43347 RTD TEMPERATURE PROBE AND 43408 ASPIRATED RADIATION SHIELD

REVISION: 4/02

Warranty and Assistance

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

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43347 RTD Temperature Probe and 43408 Aspirated Radiation Shield

1. General

The -L option on the model 43347 RTD Temperature Probe (43347-L), and the 43408 Aspirated Radiation Shield (43408-L) indicates that the cable length is user specified. This manual refers to them as the 43347 probe and the 43408 radiation shield.

The RM Young 43347 probe mounts inside of the RM Young 43408 radiation shield, and is used for measuring ambient air temperature (Figure 1).

The standard 43347 probe has an RTD uncertainty of ±0.3°C. For increased accuracy the 43347 probe can be ordered with a three point calibration (from RM Young) with an RTD uncertainty of ±0.1°C.

The 43408 radiation shield employs concentric downward facing intake tubes and a small canopy shade to isolate the temperature probe from direct and indirect radiation. The 43347 temperature probe mounts vertically in the center of the intake tubes.

A brushless 12 VDC blower motor pulls ambient air into the shield and across the temperature probe to reduce radiation errors. The blower operates off a 115 VAC/12 VDC transformer that is included with the shield.

2. Specifications

43408 ASPIRATED RADIATION SHIELD:

DIMENSIONS:
- Length: 44", extendable to 75"
- Diameter of Blower Housing: 6"

AIR FLOW RATE:
- 3 - 7 m/s depending on sensor size

TEMPERATURE RANGE: ±50° C

POWER REQUIRED:
- 12 - 14 VDC @ 420 - 480 mA
- 115 VAC/12 VDC - 800 mA transformer supplied

RADIATION ERROR:
- < 0.2°C radiation @ 1100 W/m^2 irradiance

LIFE EXPECTANCY ON BLOWER:
- 80,000 hrs @ 25°C

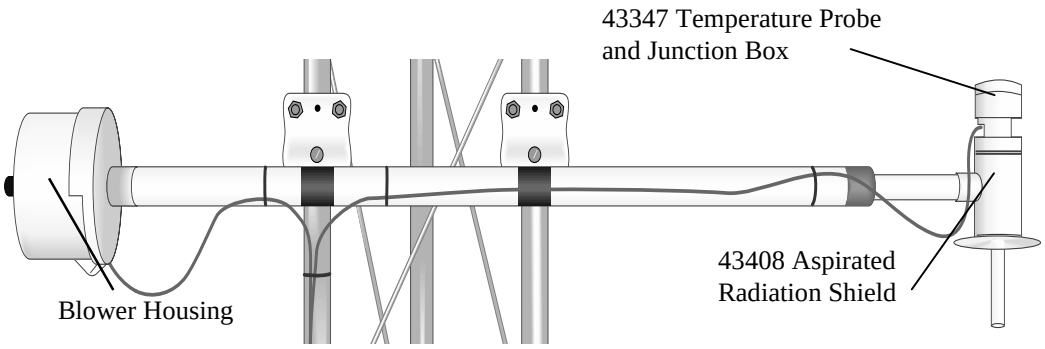

FIGURE 1. 43347 RTD Temperature Probe and 43408 Aspirated Radiation Shield

43347 RTD TEMPERATURE PROBE:

DIMENSIONS:
Probe Tip: 0.125" diameter, 2.25" long
Overall length: 7"

SENSING ELEMENT:
HY-CAL 1000 ohm Platinum RTD

TEMPERATURE RANGE: ±50°C

ACCURACY:
±0.3°C at 0° C
±0.1°C with NIST calibration

TEMPERATURE COEFFICIENT:
.00375 ohm/°C

3. Installation

Refer to the General Assembly drawing in the RM Young 43408 Instruction Manual (included) for reference to the names of shield components.

Thread the molded shield assembly into the appropriate threaded opening in the shield mounting tee at the end of the telescoping arm. Hand-tighten the shield to slightly compress the O-ring seal; do not crossthread or overtighten.

Insert the sensor mounting tube and junction box with its split bushing into the shield mounting tee. Tighten the threaded split bushing to secure the junction box in place; do not overtighten.

Two U-bolt brackets attach the radiation shield to horizontal, vertical, or diagonal tower members up to 2 inches in diameter, spaced 12 to 30 inches apart. Campbell Scientific PN 7515 10 m Aspirated Shield Mounting Bracket can be used to mount the shield to a single vertical pipe or mast, as shown in Figure 2.

The mounting arm should be horizontal with the vent holes facing downward, with the probe end pointing towards the prevailing wind. Tighten the U-bolt brackets sufficiently for a secure hold without distorting the plastic v-blocks. Loosen the band clamp and extend the arm at least 24 inches. Rotate the shield so the intake tube is oriented vertically with the intake opening facing down. Tighten the band clamp and secure the sensor lead to the arm using UV resistant cable ties.

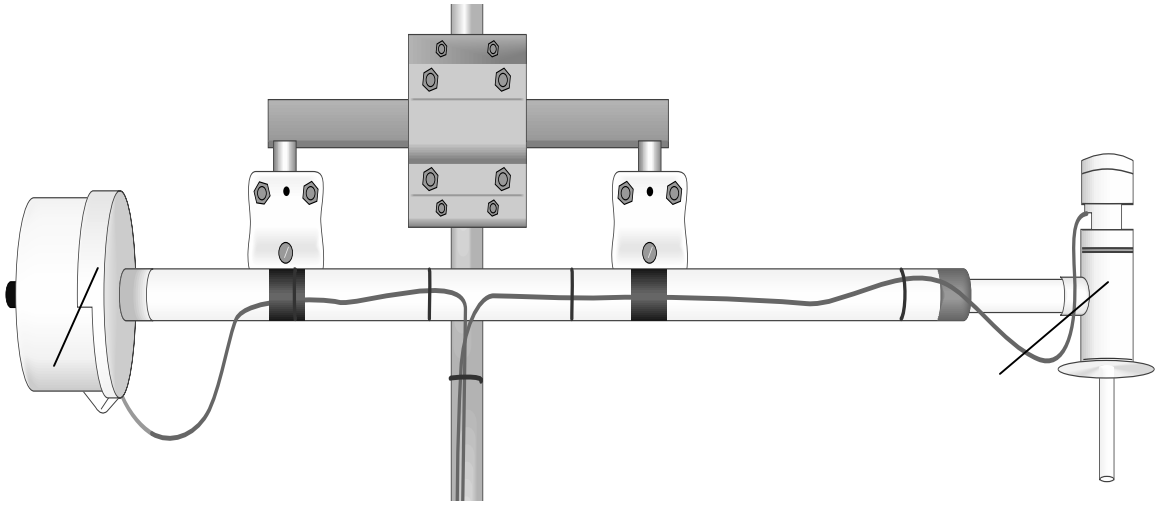

FIGURE 2. PN 7515 10 m Aspirated Shield Mounting Bracket

4. Wiring

4.1 43347 RTD Temperature Probe Wiring

The temperature probe is configured as a four wire half bridge as shown in Figure 3. Each temperature probe requires two differential inputs and one excitation channel (one excitation channel can be used for two probes). The black and orange wires connect to the first of two contiguous input channels (i.e. if channels 1 and 2 are used, the black and orange wires connect to 1H and 1L respectively, and the white and green wires connect to 2H and 2L respectively). Connections to Campbell Scientific dataloggers are given in Table 1.

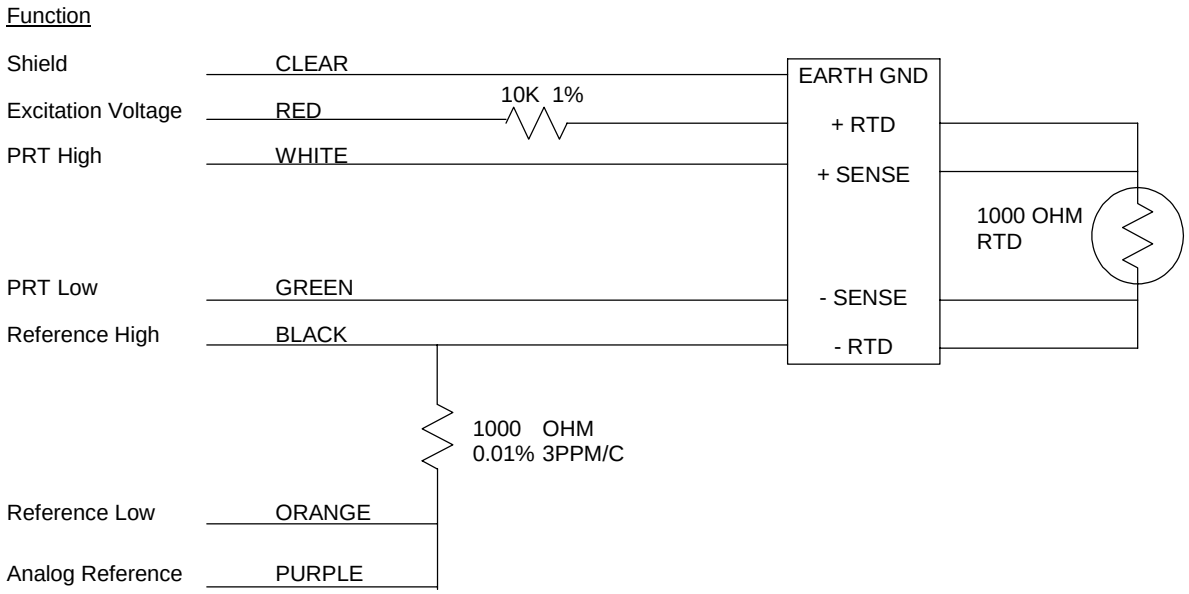

FIGURE 3. 43347 RTD Temperature Probe Wiring

TABLE 1. Datalogger Connections

Description	Color	CR10(X)	CR23X	21X / CR7
Switched Excitation	Red	Switched Excitation	Switched Excitation	Switched Excitation
RTD High	White	Differential (high)	Differential (high)	Differential (high)
RTD Low	Green	Differential (low)	Differential (low)	Differential (low)
Reference High	Black	Differential (high)	Differential (high)	Differential (high)
Reference Low	Orange	Differential (low)	Differential (low)	Differential (low)
Analog Reference	Purple	(AG)	⏚	⏚
Shield	Clear	G	⏚	⏚

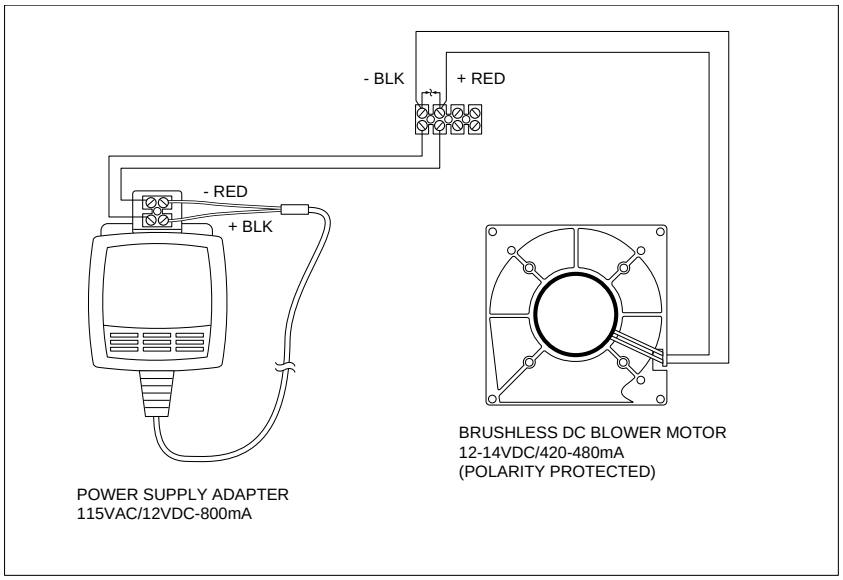

FIGURE 4. 43408 Aspirated Radiation Shield Wiring

4.2 43408 Aspirated Radiation Shield Wiring

The shield includes a 12 VDC transformer that plugs into 110 VAC. In most applications AC power is run to the tower or tripod and terminated in a junction box that is large enough to house the transformer(s).

Connect the red and black wires from the shield cable to the terminal block and transformer as shown in Figure 4.

5. Datalogger Programming

Instruction 9 is used to measure the temperature 43347 probe, which applies an excitation voltage and makes two differential voltage measurements. The first measurement is made across the fixed resistor (Rf), the second is made across the RTD (Rs). The result is the ratio of the two resistances (Rs/Rf), which is not affected by lead length.

The result from Instruction 9 is converted to temperature by Instruction 55 for calibrated temperature probes (Section 5.1), or Instruction 16 for uncalibrated temperature probes (Section 5.2).

Table 2 shows the sensor wiring for the measurement examples Sections 5.1 and 5.2.

TABLE 2. Wiring for Measurement Examples		
Color	**Function**	**Datalogger Channels used for Measurement Examples**
Clear	Shield	≑ (G) for CR10(X)
Red	Switched Excitation	E1
White	Differential High	2H
Green	Differential Low	2L
Black	Differential High	1H
Orange	Differential Low	1L
Purple	Analog Reference	≑ (AG) for CR10(X)

5.1 Programming for Calibrated 43347 RTD Temperature Probes

Instruction 9 applies an excitation voltage and makes two differential measurements. Instruction 55 converts the measurement result to temperature (°C).

Calibrated 43347 probes are provided with a calibration certificate from R.M. Young Co. that gives the relationship of resistance to temperature as Equation "T".

The measurement result of the P9 Instruction with a multiplier of 1.0 and an offset of 0.0 is the RTD resistance divided by 1000. The resistance is divided by 1000 so that the coefficients given in Equation "T" can be entered into the P55 Instruction without exponents. C0 is entered as given, C1 is divided by .001, and C2 is divided by .000001. For example:

Equation "T" from R.M. Young's RTD Calibration Report:

T=		-250.052585
	+Rx	2.375187E-01
	+R^2x	1.258482E-05

Scaled coefficients to be entered into Instruction 55:

C0 = -250.05
C1 = 237.52
C2 = 12.585

CR10(X) Example Program (for use with calibrated 43347 probe):

```
;{CR10X}
;
*Table 1 Program
  01: 5             Execution Interval (seconds)

1: Full Bridge w/mv Excit (P9)
  1:  1             Reps
  2:  24            250 mV 60 Hz Rejection Ex Range   ;CR23X (200 mV); 21X,CR7 (500 mV)
  3:  24            250 mV 60 Hz Rejection Br Range   ;CR23X (200 mV); 21X,CR7 (500 mV)
  4:  1             DIFF Channel
  5:  1             Excite all reps w/Exchan 1
  6:  2500          mV Excitation                     ;CR23X (2000 mV); 21X,CR7 (5000 mV)
  7:  1             Loc [ RTD_temp  ]
  8:  1             Mult
  9:  0             Offset

2: Polynomial (P55)
  1:  1             Reps
  2:  1             X Loc [ RTD_temp  ]
  3:  1             F(X) Loc [ RTD_temp  ]
  4:  -250.05       C0                                ; Coefficients will differ for each probe
  5:  237.52        C1
  6:  12.585        C2
  7:  0.0           C3
  8:  0.0           C4
  9:  0.0           C5
```

5.2 Programming for Uncalibrated 43347 RTD Temperature Probes

Instruction 9 applies an excitation voltage and makes two differential measurements. A multiplier of 1.0 converts the measurement result to Rs/Ro (assuming Rf and Ro both equal 1000 ohms). Instruction 16 converts Rs/Ro to temperature in accordance with DIN Standard 43760. Because the alpha of the RTD used in the temperature probe differs from DIN standard 43760, a multiplier of 1.0267 is required for Instruction 16.

CR10(X) Example Program (for use with uncalibrated 43347 probe):

```
;{CR10X}
;
*Table 1 Program
  01: 5              Execution Interval (seconds)

1: Full Bridge w/mv Excit (P9)
   1:  1           Reps
   2:  24          250 mV 60 Hz Rejection Ex Range    ; CR23X (200 mV); 21X,CR7 (500 mV)
   3:  24          250 mV 60 Hz Rejection Br Range    ; CR23X (200 mV); 21X,CR7 (500 mV)
   4:  1           DIFF Channel
   5:  1           Excite all reps w/Exchan 1
   6:  2500        mV Excitation                      ; CR23X (2000 mV); 21X,CR7 (5000 mV)
   7:  1           Loc [ RTD_temp  ]
   8:  1           Mult
   9:  0           Offset

2: Temperature RTD (P16)
   1:  1           Reps
   2:  1           R/R0 Loc [ RTD_temp  ]
   3:  1           Loc [ RTD_temp  ]
   4:  1.0267      Mult ; (0.00385/0.00375)
   5:  0           Offset
```

6. Maintenance

Inspect and clean the shield periodically to maintain optimum performance. When the shield becomes coated with a film of dirt, wash it with mild soap and warm water. Use alcohol to remove oil film. Do not use any other solvent. Check mounting bolts periodically for possible loosening due to tower vibration.

7. 43347 RTD Temperature Probe Calibration

Calibration should be checked every 12 months. Probes used to measure a temperature gradient should be checked with respect to absolute temperature, and with respect to zero temperature difference. An excellent discussion on calibration procedures can be found in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV Meteorological Measurements[1].

8. Manufacturer's Information

Refer to the RM Young 43408 Instruction Manual for additional information such as replacement parts, assembly drawings, and electrical schematics.

9. TroubleShooting

-99999 Displayed in input location:

Make sure the temperature probe is connected to the correct input channels (Sections 5 and 6). The input channel (Instruction 9) refers to the channel that the black and orange wires are connected to. The white and green wires connect to the next (higher) contiguous channel.

Unreasonable value displayed in input location:

Make sure the multiplier and offset values entered for Instruction 9 are correct. For calibrated temperature probes (Section 6.1), make sure the coefficients have been properly scaled and entered for Instruction 55. For uncalibrated temperature probes (Section 6.2), make sure the multiplier and offset values have been properly entered for Instruction 16.

Temperature reading too high:

Make sure the blower is working properly and there are no obstructions to the air flow in the sensor shield, telescoping arm, or vent holes. Also, check that the probe end of the shield points toward the prevailing wind.

10. References

[1]EPA, (1989). Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV - Meteorological Measurements, EPA Office of Research and Development, Research Triangle Park, North Carolina 27711.

Appendix A. Example CR10(X) Program for Ice Bath Calibration

The following program can be used to calibrate 43347 probes (probes ordered without the 3-point RM Young calibration) for users wanting better than ±0.3 °C. The calibration computes a multiplier for the P9 measurement Instruction (Section 5.2).

Procedure:

Immerse the stainless steel tip of the 43347 probe in a properly prepared ice bath[1] and allow the temperature to stabilize (about an hour). Program the CR10X with the program listed below. Toggle Flag 1 high, which causes the 43347 probe to be measured 100 times. The average of the measurement result is placed into input location 2 and the reciprocal of location 2 is placed into input location 3. The value from location 3 is used as the multiplier for the P9 Instruction (Section 5.2). Typical values for locations 2 and 3 would be 1.0012 and 0.998 respectively.

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

1: If Flag/Port (P91)
  1:  21            Do if Flag 1 is Low
  2:  0             Go to end of Program Table

2: Z=F (P30)
  1:  0             F
  2:  0             Exponent of 10
  3:  1             Z Loc [ counter   ]

3: Beginning of Loop (P87)
  1:  1             Delay
  2:  100           Loop Count

4: Full Bridge w/mv Excit (P9)
  1:  1             Reps
  2:  24            250 mV 60 Hz Rejection Ex Range
  3:  24            250 mV 60 Hz Rejection Br Range
  4:  1             DIFF Channel
  5:  1             Excite all reps w/Exchan 1
  6:  2500          mV Excitation
  7:  2             Loc [ result    ]
  8:  1.0           Mult
  9:  0             Offset

5: Z=Z+1 (P32)
  1:  1             Z Loc [ counter   ]
```

```
6:  If (X<=>F) (P89)
   1:   3              X Loc [ P9_mult   ]
   2:   3              >=
   3:   100            F
   4:   30             Then Do

7:  Do (P86)
   1:   10             Set Output Flag High (Flag 0)

8:  Do (P86)
   1:   21             Set Flag 1 Low

9:  End (P95)

10:  Set Active Storage Area (P80)
   1:   3              Input Storage Area
   2:   2              Loc [ result    ]

11:  Average (P71)
   1:   1              Reps
   2:   2              Loc [ result    ]

12:  Z=1/X (P42)
   1:   2              X Loc [ result    ]
   2:   3              Z Loc [ P9_mult   ]

13:  End (P95)
```

Appendix B. 43408 Aspirated Radiation Shield General Assembly Drawing