INSTRUCTION MANUAL

HMP60 Temperature and Relative Humidity Probe

Revision: 9/17

WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") 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 are not warranted.** ***** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC 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. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.

CAMPBELL SCIENTIFIC®

Campbell Scientific (Canada) Corp.
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Assistance

Products may not be returned without prior authorization. The following contact information is for Canadian and international clients residing in countries served by Campbell Scientific (Canada) Corp. directly. Affiliate companies handle repairs for clients within their territories. Please visit *www.campbellsci.ca* to determine which Campbell Scientific company serves your country.

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CAMPBELL SCIENTIFIC (CANADA) CORP.
RMA#_____
14532 131 Avenue NW
Edmonton, Alberta T5L 4X4
Canada

For all returns, the client must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.ca/repair*. A completed form must be either emailed to *repair@campbellsci.ca* or faxed to (780) 454-2655. Campbell Scientific (Canada) Corp. is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the client at the client's expense. Campbell Scientific (Canada) Corp.f reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Precautions

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.ca or by telephoning (780) 454-2505 (Canada). 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 personnel (e.g. 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

- Prior to performing site or installation work, obtain required approvals and permits.
- 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.

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.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CLIENT 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.

PLEASE READ FIRST

About this manual

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

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm
	1 ft (foot) = 304.8 mm
	1 yard = 0.914 m
	1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g
	1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

About sensor wiring

Please note that certain sensor configurations may require a user supplied jumper wire. It is recommended to review the sensor configuration requirements for your application and supply the jumper wire is necessary.

Table of Contents

PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.

Figures

Tables

CRBasic Examples

HMP60 Temperature and Relative Humidity Probe

1. Introduction

The HMP60 probe measures temperature for the range of –40 to 60 °C, and relative humidity for the range of 0 to 100% RH. It is suitable for long-term, unattended monitoring, and is compatible with all Campbell Scientific dataloggers.

For Edlog datalogger support, check the availability of an older manual at *www.campbellsci.com/old-manuals*.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- When opening the shipping package, do not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.
- Although rugged, the HMP60 should be handled as a precision scientific instrument.
- Remove the yellow cap prior to installation.
- Santoprene® rubber, which composes the black outer jacket of the 107 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

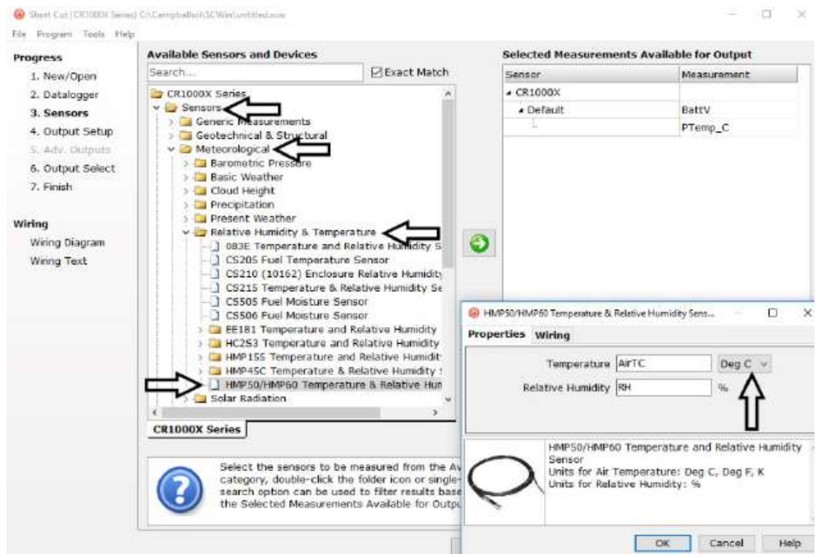
Short Cut is an easy way to program your datalogger to measure the HMP60 sensor and assign datalogger wiring terminals. *Short Cut* is available as a download on *www.campbellsci.com* and the *ResourceDVD*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

Use the following procedure to get started.

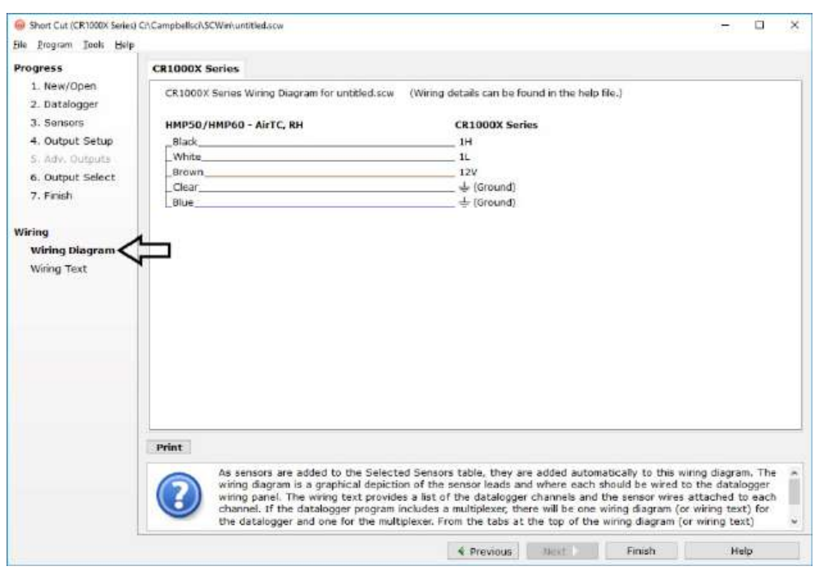
1. Open *Short Cut* and create a new program.

2. Double-click the datalogger model.

3. Under the **Available Sensors and Devices** list, select **Sensors | Meteorological | Relative Humidity & Temperature** and double-click **HMP50/HMP60 Temperature & Relative Humidity Sensor**. 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. After selecting the sensor, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed now or after more sensors are added.



5. 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**.

6. 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.

7. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 4, check the output of the sensor in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

The HMP60 Temperature and Relative Humidity probe contains a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP® capacitive relative humidity sensor. It is suitable for long-term, unattended monitoring. The humidity chip is field-replaceable, eliminating recalibration downtime.

6. Specifications

Features:

- Field-replaceable humidity chip eliminates recalibration down time
- Compatible with the CWS900-series interfaces, allowing it to be used in a wireless sensor network
- Compatible with the following dataloggers: CR200(X) series, CR300 series, CR6 series, CR800 series, CR1000X, CR1000, CR3000, CR5000, CR9000(X)

Operating Temperature:	–40 to 60 °C
Probe Length:	7.1 cm (2.8 in)
Probe Body Diameter:	1.2 cm (0.47 in)
Filter:	0.2 µm Teflon membrane
Filter Diameter:	1.2 cm (0.47 in)
Housing	
Body Material:	AISI 316 stainless steel
Filter Cap Material:	Chrome-coated ABS plastic
Classification:	IP65
Power Consumption:	1 mA typical; 5 mA maximum
Supply Voltage:	5 to 28 Vdc
Settling Time after power is switched on:	1 s
Output Signal Range:	0 to 1 Vdc

6.1 Temperature Sensor

Sensor: 1000 Ω PRT, DIN 43760B

Temperature Measurement Range: –40 to 60 °C

Temperature Accuracy: ±0.6 °C (–40 to 60 °C)

6.2 Relative Humidity Sensor

Sensor: INTERCAP®

Relative Humidity Measurement Range: 0 to 100% non-condensing

Typical Accuracy from 0 to 40 °C: ±3% RH over 0 to 90%
±5% RH over 90 to 100%

Typical Accuracy from –40 to 0 °C and 40 to 60 °C: ±5% RH over 0 to 90%
±7% RH over 90 to 100%

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.1, *Wiring to Datalogger* (p. 4), and Section 7.2, *Datalogger Programming* (p. 5). *Short Cut* does this work for you. See Section 4, *QuickStart* (p. 1), for a *Short Cut* tutorial.

7.1 Wiring to Datalogger

CAUTION Always connect the blue wire to the datalogger first, followed by the black, white, and clear wires. Connect the brown (power) wire last.

TABLE 7-1. Wire Color, Function, and Datalogger Connection		
Wire Color	**Wire Function**	**Datalogger Connection Terminal**
Black	Temperature signal	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
White	Relative humidity signal	**U** configured for single-ended analog input, **SE**
Blue	Power ground and signal reference	**G**
Brown	Power	**12V**
Clear	EMF Shield	⏚ (analog ground)
[1]U channels are automatically configured by the measurement instruction.		

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* *(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 Appendix A, *Importing Short Cut Code to CRBasic Editor* *(p. A-1)*. Programming basics for CRBasic dataloggers are provided in the following sections. Complete program examples for select dataloggers can be found in Appendix B, *Example Program* *(p. B-1)*.

7.2.1 VoltSE() Instruction

Use the **VoltSE()** CRBasic instruction to measure the HMP60's signal.

The probe output scale is 0 to 1000 millivolts for the temperature range of –40 to 60 °C and for the relative humidity range of 0 to 100%.

```
VoltSE(Dest, Reps, Range, SEChan, MeasOff, SettlingTime,
Integ/FNotch, Mult, Offset)
```

Variations:

- Temperature reported as °C — set **Mult** to **0.1** and **Offset** to **–40**
- Temperature reported as °F — set **Mult** to **.18** and **Offset** to **–40**
- Humidity reported as a percent — set **Mult** to **0.1** and **Offset** to **0**
- Humidity reported as a fraction — set **Mult** to **0.001** and **Offset** to **0**

7.3 Installation

Locate the sensor 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 measurement heights:

1.5 m (AASC)
1.25 – 2.0 m (WMO)
2.0 m (EPA)

See Section 10, *Attributions and References* *(p. 11)*, for a list of references that discuss temperature and relative humidity sensors.

When used in the field, the HMP60 must be housed inside a solar radiation shield. Typically, the 41303-5A or RAD06 six-plate solar radiation shield is used. The HMP60 is held within the 41303-5A by a mounting clamp (FIGURE 7-2).

This probe may also be housed in a 41003-5 or RAD10 ten-plate shield. Additional hardware must be used with the 41003-5. No additional hardware is required with the RAD10. A 41322 Adapter Plate allows the HMP60 to be mounted in the lower part of the 41003-5 shield.

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 and RAD10 use a double-louvered design that offers improved sensor protection from insect intrusion and driving rain and snow. In addition, the RAD06 and RAD10 shields have 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.

Each of these solar radiation shields attaches to a crossarm, mast, or user-supplied pipe with a 2.5 to 5.3 cm (1.0 to 2.1 in) outer diameter.

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

- 1/2-inch open-end wrench
- small screwdriver provided with datalogger
- small Phillips screwdriver
- UV-resistant cable ties
- small pair of diagonal-cutting pliers
- adjustable wrench with a minimum 1-7/8 inch jaw size

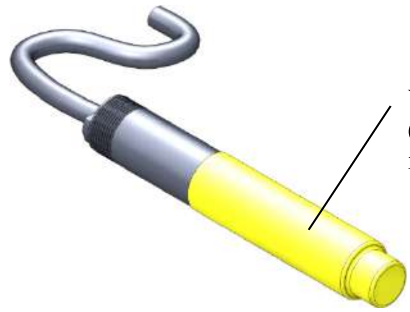


FIGURE 7-1. HMP60 as shipped

7.3.1 Installation in a 41303-5A or 41303-5B 6-Plate Shield

1. Pull off the yellow shipping cap (see FIGURE 7-1).

2. With a small Phillips screwdriver, loosen the plastic split collar at the base of the shield (reversing the removable portion if necessary) and gently insert the probe.

3. Tighten the screws on the collar until it firmly grips the probe body (see FIGURE 7-2).

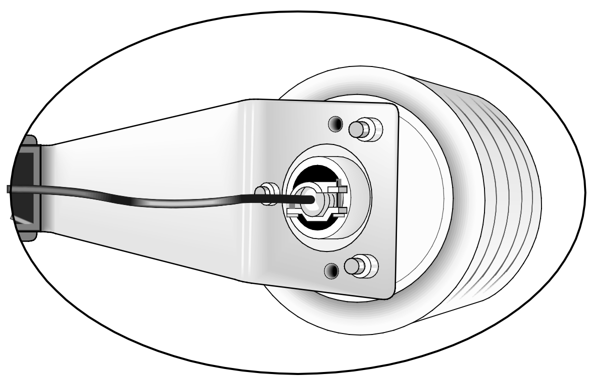


FIGURE 7-2. HMP60 and 41303-5A Radiation Shield

7.3.2 Installation in a RAD06 6-Plate Shield or RAD10 10-Plate Shield

1. Pull off the yellow shipping cap (see FIGURE 7-1).

2. Loosen the nut on the entry gland at the bottom of the shield.

3. Insert the sensor up into the gland as far as it will go. (See FIGURE 7-4.)

4. Using an adjustable wrench, tighten the nut on the gland until the sensor is held firmly in place. Do not overtighten.

7.3.3 Mount the Shield

1. Attach the radiation shield to the tripod mast, crossarm, or tower leg using the supplied U-bolt. See FIGURE 7-3 and FIGURE 7-4 for examples of shield mounting.

2. Route the cable to the datalogger, and secure the cable to the mounting structure using cable ties.

CAUTION Failure to secure the cable can lead to breakage of the wires due to fatigue caused by blowing back and forth in the wind.

FIGURE 7-3. HMP60 and 41303-5A Radiation Shield on a tripod mast (left) and on a CM202 Crossarm (right)

FIGURE 7-4. HMP60 and RAD06 Radiation Shield on a tripod mast

8. Operation

8.1 Measurement

The HMP60 Temperature and Relative Humidity Probe uses a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP® capacitive relative humidity sensor.

8.2 Long Lead Lengths

Long lead lengths cause errors in the measured temperature and relative humidity. The approximate error in temperature and relative humidity is 0.52 °C and 0.52% per 100 feet of cable length, respectively.

When long lead lengths are required and the above errors in temperature and relative humidity are unacceptable, use the EE181 or HMP155A temperature and humidity probe.

Understanding the following details are not required for the general operation of the HMP60 with Campbell Scientific's dataloggers. The signal reference and the power ground (black) are the same lead in the HMP60. When the HMP60 temperature and relative humidity are measured, both the signal reference and power ground are connected to ground at the datalogger. The signal reference/power ground lead serves as the return path for 12 V. There will be a voltage drop along this lead because the wire itself has resistance. The HMP60 draws approximately 2 mA when it is powered. The wire used in the HMP60 (pn 18159) has resistance of 26.2 Ω/1000 feet. Using Ohm's law, the voltage drop (V_d), along the signal reference/power ground lead, is given by Eq. (1).

$$
\begin{aligned}
V_d &= I \times R \\
&= 2\ \text{mA} \times 26.2\Omega/1000\ \text{ft} \\
&= 52.4\ \text{mV}/1000\ \text{ft}
\end{aligned}
\qquad (1)
$$

This voltage drop will raise the apparent temperature and relative humidity because the difference between the signal and signal reference at the datalogger has increased by V_d.

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: Relative Humidity is reported as **NAN**, **–9999**, or **0%**

1. Check that the sensor is wired to the correct analog input channels as specified by the measurement instructions.

2. Verify the voltage range code for the single-ended measurement instruction is correct for the datalogger type.

Symptom: Incorrect temperature or relative humidity

1. Verify the multiplier and offset parameters are correct for the desired units (see Section 7.2.1, *VoltSE() Instruction* (p. 5)).

9.2 Maintenance

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.

The white screen at the tip of the HMP60 should also be checked for contaminants.

When installed in close proximity to the ocean or other bodies of salt water (e.g., Great Salt Lake), a coating of salt (mostly NaCl) may build up on the radiation shield, sensor, filter and even the chip. NaCl has an affinity for water. The humidity over a saturated NaCl solution is 75%. A buildup of salt on the filter or chip will delay or destroy the response to atmospheric humidity.

The filter can be rinsed gently in distilled water. If necessary, the chip can be removed and rinsed as well (see FIGURE 9-1 and Section 9.2.1, *Procedure for Removing RH Chip* (p. 10)). Do not scratch the silver chip while cleaning. It might be necessary to repeat rinsing.

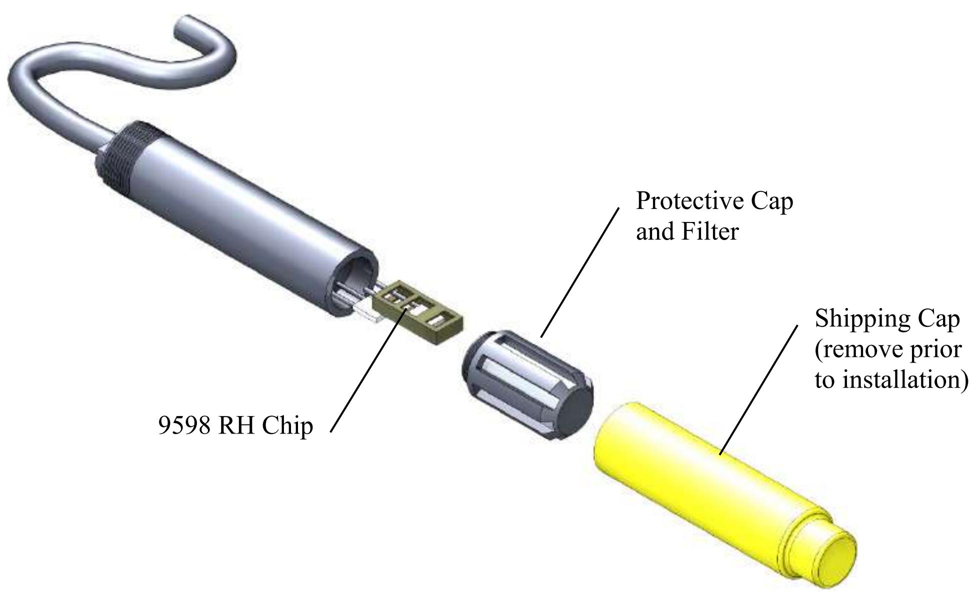


FIGURE 9-1. Exploded view of HMP60 (as shipped)

The offset and gain on the HMP60 electronics cannot be adjusted as part of a recalibration. Generally, the RH chip should be replaced every two years. To determine if the chip needs to be replaced, compare the RH reading with a reference, and replace the RH chip when the relative humidity measurement is out of tolerance.

9.2.1 Procedure for Removing RH Chip

1. Unscrew the protective cap.

2. Hold the plastic sides of the RH chip and unplug it.

CAUTION To prevent scratching, avoid touching the silver RH chip, and handle the RH chip with care.

3. Rinse the RH chip or dispose of the old RH chip.

4. Hold the sides of the rinsed or new chip and plug it in.

5. Screw on the protective cap.

10. Attributions and References

Santoprene® is a registered trademark of Exxon Mobile Corporation.

AASC, 1985: The State Climatologist (1985) Publication of the American Association of State Climatologists: *Heights and Exposure Standards for Sensors on Automated Weather Stations*, v. 9, No. 4 October, 1985. (www.stateclimate.org/publications/state-climatologist/NOAA-NCY-SCBOOKS-SC77097/00000029.pdf)

EPA, 2008: *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. IV, Meteorological Measurements, Ver. 2.0, EPA-454/B-08-002 (revised 2008).Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

Goff, J. A. and S. Gratch, 1946: Low-pressure properties of water from -160° to 212°F, *Trans. Amer. Soc. Heat. Vent. Eng.*, **51**, 125-164.

Lowe, P. R., 1977: An approximating polynomial for the computation of saturation vapor pressure, *J. Appl. Meteor.*, **16**, 100-103.

Meyer, S. J. and K. G. Hubbard, 1992: Nonfederal Automated Weather Stations and Networks in the United States and Canada: A Preliminary Survey, *Bulletin Am. Meteor. Soc.*, **73**, No. 4, 449-457.

Weiss, A., 1977: Algorithms for the calculation of moist air properties on a hand calculator, *Amer. Soc. Ag. Eng.*, **20**, 1133-1136.

WMO, 2008. *Guide to Meteorological Instruments and Methods of Observation*. World Meteorological Organization No. 8, 7th edition, Geneva, Switzerland. Many of the manuals also include siting information for relative humidity and temperature sensors.

Appendix A. Importing Short Cut Code to CRBasic Editor

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

Short Cut creates files, which can be imported into *CRBasic Editor*. Assuming defaults were used when *Short Cut* was installed, these files reside in the C:\campbellsci\SCWin folder:

- .DEF (wiring and memory usage information)
- .CR2 (CR200(X)-series datalogger code)
- .CR300 (CR300-series datalogger code)
- .CR6 (CR6-series datalogger code)
- .CR8 (CR800-series datalogger code)
- .CR1X (CR1000X datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)

Use the following procedure to import *Short Cut* code and wiring diagram into *CRBasic Editor*.

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* *(p. 1)*. 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 the .CR2, .CR300, .CR6, .CR8, .CR1X, .CR1, .CR3, or .CR5 extension. Select the file and click **Open**.
4. Immediately save the file in a folder different from C:\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 an apostrophe (**'**) begins each line. This character instructs the datalogger compiler to ignore the line when compiling.

Appendix B. Example Program

This example can be used directly with CR800-series and CR1000 dataloggers and can be modified for use with CR300- and CR6-series, CR3000, and CR5000 dataloggers.

CRBasic Example B-1. Temperature and RH Program

```
'Program measures the HMP60 probe once every 5 seconds and stores the average
'temperature and a sample of the relative humidity every 60 minutes.

'Wiring Diagram
'==============
'HMP60
'Wire     CR1000
'Color    Function                 Terminal
'------   --------                 --------
'Black    Temperature signal       SE1
'White    Relative Humidity signal SE2
'Brown    Power                    12V
'Blue     Signal & Power Reference G
'Clear    Shield                   Ground Symbol

Public AirTC
Public RH

DataTable(Temp_RH,True,-1)
  DataInterval(0,60,Min,0)
  Average(1,AirTC,FP2,False)
  Sample(1,RH,FP2)
EndTable

BeginProg
  Scan(5,Sec,1,0)
    PortSet(9,1)        'Turn on switched 12V
    Delay(0,3,Sec)      '3-second delay
    'HMP50/HMP60 Temperature & Relative Humidity Sensor measurements AirTC and RH
    VoltSe(AirTC,1,mV2500,1,0,0,_60Hz,0.1,-40)
    VoltSE(RH,1,mV2500,2,0,0,_60Hz,0.1,0)
    If RH>100 AND RH<108 Then RH=100
    CallTable(Temp_RH)
  NextScan
EndProg
```

Appendix C. Absolute Humidity

The HMP60 measures the relative humidity. Relative humidity is defined by the equation below:

$$RH = \frac{e}{e_s} \times 100 \qquad \text{(C-1)}$$

where RH is the relative humidity, e is the vapor pressure in kPa , and e_s is the saturation vapor pressure in kPa. The vapor pressure, e, is an absolute measure of the amount of water vapor in the air and is related to the dew point temperature. The saturation vapor pressure is the maximum amount of water vapor that air can hold at a given air temperature. The relationship between dew point and vapor pressure, and air temperature and saturation vapor pressure are given by Goff and Gratch (1946), Lowe (1977), and Weiss (1977).

When the air temperature increases, so does the saturation vapor pressure. Conversely, a decrease in air temperature causes a corresponding decrease in saturation vapor pressure. It follows then from Eq. (C-1) that a change in air temperature will change the relative humidity, without causing a change in absolute humidity.

For example, for an air temperature of 20 °C and a vapor pressure of 1.17 kPa, the saturation vapor pressure is 2.34 kPa and the relative humidity is 50%. If the air temperature is increased by 5 °C and no moisture is added or removed from the air, the saturation vapor pressure increases to 3.17 kPa and the relative humidity decreases to 36.9%. After the increase in air temperature, there is more energy available to vaporize the water. However, the actual amount of water vapor in the air has not changed. Thus, the amount of water vapor in the air, relative to saturation, has decreased.

Because of the inverse relationship between relative humidity and air temperature, finding the mean relative humidity is meaningless. A more useful quantity is the mean vapor pressure. The mean vapor pressure can be computed on-line by the datalogger. CRBasic dataloggers use the **VaporPressure()** instruction to calculate vapor pressure from temperature and relative humidity measurements (see Appendix C.1, *CR1000 Vapor Pressure Example* *(p. C-1)*.

C.1 CR1000 Vapor Pressure Example

The **VaporPressure()** instruction has the following syntax:

```
VaporPressure(Dest,Temp,RH)
```

Where:

`Dest` is the variable in which the results of the instruction will be stored.

`Temp` is the program variable that contains the value for the temperature sensor. The temperature measurement must be in degrees Celsius.

`RH` is the program variable that contains the value for the relative humidity sensor. The relative humidity measurement must be in percent of RH.

CRBasic Example C-1. Vapor Pressure Program

```
'Wiring Diagram
'==============
'HMP60
'Wire     CR1000
'Color    Function                  Terminal
'------   --------                  --------
'Black    Temperature signal        SE1
'White    Relative Humidity signal  SE2
'Brown    Power                     12V
'Blue     Signal & Power Reference  G
'Clear    Shield                    Ground Symbol

Public AirTC
Public RH
Public VP

DataTable(Table1,True,-1)
  DataInterval(0,60,Min,0)
  Average(1,AirTC,FP2,0)
  Sample(1,RH,FP2)
  Average(1,VP, FP2,0)
EndTable

BeginProg
  Scan(5,Sec,1,0)
    'HMP60 Temperature & Relative Humidity Sensor measurements AirTC and RH:
    VoltSE(AirTC,1,mV2500,1,0,0,_60Hz,0.1,-40.0)
    VoltSE(RH,1,mV2500,2,0,0,_60Hz,0.1,0)
    If (RH>100) AND (RH<108) Then RH=100
    VaporPressure(VP,AirTC,RH)
    CallTable(Table1)
  NextScan
EndProg
```

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