV 60 Hz rejection Range
   03: 1            IN Chan
   04: 3            Excite all reps w/EXchan 3
   05: 2000         mV Excitation
   06: 15*          Loc [:Ref_Temp]
   07: 800          Mult
   08: 0            Offset

02:  Polynomial (P55)
   01: 1            Rep
   02: 15*          X Loc Air Temp
   03: 15*          F(X) Loc [:Ref_Temp]
   04: -53.46       C0
   05: 90.807       C1
   06: -83.257      C2
   07: 52.283       C3
   08: -16.723      C4
   09: 2.211        C5

*  Proper entries will vary with program and input location assignments.
```