HMP50
Temperature and Relative Humidity Probe

Instruction Manual

Issued 1.12.09

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.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package.

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.

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
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/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.

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® EUROPE
WHEN MEASUREMENTS MATTER

Contents

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Tables

HMP50 Temperature and Relative Humidity Probe

1. General

The HMP50 Temperature and Relative Humidity probe contains a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP® capacitive relative humidity sensor.

2. Specifications

Operating Temperature: -40°C to +60°C

Storage Temperature: -40°C to +80°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 Material: chrome-coated aluminium and chrome-coated ABS Plastic

Power Consumption: <2 mA

Supply Voltage: 7 to 28 VDC

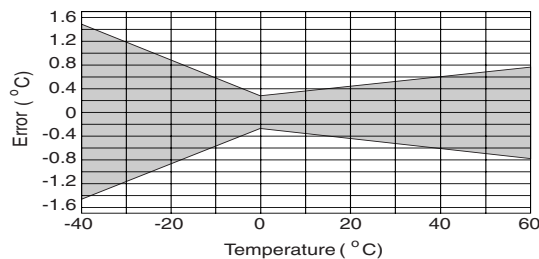Settling Time after power is switched on: 1 second

2.1 Temperature Sensor

Sensor: 1000 Ω PRT, DIN 43760B

Temperature Measurement Range: -40°C to +60°C

Temperature Output Signal range: 0 to 1.0 VDC

Temperature Accuracy:

2.2 Relative Humidity Sensor

Sensor: INTERCAP®

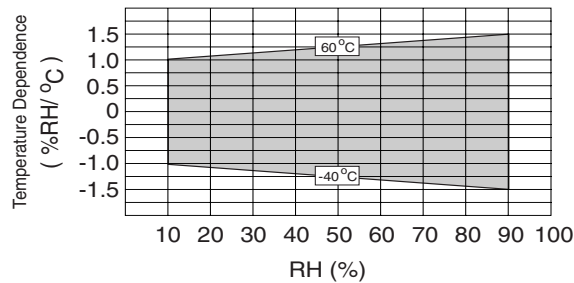Relative Humidity Measurement Range: 0 to 98% non-condensing

RH Output Signal Range: 0 to 1.0 VDC

Accuracy at 20°C
    ±3% RH (0 to 90% Relative Humidity)
    ±5% RH (90 to 98% Relative Humidity)

Temperature Dependence of Relative Humidity Measurement:

Typical Long Term Stability: Better than 1% RH per year

Response Time (at 20°C, 90% response to a steep change in humidity):
    15 seconds with membrane filter

3. Installation

3.1 Siting

For monitoring outside air temperature and humidity sensors should be located over an open level area at least 9 m (EPA) in diameter. The surface should be covered by short grass, or where grass does not grow, the natural earth surface. 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 +/- 1.0 m (AASC)
1.25 – 2.0 m (WMO)
2.0 m (EPA)
2.0 m and 10.0 m temperature difference (EPA)

See Section 9 for a list of references that discuss temperature and relative humidity sensors.

3.2 Mounting and Assembly

Pull off the yellow shipping cap (see Figure 1).

The HMP50 must be housed inside a solar radiation shield when used in the field. The 41303-5A 6-Plate Radiation Shield (Figures 2 and 3) mounts to a tripod mast, tower leg, or CM202, CM204, or CM206 crossarm. The HMP50 is held within the 41303-5A by a mounting clamp (Figure 3).

NOTE   The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

Yellow Shipping Cap
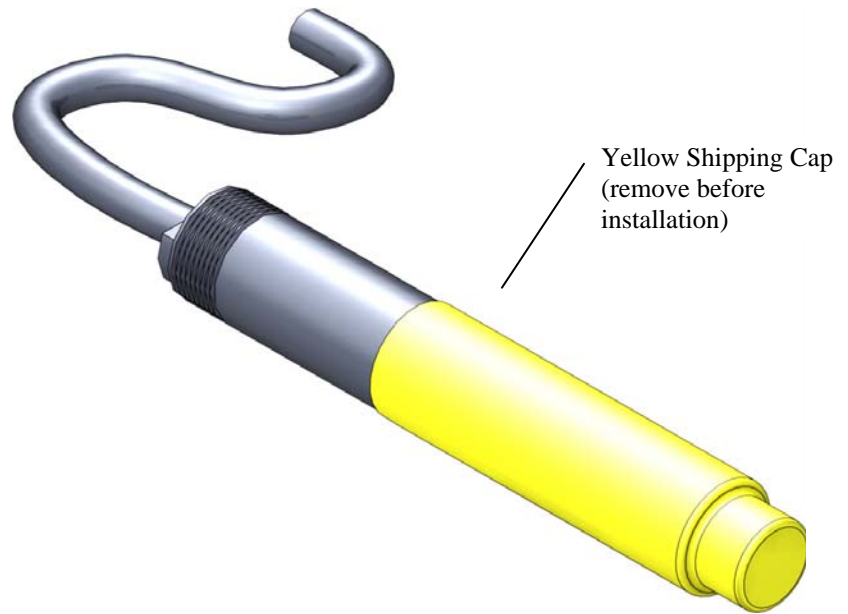(remove before
installation)

Figure 1. HMP50 as Shipped

*Figure 2. HMP50 and 41303-5A Radiation Shield
on a Tripod Mast*

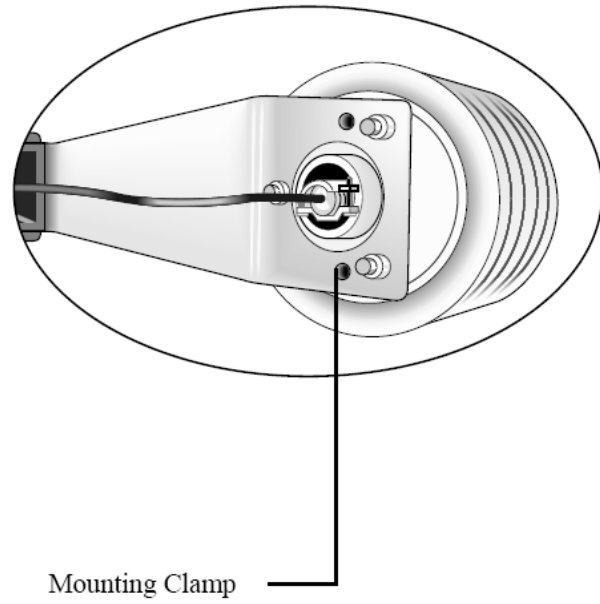*Figure 3. HMP50 and 41303-5A Radiation Shield
on a CM202 Crossarm*

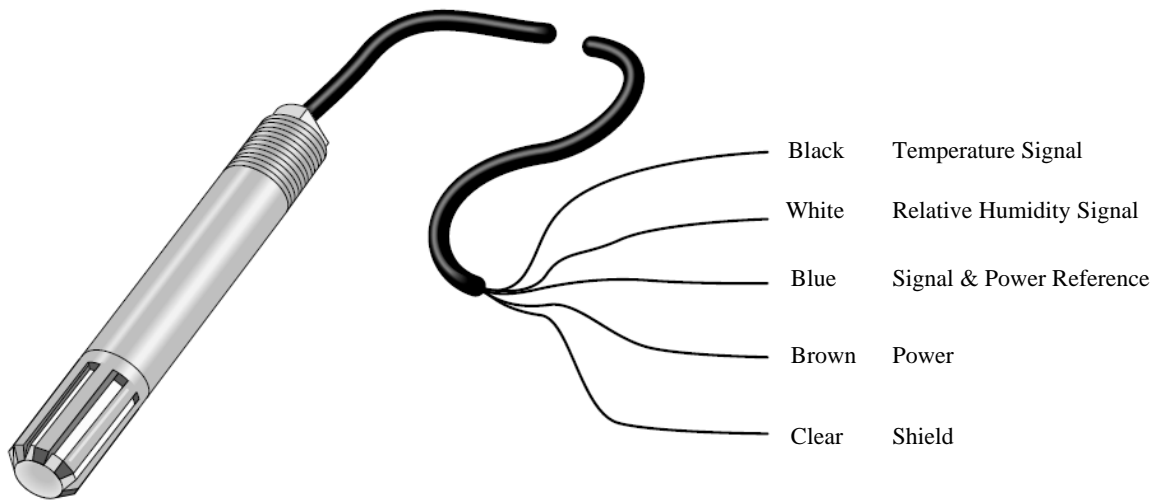*Figure 4. HMP50 and 41303-5A Radiation Shield*

Figure 5. HMP50 Wiring

Table 1. Datalogger Connections				
Wire Function	Colour	CR800, CR3000, CR200, CR23X, CR1000	CR10(X), CR510	21X, CR7
Temp Signal	Black	Single-Ended Input	Single-Ended Input	Single-Ended Input
RH Signal	White	Single-Ended Input	Single-Ended Input	Single-Ended Input
Power & Signal Ground	Blue	G	G	⏚
Power 12V	Brown	12 V	12 V	12 V
Shield	Clear	⏚	G	⏚

4. Wiring

Connections to Campbell Scientific dataloggers are given in Table 2. The probe is measured by two single-ended analogue input channels, one for temperature and one for relative humidity.

CAUTION
Always connect the Blue lead to the datalogger first, followed by the Black, White, and Clear leads. Connect the Brown (Power) lead last.

5. Example Programs

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.

The temperature and relative humidity signals from the HMP50 are measured using two single-ended analogue measurements (Instruction 1).

The probe output scale is 0 to 1000 millivolts for the temperature range of -40°C to +60°C and for the relative humidity range of 0 to 100%. Tables 3 and 4 provide calibration information for temperature and relative humidity.

Table 2. Calibration for Temperature		
Units	Multiplier (degrees mV^{-1})	Offset (degrees)
Celsius	0.1	-40
Fahrenheit	0.18	-40

<table>
<tr><th colspan="3">Table 3. Calibration for Relative Humidity</th></tr>
<tr><th>Units</th><th>Multiplier
(% mV^{-1})</th><th>Offset
(%)</th></tr>
<tr><td>Percent</td><td>0.1</td><td>0</td></tr>
<tr><td>Fraction</td><td>0.001</td><td>0</td></tr>
</table>

<table>
<tr><th colspan="4">Table 4. Wiring for CR1000 and CR10X Examples</th></tr>
<tr><th>Description</th><th>Colour</th><th>CR1000</th><th>CR10(X)</th></tr>
<tr><td>Temperature</td><td>Black</td><td>SE 1</td><td>SE 3 (2H)</td></tr>
<tr><td>Relative Humidity</td><td>White</td><td>SE 2</td><td>SE 4 (2L)</td></tr>
<tr><td>Signal & Power Reference</td><td>Blue</td><td>G</td><td>G</td></tr>
<tr><td>Power</td><td>Brown</td><td>12 V</td><td>12 V</td></tr>
<tr><td>Shield</td><td>Clear</td><td>⏚</td><td>G</td></tr>
</table>

5.1 Example for CR1000

```
'CR1000
'Created by SCWIN (2.1)

Public AirTC
Public RH

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

BeginProg
    Scan(5,Sec,1,0)
        'HMP50 Temperature & Relative Humidity Sensor measurements AirTC and RH:
        VoltSE(AirTC,1,mV2500,1,0,0,_50Hz,0.1,-40.0)
        VoltSE(RH,1,mV2500,2,0,0,_50Hz,0.1,0)
        If (RH>100) And (RH<108) Then RH=100
        CallTable(Table1)
    NextScan
EndProg
```

5.2 Example for CR10X

```
;Measure the HMP50 temperature.
;
01: Volt (SE) (P1)
  1:  1           Reps
  2:  5           2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                            CR7 (5000 mV)
  3:  3           SE Channel                ;Black wire (SE 3), Blue wire (G)
  4:  1           Loc [ T_C     ]
  5:  .1          Mult                      ;See Table 3 for alternate multipliers
  6:  -40         Offset                    ;See Table 3 for alternate offsets

;Measure the HMP50 relative humidity.
;
02: Volt (SE) (P1)
  1:  1           Reps
  2:  5           2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                            CR7 (5000 mV)
  3:  4           SE Channel                ;White wire (SE 4), Blue wire (G)
  4:  3           Loc [ RH_pct   ]
  5:  .1          Mult                      ;See Table 4 for alternate multipliers
  6:  0           Offset

;Limit the maximum relative humidity to 100%.
;
03: If (X<=>F) (P89)
  1:  3           X Loc [ RH_pct   ]
  2:  3           >=
  3:  100         F
  4:  30          Then Do

04: Z=F (P30)
  1:  100         F
  2:  0           Exponent of 10
  3:  3           Z Loc [ RH_pct   ]

05: End (P95)
```

6. 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 HMP45C temperature and humidity probe.

Understanding the following details are not required for the general operation of the HMP50 with Campbell Scientific's dataloggers. The signal reference and the power ground (black) are the same lead in the HMP50. When the

HMP50 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 HMP50 draws approximately 2 mA when it is powered. The wire used in the HMP50 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).

$$
\begin{aligned}
V_d \quad &= I * R \\
&= 2\,\text{mA} * 26.2\,\Omega \,/\, 1000\,\text{ft} \\
&= 52.4\,\text{mV} \,/\, 1000\,\text{ft}
\end{aligned}
\tag{1}
$$

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. The approximate error in temperature and relative humidity is 0.35°C and 0.35% per 100 feet of cable length, respectively.

7. Absolute Humidity

The HMP50 measures the relative humidity. Relative humidity is defined by the equation below:

$$
RH = \frac{e}{e_s} * 100
\tag{2}
$$

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

When the air temperature increases, so does the saturation vapour/ pressure. Conversely, a decrease in air temperature causes a corresponding decrease in saturation vapour pressure. It follows then from Eq. (2) 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 vapour pressure of 1.17 kPa, the saturation vapour 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 vapour 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 vapour in the air has not changed. Thus, the amount of water vapour 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 vapour pressure. The mean vapour pressure can be computed on-line by the datalogger. CRBasic dataloggers use the VapourPressure instruction to calculate vapour pressure from temperature and relative humidity measurements (see Section 7.1). Edlog dataloggers must first calculate the saturation vapour pressure and then calculate vapour pressure (see Section 7.2).

Table 5. Wiring for Vapour Pressure Examples			
Description	Colour	CR10(X)	CR1000
Temperature	Black	SE 3 (2H)	SE 1 (1H)
Relative Humidity	White	SE 4 (2L)	SE 2 (2H)
Signal & Power Reference	Blue	G	G
Power	Brown	12 V	12 V
Shield	Clear	G	⏚

7.1 CR1000 Vapour Pressure Example

The VapourPressure instruction has the following syntax:

VapourPressure (Dest, Temp, RH)

Where:

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

Temp—the program variable that contains the value for the temperature sensor. The temperature measurement must be in degrees C.

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

```
'CR1000

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)
        'HMP50 Temperature & Relative Humidity Sensor measurements AirTC and RH:
        VoltSE(AirTC,1,mV2500,1,0,0,_50Hz,0.1,-40.0)
        VoltSE(RH,1,mV2500,2,0,0,_50Hz,0.1,0)
        If (RH>100) And (RH<108) Then RH=100
        VapourPressure(VP,AirTC,RH)
        CallTable(Table1)
    NextScan
EndProg
```

7.2 Sample CR10(X) Program that Computes Vapour Pressure and Saturation Vapour Pressure

```
;Measure the HMP50 temperature.
;
01: Volt (SE) (P1)
  1:  1              Reps
  2:  5              2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                                CR7 (5000 mV)
  3:  3              SE Channel                ;Black wire (SE 3), Blue wire (G)
  4:  1              Loc [ T_C     ]
  5:  .1             Mult                      ;See Table 3 for alternate multipliers
  6:  -40            Offset                    ;See Table 3 for alternate offsets

;Measure the HMP50 relative humidity.
;
02: Volt (SE) (P1)
  1:  1              Reps
  2:  5              2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                                CR7 (5000 mV)
  3:  4              SE Channel                ;White wire (SE 4), Blue wire (G)
  4:  2              Loc [ RH_frac ]
  5:  .001           Mult                      ;See Table 4 for alternate multipliers
  6:  0              Offset
```

```
;Limit the maximum value of relative humidity
;to 1 (expressed as a fraction).
;
03:  If (X<=>F) (P89)
  1:   2            X Loc [ RH_frac  ]
  2:   3            >=
  3:   1            F
  4:   30           Then Do

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

05:  End (P95)

;Compute the saturation vapour pressure in kPa.
;The temperature must be in degrees Celsius.
;
06:  Saturation Vapour Pressure (P56)
  1:   1            Temperature Loc [ T_C    ]
  2:   3            Loc [ e_sat   ]

;Compute the vapour pressure in kPa.
;Relative humidity must be a fraction.
;
07:  Z=X*Y (P36)
  1:   3            X Loc [ e_sat   ]
  2:   2            Y Loc [ RH_frac ]
  3:   4            Z Loc [ e       ]
```

8. Maintenance

The HMP50 Probe requires minimal maintenance. Check monthly to make sure the radiation shield is free from debris. The white screen at the tip of the probe 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 build-up 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 6 and Section 8.1). Do not scratch the silver chip while cleaning. It might be necessary to repeat rinsing.
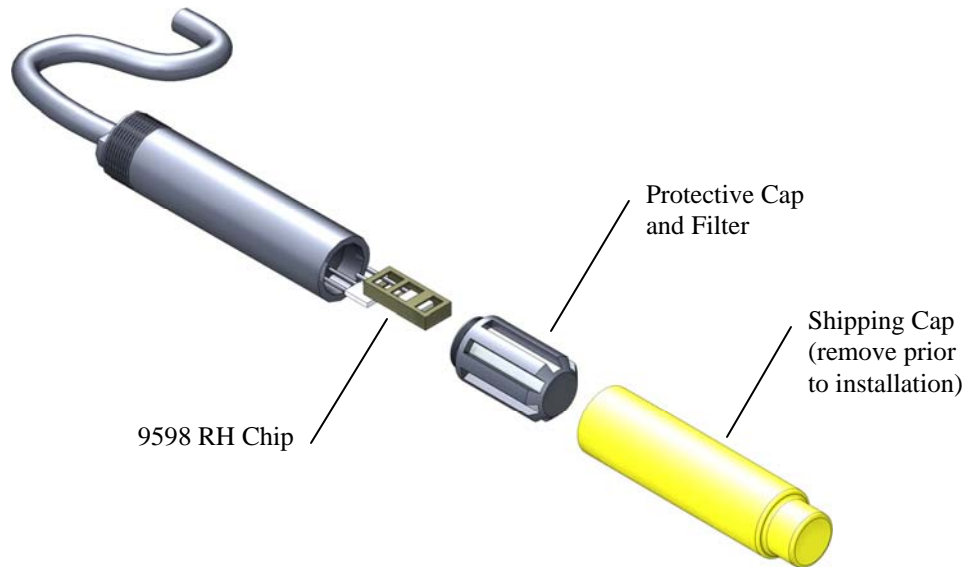
Figure 6. Exploded View of HMP50 (as shipped)

The offset and gain on the HMP50 electronics cannot be adjusted as part of a recalibration. Replace the RH chip as needed.

8.1 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.

9. References

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 vapour pressure, *J. Appl. Meteor.*, **16**, 100-103.

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

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