Product Manual

Sensor

# HMP155A

## Temperature and Relative Humidity Probe

Revision: 10/2021

CSL I.D - 868

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

# Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, 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. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

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.


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# 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.

Part numbers prefixed with a "#" symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

## 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.

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# *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.eu or by telephoning +44(0) 1509 828 888 (UK). 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**

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- 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, or 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 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.

# Table of contents

# 1. Introduction

The HMP155A probe monitors relative humidity (RH) for the range of 0 to 100% RH and temperature for the range of –80 to 60 °C. It provides reliable measurements for a wide range of applications as part of a weather station system or as a single instrument. All Campbell Scientific data loggers are compatible.

> NOTE:
> This manual provides information only for CRBasic data loggers. For retired Edlog data logger support, see an older manual at www.campbellsci.com/old-manuals.

# 2. Precautions

- READ AND UNDERSTAND the Safety section at the front 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 HMP155A 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

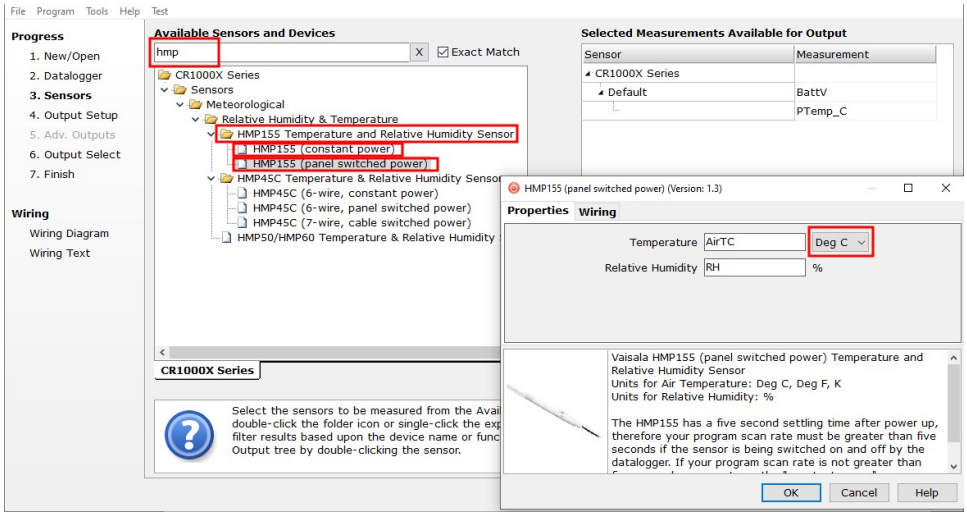
- Upon receipt of the HMP155A, inspect the packaging and contents for damage. File damage claims with the shipping company.
- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the expected product and cable length were received.

# 4. QuickStart

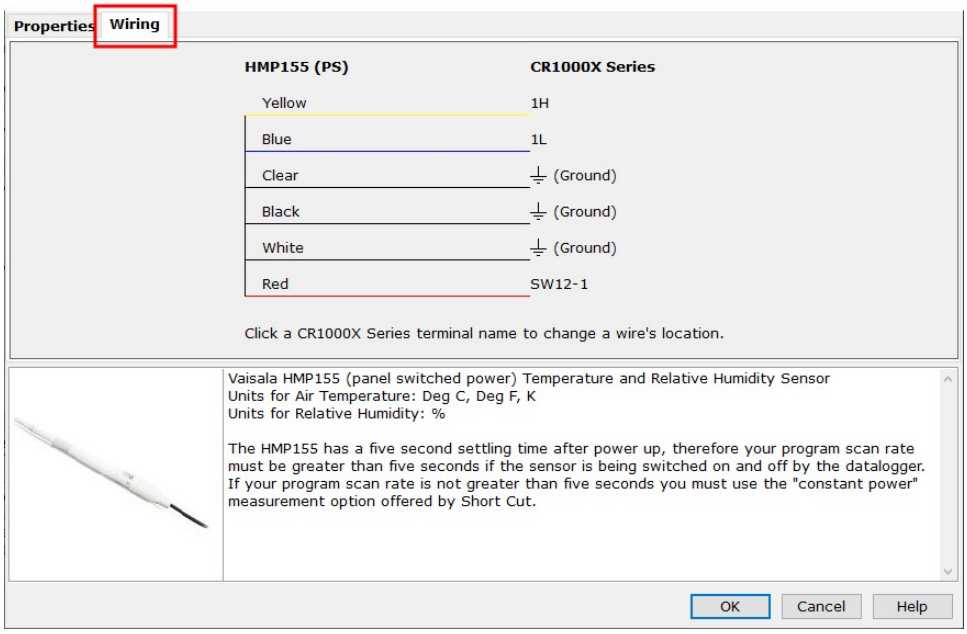
A video that describes data logger programming using *Short Cut* is available at: www.campbellsci.eu/videos/cr1000x-data logger-getting-started-program-part-3. *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available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

The following procedure also shows using *Short Cut* to program the HMP155A.

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 HMP155A or locate the sensor in the **Sensors** > **Meteorological** > **Relative Humidity & Temperature** > **HMP155 Temperature and Relative Humidity Sensor** folder. Double-click either **HMP155 (constant power)** or **HMP155 (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.

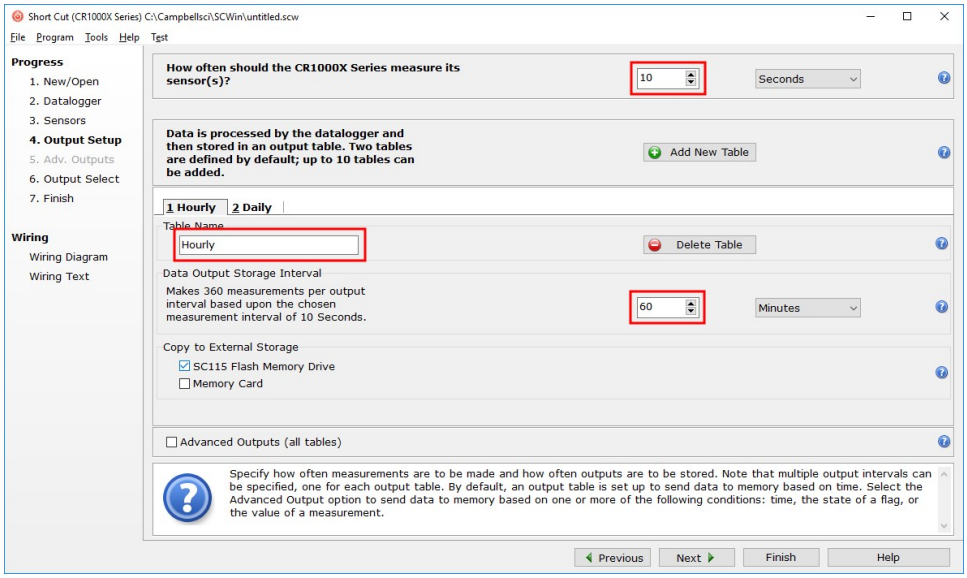


4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

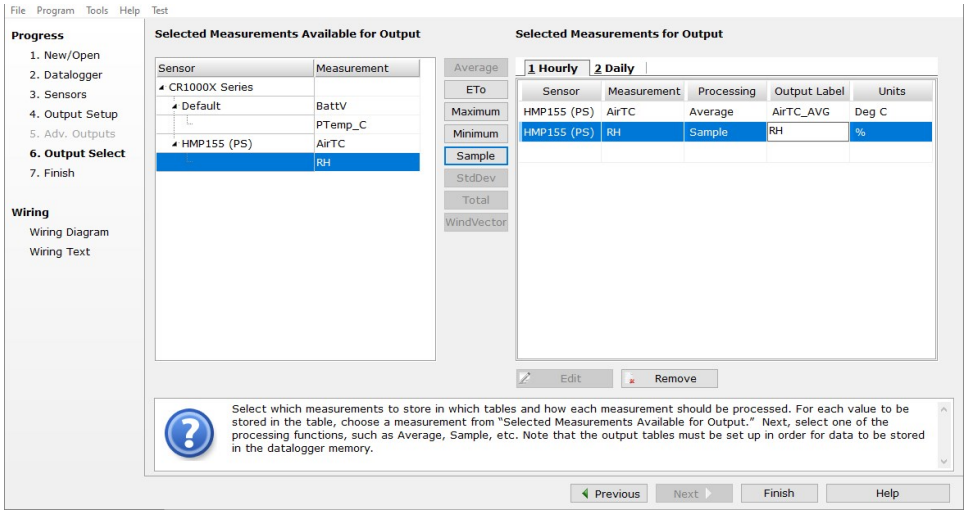



5. Repeat steps three and four for other sensors.
6. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**.

> **NOTE:**
> The HMP155A has a five second settling time after power up; therefore the scan rate must be greater than five 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 HMP155A Temperature and Relative Humidity probe contains a platinum resistance temperature detector (PRT) and a Vaisala HUMICAP® 180 capacitive relative humidity sensor.

The HMP155A outputs a 0 to 1 VDC signal for temperature and relative humidity that can be measured by all models of Campbell Scientific data loggers with model HMP155ACBL1 cable. The HMP155A also has RS-485 outputs for temperature and relative humidity that can be directly interfaced to the CR6 and CR1000X data logger using the HMP155ACBL2 cable. The RS-485 output can also be used with our CR800, CR850, CR3000, and CR1000 data loggers, but they require both the HMP155ACBL2 cable and the SDM-SIO1A or SDM-SIO4A Serial I/O Module (RS-485 output (p. 22)). The RS-485 output has a higher current drain than that listed in the specifications.

The HMP155A can be powered continuously, or the power may be switched to conserve battery life. The HMP155A consumes less than 3 milliamps current at 12 VDC. Approximately 2 seconds is required for the sensor to warm up after power is switched on. At measurement rates slower than once per 5 seconds, the overall power consumption (data logger and sensors) may be reduced

by switching power to the HMP155A. Current Campbell Scientific data loggers have a built-in switched 12 VDC that can be used to control power.

> NOTE:
> HMP155A sensors purchased directly from Vaisala with serial numbers < E4430001 require approximately 5 seconds warm up time.

Features:

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

# 6. Specifications

Dimensions in mm [inches]

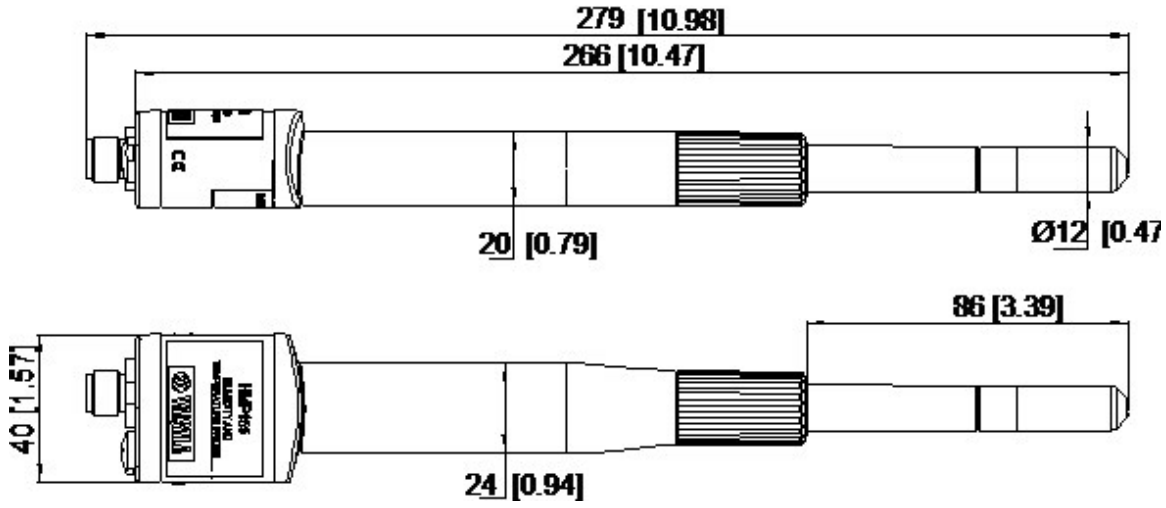



*FIGURE 6-1. Probe dimensions*

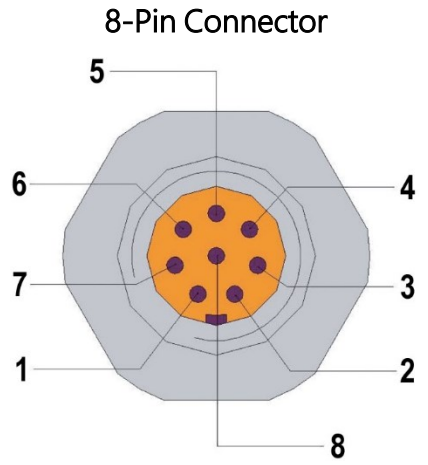



*FIGURE 6-2. Wiring of HMP155A 8-pin connector*

*HMP155ACBL1 Cable provided by Campbell Scientific

1 = $V_{OUT}1$ (yellow, temp)

2 = no connection

3 = $A_{GND}$ (white)

4 = $V_{OUT}2$ (blue, RH)

5 = no connection

6 = no connection

7 = $V_{CC}$ (red)

8 = GND (black)

– = SHIELD (clear)

*Note: HMP155ACBL2 for RS-485 is described in RS-485 output (p. 22).

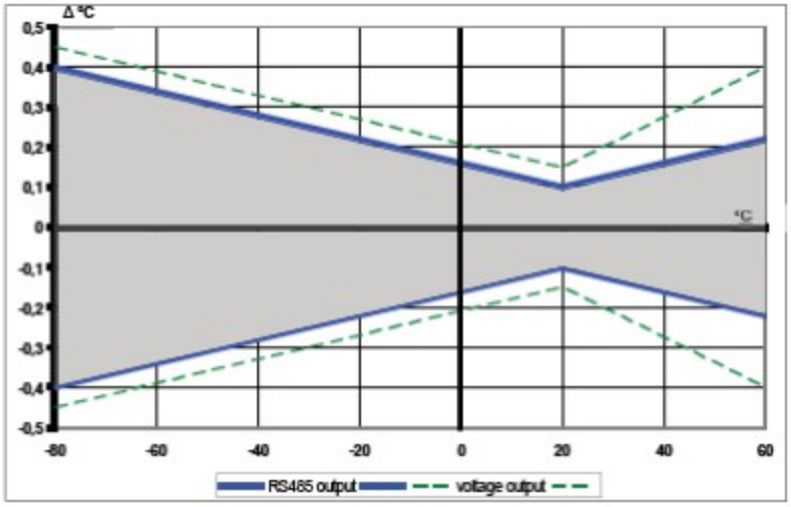
| | |
|---|---|
| **Operating temperature range for humidity measurement:** | –80 to 60 °C (–112 to 140 °F) |
| **Storage temperature range:** | –80° to 60 °C (–112 to 140 °F) |
| **Electromagnetic compatibility:** | Complies with EMC standard EN61326-1, Electrical equipment for measurement control and laboratory use - EMC requirements for use in industrial locations |
| **Filter:** | Sintered PTFE |
| **Housing material:** | PC |
| **Housing classification:** | IP66 |

| | |
|---|---|
| **Weight:** | 86 g (3 oz) |
| **Voltage outputs:** | 0 to 1 VDC |
| **Average current consumption:** | <3 mA (analogue output mode) |
| **Operating voltage:** | 7 to 28 VDC |
| **Settling time at power-up:** | 2 s |

# 6.1 Temperature sensor

| | |
|---|---|
| **Measurement range:** | –80 to 60 °C (–112 to 140 °F) |
| **Accuracy with voltage output** | |
| **at –80 to 20 °C:** | ±(0.226 – 0.0028 x temperature) °C |
| **at 20 to 60 °C:** | ±(0.055 + 0.0057 x temperature) °C |

See the following graph:




| | |
|---|---|
| **Temperature sensor:** | Pt 100 RTD 1/3 Class B IEC 751 |
| **Response time (63 %) for additional temperature probe in 3 m/s air flow:** | 63% <20 s<br>90% <35 s |

## 6.2 Relative humidity sensor

| | |
|---|---|
| **Measurement range:** | 0 to 100% RH |
| **Accuracy (including non-linearity, hysteresis and repeatability)** | |
| **15 to 25 °C (59 to 77 °F):** | ±1% RH (0 to 90% RH)<br>±1.7% RH (90 to 100% RH) |
| **-60 to -40 °C (-76 to -40 °F):** | ± (1.4 + 0.032 × reading) % RH |
| **-40 to -20 °C (-40 to -4 °F):** | ± (1.2 + 0.012 × reading) % RH |
| **-20 to 40 °C (-4 to 104 °F):** | ± (1.0 + 0.008 × reading) % RH |
| **40 to 60 °C (104 to 140 °F):** | ± (1.2 + 0.012 × reading) % RH |
| **Factory calibration uncertainty (20 °C):** | ±0.6% RH (0 to 40% RH)<br>±1.0% RH (40 to 97% RH)<br>(Defined as ±2 standard deviation limits. Small variations possible, see also calibration certificate.) |
| **Humidity sensor:** | HUMICAP®180R |
| **Response time for HUMICAP®180R(C) at 20 °C in still air with sintered PTFE filter and a 0% to 75% RH step change:** | 20 s (63% step change);<br>60 s (90% step change) |

# 7. Installation

If you are programming your data logger with ***Short Cut***, skip Wiring to data logger (p. 8) and Data logger programming (p. 10). ***Short Cut*** does this work for you. See QuickStart (p. 2) for a ***Short Cut*** tutorial.

## 7.1 Wiring to data logger

The HMP155A probe can be measured with two single-ended or differential analogue input channels. Differential measurements are recommended for cable lengths greater than 6.1 m (20 ft). See Long cable lengths (p. 15).

Connections to CRBasic data loggers are given in Table 7-1 (p. 9) and Table 7-2 (p. 9). To wire an Edlog data logger, see an older manual at www.campbellsci.com/old-manuals, or contact Campbell Scientific for assistance.

Table 7-1: Wire colour, function, and data logger connection for single-ended measurements

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

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

**CAUTION:**
When measuring the HMP155A with single-ended measurements, the white and black wires must both be connected to ⏚. Doing otherwise will connect the data logger analogue and power ground planes to each other, which in some cases can cause offsets on low-level analogue measurements. To avoid 3 mA flowing into analogue ground, switch the sensor on/off for its own measurement.

Table 7-2: Wire colour, function, and data logger connection for differential measurements

| Wire colour | Wire function | Data logger connection terminal |
|---|---|---|
| Yellow | Temperature signal | **U** configured for differential analogue input H[1], **Diff H** |
| Jumper to White | Temperature signal reference | **U** configured for differential analogue input L, **Diff L** |
| Blue | Relative humidity signal | **U** configured for differential analogue input H, **Diff H** |
| White | Signal reference | **U** configured for differential analogue input L, **Diff L** |

| Table 7-2: Wire colour, function, and data logger connection for differential measurements | | |
|---|---|---|
| Wire colour | Wire function | Data logger connection terminal |
| Black | Power ground | G |
| 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. 21). Programming basics for CRBasic data loggers are provided in the following sections. Downloadable example programs are available at www.campbellsci.eu/downloads/hmp155a-example-programs.

Measure the HMP155A with either the `VoltSE()` or `VoltDiff()` measurement instruction as described in the following sections.

For a discussion on errors caused by long cable lengths, see Long cable lengths (p. 15).

> NOTE:
> HMP155A sensors purchased directly from Vaisala with serial numbers < E4430001 require approximately 5 seconds warm up time.

## 7.2.1 `VoltSE()` instruction

When cable lengths are shorter than 6.1 metres or when power is switched, use the `VoltSE()` measurement instruction to measure the temperature and relative humidity. The HMP155A output scale is 0 to 1000 millivolts for the temperature range of –80 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 0.14 and `Offset` to –80
- Temperature reported as °F – set `Mult` to .252 and `Offset` to –112
- 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

### 7.2.2 `VoltDiff()` instruction

When cable lengths are longer than 6.1 metres or when the sensor is constantly powered, the `VoltDiff()` measurement instruction is used to measure the HMP155A sensor. The HMP155A output scale is 0 to 1000 millivolts for the temperature range of -80 to 60 °C and for the relative humidity range of 0 to 100%.

```
VoltDiff(Dest, Reps, Range, DiffChan, RevDiff, SettlingTime, Integ/FNotch, Mult,
Offset)
```

Variations:

- Temperature reported as °C – set `Mult` to 0.14 and `Offset` to –80
- Temperature reported as °F – set `Mult` to .252 and `Offset` to –112
- 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 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 References (p. 19) for a list of references that discuss temperature and relative humidity sensors.

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

To install the HMP155A, you will need the 41005-5 or RAD14 14-Plate Radiation Shield. The HMP155A is packaged with a white connector cover and a yellow sensor head protective cap. See FIGURE 7-1 (p. 12).

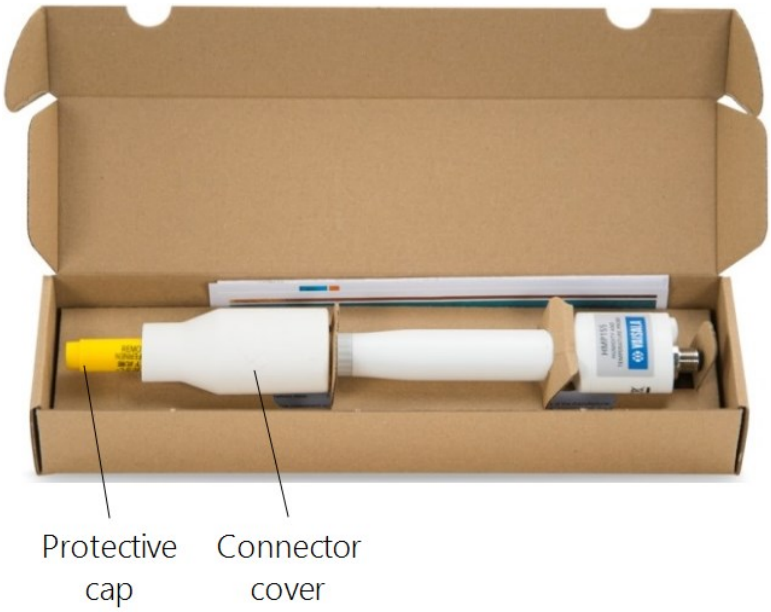



*FIGURE 7-1. HMP155A in shipping box*

1. Slide the white connector cover off the sensor head before removing the sensor from the box.

2. Squeeze the sides of the white connector cover and insert the cable's connector through it (see FIGURE 7-2 (p. 13)).


*FIGURE 7-2. Cable routed through the connector cover*

3. Attach the cable to the mating connector on the bottom of the HMP155A (see FIGURE 7-3 (p. 13)).

*FIGURE 7-3. Cable connected to the sensor*

4. Slide the white connector cover over the connector and gently push it up as far as it will go. The white connector cover has built-in molded stops that will only allow it to slide up so far (see FIGURE 7-4 (p. 13)).

*FIGURE 7-4. HMP155A with connector cover in place and without protective cap*

## 7.3.1 Installation in a 41005-5 14-plate shield

1. Loosely thread the collar adapter into the base of the 14-plate shield.
2. Remove the yellow protective cap on the HMP155A, and insert the sensor into the shield. See FIGURE 7-5 (p. 14) (left) and FIGURE 7-6 (p. 15).
3. Hold the collar and sensor, and finish threading the collar into the shield by hand. Tighten the hex plug so it compresses against the body of the HMP155A to hold it inside the 41005-5 radiation shield. Use an adjustable wrench if necessary, but do not overtighten the collar.

## 7.3.2 Installation in a RAD14 14-plate shield

1. Loosen the nut on the entry gland at the bottom of the shield.
2. Remove the yellow protective cap on the HMP155A, and insert the sensor into the shield.
3. Insert the sensor up into the gland as far as it will go. See FIGURE 7-5 (p. 14) (right).
4. Using an adjustable wrench, tighten down 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 7-5 (p. 14) and FIGURE 7-6 (p. 15) for examples of shield mounting.
2. Route the cable to the data logger, and secure the cable to the mounting structure using cable ties.

*FIGURE 7-5. HMP155A and 41005-5 14-plate radiation shield (left) and RAD14 (right) on a tripod mast*

*FIGURE 7-6. HMP155A and 41005-5 14-plate radiation shield on a CM200-series crossarm*

# 8. Operation

## 8.1 Measurement

The HMP155A uses a 100 Ω PRT to measure temperature and a Vaisala HUMICAP® 180 capacitive sensor to measure relative humidity. Campbell Scientific data loggers measure the analogue voltage outputs of the HMP155A Temperature and Relative Humidity Probe with either the `VoltSE()` or `VoltDiff()` measurement instruction.

## 8.2 Long cable lengths

This section describes the error associated with measuring the HMP155A with a single-ended measurement when the probe has a long cable. To avoid these problems, Campbell Scientific recommends measuring the HMP155A using a differential analogue measurement when long cable lengths are required. Generic data logger connections for measuring the HMP155A using a differential measurement are given in Table 7-2 (p. 9).

Understanding the details in this section is not required for the general operation of the HMP155A with Campbell Scientific data loggers.

The signal reference (white) and the power ground (black) are connected inside the HMP155A. When the HMP155A temperature and relative humidity are measured using a single-ended analogue measurement, both the signal reference and the power ground are connected to ground

at the data logger, and both serve as the return path for 12 V. The voltage will drop along those wires because the wires have resistance.

The HMP155A draws approximately 4 mA when it is powered. The wire used in the HMP155A has resistance of 27.7 Ω/1000 ft. Since the signal reference and the power ground are both connected to ground at the data logger, the effective resistance of those wires together is half of 27.7 Ω/1000 ft, or 13.9 Ω/1000 ft. Using Ohm's law, the voltage drop ($V_d$), along the signal reference/power ground, is given by Eq. 1 (p. 16).

$$\begin{aligned} V_d &= I \times R \\ &= 4\ \mathrm{mA} \times 13.9\ \Omega/1000\ \mathrm{ft} \\ &= 55.6\ \mathrm{mV}/1000\ \mathrm{ft} \end{aligned} \qquad \text{Eq. 1}$$

This voltage drop will raise the apparent temperature and relative humidity because the difference between the signal and the signal reference wire at the data logger has increased by $V_d$. The approximate error in temperature and relative humidity is 0.56 °C and 0.56% per 100 feet of cable length, respectively.

# 8.3 Absolute humidity

The HMP155A measures relative humidity. Relative humidity is defined by the following equation:

$$RH = \frac{e}{e_s} * 100 \qquad \text{Eq. 2}$$

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 dewpoint temperature. The saturation vapour pressure is the maximum amount of water vapour that air can hold at a given air temperature. The relationship between dewpoint 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 (p. 16) 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 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,

the air can hold more water vapour. 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 online by the data logger (see example program available at www.campbellsci.eu/downloads/hmp155a-example-programs).

# 9. Troubleshooting and maintenance

## 9.1 Troubleshooting

Symptom: Relative Humidity is reported as –9999, NAN, –80 °C, or 0%

1. Check that the sensor is wired to the correct analogue input channels as specified by the measurement instructions.
2. Verify the range code for the single-ended or differential measurement instruction is correct for the data logger type.
3. Verify the red power wire is correctly wired to the 12V or SW12V channel. The channel 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 – 80.0; relative humidity % = mV * 0.1).

Symptom: Incorrect temperature or relative humidity

1. Verify the multiplier and offset parameters are correct for the desired units (Data logger programming (p. 10)).

## 9.2 Maintenance

The HMP155A 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 contaminates.

When installed in close proximity to the ocean or other bodies of salt water, 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. Do not scratch the chip while cleaning.

Recalibrate the HMP155A annually. Refer to the About this manual page at the front of this document for the procedure for returning the HMP155A to the factory to get recalibrated.

### 9.2.1 Cleaning

Clean the probe with a soft, lint-free cloth moistened with mild detergent.

### 9.2.2 Changing the probe filter

1. Remove the filter from the probe.
2. After removing the filter, check the O-ring and change it if necessary.
3. Install a new filter on the probe.

New filters can be ordered from Campbell Scientific or Vaisala.

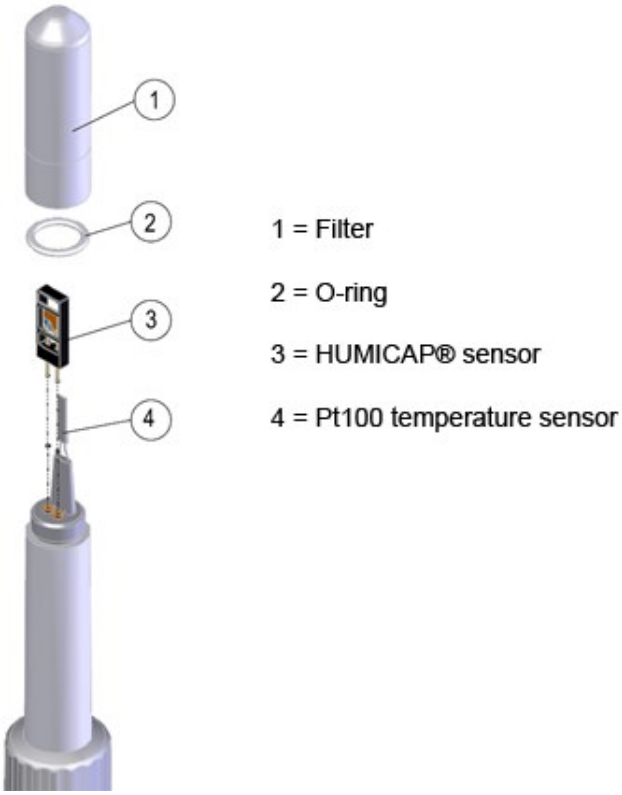



*FIGURE 9-1. Changing the filter*

Long term exposure of the HUMICAP® relative humidity sensor to certain chemicals and gases may affect the characteristics of the sensor and shorten its life. Table 9-1 (p. 19) lists the maximum ambient concentrations, of some chemicals, that the HUMICAP® can be exposed to.

Table 9-1: Chemical tolerances of HMP155A

| Chemical | Concentration (PPM) |
|---|---|
| Organic solvents | 1000 to 10,000 |
| Aggressive chemicals (e.g., $SO_2$, $H_2SO_4$, $H_2S$, HCl, $Cl_2$, etc.) | 1 to 10 |
| Weak acids | 100 to 1000 |
| Bases | 10,000 to 100,000 |

# 10. References

Santoprene® is a registered trademark of Exxon Mobile Corporation.

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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.

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.

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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.

# 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. RS-485 output

The HMP155A outputs a 0 to 1 VDC signal for temperature and relative humidity that can be measured by all models of Campbell Scientific data loggers with model HMP155ACBL1 cable. The HMP155A also has RS-485 outputs for temperature and relative humidity that can be interfaced to the CR6 or CR1000X data loggers with model HMP155ACBL2 cable. The RS-485 output can also be used with our CR800, CR850, CR3000, and CR1000 data loggers, but they require both the HMP155ACBL2 cable and the SDM-SIO1A or SDM-SIO4A Serial I/O Module.

The data logger program that uses the SDM-SIO1A/SIO4A to read the RS-485 output is similar to the program that directly reads the RS-485 output. The data logger program should send the commands 'SMODE RUN' and 'R' to enable the RS-485 output. `SerialInRecord()` and `Mid()` instructions parse the serial string and put the temperature and relative humidity values into public variables. A downloadable example program is available at www.campbellsci.eu/downloads/hmp155a-example-programs.

The MD485 Multidrop Interface can also be used to interface the RS-485 outputs. This option requires a USB to RS-485 cable (available from Vaisala) to change the default baud rate of the RS-485 output from the default of 4800 to a baud rate supported by the MD485.

## B.1 SDM-SIO1A or SDM-SIO4A serial I/O module interface option

The SDM-SIO1A/SIO4A module is used to interface the RS-485 outputs of the HMP155A to the data logger. The SDM-SIO1A and SDM-SIO4A have the same functionality. The SDM-SIO4A has more terminals allowing more sensors to be connected to it. The SDM-SIO1A/SIO4A functions like a built-in serial port to the data logger. Data are buffered in the SIO1A/SIO4A and retrieved by the data logger using standard program instructions.

The following table provides wiring to the SDM-SIO1A/SIO4A.

| Table B-1: SDM-SIO1A/SIO4A wiring | | | | |
|---|---|---|---|---|
| HMP155ACBL2 cable | Vaisala cable[1] | SDM-SIO1A/SIO4A | Data logger | Pin-out |
| Blue | Pink | RTS/TD+ | | 6 |
| Yellow | Brown | Tx/TD - | | 2 |
| Black | Red | | G | 8 |
| Red | Blue | | 12V | 7 |
| White | Green | RG | | 3 |
| Clear | Black | | G | not connected |

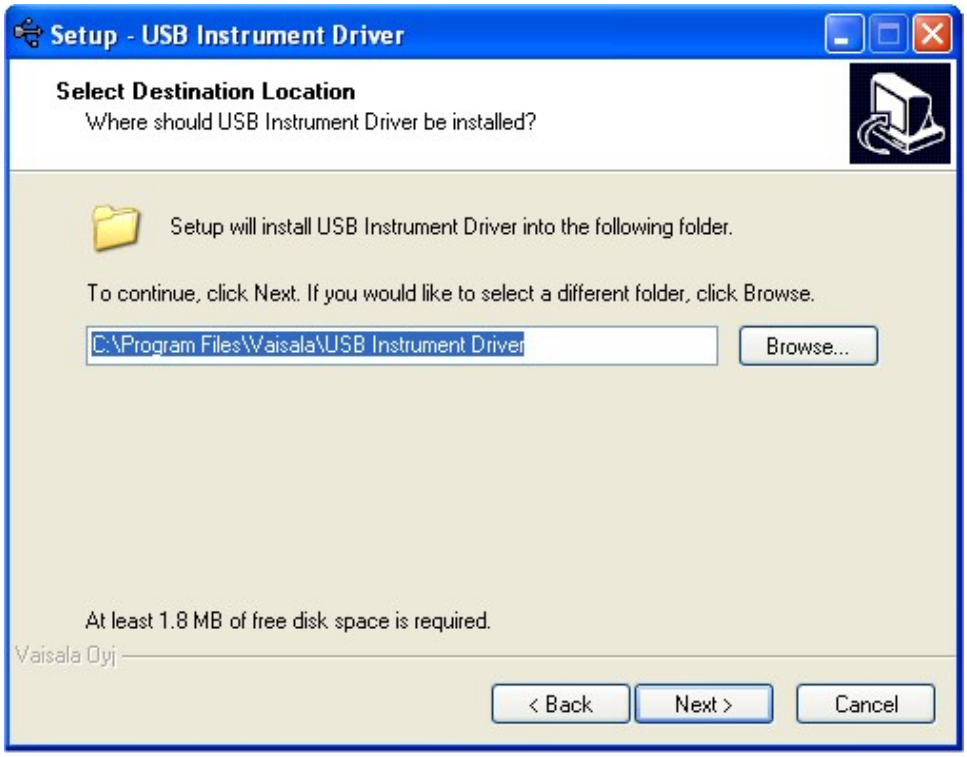
[1] The gray, pink, and brown wires on the Vaisala cable are not connected.

# B.2 MD485 interface option

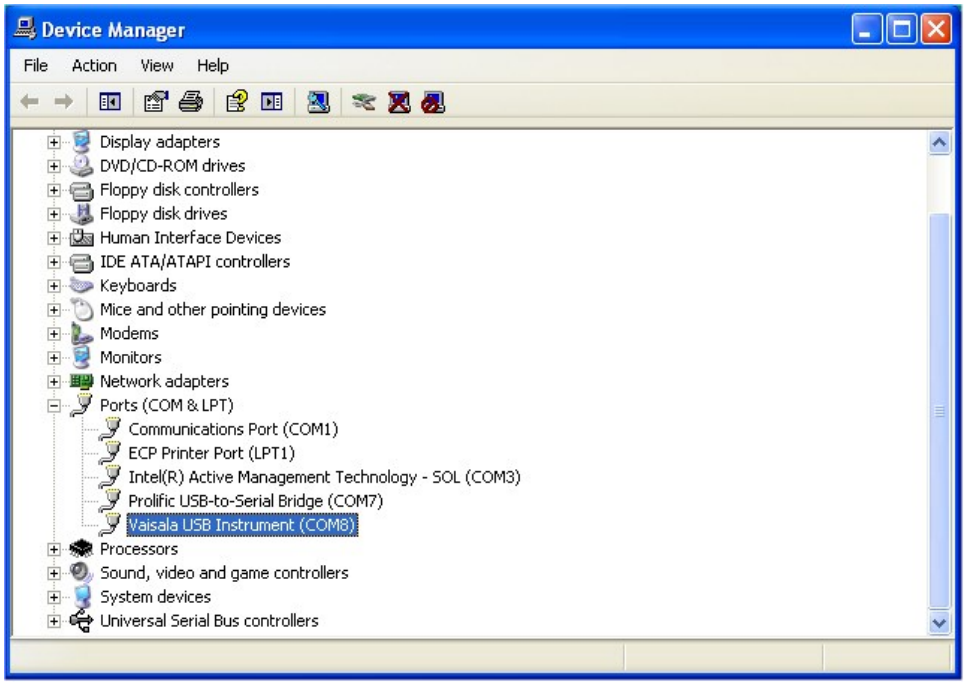
The MD485 Multidrop Interface can be used to interface the RS-485 outputs of the HMP155A to the data logger **CS I/O** port. Connect the MD485 **CS I/O** port to the data logger **CS I/O** port with an SC12 cable.

The HMP155A has a default RS-485 baud rate of 4800, which must be changed to 9600 to be compatible with the MD485. To change settings in the HMP155A, Vaisala USB to RS-485 cable is required to interface the HMP155A sensor to a computer. Commands to change settings are sent to the HMP155A using a terminal emulator such as Windows ***HyperTerminal***.

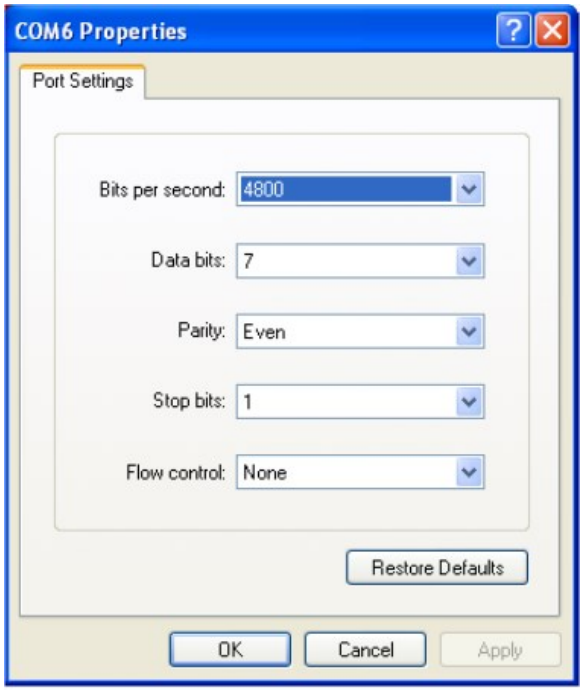
Vaisala USB to RS-485 cable includes a CD with drivers that must be installed on the computer before the cable can be used. Insert the CD into the computer CD drive and follow the prompts.




Use the **Device Manager** in Windows to determine which COM port the USB/RS-485 cable was assigned:



Configure Windows ***HyperTerminal*** for the appropriate COM port (for example, COM8 in the example above) for the default HMP155A RS-485 settings of 4800 baud, 7, E, 1.




Using ***HyperTerminal***, send the following commands to the HMP155A:

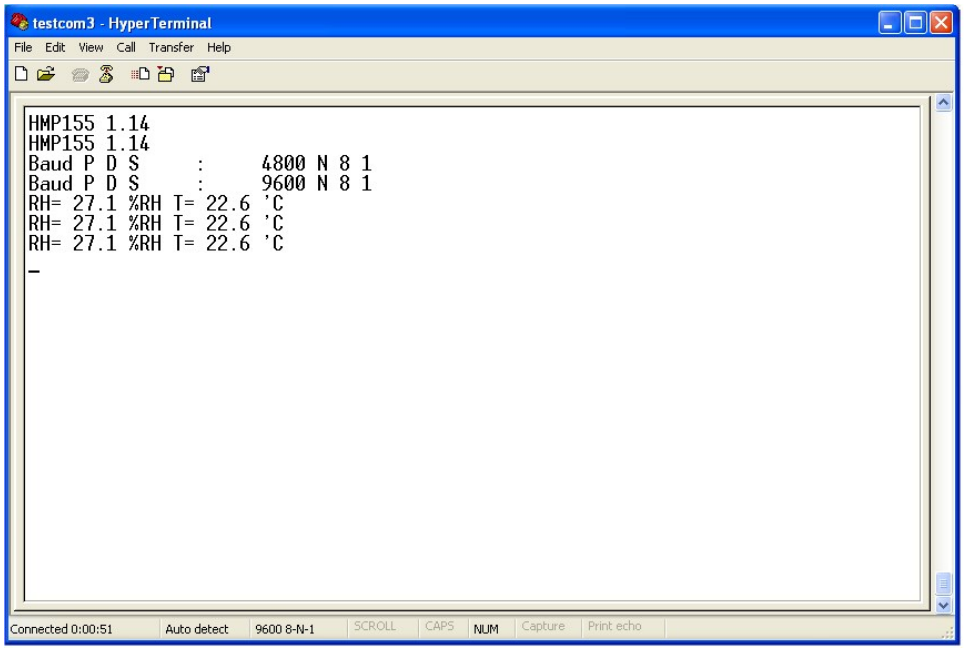
VERS[enter] to get a response from the sensor; for example, HMP155A 1.26

SERI[enter] to get the current RS-485 settings; for example, 4800 E 7 1

SERI 9600 N 8 1[enter] to change the RS-485 settings; response should be 9600 N 8 1

R[enter] to put the sensor in the Run mode to output continuous measurements

The following shows the responses to the commands.

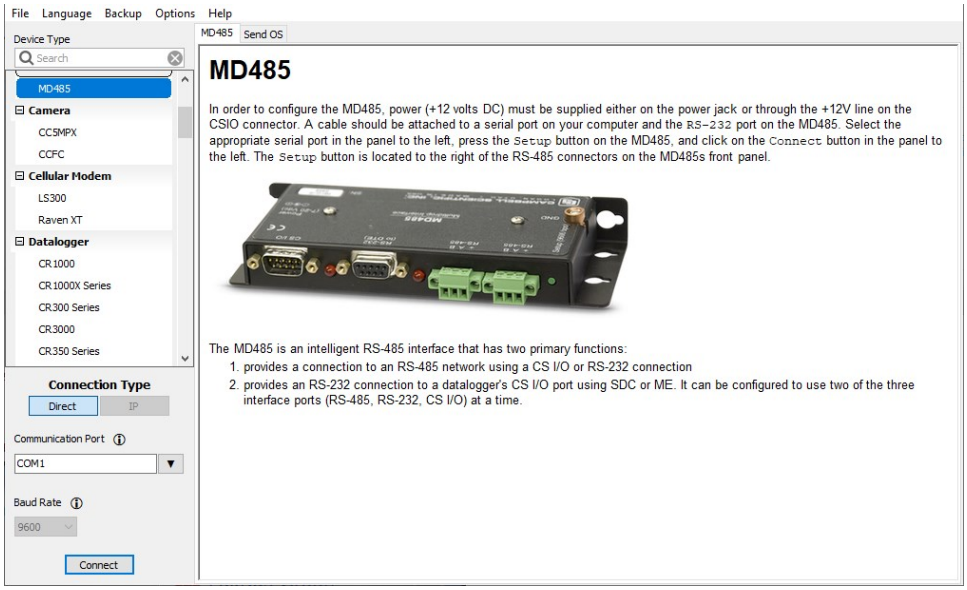



After changing the settings, change the baud rate in ***HyperTerminal*** to 9600, and make sure the relative humidity and temperature string is being displayed before connecting the sensor to the MD485.

# B.2.1 MD485 multidrop interface configuration

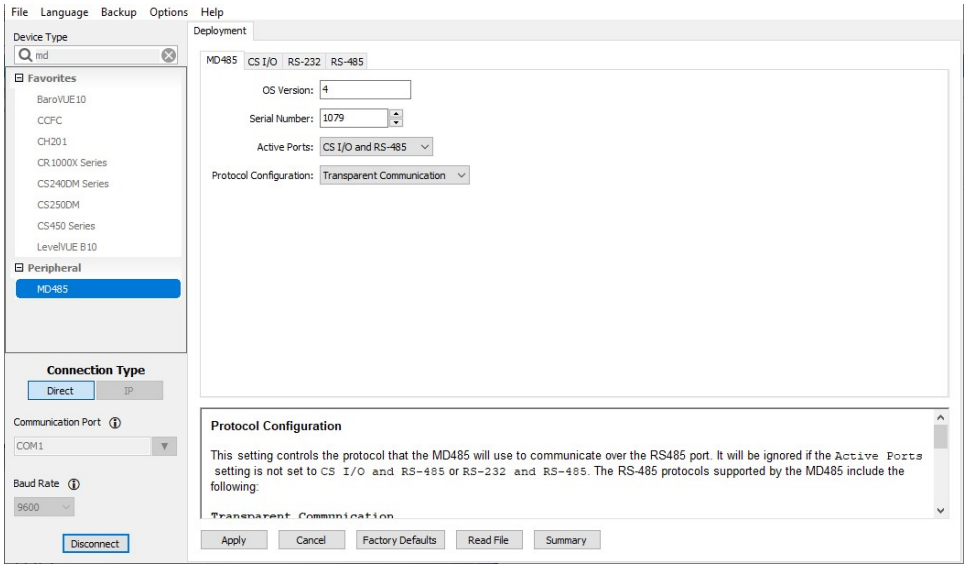
Using the ***Device Configuration Utility***, configure the MD485 using the following procedure.

1. Open ***Device Configuration Utility***.
2. Type MD485 in the **Device Type** box and click MD485.

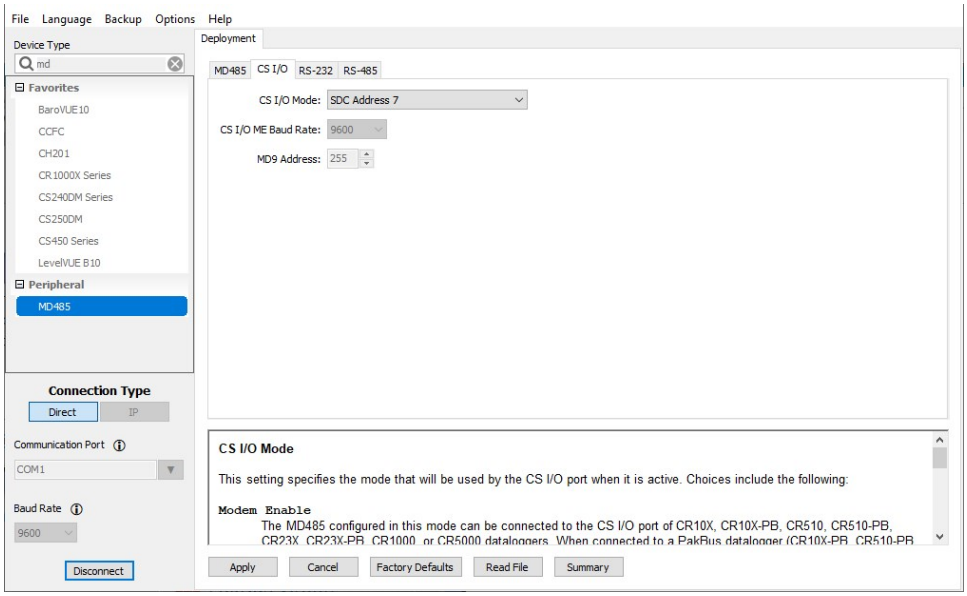



3. Connect the MD485 to power.
4. Connect the MD485 RS-232 port to a computer serial port.
5. Select the **Communication Port** in the left panel.
6. Click **Connect**.

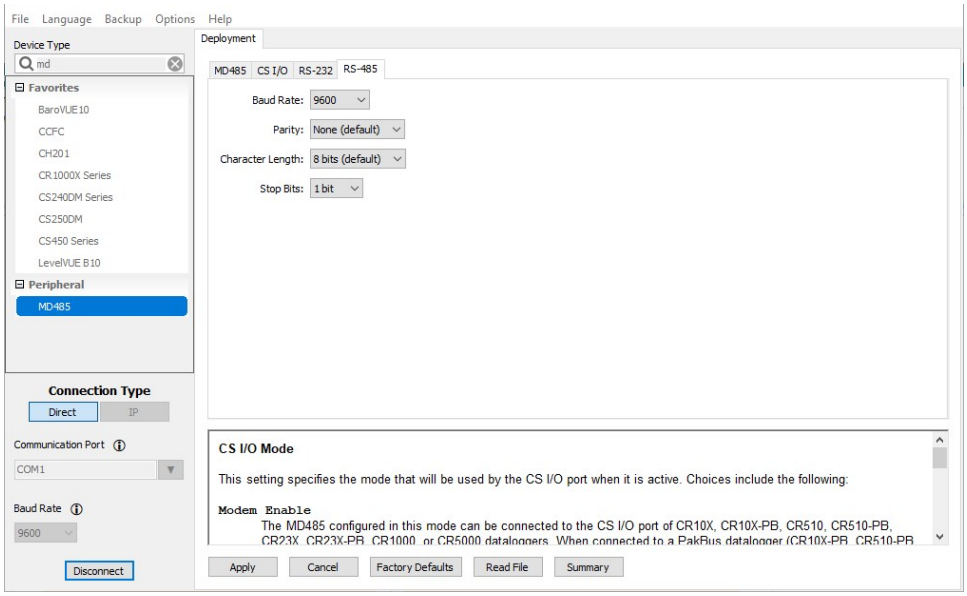
7. Select **CS I/O and RS-485** for the **Active Ports** and **Transparent Communication** as the **Protocol Configuration**.




8. Click the **CS I/O** tab and select **SDC Address 7** for the **CS I/O Mode**.



9. Click the **RS-485** tab and select **9600** for the **Baud Rate**.




10. Connect the MD485 **CS I/O** port to the data logger **CS I/O** port using an SC12 cable.
11. Use the HMP155ACBL2 to connect the HMP155A sensor to the MD485 and the data logger as shown in the following table. The table also shows wiring for cables purchased from Vaisala.

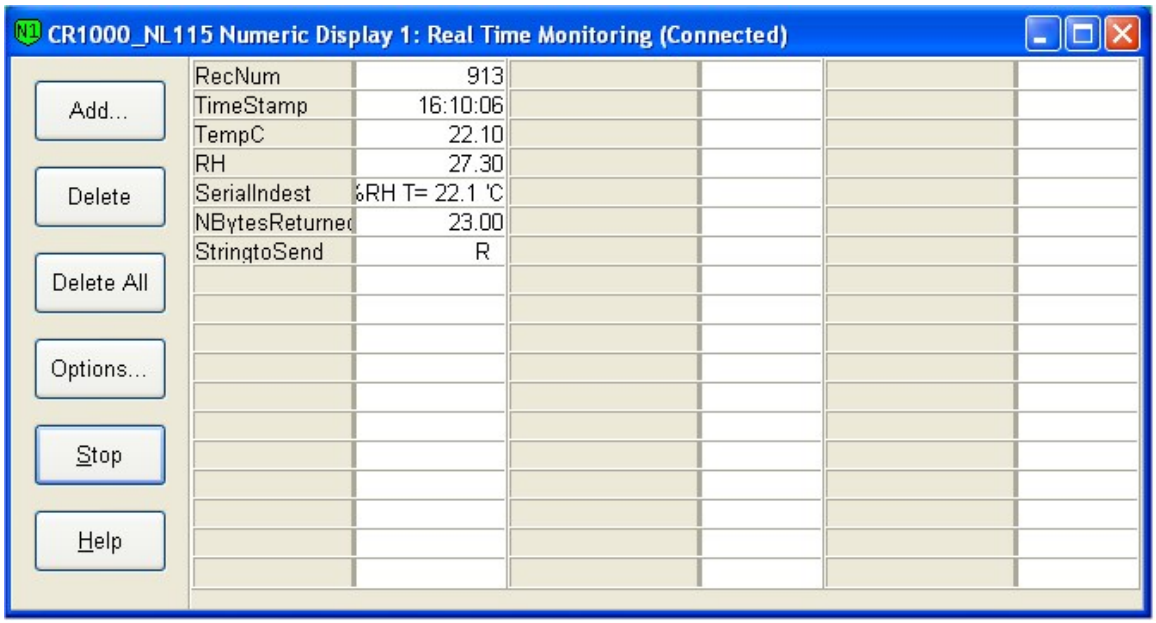
**Table B-2: MD485 to data logger connection**

| HMP155ACBL2 cable | HMP155A Vaisala cable | MD485 | Data logger[1] | Connector pin-out |
|---|---|---|---|---|
| Blue | Pink | B | | 6 |
| Yellow | Brown | A | | 2 |
| Black | Red | | G | 8 |
| Red | Blue | | 12V | 7 |
| White | Green | | G | 3 |
| Shield (clear) | Black | | G | Not connected |

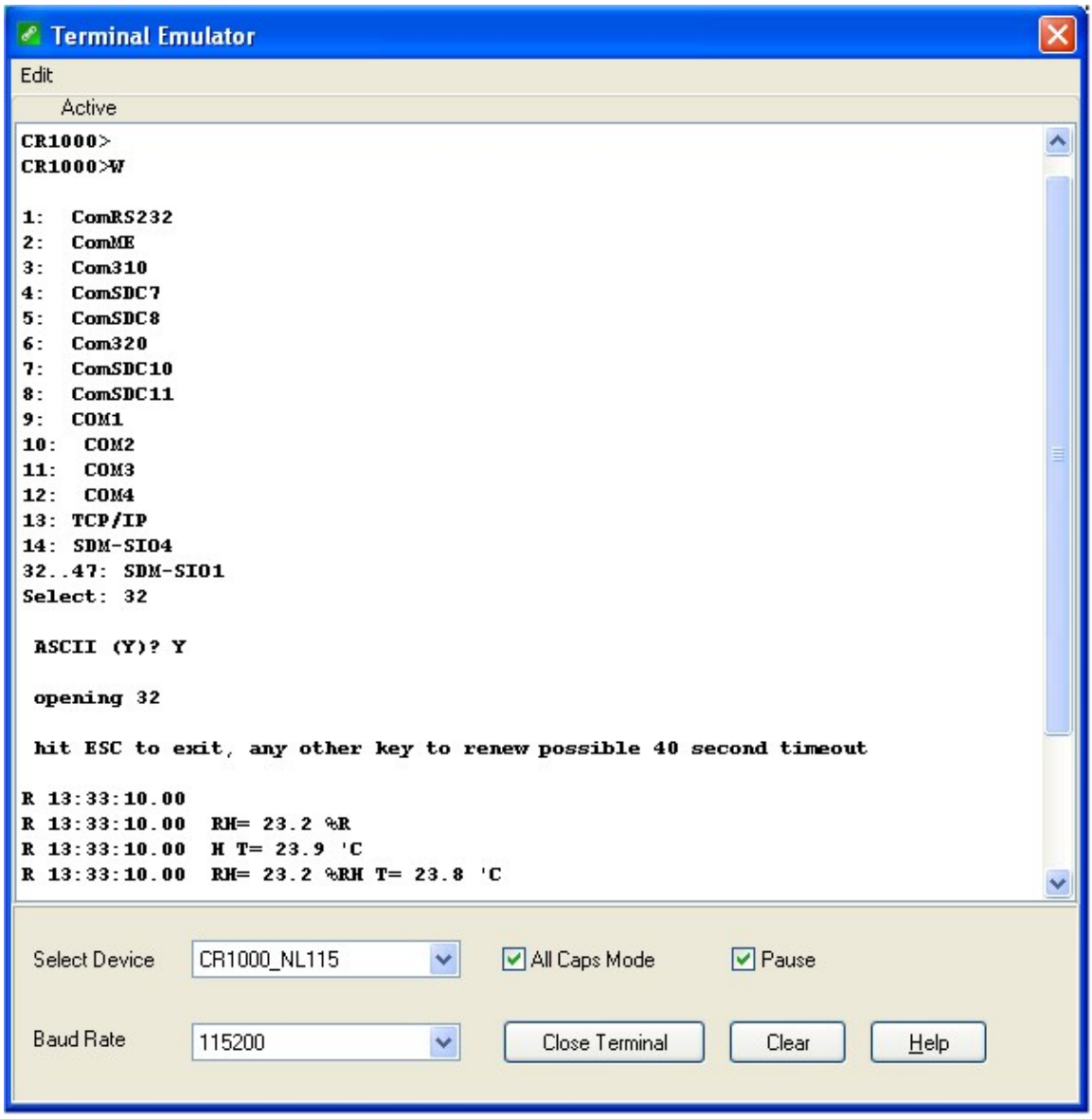
[1] The gray, pink, and brown wires on the Vaisala cable are not used.

# B.3 Numeric display

The public variables for temperature and relative humidity can be viewed in the **Numeric Display** mode.




For troubleshooting purposes, the serial data buffer in the data logger can be viewed using the 'W' terminal command. This is done by connecting to the data logger from the **Connect** button of ***LoggerNet*** or ***PC400W***. From the **Connect** screen, select **Tools** > **Terminal Emulator**. Click the **Open Terminal** button, and press the enter key to get the prompt with the data logger model. Type 'W' for the **Serial Comms Sniffer**. Type 32 for the SDM-SIO1A/SIO4A or 4 for the MD485, then type Y for ASCII. Raw serial data received by the buffer is displayed on the screen.


Terminal Emulator
Edit
Active
CR1000>
CR1000>W
1: ComRS232
2: ComME
3: Com310
4: ComSDC7
5: ComSDC8
6: Com320
7: ComSDC10
8: ComSDC11
9: COM1
10: COM2
11: COM3
12: COM4
13: TCP/IP
14: SDM-SIO4
32..47: SDM-SIO1
Select: 32
ASCII (Y)? Y
opening 32
hit ESC to exit, any other key to renew possible 40 second timeout
R 13:33:10.00
R 13:33:10.00 RH= 23.2 %R
R 13:33:10.00 H T= 23.9 'C
R 13:33:10.00 RH= 23.2 %RH T= 23.8 'C
Select Device
CR1000_NL115
All Caps Mode
Pause
Baud Rate
115200
Close Terminal
Clear
Help

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