Product Manual

Sensor

EE181

Temperature and Relative Humidity Probe

Revision: 10/2021

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Table of contents

1. Introduction

The EE181 is a rugged, accurate temperature and relative humidity probe that is ideal for long-term, unattended applications in all climates. The probe uses an E+E Elektronik® capacitive RH element with a proprietary coating to measure relative humidity and a 1000 Ω PRT to measure temperature. For optimum results, the EE181 should be recalibrated annually.

For Edlog data logger support, contact Campbell Scientific.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.
- Although the EE181 is rugged, it should be handled as a precision scientific instrument.
- Do not touch the sensor element.
- Santoprene® rubber, which composes the black outer jacket of the 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

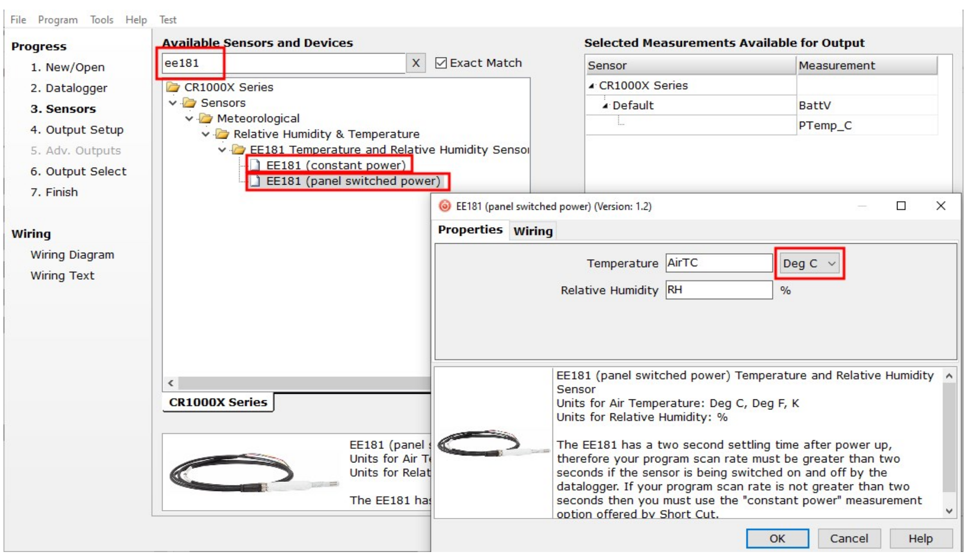
- Upon receipt of the EE181, inspect the packaging and contents for damage. File damage claims with the shipping company.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the expected product and cable length were received.

4. QuickStart

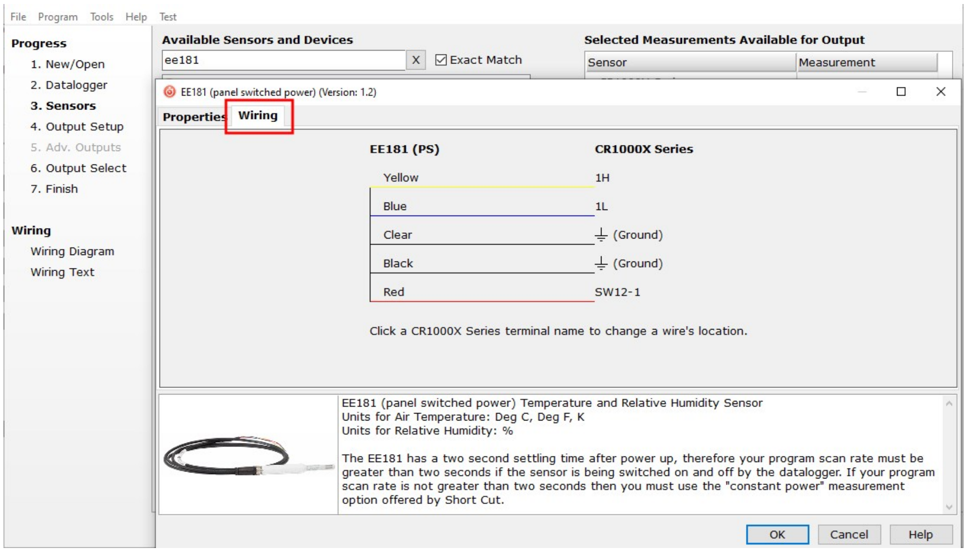
A video that describes data logger programming using ***Short Cut*** is available at: www.campbellsci.com/videos/cr1000x-data logger-getting-started-program-part-3. ***Short Cut*** is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. ***Short Cut*** is available as a download on www.campbellsci.com. It is included in installations of ***LoggerNet***, ***RTDAQ***, and ***PC400***.

Use the following procedure to get started.

1. Open ***Short Cut*** and click **Create New Program**.
2. Double-click the data logger model.
3. In the **Available Sensors and Devices** box, type EE181 or locate the sensor in the **Sensors** > **Meteorological** > **Relative Humidity & Temperature** > **EE181 Temperature and Relative Humidity Sensor** folder. Double-click either **EE181 (constant power)** or **EE181 (panel switched power)**; the panel switched power option uses less current but requires a scan rate that is greater than 5 seconds. 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.



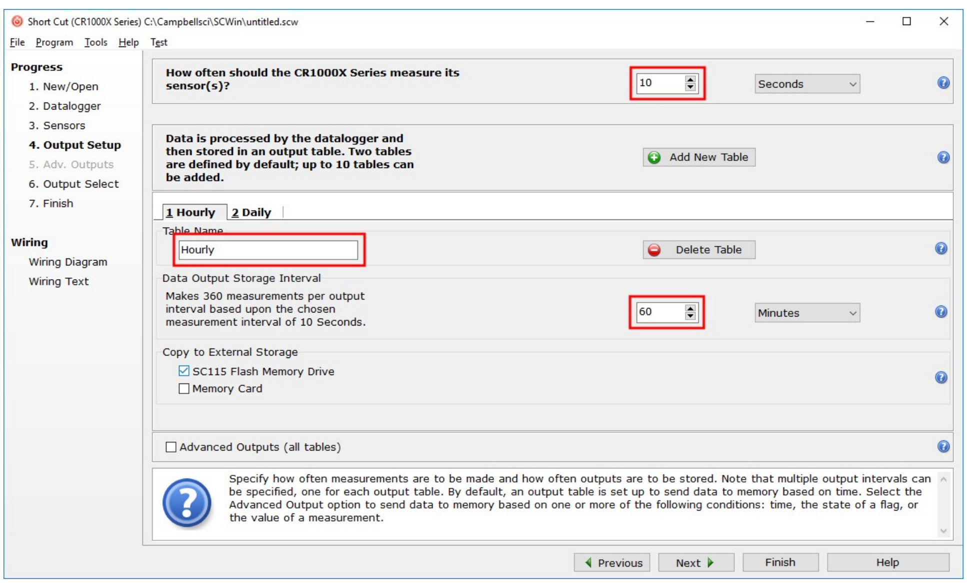
4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.



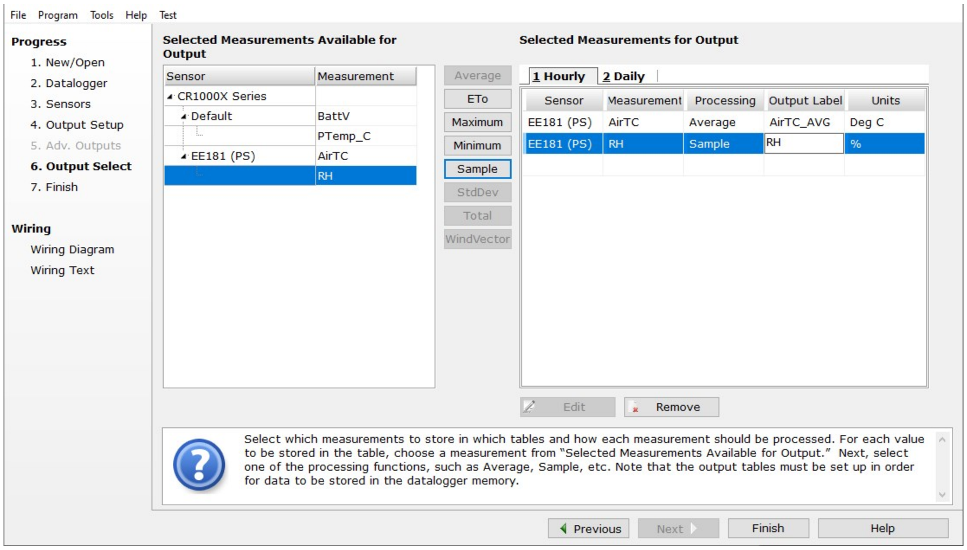
5. Repeat steps three and four for other sensors.

6. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**.

> **NOTE:**
> The EE181 has a two second settling time after power up; therefore, the scan rate must be greater than two seconds when using the panel switched power option.



7. Select the measurement and its associated output option.



8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
9. If the sensor is connected to the data logger, check the output of the sensor in the data display in ***LoggerNet***, ***RTDAQ***, or ***PC400*** to make sure it is making reasonable measurements.

5. Overview

The EE181 is a digital probe with linear voltage outputs for temperature and humidity. Its voltage signals are measured with two single-ended inputs on the data logger.

Campbell Scientific recommends 12 V power when used with our data loggers. When minimizing power use is important, power can be switched on and off for the measurement, provided there is a two-second warm-up delay. Switching power avoids constant current flow through data logger ground, which can affect the accuracy of low-level single-ended voltage measurements.

The EE181 uses a metal mesh filter with excellent response, protection against dust, and no water absorption.

Features:

- Well-suited for long-term, unattended applications
- Accurate and rugged
- Compatible with the following CRBasic data loggers: CR6, CR1000X, CR800 series, CR300 series, CR3000, CR1000

6. Specifications

Operating temperature:	–40 to 60 °C
Storage temperature:	–40 to 80 °C
Probe length:	160 mm (6.3 in), 172 mm (6.77 in) including connector
Probe diameter:	21 mm (0.83 in)
Weight with 5 m cable:	290 g (10.2 oz)
Housing:	Plastic material / IP65
Filter:	30 µm pore size, stainless steel mesh
Power consumption:	<1.2 mA at 12 V
Supply voltage (using Campbell Scientific cable):	7 to 30 VDC (12 VDC recommended)
Start-up time:	2 s typical
Maximum cable length:	300 m (1000 ft) with 12 V power
Analog outputs	
Offset at 0 V:	±3 mV (maximum)
Deviation from digital signal:	< ±1 mV (0.1 °C, 0.1% RH)
Compliance:	View the EU Declaration of Conformity at www.campbellsci.com/ee181-l

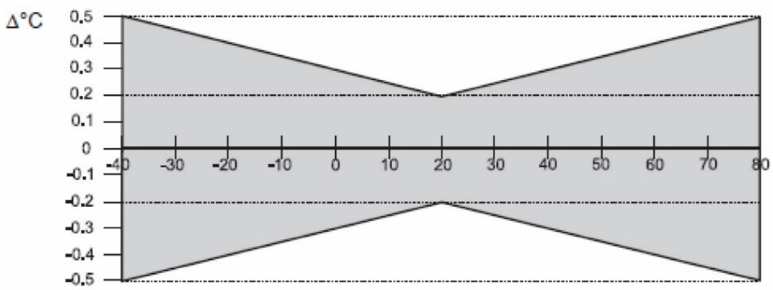
6.1 Temperature measurement

Sensor:	Pt1000 Class A
Measurement range:	–40 to 60 °C
Output signal range:	0 to 1.0 V
Accuracy at 23 °C:	±0.2 °C
Long term stability:	<0.1 °C/year

Sensor time constant [63% step change (1 m/s air flow at sensor)]

Standard PE filter:	≤22 s
Optional Teflon filter:	≤30 s

Accuracy over measurement range:



6.2 Relative humidity measurement

Sensor:		HC101
Measurement range:		0 to 100% non-condensing
Output signal range:		0 to 1.0 VDC
Accuracy* (including hysteresis, non-linearity and repeatability, traceable to international standards, administrated by NIST, PTB, BEV)		
–15 to 40 °C:	≤90% RH	± (1.3 + 0.003 • RH reading) % RH
–15 to 40 °C:	>90% RH	± 2.3% RH
–25 to 60 °C:		± (1.4 + 0.01 • RH reading) % RH
–40 to 60 °C:		± (1.5 + 0.015 • RH reading) % RH
Typical long-term stability:		<1% RH per year
Sensor time constant [63% of a 35 to 80% RH step change (1 m/s air flow at sensor)]		
Standard PE filter:		≤22 s
Optional Teflon filter:		≤30 s

* The accuracy statement includes the uncertainty of the factory calibration with an enhancement factor k=2 (2-times standard deviation).

The accuracy was calculated in accordance with EA-4/02 and with regard to GUM (Guide to the Expression of Uncertainty in Measurement).

7. Installation

If you are programming your data logger with ***Short Cut***, skip Wiring to data logger (p. 7) and Data logger programming (p. 7). ***Short Cut*** does this work for you. See QuickStart (p. 2) for a ***Short Cut*** tutorial.

7.1 Wiring to data logger

Connections to Campbell Scientific data loggers for measuring humidity and temperature using two single-ended analog inputs are given in Table 7-1 (p. 7). See Long cable lengths (p. 12) for a discussion on errors caused by long cable lengths.

Table 7-1: Wire color, function, and data logger connection for single-ended measurement

Wire color	Wire function	Data logger connection terminal
Yellow	Temperature signal	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
Blue	Relative humidity signal	**U** configured for single-ended analog input, **SE**
Black	Signal reference	⏚ (analog ground)
Clear	Shield	⏚
Red	Power	**12V** or **SW12V**

[1]**U** terminals are automatically configured by the measurement instruction.

7.2 Data logger programming

Short Cut is the best source for up-to-date programming code for Campbell Scientific data loggers. If your data acquisition requirements are simple, you can probably create and maintain a data logger 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 QuickStart (p. 2). If you wish to import ***Short Cut*** code into ***CRBasic Editor*** to create or add to a customized program, follow the procedure in Importing Short Cut code into CRBasic Editor (p. 17). Programming basics for CRBasic data loggers are provided in the following sections. Complete program examples for select data loggers can be found in Example programs (p. 18).

Measure the EE181 with the `VoltSE()` measurement instruction as described in the following section.

For a discussion on errors caused by long cable lengths, see Long cable lengths (p. 12).

7.2.1 `VoltSE()` instruction

When cable lengths are shorter than 6.1 meters or when power is switched, use the `VoltSE()` measurement instruction to measure the temperature and relative humidity. The EE181 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**

> NOTE:
> When the probe is connected to a CS110 Electric Field Meter, the probe is measured by the CS110 internal CR1000 data logger module using `VoltSE()` instructions. Relative humidity and temperature signals are measured on single-ended terminals 1 and 2, respectively. 250 µs integration should be used in the `VoltSE()` instructions.

7.3 Mounting

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 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 to 2.0 m (WMO)
2.0 m (EPA)

See Attributions and References (p. 16) for a list of references that discuss temperature and relative humidity sensors.

When used in the field, the EE181 must be housed in a radiation shield such as the RAD10E naturally aspirated shields.

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 RAD10E uses a double-louvered design that offers improved sensor protection from insect intrusion and driving rain and snow. In addition, the RAD10E shield has 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.

The RAD10E radiation shield 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. See FIGURE 7-2 (p. 12) for an example of shield mounting.

The optimal location for the EE181 sensor tip inside a multi-plate shield is approximately 1/3 to 1/2 of the way down from the top shield plate. With a ten-plate shield, the tip of the EE181 should be located around three to four plates down from the top of the shield. See FIGURE 7-1 (p. 10).

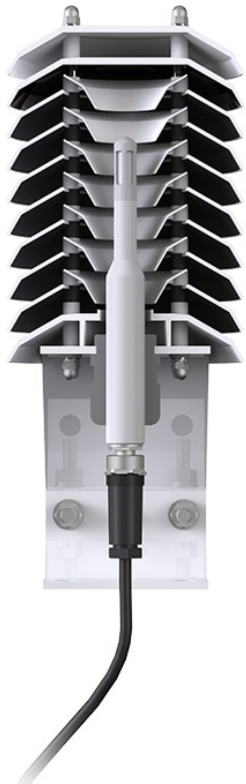


FIGURE 7-1. EE181 sensor placement in a RAD10E multi-plate shield

Tools required:

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

Attach the probe to the cable by aligning the keyed connectors, pushing the connectors together, and finger tightening the knurled ring.

> **CAUTION:**
> Only finger tighten the knurled ring. Using a wrench may damage the connector.

7.3.1 Shield installation

Campbell Scientific recommends the EE181 with the MetSpec RAD10E multi-plate radiation shield due to shield performance in bright sunlight and low wind speeds as well as over snow or reflective surfaces. The EE181 will work with the RM Young 10-plate shield but requires an adapter to accommodate sensor girth.

NOTE:
Do not mount the shield or route the sensor cable into the enclosure until after the EE181 is installed inside the shield.

7.3.1.1 Installation in a RAD10E 10-plate shield

1. Loosen the nut on the entry gland at the bottom of the shield.
2. Insert sensor into the bottom of the multi-plate shield. Situate the gland so it’s 1.25 to 2.5 cm (0.5 to 1 in) above the sensor connector. See FIGURE 7-1 (p. 10).
3. Using an adjustable wrench, tighten down the nut on the gland until the sensor is held firmly in place. Do not overtighten.

7.3.1.2 Installation in a 41003-5 10-plate shield

1. Slide the adapter over the sensor body and situate the adapter so it’s 1.25 to 2.5 cm (0.5 to 1 in) above the sensor connector.
2. Insert sensor and adapter into the bottom of the multi-plate shield.
3. Hold the collar and sensor and finish threading the collar into the shield by hand. Tighten the collar around the probe until it firmly grips the body of the probe. Use an adjustable wrench if necessary, but do not overtighten the collar.

7.3.2 Mount the shield

1. Attach the radiation shield to the tripod mast, crossarm, or tower leg using the supplied U-bolt. See FIGURE 7-2 (p. 12) for an example of shield mounting.
2. Route the cable to the data logger, 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 7-2. EE181 and RAD10E solar radiation shield on a tripod mast

8. Operation

8.1 Measurement

The probe uses E+E Elektronik coated HC101 capacitive sensor to measure RH and a 1000 Ω PRT to measure temperature. Campbell Scientific data loggers measure the analog voltage outputs of the EE181 Temperature and Relative Humidity Probe with the `VoltSE()` measurement instruction.

8.2 Low power operation

The EE181 draws less than 1.2 mA powered from 12 V. The EE181 can be continuously powered from the **12V** terminal, or power can be switched with the **SW12V** terminal to conserve battery life. When power is switched, a two-second warm-up period is required. This is programmed with the `Delay()` instruction, using 0 for the delay option.

8.3 Long cable lengths

Long cable lengths cause errors in the measured temperature and relative humidity. The approximate error in temperature and relative humidity is 0.31 °C and 0.31% per 100 feet of cable length, respectively.

When long cable lengths are required and the above errors in temperature and relative humidity are unacceptable, use the HMP155A temperature and relative humidity probe instead.

Understanding the following details are not required for the general operation of the EE181 with Campbell Scientific data loggers. The signal reference and the power ground (black) are the same wire in the EE181. When the EE181 temperature and relative humidity are measured, both the signal reference and power ground are connected to ground at the data logger. The signal reference/power ground wire serves as the return path for 12 V. There will be a voltage drop along this wire because the wire has resistance. The EE181 draws approximately 1.2 mA (worst case) when it is powered. The wire used in the EE181 has resistance of 25.67 Ω/1000 feet. Using Ohm's law, the voltage drop (V_d), along the signal reference/power ground wire, is given by Eq. 1 (p. 13).

$$\begin{aligned} V_d &= I \times R \\ &= 1.2\ \mathrm{mA} \times 25.67\ \Omega/1000\ \mathrm{ft} \\ &= 30.804\ \mathrm{mV}/1000\ \mathrm{ft} \end{aligned}$$ **Eq. 1**

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

8.4 Absolute humidity

The EE181 measures relative humidity. Relative humidity is defined by the following equation:

$$\mathrm{RH} = \frac{\mathrm{e}}{\mathrm{e_s}} \times 100$$ **Eq. 2**

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 dewpoint temperature. The saturation vapor pressure is the maximum amount of water vapor that air can hold at a given air temperature. The relationship between dewpoint and vapor pressure, and air temperature and saturation vapor pressure are given by Goff and Gratch (1946), Lowe (1977), and Weiss (1977). Relative humidity is relative to saturation above water, even below freezing point. This is why these sensors should not measure 100% RH below zero degrees C, as described in Measurement below 0 °C (p. 14).

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. 2 (p. 13) that a change in air temperature will change the relative humidity, without causing a change 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, the air can hold more water vapor. 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 online by the data logger (see CRBasic Example 2 (p. 19)).

8.4.1 Measurement below 0 °C

The EE181 provides a humidity reading that is referenced to the saturated water vapor pressure above liquid water, even at temperatures below 0 °C, where ice might form. This is the common way to express relative humidity and is as defined by the World Meteorological Organization. If an RH value is required referenced to ice, the EE181 readings will need to be corrected.

One consequence of using water as the reference is that the maximum humidity that will normally be output by the sensor for temperatures below freezing is as follows:

100% RH at 0 °C	82% RH at –20 °C
95% RH at –5 °C	78% RH at –25 °C
91% RH at –10 °C	75% RH at –30 °C
87% RH at –15 °C	

In practical terms this means that, for instance, at –20 °C the air is effectively fully saturated when the sensor outputs 82% RH.

9. Troubleshooting and maintenance

> **NOTE:**
> All factory repairs and recalibrations require a returned materials authorization (RMA) and completion of the "Declaration of Hazardous Material and Decontamination" form. Refer to the Assistance page at the end of this manual for more information.

9.1 Troubleshooting

Symptom: Relative Humidity is reported as –9999, NAN, –40 °C, or 0%

1. Check that the sensor is wired to the correct analog input terminals as specified by the measurement instructions.
2. Verify the range code for the single-ended measurement instruction is correct for the data logger type.
3. Verify the red power wire is correctly wired to the **12V** or **SW12V** terminal. The terminal the wire is connected to will depend on the data logger program.

   Connect the red wire to a **12V** terminal to constantly power the sensor for troubleshooting purposes. With the red wire connected to 12V, a voltmeter can be used to check the output voltage for temperature and relative humidity on the yellow and blue wires respectively (temperature °C = mV • 0.14 – 40.0; relative humidity % = mV • 0.1).

Symptom: Incorrect temperature or relative humidity

1. Verify the multiplier and offset parameters are correct for the desired units (VoltSE() instruction (p. 8)).

9.2 Maintenance

The EE181 probe requires minimal maintenance, but dust, debris, and salts on the filter cap will degrade sensor performance. Check the metal mesh filter on the end of the sensor for debris. If dirt or salt is engrained into the filter, it should be cleaned with distilled water or replaced. For particularly stubborn contamination, swish the entire probe tip in isopropyl alcohol (rubbing alcohol) and rinse off with distilled water. Make sure the filter is connected firmly with your fingers — do not over tighten.

Check the radiation shield monthly to make sure it is free from dust and debris. To clean the shield, remove the sensor from the shield. 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.

Replace filters that cannot be successfully cleaned. To replace the filter, unscrew the filter from the probe and pull it straight away, being careful not to bend or damage the sensors. Before putting on the replacement filter, check the alignment of the sensors with the probe, and if necessary, carefully correct the alignment before installing the filter.

A coating of salt (mostly NaCl) may build up on the radiation shield, sensor, filter and even the sensor element. A buildup of salt on the filter or sensors will delay or destroy the response to atmospheric humidity.

Long-term exposure of the relative humidity sensor to certain chemicals and gases may affect the characteristics of the sensor and shorten its life. The resistance of the sensor depends strongly on the temperature and humidity conditions and the length of the pollutant influence.

The sensor should be calibrated annually. Please refer to the Limited warranty and Assistance sections at the end of the manual for more information.

10. Attributions and References

E+E Elektronik® is a registered trademark of E+E Elektronik Ges.m.b.H.

Santoprene® is a registered trademark of Exxon Mobile Corporation.

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

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Appendix A. Importing ***Short Cut*** code into ***CRBasic Editor***

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the ***CRBasic Editor***. By default, these files reside in the C:\campbellsci\SCWin folder.

Import ***Short Cut*** program file and wiring information into ***CRBasic Editor***:

1. Create the ***Short Cut*** program. After saving the ***Short Cut*** program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > NOTE:
   > Once the file is edited with ***CRBasic Editor***, ***Short Cut*** can no longer be used to edit the program it created.

2. To add the ***Short Cut*** wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information into it.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video ▶.

Appendix B. Example programs

The following examples are for the CR6 data logger. Other data loggers are programmed similarly.

CRBasic Example 1: CR6 program measuring the EE181

```
'Program measures EE181 with single-ended inputs once every 5 seconds
'and stores the average temperature and a sample of the relative
'humidity every 60 minutes.


'Wiring Diagram
'==============
'EE181
'Wire CR6
'Color: Function - Terminal
'------ -------- --------
'Red: Power - SW12-1
'Yellow: Temperature signal - U1
'Blue: Relative Humidity signal - U2
'Black: Power Ground - Ground Symbol
'Clear: Shield - Ground Symbol

Public AirTC : Units AirTC = °C
Public RH : Units RH = %

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

BeginProg
  Scan(5,Sec,1,0)
    SW12 (1,1 ) 'Turn on switched 12V
    Delay(0,2,Sec) '2-second delay
    'EE181 Temperature & Relative Humidity Sensor measurements AirTC and RH:
    VoltSe(AirTC,1,mV1000,U1,0,0,60,0.1,-40)
    VoltSe(RH,1,mV1000,U2,0,0,60,0.1,0)
    SW12 (1,0 ) 'Turn off switched 12V
    CallTable(Temp_RH)
  NextScan
EndProg
```

CRBasic Example 2: CR6 program that computes vapor pressure and saturation vapor pressure

```
'Program measures EE181 with single-ended inputs once every 5 seconds
'and stores the average temperature and a sample of the relative
'humidity every 60 minutes.

'Wiring Diagram
'==============
'EE181
'Wire CR6
'Color: Function - Terminal
'------ -------- --------
'Red: Power - SW12-1
'Yellow: Temperature signal - U1
'Blue: Relative Humidity signal - U2
'Black: Power Ground - Ground Symbol
'Clear: Shield - Ground Symbol

Public AirTC : Units AirTC = °C
Public RH : Units RH = %
Public e_Sat : Units e_Sat = kPa
Public e_kPa : Units e_kPa = kPa

DataTable(Temp_RH,True,-1)
  DataInterval(0,60,Min,0)
  Average(1,AirTC,FP2,0)
  Sample(1,RH,FP2)
  Sample(1,e_kPa,IEEE4)
EndTable

BeginProg
  Scan(5,Sec,1,0)
    SW12 (1,1 ) 'Turn on switched 12V
    Delay(0,2,Sec) '2-second delay
    'EE181 Temperature & Relative Humidity Sensor measurements
    'AirTC and RH:
    VoltSe(AirTC,1,mV1000,U1,0,0,60,0.1,-40.0)
    VoltSe(RH,1,mV1000,U2,0,0,60,0.1,0)
    SW12 (1,0 ) 'Turn off switched 12V
    'Calculate Vapor Pressure
    'Calculate Saturation Vapor Pressure
    SatVP(e_Sat, AirTC)
    'Compute Vapor Pressure, RH must be a fraction
    e_kPa = e_Sat * RH/100
    CallTable(Temp_RH)
  NextScan
EndProg
```

Limited warranty

Products manufactured by Campbell Scientific are warranted by Campbell Scientific to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified on the corresponding product webpage. See Product Details on the Ordering Information pages at www.campbellsci.com. Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

Refer to www.campbellsci.com/terms#warranty for more information.

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Assistance

Products may not be returned without prior authorization.

Products shipped to Campbell Scientific require a Returned Materials Authorization (RMA) or Repair Reference number and must be clean and uncontaminated by harmful substances, such as hazardous materials, chemicals, insects, and pests. Please complete the required forms prior to shipping equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page for the Global Sales and Support Network or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country.

To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Safety

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.com. 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 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

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- 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.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

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.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

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

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Global Sales & Support Network

A worldwide network to help meet your needs

Campbell Scientific Regional Offices

Australia

Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

India

Location: New Delhi, DL India
Phone: 91.11.46500481.482
Email: info@campbellsci.in
Website: www.campbellsci.in

South Africa

Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Spain

Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

Thailand

Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: info@campbellsci.asia
Website: www.campbellsci.asia

UK

Location: Shepshed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA

Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com