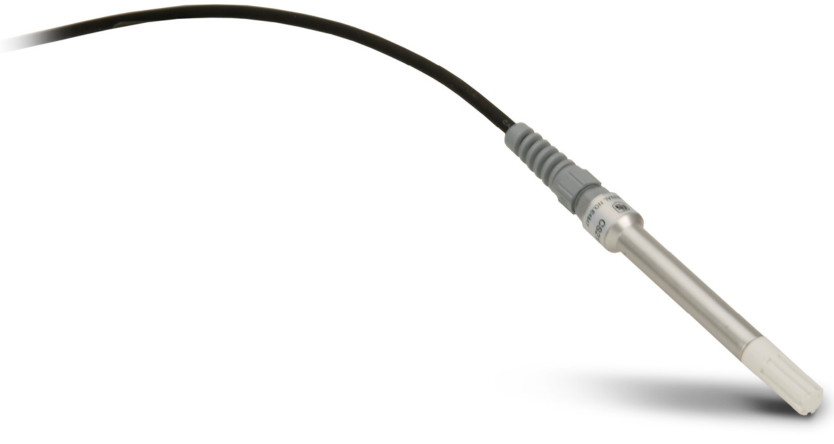
INSTRUCTION MANUAL

CS215 Temperature and Relative Humidity Probe

Revision: 7/12



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CS215 Temperature and Relative Humidity Probe

1. Introduction

The CS215 Temperature and Relative Humidity probe is designed for general meteorological and other datalogging applications. It utilizes the SDI-12 communications protocol to communicate with any SDI-12 recorder simplifying installation and programming.

Before using the CS215, please study

- Section 2, *Cautionary Statements*
- Section 3, *Initial Inspection*
- Section 4, *Quickstart*

More details are available in the remaining sections.

2. Cautionary Statements

- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, consult with a Campbell Scientific applications engineer.

- Although the CS215 is rugged, it should be handled as a precision scientific instrument.

- 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.

- When removing the probe from a radiation shield, withdraw it from the shield carefully, as the foam filter is easily broken if bent or knocked.

3. Initial Inspection

- Upon receipt of the CS215, 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 correct product and cable length are received.

- The CS215 is shipped with an instruction manual or a ResourceDVD.

4. Quickstart

4.1 Step 1 — Mount the Probe

Review Section 7, *Installation*, for complete instructions. To install the CS215, you will need:

- 41305-5A 6-plate Radiation Shield
- 1/2" open end wrench
- small screw driver provided with datalogger
- small Phillips screwdriver
- UV resistant cable ties
- small pair of diagonal-cutting pliers

1. Loosen the plastic split collar at the base of the shield (reversing the removable portion if necessary) and gently insert the probe.

2. Tighten the collar until it lightly grips the probe body.

3. Continue to push the probe up into the body of the shield until the step in the tube stops it from going any further.

4. Tighten the collar until it securely grips the probe.

5. Attach the radiation shield to the tripod mast, crossarm, or tower leg using the supplied U-bolt. See Figures 4-1 and 4-2 for examples of shield mounting.

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

CAUTION Failure to secure the cable can lead to breakage of the wires due to fatigue if the cable is allowed to blow back and forth in the wind.

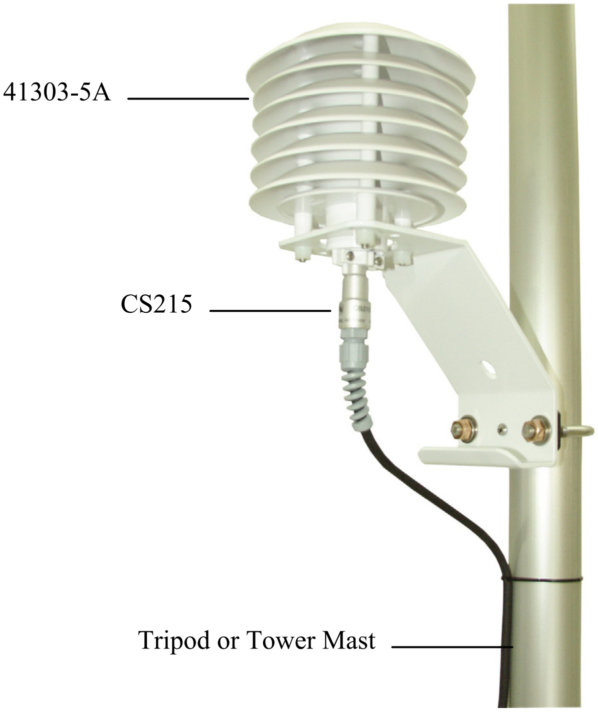


FIGURE 4-1. CS215 and 41303-5A Radiation Shield on a tripod mast

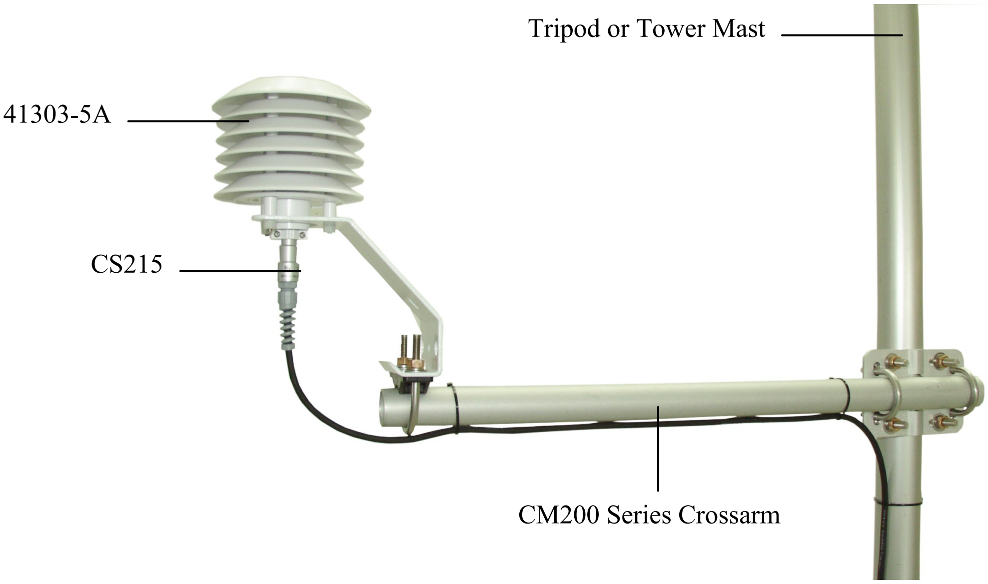
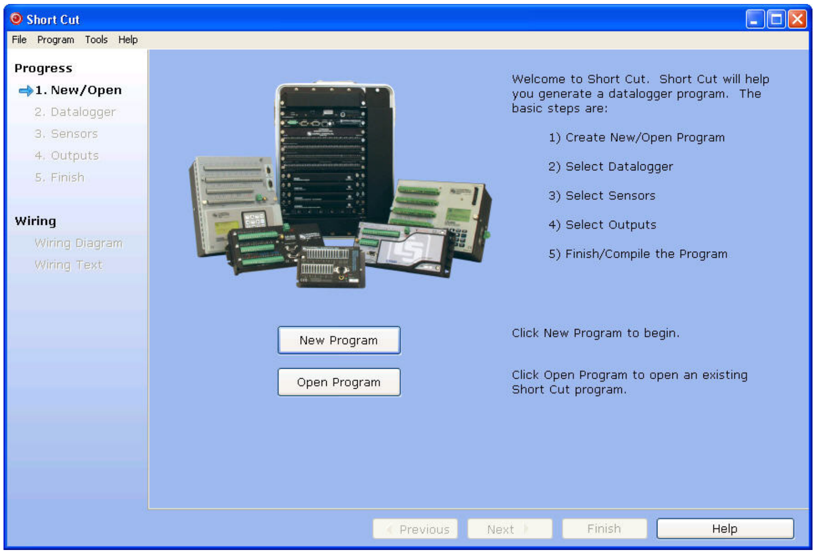


FIGURE 4-2. CS215 and 41303-5A Radiation Shield on a CM200 Series Crossarm

4.2 Step 2 — Use SCWin Short Cut to Program Datalogger and Generate Wiring Diagram

The simplest method for programming the datalogger to measure the CS215 is to use Campbell Scientific's SCWin Short Cut Program Generator.

1. Open Short Cut and click on **New Program**.



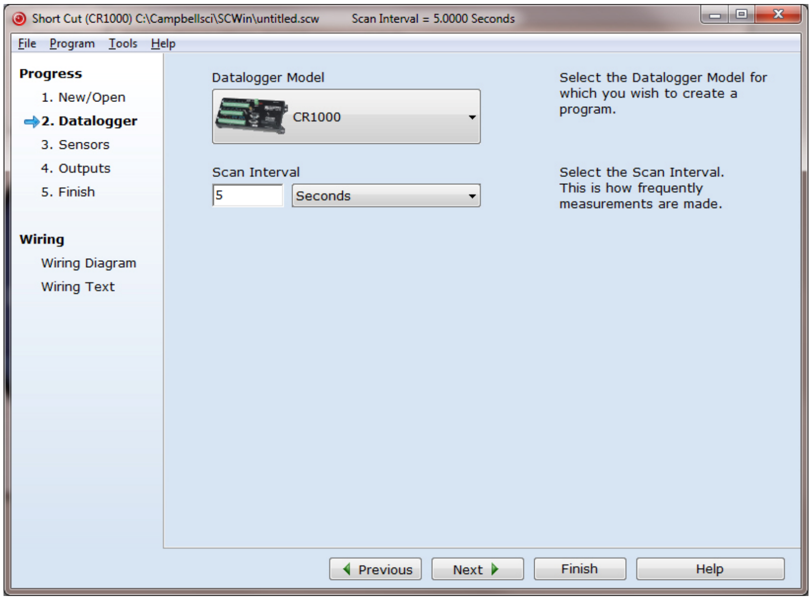
Welcome to Short Cut. Short Cut will help you generate a datalogger program. The basic steps are:

1) Create New/Open Program
2) Select Datalogger
3) Select Sensors
4) Select Outputs
5) Finish/Compile the Program

Click New Program to begin.

Click Open Program to open an existing Short Cut program.

2. Select a datalogger and scan interval.



Short Cut (CR1000) C:\Campbellsci\SCWin\untitled.scw Scan Interval = 5.0000 Seconds

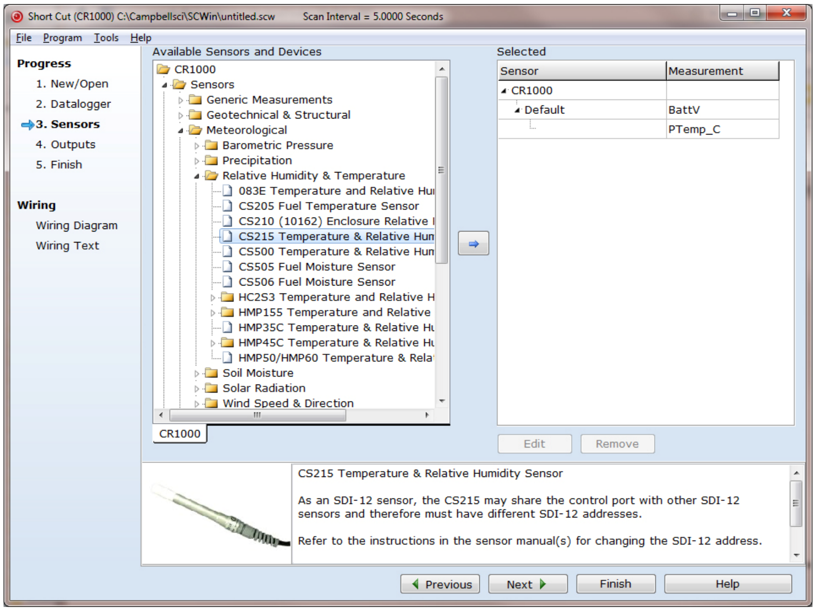
Datalogger Model: CR1000

Select the Datalogger Model for which you wish to create a program.

Scan Interval: 5 Seconds

Select the Scan Interval. This is how frequently measurements are made.

3. Select **CS215 Temperature and Relative Humidity Sensor** then click the **right arrow** to add it to the list of sensors to be measured.

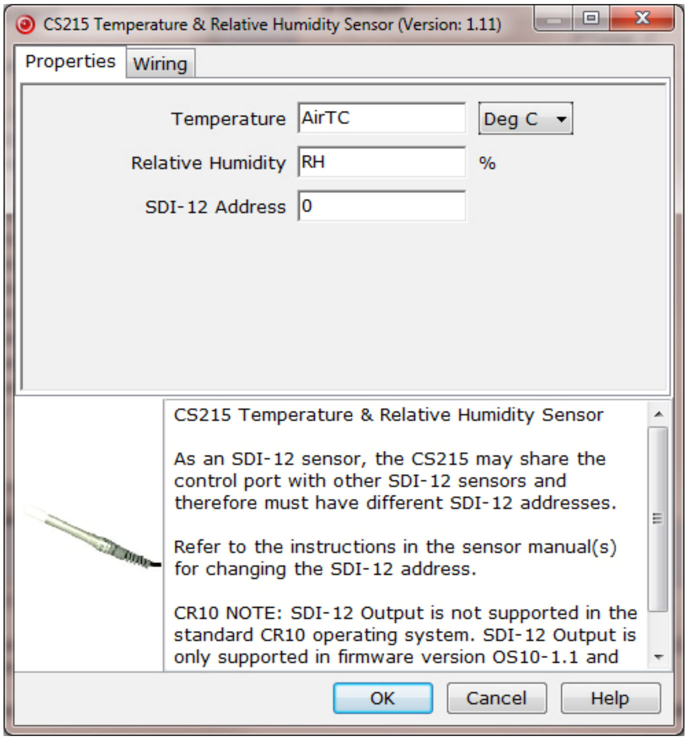


CS215 Temperature & Relative Humidity Sensor

As an SDI-12 sensor, the CS215 may share the control port with other SDI-12 sensors and therefore must have different SDI-12 addresses.

Refer to the instructions in the sensor manual(s) for changing the SDI-12 address.

4. Define the name of the public variables. Variables default to **AirTC** and **RH** that hold the air temperature and relative humidity measurements. Select the desired units of measure. Units default to **Deg C**.



Temperature AirTC Deg C

Relative Humidity RH %

SDI-12 Address 0

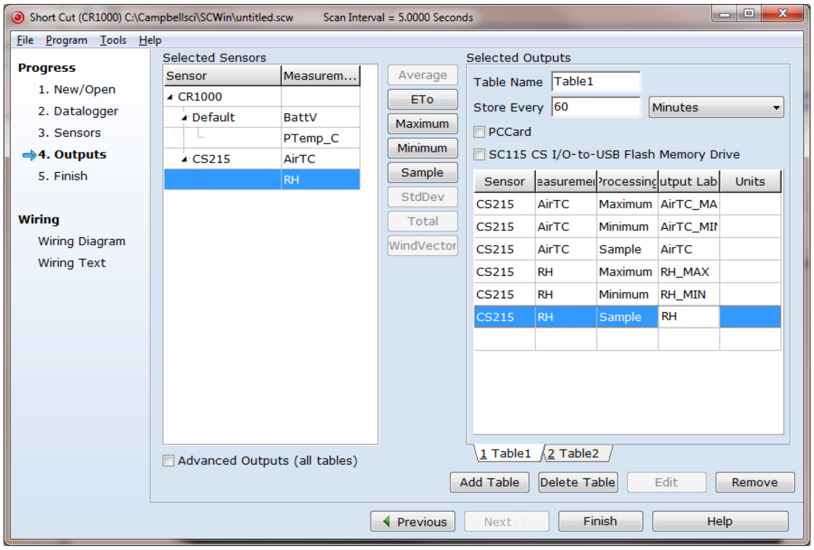
CS215 Temperature & Relative Humidity Sensor

As an SDI-12 sensor, the CS215 may share the control port with other SDI-12 sensors and therefore must have different SDI-12 addresses.

Refer to the instructions in the sensor manual(s) for changing the SDI-12 address.

CR10 NOTE: SDI-12 Output is not supported in the standard CR10 operating system. SDI-12 Output is only supported in firmware version OS10-1.1 and

5. Choose the outputs for the AirTC and RH and then select finish.



Selected Sensors

Sensor	Measurem...
CR1000	
Default	BattV
	PTemp_C
CS215	AirTC
	RH

☐ Advanced Outputs (all tables)

Selected Outputs

Table Name Table1

Store Every 60 Minutes

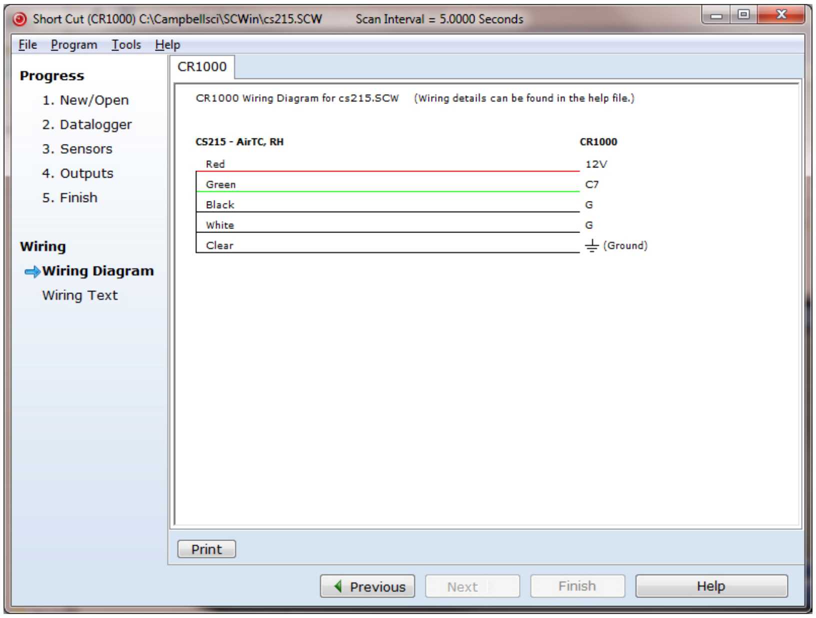
☐ PCCard

☐ SC115 CS I/O-to-USB Flash Memory Drive

Sensor	easuremei	Processing	utput Lab	Units
CS215	AirTC	Maximum	AirTC_MA	
CS215	AirTC	Minimum	AirTC_MII	
CS215	AirTC	Sample	AirTC	
CS215	RH	Maximum	RH_MAX	
CS215	RH	Minimum	RH_MIN	
CS215	RH	Sample	RH	

1 Table1 | 2 Table2

6. Wire according to the wiring diagram generated by SCWin Short Cut.



CR1000 Wiring Diagram for cs215.SCW (Wiring details can be found in the help file.)

CS215 - AirTC, RH	CR1000
Red	12V
Green	C7
Black	G
White	G
Clear	⏚ (Ground)

5. Overview

The CS215 probe uses a single chip element that incorporates both a temperature and RH sensor. Each element is individually calibrated with the calibration corrections stored on the chip. The element is easily changed in the field. Replacement of the element effectively fully recalibrates the probe both for temperature and humidity, thus minimizing downtime and calibration costs.

Low power electronics within the CS215 controls the measurement made by the sensor element, applies temperature and linearization corrections to the readings and presents the data via an SDI-12 compatible interface to a datalogger.

The probe is fitted with a low-cost sintered plastic filter to minimize the effects of dust and dirt on the sensor. The filter is lightweight and hydrophobic, thereby minimizing the effect of the time response of the sensor.

The probe housing is designed to withstand permanent exposure to all weathers and to fit into a range of radiation shields including lower cost compact shields.

Lead length for the CS215 is specified when the sensor is ordered.

Table 5-1 gives the recommended lead lengths.

TABLE 5-1. Recommended Lead Lengths

2 m Height		**Atop a tripod or tower via a 2 ft crossarm such as the CM202**							
Mast/Leg	**CM202**	**CM6**	**CM10**	**CM110**	**CM115**	**CM120**	**UT10**	**UT20**	**UT30**
9'	11'	11'	14'	14'	19'	24'	14'	24'	37'

Note: Add two feet to the cable length if you are mounting the enclosure on the leg base of a light-weight tripod.

The probe's cable can terminate in:

- Pigtails that connect directly to a Campbell Scientific datalogger (option –PT).
- Connector that attaches to a prewired enclosure (option –PW). Refer to www.campbellsci.com/prewired-enclosures for more information.

6. Specifications

Features:

- Accurate and stable measurements
- Field changeable element allows on-site recalibration
- Each sensor element is individually calibrated so no further adjustment of the probe is required
- Low power consumption
- Digital SDI-12 output

Compatibility Dataloggers:	CR200(X) series CR800 series CR1000 CR3000 CR5000 CR510 CR10(X) CR23X
Sensing Element:	Sensirion SHT75; each element is individually calibrated with the calibration corrections stored on the chip

6.1 Temperature Measurement

Operating Range:	-40° to +70°C
Accuracy:	±0.3°C at 25°C, ±0.4°C over +5° to +40°C, ±0.9°C over -40° to +70°C
Response Time with Filter:	120 s (63% response time in air moving at 1 m/s)
Default Units:	Degrees Celsius

6.2 Relative Humidity

Operating Range:	0 to 100% RH (-20° to +60°C; see Appendix A)
Accuracy (at 25°C):	±2% over 10 to 90%, ±4% over 0 to 100%
Short Term Hysteresis:	<1% RH
Temperature Dependence:	Compensated to better than ±2% over -20 to 60°C
Typical Long-Term Stability:	Better than ±1.0% per year
Response Time with Filter:	<10s (63% response time in air moving at 1 m/s at humidities <85%)
Environmental Performance:	See Appendix A
Calibration Traceability:	See Appendix B
Supply Voltage:	6 to 16 Vdc
Current Consumption:	Typically 70 µA quiescent, 1.7 mA during measurement (takes 0.7 s)
Diameter:	12 mm at sensor tip, maximum 18 mm at cable end
Length:	180 mm, including cable strain relief
Housing Material:	Anodized aluminum
Filter Material:	Sintered high-density polyethylene, average pore size 13 µm
EMC Compliance:	Tested and conforms to BS EN61326:2002

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.

7. Installation

7.1 Siting

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

See Section 10 for a list of references that discuss temperature and relative humidity sensors.

7.2 Assembly and Mounting

The CS215 must be housed inside a radiation shield when used in the field. Typically, the 41303-5 6-plate shield is used. This radiation shield has a U-bolt for attaching the shield to tripod mast / tower leg (see Figure 4-1 in Section 4, *Quickstart*), or CM200 series crossarm (see Figure 4-2 in Section 4, *Quickstart*). The radiation shield ships with the U-bolt configured for attaching the shield to a vertical pipe. Move the U-bolt to the other set of holes to attach the shield it to a crossarm.

The probe will also fit into the 41003-5 10-plate radiation shield. The 41003-5 requires the 18.5 adapter (CSI PN 6637). For this shield, tighten the sensor grip around the probe where it best matches the size of the grip. (The probe will also fit directly into most of the R.M. Young shields, where the probe enters the shield from the top, pointing downwards.)

CAUTION When removing the probe from the shield, withdraw it from the shield carefully, as the foam filter is easily broken if bent or knocked.

For other applications the CS215 can be installed in any orientation. Install it away from obvious sources of heat, including solar radiation.

NOTE It is best to protect the filter at the top of the sensor from exposure to liquid water as while the hydrophobic nature of the filter will repel light rain, driving rain can force itself into the pore structure of the filter and then take some time to dry out.

7.3. Wiring

Connections to Campbell Scientific dataloggers are given in Table 7-1. When Short Cut for Windows software is used to create the datalogger program, the sensor should be wired to the channels shown on the wiring diagram created by Short Cut.

TABLE 7-1. Connections to Campbell Scientific Dataloggers

Color	Description	CR800 CR5000 CR3000 CR1000	CR510 CR500 CR10(X)	CR23X	CR200(X)
Red	12V	12V	12V	12V	12V
White	Power Ground	G	G	⏚	G
Black	Power Ground	G	G	⏚	G
Green	SDI-12 Signal	* Control Port	Control Port	Control Port	Control Port
Clear	Shield	⏚	G	⏚	⏚

* dedicated SDI-12 port on CR5000

To use more than one probe per datalogger, you can either connect the different probes to different SDI-12 compatible ports on the datalogger or change the SDI-12 addresses of the probes and let them share the same connection. Using the SDI-12 address minimizes the use of ports on the datalogger and also allows probes to be connected in a "daisy-chain" fashion which can minimize cable runs in some applications. (However, see below for limits on the total cable length.)

There are two ways to set the SDI-12 address of the CS215:

- By sending the required commands to the sensors via an SDI-12 recorder/datalogger that allows talk through to the sensor.
- By loading a program into the recorder that sends the required commands (see Section 7.5, *Changing the SDI-12 Address Using LoggerNet and a Datalogger*).

7.3.1 Long Cables

As the measurement data is transferred between the probe and datalogger digitally, there are no offset errors incurred with increasing cable length as seen with analog sensors. However, with increasing cable length there is still a point when the digital communications will break down, resulting in either no response from the sensor or corrupted readings. The original SDI-12 standard specifies the maximum total cable length for the cable as being 200 feet (61 meters). To ensure proper operation with long cables follow these guidelines:

- Use low capacitance, low resistance, screened cable (as fitted by Campbell Scientific). With such cable, distances of several hundred meters to the sensor are possible.
- Ensure that the power ground cable has low resistance and is connected to the same ground reference as the datalogger control ports.
- Be aware that “daisy chaining” sensors reduces the maximum cable length roughly in proportion to the number of sensors connected in parallel.

7.3.2 Power Conservation

The CS215 draws less than 70 µA of current between measurements from its 12 V supply. In most applications this is insignificant compared to the datalogger and other power uses so the sensor can be permanently connected.

In very low power applications battery power can be conserved by turning the 12 V supply to the CS215 on just before the measurement (allowing a ‘warm-up’ time of at least 100 ms) and then turning it off afterwards.

This switching can be achieved in different ways depending on the type and model of your datalogger. If available, the switched 12 V output of the datalogger can be used.

7.4 Reading the Sensor

The CS215 output is measured using a standard SDI-12 instruction to read the data from an SDI-12 sensor. For CRBasic dataloggers, the **SDI12Recorder()** instruction is used. For Campbell Scientific Edlog dataloggers, Instruction 105 is used. If using the sensor with other SDI-12 recorders, please refer to your system’s documentation. Further details of the SDI-12 commands can be found at: www.sdi-12.org.

The CS215 complies with a subset of the SDI-12 1.3 instruction set. Specifically, it supports these SDI-12 commands:

- aM!, initiate measurement (and the subsequent aD0! “get data” command which is automatically sent by a Campbell Scientific datalogger)
- aC!, initiate concurrent measurement, where the datalogger gets the data some time later using the aD0! Command (see the datalogger manual for a more detailed explanation)
- aI!, send identification
- aAb!, change address to b
- ?! query the address of one sensor

CS215 sensors with serial numbers after E1587 also support these additional SDI-12 commands. (Older sensors can be upgraded to do this but as they need to be returned to the factory for an upgrade this is not normally economic.)

- aR! (or aR0!), continuous measurements where the sensor will start to make measurements every 11 seconds automatically and return the most recent value, without delaying its response to make the measurement (see note below). This instruction usually takes less than 300 milliseconds to execute.

NOTE The sensor will automatically switch to making measurements every 11 seconds (±2 second) the first time it receives the aR! command. It makes the measurements based on its own clock which is not synchronized to the datalogger clock. This means measurements made with the aR! command can be up to 11 seconds old. This is not normally an issue for environmental measurements due to slow rate of change of RH and temperature. If measurements are requested more frequently than every 11 seconds the aR! option will return repeated values, up until the point the sensor takes its next measurement. If measurements are requested at 2 sec or faster, the sensor will increase its measurement rate to approximately every 5 seconds. The automatic measurement mode can only be cancelled by powering down the sensor to reset it.

- aMC!, aCC!, aRC!, which are the same as the instructions above but where the C at the end of the instruction forces a validation for the data received from the sensor using a checksum. If the checksum is invalid, the logger will re-request the data up to three times. The checksum validation increases the measurement time by about 40 milliseconds if there are no errors. Retries will increase the measurement time in proportion to the number of retries. Use of the checksum option is only normally necessary for very long cable runs.

Where in all cases “a” is the address of the sensor and “!” is the command terminator. These two characters are normally sent implicitly by Campbell Scientific dataloggers.

7.4.1 Measurements at Slow Scan Rates

If the scan rate of your measurement sequence is slow (several seconds or more), use the aM! command to read the data from the sensor in the main scan for CRBasic or main table for Edlog. If the scan rate has to be faster, please refer to Section 7.4.2, *Measurements at Fast Scan Rates*.

With Campbell Scientific dataloggers, the aM! command involves just one program instruction. The datalogger sends the command, waits and then automatically sends the ‘aD0!’ (get data) command and collects the measurements from the sensor. The sensor returns two values (temperature in degrees Celsius and relative humidity as a percentage (0 to 100)).

NOTE If your Short Cut version does not include specific support for the CS215, the generic SDI12 Sensor instruction can be used by setting the first parameter label to represent temperature and the second for relative humidity.

Example programs for measurement at Slow Scan Rates are shown in the Example Programs (see Section 7.4.3).

7.4.2 Measurements at Fast Scan Rates

7.4.2.1 CRBasic Dataloggers

CRBasic dataloggers that support the **SlowSequence()** function (CR800, CR850, CR1000, CR3000, and CR5000) can run the SDI-12 instruction entirely as a background process causing minimum interference to other measurements that use the analog hardware.

This is implemented by including the measurement in a **SlowSequence()** section of the program, thus allowing faster programs to run as the main scan.

NOTE For the CR5000 use a control port rather than the SDI-12 port to allow the SDI12recorder instruction to run in the slow sequence.

The example program provided in Section 7.4.3.4, *CR5000 Program for Measuring One Sensor Every 30 Seconds*, shows how the **SlowSequence()** can be used to make measurements from the CS215 while the main scan can run at a much faster rate.

7.4.2.2 Edlog Dataloggers

The aM! command takes about 700 milliseconds in total to make a measurement from the CS215. If it is included in the main program table (table 1) the program will be delayed for this interval which will limit the maximum scan rate for fast running programs.

For Edlog dataloggers, it is possible to put the SDI-12 instruction in table 2, which allows table 1 to interrupt and pause the SDI-12 instruction letting it run other instructions. However, table 1 cannot interrupt the instruction while SDI-12 communications are taking place, only when datalogger is waiting for the sensor to take the measurement. As the initiation of the sensor and also the transfer of data from the sensor each take approximately 200 milliseconds this limits the scan rate of table 1 to about 250 milliseconds, and only then if table 1 itself takes little time to execute.

The aC! concurrent measurement command can also be used where the sensor measurement is initiated with one command and data is collected after a minimum delay of one second or any time thereafter. With Campbell Scientific dataloggers this is done by using the SDI-12 recorder instruction with the aC! command. The datalogger will return -99999 for the temperature reading for the call of the instruction that initiates the measurement. At the next call of the instruction the datalogger will request the data and record the correct temperature.

Using the aC! command requires more detailed programming to ensure the out of range values are not recorded as real temperatures. It also has similar limitations to running the instruction in table 2 when trying to make other measurements at a fast scan rate. This is because the program will still be delayed by approximately 200 ms for both the initiation of the measurement and the subsequent reading of data from the sensor. Using the aC! command can be useful where predictable timing of the program is required (without the complications of working out how different program tables will interrupt each other).

7.4.3 Example Programs

7.4.3.1 CR200(X) Program for Measuring One Sensor Every 30 Seconds

```
'CR200(X) Series Datalogger
'Example program showing measurement of a single CS215 sensor every 30 sec

'Declare the variables we are going to use
Public CS215meas(2)'An array suitable to read the SDI-12 data into
Alias CS215meas(1) = Temperature
Alias CS215meas(2) = RH

'Define Data Table to hold the stored data
DataTable (CS215data,1,-1)
  DataInterval (0,15,min) 'As an example store the average every 15 mins
  Average (1,Temperature,False)
  Average (1,RH,False)
EndTable

'Main Program
BeginProg
  Scan (30,Sec) 'Scan every 30 seconds
  SDI12Recorder (CS215meas(),0M!,1.0,0) 'Read the values into the array
  CallTable CS215data 'Call the table instruction to calculate and store the averages
  NextScan
EndProg
```

7.4.3.2 CR800 Program for Measuring One Sensor Every 10 Seconds

```
'CR800
'Example program showing measurement of a single CS215 sensor every 10 seconds.

'Declare Variables and Units we are going to use.
Public TRHData(2)

Alias TRHData(1)=AirTC
Alias TRHData(2)=RH

Units AirTC=Deg C
Units RH=%

'Define Data Tables to store data
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,10)'As an example store the data every 60 minutes.
  Average(1,AirTC,FP2,False)
  Sample(1,RH,FP2)
EndTable

'Main Program
BeginProg
  Scan(10,Sec,1,0)'Scan every 10 seconds
    'CS215 Temperature & Relative Humidity Sensor (CSL) measurements AirTC and RH:
    SDI12Recorder(AirTC,3,"0","M!",1,0)
    'Call Data Tables and Store Data
    CallTable(Table1)
  NextScan
EndProg
```

7.4.3.3 CR3000 Program for Measuring One Sensor Every 10 Seconds

```
'CR3000
'Example program showing measurement of a single CS215 sensor every 10 seconds

'Declare Variables and Units we are going to use.
Public TRHData(2)

Alias TRHData(1)=AirTC
Alias TRHData(2)=RH

Units AirTC=Deg C
Units RH=%

'Define Data Tables to store data.
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,10)'As an example store the data every 60 minutes.
  Average(1,AirTC,FP2,False)
  Sample(1,RH,FP2)
EndTable

'Main Program
BeginProg
  Scan(10,Sec,1,0) 'Scan every 10 seconds
  'CS215 Temperature & Relative Humidity Sensor (CSL) measurements AirTC and RH:
    SDI12Recorder(AirTC,7,"0","M!",1,0)
    'Call Data Tables and Store Data
    CallTable(Table1)
  NextScan
EndProg
```

7.4.3.4 CR5000 Program for Measuring One Sensor Every 30 Seconds

```
'CR5000 Series Datalogger
'Example program showing measurement of a single CS215 sensor every 30 sec
'in the slow sequence

'Declare the variables we are going to use
Public Batt_Volt, PTemp, CS215meas(2) 'An array suitable to reading the SDI12 data
into
Alias CS215meas(1) = Temperature
Alias CS215meas(2) = RH

'Main Program - in this example it is running fast just measuring the
'battery voltage and panel temperature
BeginProg
  Scan (50,mSec,0,0) 'Scan every 50 milliseconds
    PanelTemp (PTemp,250)
    Battery (Batt_volt)
  NextScan

SlowSequence

'Define Data Table to hold the stored data for the CS215
DataTable (CS215dat,1,-1)
  DataInterval (0,15,min,1) 'As an example store the average every 15 mins
Average (1,Temperature,IEEE4,False)
  Average (1,RH,IEEE4,False)
EndTable

Scan (30,sec,0,0)
SDI12Recorder (CS215meas(),1,0M!,1.0,0) 'Read the values into the array
'NOTE: we had to use a control port for SDI-12 as this is in the slow sequence
  CallTable CS215dat 'Call the table instruction to calculate and store the Avs
NextScan

EndProg
```

7.4.3.5 CR10(X) Program Measuring a Sensor Every Minute

The following example is written for the CR10(X). Programs for the CR500, CR510, and CR23X would be similar.

The program below shows a simple example reading a sensor which has been set up with address 0 (the default) and connected to control port 1.

NOTE In Edlog, you have to manually assign input locations in the Inloc Editor to ensure two locations are free (refer to Edlog help for more information).

```
;{CR10X}
;Example program for a CS215 sensor on control port 1
;Measures every minute and stores some summary statistics
;once per hour

*Table 1 Program
  01: 60          Execution Interval (seconds)

;Measure the sensor on control port 1
;Note you have to manually assign the labels in the Inloc Editor
;to make sure two locations are free.

1: SDI-12 Recorder (P105)
  1: 0000         SDI-12 Address
  2: 00           SDI-12 Command
  3: 1            Port
  4: 1            Loc [ Temp ]
  5: 1.0          Mult
  6: 0.0          Offset

;Now store some statistics.

2: If time is (P92)
  1: 0            Minutes (Seconds --) into a
  2: 60           Interval (same units as above)
  3: 10           Set Output Flag High (Flag 0)

3: Real Time (P77)
  1: 111          Day,Hour/Minute,Seconds (midnight = 0000)

4: Average (P71)
  1: 1            Reps
  2: 1            Loc [ Temp ]

5: Sample (P70)
  1: 1            Reps
  2: 2            Loc [ RH ]

*Table 2 Program
  02: 0.0000      Execution Interval (seconds)

*Table 3 Subroutines

End Program
```

7.5 Changing the SDI-12 Address Using LoggerNet and a Datalogger

Up to ten CS215s or other SDI-12 sensors can be connected to a single datalogger control port. Each SDI-12 device must have a unique SDI-12 address between 0 and 9. (The CS215 also supports the extended range up to 126.)

The factory-set SDI-12 address for the CS215 is 0. The CS215 SDI-12 address is changed in software by issuing the aAb! command to the CS215 over the SDI-12 interface, where *a* is the current address and *b* is the new address. The current address can be found by issuing the ?! command.

The address *can* be changed by loading a program into the datalogger that includes an instruction to send the aAb! command to change the sensor from its old address "a" to new address "b". (For an Edlog datalogger this involves using instruction 105 with the character "A" followed by the character for the new address sent as extended commands, using P68. Refer to the datalogger manual for further details. CRBasic programs can simply have the aAb string embedded as the string command.)

However, changing the address using a program is not the simplest way as most Campbell Scientific dataloggers (with the exception of the CR5000 at present) support a method of directly interacting with SDI-12 sensors via a terminal emulator. This allows you to get confirmation that the change of address has worked, using the ?! command. This can be done using a computer running LoggerNet to issue any valid SDI-12 command through the datalogger to the CS215 as described in the following sections.

7.5.1 CR200(X) Series Datalogger

1. Connect a single CS215 to the datalogger using Control Port C1/SDI12 as described in Section 7.3, *Wiring*, and download a datalogger program that does not contain the **SDI12Recorder()** instruction.

2. In the LoggerNet Toolbar, navigate to and activate the Tools|Terminal Emulator … menu. The "Terminal Emulator" window will open. In the Select Device menu, located in the lower left-hand side of the window, select the station.

3. Click on the Open Terminal button. If communications between the datalogger and PC are successful, the red bar located in the upper left-hand side of the window will turn green.

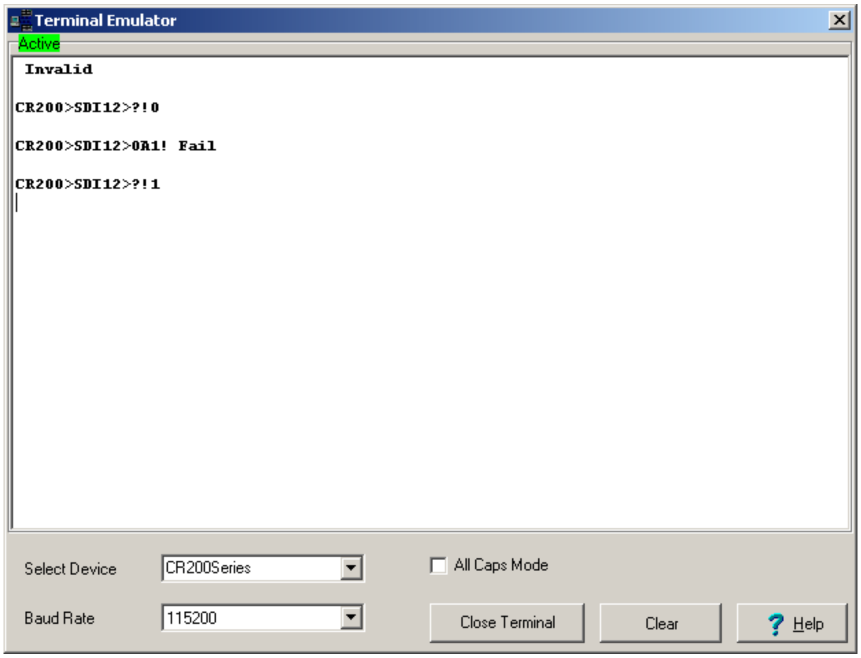
4. Press the <enter> key until the datalogger responds with the "**`CR200(X)>`**" prompt.

5. To query the CS215 for its current SDI-12 address, press the <enter> key. At the "**`CR200(X)>`**" prompt, make sure you are in Caps Lock mode and enter the command SDI-12>?! and press the <enter> key. The CS215 will respond with the SDI-12 address.

6. To change the SDI-12 address, press the <enter> key. At the "**`CR200(X)>`**" prompt enter the command **`SDI12>aAb!`**; where *a* is the current address from the above step and *b* is the new address. The CS215

will change its address and the datalogger will exit the SDI-12 Transparent Mode and respond with "`Fail`".

7. Verify the new SDI-12 address. Press the <enter> key. At the "**`CR200(X)>`**" prompt enter the command SDI12>?! and press the <enter> key. The CS215 will respond with the new address.



```
 Invalid

CR200>SDI12>?!0

CR200>SDI12>0A1! Fail

CR200>SDI12>?!1
```

Select Device CR200Series

Baud Rate 115200

☐ All Caps Mode

FIGURE 7-1. Screen capture of SDI-12 Transparent Mode on CRBasic CR200(X) Series Datalogger using control port C1/SDI12 and changing SDI-12 address from 0 to 1

7.5.2 CR800/CR850 Datalogger

1. Connect a single CS215 to the datalogger using Control Port C3/SDI12 as described in Section 7.3, *Wiring*, and download a datalogger program that does not contain the **SDI12Recorder()** instruction.

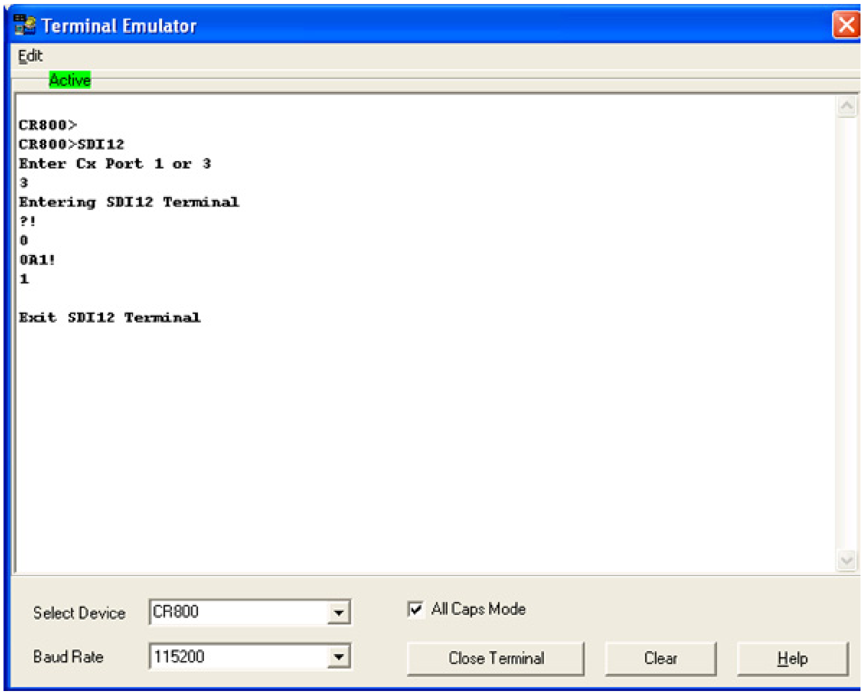
2. In the LoggerNet Toolbar, navigate to and activate the Tools|Terminal Emulator … menu. The "Terminal Emulator" window will open. In the Select Device menu, located in the lower left-hand side of the window, select the station.

3. Click on the Open Terminal button. If communications between the datalogger and PC are successful, the red bar located in the upper left-hand side of the window will turn green.

4. Press the <enter> key until the datalogger responds with the "**`CR800>`**" prompt.

5. To query the CS215 for its current SDI-12 address, press the <enter> key. At the "**`CR800>`**" prompt, make sure you are in Caps Lock mode and

enter the command SDI12 and press the <enter> key. The CR800 will respond with “Enter control port 1 or 3.” Enter control port and press enter. Type in ?! and the CS215 will respond with SDI-12 address. If no characters are typed within 12 seconds, then the mode is exited.



```
CR800>
CR800>SDI12
Enter Cx Port 1 or 3
3
Entering SDI12 Terminal
?!
0
0A1!
1

Exit SDI12 Terminal
```

FIGURE 7-2. Screen capture of SDI-12 Transparent Mode on CRBasic CR800 Datalogger using control port 3 and changing SD1-12 address from 0 to 1

6. To change the SDI-12 address, press the <enter> key. At the “**`CR800>`**” prompt enter the command **`SDI-12`** and press the <enter> key. Enter control port 1 or 3, press the <enter> key, and enter **`aAb!`**; where *a* is the current address from the above step and *b* is the new address. The CS215 will change its address and the datalogger will respond with the new address and then exit the SDI-12 Transparent Mode.

7.5.3 CR1000 Datalogger

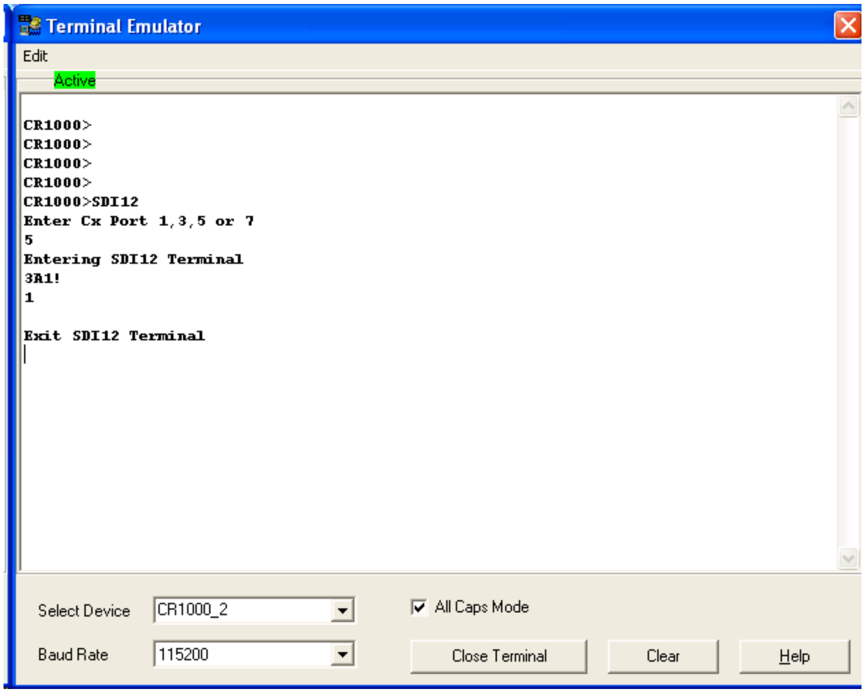
1. Connect a single CS215 to the datalogger using Control Port C5/SDI12 as described in Section 7.3, *Wiring*, and download a datalogger program that does not contain the **SDI12Recorder()** instruction.

2. In the LoggerNet Toolbar, navigate to and activate the Tools|Terminal Emulator … menu. The “Terminal Emulator” window will open. In the Select Device menu, located in the lower left-hand side of the window, select the station.

3. Click on the Open Terminal button. If communications between the datalogger and PC are successful, the red bar located in the upper left-hand side of the window will turn green.

4. Press the <enter> key until the datalogger responds with the "**`CR1000>`**" prompt.

5. To query the CS215 for its current SDI-12 address, press the <enter> key. At the "**`CR1000>`**" prompt, make sure you are in Caps Lock mode and enter the command SDI12 and press the <enter> key. The CR1000 will respond with "Enter control port 1, 3, 5, or 7." Enter control port and press enter. Type in ?! and the CS215 will respond with SDI-12 address. If no characters are typed within 12 seconds, then the mode is exited.



```
CR1000>
CR1000>
CR1000>
CR1000>
CR1000>SDI12
Enter Cx Port 1,3,5 or 7
5
Entering SDI12 Terminal
3A1!
1

Exit SDI12 Terminal
```

Select Device: CR1000_2

Baud Rate: 115200

☑ All Caps Mode

FIGURE 7-3. Screen capture of SDI-12 Transparent Mode on CRBasic CR1000 Datalogger using control port 5 and changing SD1-12 address from 3 to 1

6. To change the SDI-12 address, press the <enter> key. At the "**`CR1000>`**" prompt enter the command **`SDI-12`** and press the <enter> key. Enter control port 1, 3, 5, or 7, press the <enter> key, and enter **`aAb!`**; where *a* is the current address from the above step and *b* is the new address. The CS215 will change its address and the datalogger will respond with the new address and then exit the SDI-12 Transparent Mode.

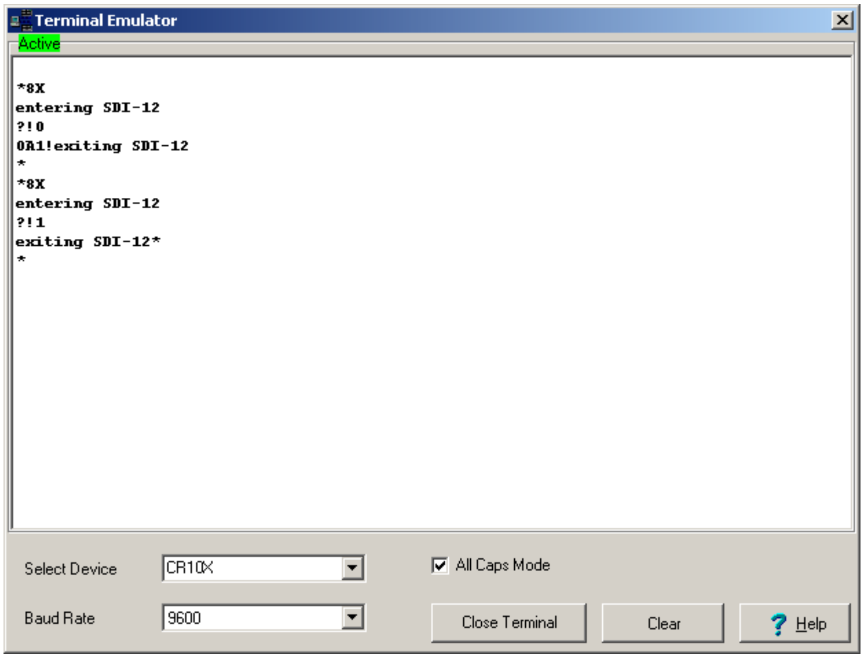
7.5.4 Mixed-Array "Edlog" Dataloggers

1. Connect a single CS215 to the datalogger using Control Port *p* as described in Section 7.3, *Wiring*, and download a datalogger program that contains the SDI-12 Recorder (Instruction 105) instruction with valid entries for each parameter.

2. In the LoggerNet Toolbar, navigate to and activate the Tools|Terminal Emulator… menu. The "Terminal Emulator" window opens. In the Select

Device menu, located in the lower left-hand side of the window, select the station.

3. Click on the Open Terminal button. If communications between the datalogger and PC are successful, the red bar located in the upper left-hand side of the window will turn green.
4. Click inside the “Terminal Emulator” window and press the <enter> key until the datalogger responds with the “*” prompt.
5. To activate the SDI-12 Transparent Mode on Control Port *p*, enter *p*X and press the <enter> key. The datalogger will respond with **`entering SDI-12`**. If any invalid SDI-12 command is issued, the datalogger will exit the SDI-12 Transparent Mode.
6. To query the CS215 for its current SDI-12 address, enter the command ?!. The CS215 will respond with the current SDI-12 address.
7. To change the SDI-12 address, enter the command *a*A*b*!; where *a* is the current address from the above step and *b* is the new address. The CS215 will change its address and the datalogger will exit the SDI-12 Transparent Mode.
8. To activate the SDI-12 Transparent Mode on Control Port *p*, enter *p*X and press the <enter> key. Verify the new SDI-12 address by entering the ?! command. The CS215 will respond with the new address.
9. To exit the SDI-12 Transparent Mode, enter ∗.



```
*8X
entering SDI-12
?!0
0A1!exiting SDI-12
*
*8X
entering SDI-12
?!1
exiting SDI-12*
*
```

Select Device: CR10X

Baud Rate: 9600

☑ All Caps Mode

FIGURE 7-4. Screen capture of SDI-12 Transparent Mode on Edlog array-based datalogger (CR10X) using control port 8 and changing SDI-12 address from 0 to 1

7.5.5 Table-Based "Edlog" Dataloggers

1. Connect a single CS215 to the datalogger Control Port *p* as described in Section 7.3, *Wiring*, and download a datalogger program that contains the SDI-12 Recorder (Instruction 105) instruction with valid entries for each parameter.

2. In the LoggerNet Toolbar, navigate to and activate the Tools|Terminal Emulator … menu. The "Terminal Emulator" window will open. In the Select Device menu, located in the lower left-hand side of the window, select the station.

3. Click on the Open Terminal button. If communications between the datalogger and PC are successful, the red bar located in the upper left-hand side of the window will turn green.

4. Click inside the "Terminal Emulator" window and press the <enter> key until the TD datalogger responds with the ">" prompt.

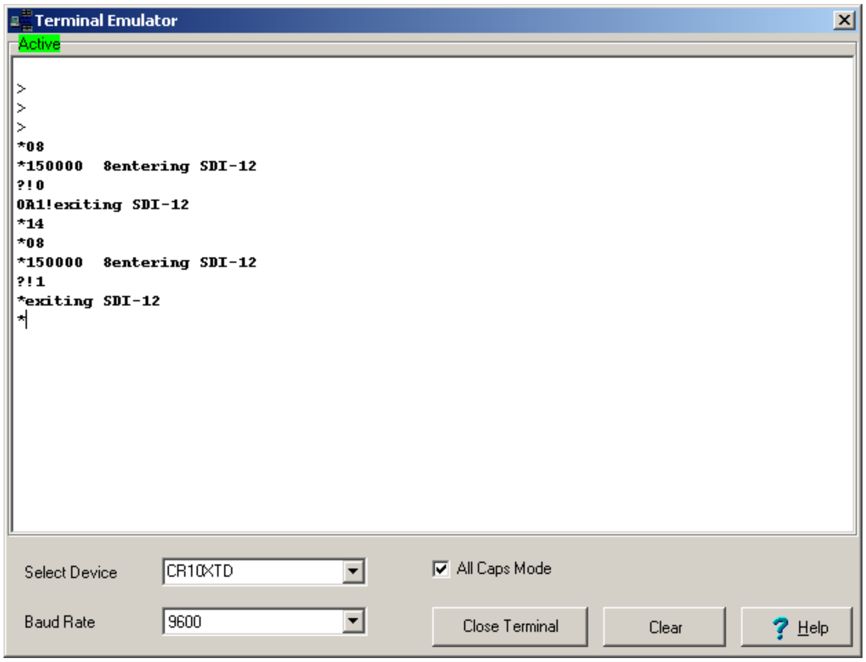
5. To activate the SDI-12 Transparent Mode on Control Port *p*, enter **`.8`**. The TD datalogger will respond with a "." prompt. At the "." prompt enter **`#`**. The TD datalogger will respond with **`150000`**. Finally, enter *p* (Control Port *p*) and press the <enter> key. The TD datalogger will respond with **`entering SDI-12`**.

6. To query the CS215 for its current SDI-12 address, enter the command ?!. The CS215 will respond with the current SDI-12 address.

7. To change the SDI-12 address, enter the command *a*A*b*!; where *a* is the current address from the above step and *b* is the new address. The CS215 will change its address and the datalogger will exit the SDI-12 Transparent Mode.

8. To activate the SDI-12 transparent mode, on Control Port *p*, enter **`.8`**. The TD datalogger will respond with a "." prompt. At the "." prompt enter **`#`**. The TD datalogger will respond with **`150000`**. Finally, enter *p* (Control Port *p*) and press the <enter> key. The TD datalogger will respond with **`entering SDI-12`**. Verify the new SDI-12 address by entering the ?! command. The CS215 will respond with the new address.

9. To exit the SDI-12 Transparent Mode, type in `*`.



```
>
>
>
*08
*150000  8entering SDI-12
?!0
0A1!exiting SDI-12
*14
*08
*150000  8entering SDI-12
?!1
*exiting SDI-12
*
```

Select Device: CR10XTD

Baud Rate: 9600

FIGURE 7-5. Screen capture of SDI-12 Transparent Mode on Edlog table-based datalogger using control port 8 and changing SDI-12 address from 0 to 1

8. Maintenance and Calibration

The CS215 probe requires minimal maintenance.

- Check monthly to make sure that the radiation shield is free from dust and debris.
- Clear the white filter on the end of the sensor of similar debris. If dirt or salt is engrained into the filter, it should be cleaned with distilled water or more simply replaced. Make sure the filter is done up firmly with your fingers – do not over tighten.

The life of the humidity chip element is quoted as many years with a typical drift of less than 1% per year when used in ‘clean’ environments. However, as it can be difficult to define what the sensor has been exposed to and as the element of the CS215 is relatively low cost, we recommend that you replace the sensor element at the normal interval you would recalibrate similar probes, e.g. annually. Replacing the element effectively brings the probe back to a factory calibration state both for temperature and RH without incurring a costly return for factory calibration.

If you wish to have an old element’s calibration checked so that you can formally record the probe’s pre-calibration state (pre-sensor replacement), you can measure its performance by plugging it into another sensor.

8.1 Sensor Element Replacement

To replace the element:

1. Disconnect the sensor from the 12 V power supply.

2. Remove the filter by unscrewing it in a counter-clockwise direction when looking towards the tip of the sensor.

CAUTION The filter cap unscrews from the probe. Attempting to pull it off will destroy it.

---

3. Identify the sensor element referring to Figure 8-1 below, which shows a side-on view of the end of the probe and sensor element. Before removing the element carefully study the probe and note its orientation after reading the following description:

    - The element plugs into the black plastic socket that protrudes by about 1 mm from the end of the metal body of the sensor.
    - There are eight holes in the socket, while the element only has four pins in line.
    - The element will work when fitted into either side of socket but must be installed in one of the two possible orientations to work.
    - The correct orientation is with the black molded tip of the element (that contains the sensing components) mounted directly above the center of the socket.
    - Figure 8-1 shows the correct orientation, while Figure 8-2 shows the incorrect orientation

---

CAUTION If the sensor is inserted in one of the wrong orientations, it will not work. Excessive power will be drawn from the supply and the element may be damaged if left powered in this state for more than a few seconds.

---

4. Once the correct orientation of the probe is identified, first make sure that your hands are clean to avoid getting dirt or grease on the element.

5. Grasp the body of the sensor (this also ensures you are at the same electrical potential as the element) and holding the black tip of the element between your fingertips pull the element out of the socket. Store the old element in electrostatic protective packaging if you wish to retain it.

6. With the element removed check for dirt and/or corrosion around the socket. Clean any dirt away using a damp cloth to remove any salts that might be there.

7. Unpack the replacement element making sure that you touch the packaging rather than the element first to avoid static discharges directly to the element.

8. Either hold the element by the black top of the package (the other end to the gold plated pins) or use a pair of fine nosed pliers or tweezers to grip the sensor by the pins. Carefully offer up the pins to the socket in the end of probe.

9. Confirm the correct orientation and then gently push the pins into the socket until they will not go in any further.

10. Before replacing the filter element and turning on the power to the sensor double-check the sensor is inserted in the correct orientation, referring to Figure 8-1.

11. Screw the filter back onto the end of the probe making sure it clears the sensor element. If the element appears too close to the filter, there is a fair chance that it has been inserted in the incorrect orientation or that the legs of the element have been bent. Screw the filter onto the thread and tighten gently with your fingers.

CAUTION

Only tighten the filter approximately 1/8th of a turn by hand when the filter is fully screwed onto the thread. Over tightening the filter will damage it and cause problems in inserting and removing the probe from some shields.

NOTE

It is virtually impossible to touch and damage the sensing elements which are enclosed within the black molded plastic at the tip. However, if during the process of handling the element dirt, salt or grease are left on the plastic, it may influence the measurements made.

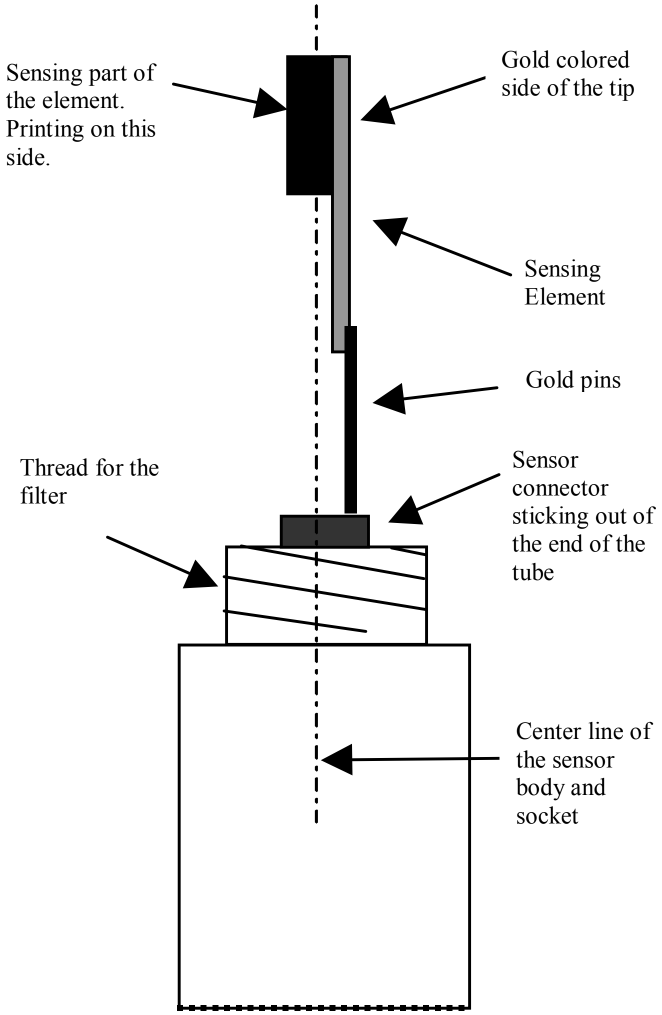


FIGURE 8-1. Correct fit of sensor element (side view)

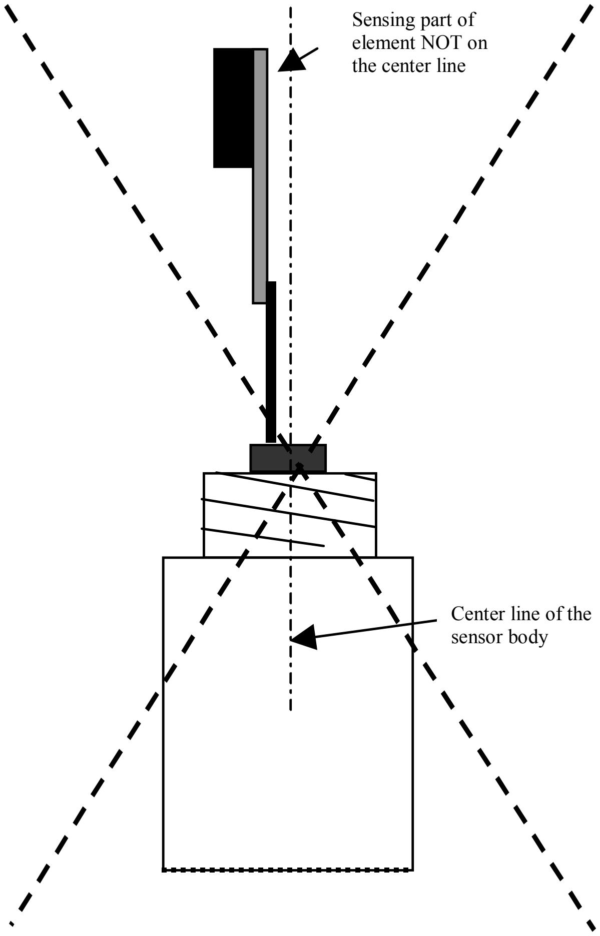


FIGURE 8-2. Incorrect fit of sensor element (side view)

9. Troubleshooting

Symptom: -9999 or NAN for temperature, 0 or unchanging value for RH

1. Verify the green wire is connected to the control port specified by the SDI12 measurement instruction.

2. Verify the red power wire is connected to a 12V terminal; check the voltage with a DVM. If a switched 12V terminal is used, temporarily connect the red wire to a 12V terminal (non-switched) for test purposes.

3. Verify the probe's SDI12 address matches the address entered for the SDI12 measurement instruction. The default address is 0, which can be verified or changed with the commands described in Section 7.5, *Changing the SDI-12 Address Using LoggerNet and a Datalogger*.

4. Remove the filter tip and verify that the sensing element has been installed with the proper orientation as described in Section 8, *Maintenance and Calibration*.

Symptom: Incorrect temperature or relative humidity

1. If 12V power is switched "on" for the measurement, verify the program is allowing a "warm-up" time of at least 100 ms.

2. Check to see if the filter tip has been contaminated. Replace the filter tip (PN 18142), or clean with distilled water as needed.

3. The specification for drift is 1% per year. Calibration can be checked by temporarily installing a new sensing element and comparing readings to those taken with the original element. Replace the element (PN 18144) annually, or as needed.

10. References

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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.

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

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

WMO, 2008. *Guide to Meteorological Instruments and Methods of Observation*. World Meteorological Organization No. 8, 7th edition, Geneva, Switzerland.

Appendix A. Environmental Performance

This Appendix details tests and limitations of the sensor when exposed to extremes of the environment.

A.1 Tests to Defined Standards

The sensor element has been tested by the manufacturer and found to comply with various environmental test standards as shown in the table below:

TABLE A-1. Environmental Tests

Environment	Norm	Results
Temperature Cycles	JESD22-A104-B -40/+125°C, 1000 cycles	Within Specifications
HAST Pressure Cooker	JESD22-A110-B 2.3bar 125°C 85%RH	Reversible shift by +2%RH
Salt Atmosphere	DIN-50021SS	Within Specifications
Condensing Air	-	Within Specifications
Freezing cycles fully submerged	-20/+90°C, 100cycles, 30min dwell time	Reversible shift by +2%RH
Various Automotive Chemicals	DIN 72300-5	Within Specifications
Cigarette smoke	Equivalent to 15years in a mid-size car	Within Specifications

N.B. The temperature sensor passed all tests without any detectable drift. Package and electronics also passed 100%

A.2 Exposure to Pollutants

All capacitative sensors are susceptible to pollutants to some degree. The vapors may interfere with the polymer layers used in the structure of the sensing element. The diffusion of chemicals into the polymer may cause temporary or even permanent shifts in both offset and sensitivity.

After low levels of exposure, in a clean environment the contaminants will slowly outgas and the sensor recovers. High levels of pollutants may cause permanent damage to the sensing polymer.

As a general rule the sensor will not be damaged by levels of chemicals which are not too dangerous to human health (see table A-1) so damage is not normally a problem in outdoor applications. Avoid exposing the sensor to chemicals at higher concentrations.

A.3 Operating Range of RH Element

The RH sensor is specified to work over the entire humidity range of 0-100% RH for the temperature range -20 to +60°C. It will give readings over an extended range as shown in the figure below (although the electronics of the CS215 probe are not specified to operate beyond +70°C).

When used outside the range of normal conditions or when subject to prolonged periods of condensation or freezing the sensor calibration may be temporarily altered, normally resulting in a change of <+3% RH. Once the sensor returns to normal conditions the calibration will settle back, over the course of several days, to the "standard" calibration. In laboratory conditions it is possible to speed up this process by a reconditioning process, as follows: 80-90 °C at < 5 %RH for 24h (baking) followed by 20-30 °C at > 74 %RH for 48h (re-hydration).

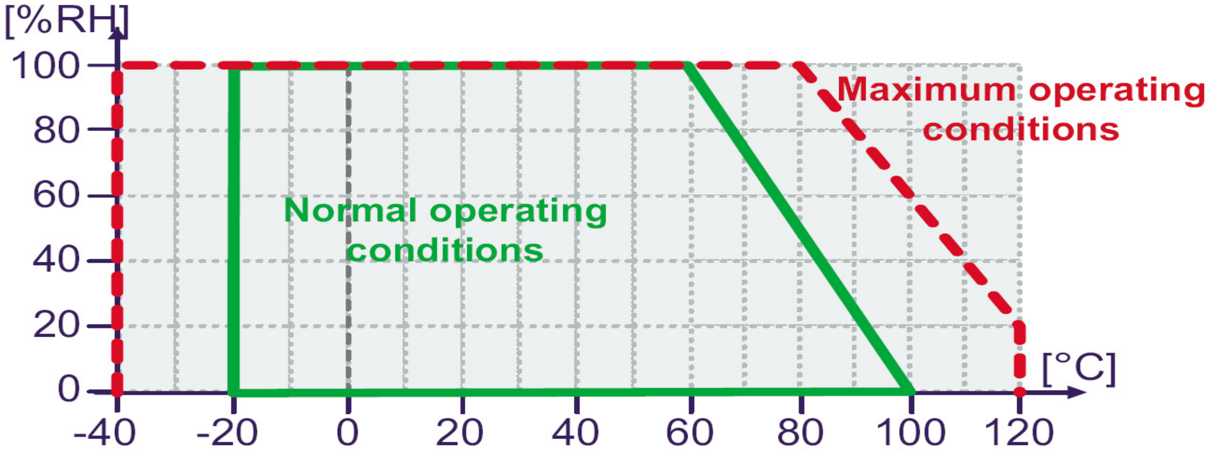

FIGURE A-1. Normal operating conditions of RH element

A.4 Measurement Below 0˚C

The CS215 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 CS215 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
95%RH at -5˚C
91%RH at -10˚C
87%RH at -15˚C
82%RH at -20˚C
78%RH at -25˚C
75%RH at -30˚C

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

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