MetSENS-Series

Compact Weather Sensors

Table of contents

1. Introduction

The MetSENS-series compact weather sensors monitor different combinations of common meteorological parameters to international standards—all in a single, integrated instrument. A variety of output options ensure plug and play operability in a wide variety of applications.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, consult with a Campbell Scientific support and implementation engineer.
- Opening the unit or breaking the security seal will void the warranty and the calibration.
- The sensor is a precision instrument. Please handle it with care.
- When installing the unit, handle with lint free gloves and degrease the unit to reduce the build-up of deposits.

3. Initial inspection

Upon receipt of the MetSENS-series sensor, inspect the packaging and contents for damage. File damage claims with the shipping company.

Each MetSENS-series sensor is shipped pre-configured, with a test report and cable. Configuration and cable type depends on the communication mode chosen: SDI-12, Modbus RS-485, or RS-232. The cable length can be 5 m (17 ft), 15 m (50 ft), 46 m (150 ft), or user specified.

Replacement cables are as follows:

- METSENSCBL1 SDI-12 Replacement Cable
- METSENSCBL2 RS-485 Replacement Cable
- METSENSCBL3 RS-232 Replacement Cable

4. QuickStart

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

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

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 MetSENS or locate the sensor in the **Sensors** > **Meteorological** > **Basic Weather** > **MetSENS** folder. Double-click the appropriate sensor model and output. Type the correct **SDI-12 Address** (default is zero) or **Modbus Address** (default is 41). If measuring barometric pressure, type the elevation of the site in the same units as the **Site elevation units**. Default units are meters, which can be changed by clicking on the **Site elevation units** box and selecting **Feet**.
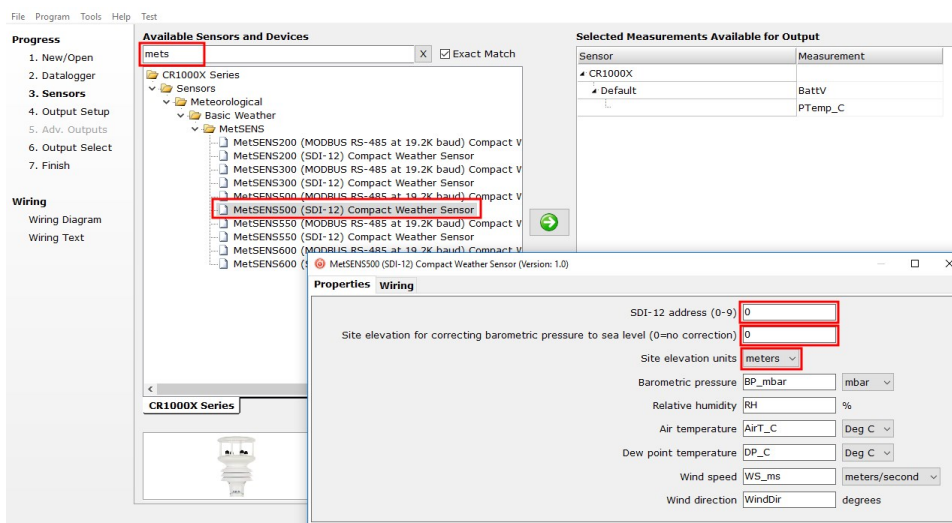
4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.
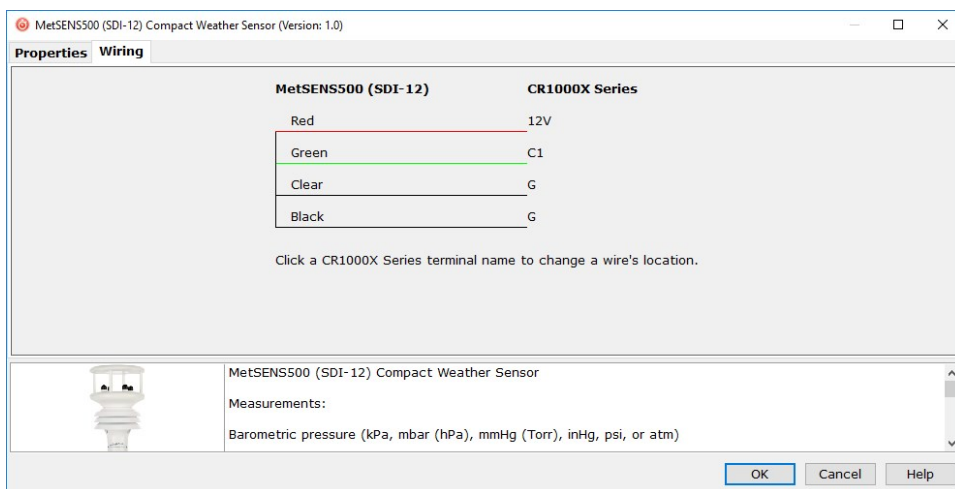
5. Repeat steps three and four for other sensors.

6. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**.
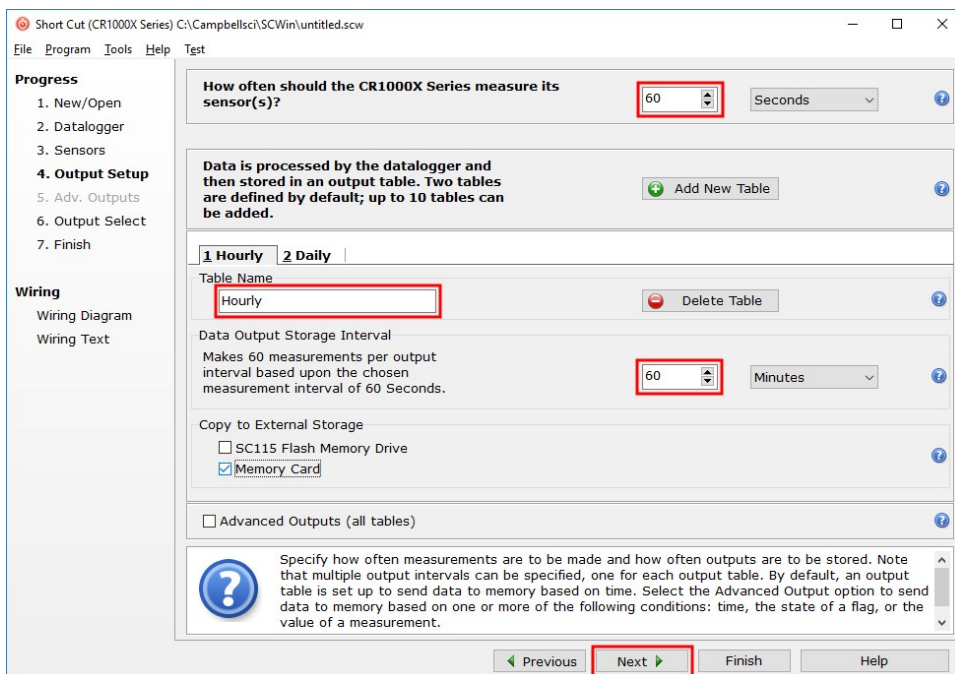
7. Select the measurement and its associated output option.
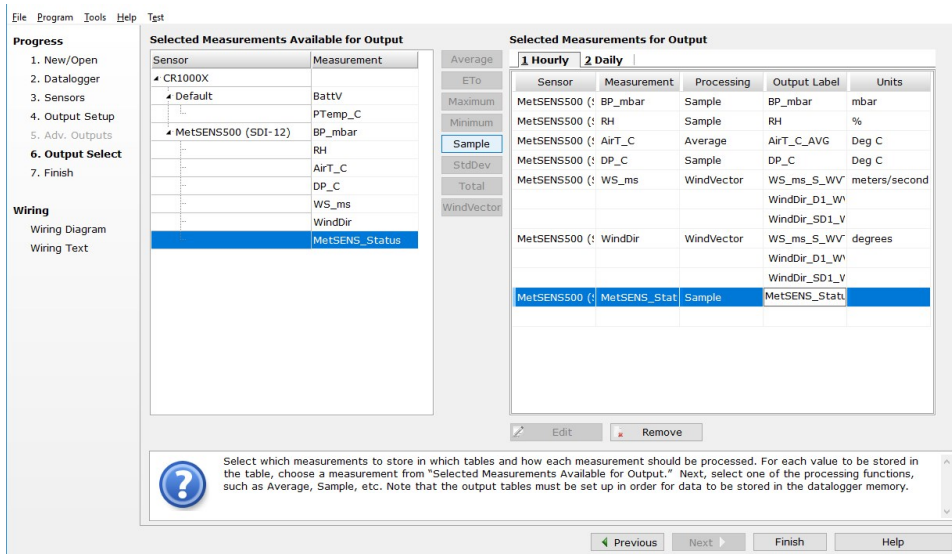
8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

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. Specifications

Sampling rate:	1 Hz
Digital communication modes:	Serial RS-232, RS-485, SDI-12, NMEA, Modbus, ASCII

Default configuration

RS-485:	19200 baud rate, 8 data bits, even parity, one stop bit; default Modbus address is 41
SDI-12:	Default SDI-12 address is 0
RS-232:	9600 baud rate, 8 data bits, even parity, one stop bit
IP rating:	66
Operating temperature range:	–40 to 70 °C
Operating voltage:	5 to 30 VDC
Typical current drain @ 12 VDC:	25 mA continuous high mode, 0.7 mA eco-power mode (1 hour polled)
Compliance:	CE and RoHS compliant.

Where applicable, all individual parameters meet or exceed specifications of IEC 61724-1 (2017, 2021).

Compliance documents available at:
www.campbellsci.com/metsens200 ↗
www.campbellsci.com/metsens300 ↗
www.campbellsci.com/metsens500 ↗
www.campbellsci.com/metsens550 ↗
www.campbellsci.com/metsens600 ↗
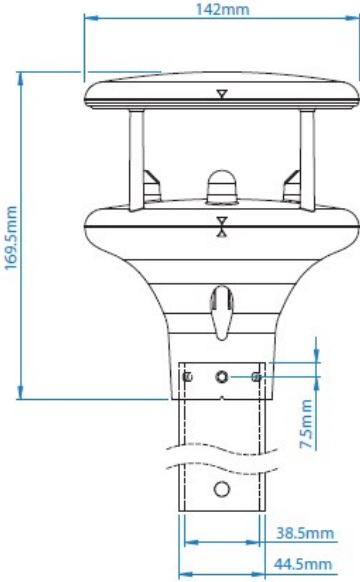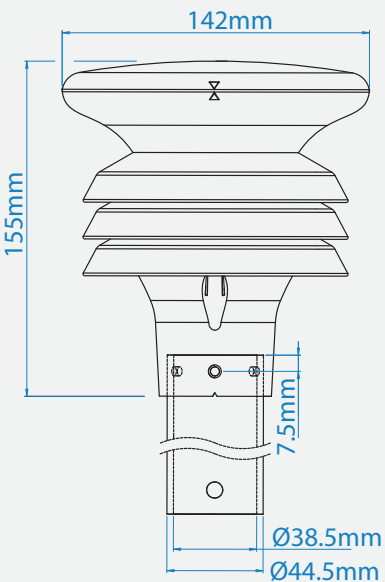
Table 5-1: Measurements, weight, and dimensions			
Model	Measurements	Weight	Dimensions
MetSENS200	Wind speed Wind direction Compass	0.5 kg (1.1 lb)	
MetSENS300	Air temperature Relative humidity Barometric pressure	0.5 kg (1.1 lb)	
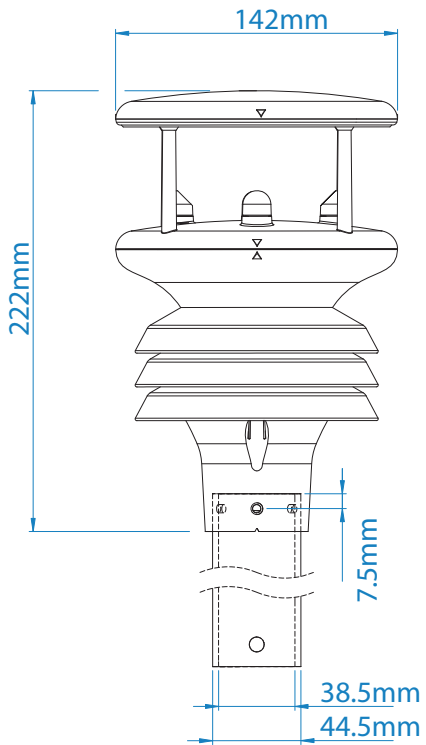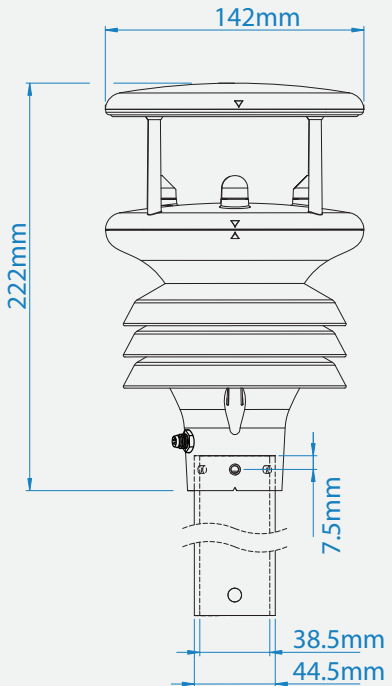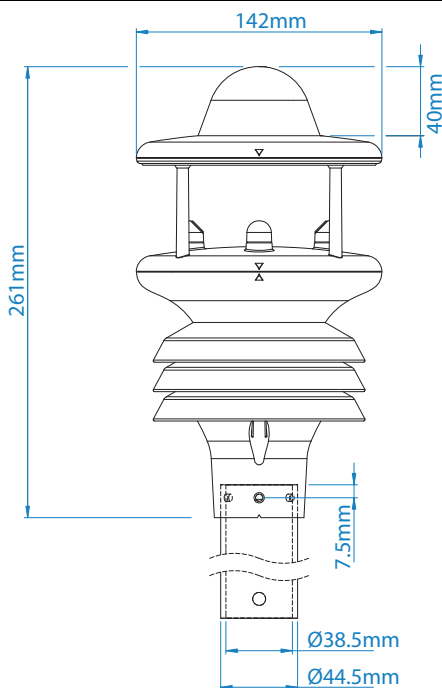
Model	Measurements	Weight	Dimensions
MetSENS500	Air temperature Relative humidity Barometric pressure Wind speed Wind direction Compass	0.7 kg (1.5 lb)	142mm / 222mm / 7.5mm / 38.5mm / 44.5mm
MetSENS550	Air temperature Relative humidity Barometric pressure Wind speed Wind direction Compass Connector for the TE525METS or other rain gage	0.7 kg (1.5 lb)	142mm / 222mm / 7.5mm / 38.5mm / 44.5mm

Table 5-1: Measurements, weight, and dimensions

Table 5-1: Measurements, weight, and dimensions			
Model	**Measurements**	**Weight**	**Dimensions**
MetSENS600	Air temperature Relative humidity Barometric pressure Wind speed Wind direction Compass Precipitation (optical)	0.8 kg (1.8 lb)	142mm 40mm 261mm 7.5mm Ø38.5mm Ø44.5mm

5.1 Air temperature measurement

Measurement range: −40 to 70 °C

Resolution: 0.1 °C

Accuracy: ±0.3 °C @ +20 °C

5.2 Relative humidity measurements

Measurement range: 0 to 100%

Resolution: 0.1 %

Accuracy: ± 2% @ 20 °C (10 to 90% RH)

5.3 Barometric pressure measurements

Measurement range: 300 to 1100 hPa

Resolution: 0.1 hPa

Accuracy: ±0.5 hPa @ 25 °C

5.4 Wind speed measurements

Measurement range:	0.01 to 60 m/s
Resolution:	0.01 m/s
Starting threshold:	0.01 m/s
Accuracy:	±3% (up to 40 m/s), ±5% (up to 60 m/s)

5.5 Wind direction measurements

Measurement range:	0° to 359°
Resolution:	1°
Accuracy:	±3° (up to 60 m/s)

5.6 Precipitation input

Measurement input type:	Triggering
Range:	0 to 1000 mm/hr
Resolution:	from 0.01 mm
Input to MetSENS550:	Contact closure via an M8 male, 4-pin connector. User-supplied 20 m cable or mating female connector required.

5.7 Precipitation measurements

Measurement input type:	Optical
Range:	0 to >300 mm/hr
Resolution:	0.08 mm
Repeatability:	3%

5.8 Compass

Measurement range:	0 to 359°
Resolution:	1°
Units of measure:	Degrees
Accuracy:	±3°

6. Installation

If you are programming your data logger with *Short Cut*, skip Wiring (p. 10) and Programming (p. 11). *Short Cut* does this work for you. See QuickStart (p. 2) for a tutorial.

6.1 Wiring

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

6.1.1 RS-485 wiring

The RS-485 output can be directly read by a MeteoPV, CR6, CR1000X, or Modbus RTU RS-485 network (Table 6-1 [p. 10]). Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output. Refer to the MD485 manual for more information. The Modbus address must be unique and may need to be changed if another sensor on the bus has the same address. Contact Campbell Scientific technical support for assistance changing MB address.

Table 6-1: RS-485 pin-out, wire color, function, and data logger connection			
Wire color	Pin-out	Function	Data logger[1] connection
Green	5, 7	RS-485 A–	**A-**, **C** (odd)
White	4, 6	RS-485 B+	**B+**, **C** (even)
Red	2	12 VDC	**12V**
Black	3, 1	Power and signal ground	**G**
Clear	NC	Shield	**G**
[1]Assumes the sensor directly connects to the data logger.			

6.1.2 SDI-12 wiring

Table 6-2 (p. 11) provides wiring and pin-out information when using a MetSENS-series sensor with an SDI-12 output.

Table 6-2: SDI-12 pin-out, wire color, function, and data logger connection			
Wire color	Pin-out	Function	Data logger connection
Green	9	SDI-12 signal	**C**, **SDI-12**, or **U** configured for SDI-12[1]
Red	2	Power	**12V**
Black	3, 1	Power and signal ground	**G**
Clear	NC	Shield	**G**
[1]**U** and **C** terminals are automatically configured by the measurement instruction.			

For CR6 and CR1000X data loggers, triggering conflicts may occur when a companion terminal is used for a triggering instruction such as `TimerInput()`, `PulseCount()`, or `WaitDigTrig()`. For example, if this product is connected to **C3** on a CR1000X, **C4** cannot be used in the `TimerInput()`, `PulseCount()`, or `WaitDigTrig()` instructions.

6.1.3 RS-232 wiring

The RS-232 output can be directly read by a CR6 or CR1000X data logger (Table 6-3 [p. 11]).

Table 6-3: RS-232 pin-out, wire color, function, and data logger connection			
Wire Color	Pin-out	Function	Data logger[1] connection
Green	7	RS-232 RXD	**C** (odd)
White	5	RS-232 TXD	**C** (even)
Red	2	12 VDC	**12V**
Black	3, 1	Power and signal ground	**G**
Clear	NC	Shield	**G**
[1]Assumes the sensor directly connects to the data logger.			

6.2 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. 24). Programming basics for CRBasic data loggers are provided in the following section. Downloadable example programs are available at:

www.campbellsci.com/downloads/metsens200-example-programs ☑

www.campbellsci.com/downloads/metsens300-example-programs ☑

www.campbellsci.com/downloads/metsens500-example-programs ☑

www.campbellsci.com/downloads/metsens550-example-programs ☑

www.campbellsci.com/downloads/metsens600-example-programs ☑

6.2.1 Modbus programming

The RS-485 output can be directly read by a MeteoPV, CR6-series, CR1000X-series, or Modbus RTU RS-485 network. Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output. Refer to the MD485 manual for information about using the MD485. Refer to www.campbellsci.com/videos/meteopv ▶ for information about using the MeteoPV.

A CR6 or CR1000X data logger programmed as a Modbus client can retrieve the values stored in the input registers (Modbus measurements [p. 15]). To do this, the CRBasic program requires `SerialOpen()` followed by `ModbusClient()`.

> **NOTE:**
> `ModbusClient()` was formerly `ModbusMaster()`. Campbell Scientific, in conjunction with the Modbus Organization, is now using "client-server" to describe Modbus communications. The Modbus client(s) initiates communications and makes requests of server device(s). Server devices process requests and return an appropriate response (or error message). See https://modbus.org for more information. Existing programs that use the old Modbus terminology will still compile in the data logger.

The `SerialOpen` instruction has the following syntax:

```
SerialOpen (ComPort, Baud, Format, TXDelay, BufferSize, Mode)
```

The `Format` parameter is typically set to logic 1 low; even parity, one stop bit, 8 data bits. The `Mode` parameter should configure the ComPort as RS-485 half-duplex, transparent.

The `ModbusClient()` instruction has the following syntax:

```
ModbusClient (Result, ComPort, Baud, Addr, Function, Variable, Start, Length,
Tries, TimeOut, [ModbusOption])
```

The **Addr** parameter must match the sensor Modbus address. To collect all of the values, the **Start** parameter needs to be 1 and the **Length** parameter needs to correspond with the register count (see Modbus measurements [p. 15]). **ModbusOption** is an optional parameter described in the *CRBasic Editor* Help.

6.2.2 SDI-12 programming

The `SDI12Recorder()` instruction is used to measure a MetSENS-series configured for SDI-12 measurements. The `SDI12Recorder()` instruction sends a request to the sensor to make a measurement and then retrieves the measurement from the sensor. See SDI-12 measurements (p. 18) for more information.

For most data loggers, the `SDI12Recorder()` instruction has the following syntax:

```
SDI12Recorder(Destination, SDIPort, SDIAddress, "SDICommand", Multiplier, Offset,
FillNAN, WaitonTimeout)
```

Valid values for the **SDIAddress** are 0 through 9, a through z, and A through Z; alphabetical characters need to be enclosed in quotation marks (for example, **"A"**). Also enclose the **SDICommand** in quotation marks as shown. The **Destination** parameter must be an array. The required number of values in the array depends on the command; see Table 7-5 (p. 19).

FillNAN and **WaitonTimeout** are optional parameters (refer to *CRBasic Editor* help for more information).

6.2.3 RS-232 programming

The RS-232 instructions are shown in Table 6-4 (p. 14).

Table 6-4: RS-232 serial instructions	
Instruction	Function
SerialFlush()	Clears the buffer.
Scan()	Establish a scan rate.
SerialOut()	Send command to sensor.
SerialIn()	Set up the COM port to receive the incoming serial data. Note that in the beginning of the CRBasic program, the variable used in SerialIn() instruction needs to be declared as an ASCII string format.
SplitStr()	Split out digital count value from the input string.

6.3 Siting considerations for wind measurements

Locate the sensor away from obstructions such as trees and buildings. The horizontal distance from an obstruction should be at least ten times the height of the obstruction. If it is necessary to mount the sensor on the roof of a building, the height of the sensor above the roof, should be at least 1.5 times the height of the building. The sensors should also be mounted away from electrical equipment that generate magnetic fields, which will affect the electronic compass.

The sensor has four notches that need to be aligned to the magnetic north. A declination correction factor can be added to the Magnetic North heading from the wind direction measurement. Map and declination figures in decimal figures can be obtained from www.geosats.com/magdecli.html ☐ or www.ngdc.noaa.gov/geomag/declination.shtml ☐.

6.4 Mounting

Two mounting bracket kits are offered for the MetSENS-series sensors. The ClimaVUE 50, MetSENS, or WindSonic Mounting Pipe Kit secures the sensor to a crossarm and consists of a mounting tube, three pan truss screws, CM220 Right Angle Mounting bracket, two U-bolts, and four nuts. The MetSENS or WINDSONIC Stand Mount secures the sensor to either a vertical pole or a horizontal crossarm. It consists of a mounting stand, three pan screws, a plate, two carriage screws, two washers, two lock washers, and two wing nuts.

> **NOTE:**
> When installing the unit, handle with lint free gloves and degrease the unit to reduce the build-up of deposits.

Mounting procedure:

1. If using the mounting pipe kit, thread the connector end of the cable through the tubing; start at the end without the three threaded holes.
2. Attach the cable connector to the mating connector located on the bottom of the sensor.
3. Use the three pan screws to secure the sensor to the tubing or mounting stand.
4. If applicable, mount the crossarm to the tripod or tower.
5. If using the pipe kit, mount the tubing to the crossarm with the CM220 Right Angle Mounting bracket, U-bolts, and nuts. If using the stand mount, secure the mounting stand to the pole or crossarm with the plate, carriage screws, washers, lock washers, and wing nuts.
6. If measuring wind direction, ensure that the four notches on the sensor are aligned to the magnetic north (see www.geosats.com/magdecli.html ⬈ or www.ngdc.noaa.gov/geomag/declination.shtml ⬈).
7. If using the MetSENS600, level the rain sensor both horizontally and vertically level by using a torpedo level.
8. Route the cable down the crossarm and tripod or pole to the instrument enclosure.
9. Secure the cable to the crossarm and tripod or pole by using cable ties.

7. Operation

7.1 Modbus measurements

The following tables show the Modbus registers for each model.

Table 7-1: MetSENS200 RS-485 registers

Starting register number	Register count	Data format	Label	Units	Description
40001	2	FLOAT	DIR	°	Current, uncorrected wind direction
40003	2	FLOAT	SPEED	m/s	Current wind speed
40005	2	FLOAT	COMPASSH	°	Compass heading of north mark
40007	2	FLOAT	VOLT	VDC	Supply voltage
40009	2	FLOAT	AVGDIR	°	5 min. average wind direction, updated every 30 s
40011	2	FLOAT	AVGSPEED	m/s	5 min. average wind speed, updated every 30 s
40013	2	FLOAT	GDIR	°	Direction of wind gust
40015	2	FLOAT	GSPEED	m/s	3 s wind gust, updated every 30 s
40017	2	UNIT32	STATUS		Sensor status code (p. 23)

Table 7-2: MetSENS300 RS-485 registers

Starting register number	Register count	Data format	Label	Units	Description
40001	2	FLOAT	PRESS	hPa	Barometric pressure
40003	2	FLOAT	RH	%	Relative humidity
40005	2	FLOAT	TEMP	°C	Air temperature
40007	2	FLOAT	DEWPOINT	°C	Dewpoint
40009	2	FLOAT	VOLT	VDC	Supply voltage
40011	2	UNIT32	STATUS		Sensor status code (p. 23))

Starting register number	Register count	Data format	Label	Units	Description
Table 7-3: MetSENS500 RS-485 registers					
40001	2	FLOAT	DIR	°	Current, uncorrected wind direction
40003	2	FLOAT	SPEED	m/s	Current wind speed
40005	2	FLOAT	COMPASSH	°	Compass heading of north mark
40007	2	FLOAT	PRESS	hPa	Barometric pressure
40009	2	FLOAT	RH	%	Relative humidity
40011	2	FLOAT	TEMP	°C	Air temperature
40013	2	FLOAT	DEWPOINT	°C	Dewpoint
40015	2	FLOAT	VOLT	VDC	Supply voltage
40017	2	FLOAT	AVGDIR	°	5 min. average wind direction, updated every 30 s
40019	2	FLOAT	AVGSPEED	m/s	5 min. average wind speed, updated every 30 s
40021	2	FLOAT	GDIR	°	Direction of wind gust
40023	2	FLOAT	GSPEED	m/s	3 s wind gust, updated every 30 s
40025	2	UNIT32	STATUS		Sensor status code (p. 23)

Table 7-4: MetSENS550/MetSENS600 RS-485 registers					
Starting register number	Register count	Data format	Label	Units	Description
40001	2	FLOAT	DIR	°	Current, uncorrected wind direction
40003	2	FLOAT	SPEED	m/s	Current wind speed
40005	2	FLOAT	COMPASSH	°	Compass heading of north mark
40007	2	FLOAT	PRESS	hPa	Barometric pressure
40009	2	FLOAT	RH	%	Relative humidity
40011	2	FLOAT	TEMP	°C	Air temperature
40013	2	FLOAT	DEWPOINT	°C	Dewpoint
40015	2	FLOAT	VOLT	VDC	Supply voltage
40017	2	FLOAT	AVGDIR	°	5 min. average wind direction, updated every 30 s
40019	2	FLOAT	AVGSPEED	m/s	5 min. average wind speed, updated every 30 s
40021	2	FLOAT	GDIR	°	Direction of wind gust
40023	2	FLOAT	GSPEED	m/s	3 s wind gust, updated every 30 s
40025	2	FLOAT	PRECIPT	mm	Total accumulated precipitation since powerup
40027	2	UNIT32	STATUS		Sensor status code (p. 23)

7.2 SDI-12 measurements

The MetSENS-series sensors respond to the SDI-12 commands shown in Table 7-5 (p. 19). The MC! commands are the same as the M! commands except a cyclic redundancy check (CRC) is included.

Table 7-5: SDI-12 commands and values returned[1]			
SDI-12 command[2]	Values returned	Units	Response time
*a*M! or *a*MC!	1. Address (0 through 9) 2. Relative wind direction 3. Relative wind speed 4. Corrected wind direction 5. Status (4-digit code); see Sensor status code (p. 23)	1. n/a 2. ° 3. m/s 4. ° 5. n/a	3 s
*a*M1! or *a*MC1!	1. Address (0 through 9) 2. Temperature 3. Relative humidity 4. Dew point 5. Barometric pressure 6. Status (4-digit code); see Sensor status code (p. 23) 7. Wind chill 8. Heat index 9. Air density 10. Wet bulb temperature	1. n/a 2. °C 3. % 4. °C 5. hPa 6. n/a 7. °C 8. °C 9. kg/m^2 10. °C	2 s
*a*M2! or *a*MC2!	1. Address (0 through 9) 2. Relative wind direction 3. Relative wind speed 4. Status (4-digit code); see Sensor status code (p. 23)	1. n/a 2. ° 3. m/s 4. n/a	3 s
*a*M3! or *a*MC3!	1. Address (0 through 9) 2. Precipitation intensity 3. Total precipitation 4. Status (4-digit code); see Sensor status code (p. 23)	1. n/a 2. mm/hr 3. mm 4. n/a	3 s
?!	Returns the SDI-12 Address		
[1]Not all outputs are available for all sensors.			
[2]*a* is the SDI-12 address. In the `SDI12Recorder()` CRBasic instruction, the command parameter does not include the SDI-12 address because the address is a separate parameter.			

7.3 RS-232 default settings

The following are factory-default data strings. provides the RS-232 default settings.

MetSENS200

```
NODE, DIR, SPEED, CDIR, VOLT, STATUS, CHECK
┐ Q,021,000.01,090,+05.1,0000,└ 36
```

Where,

┐ :	STX (Start of String character; ASCII value 2)
Q:	Node letter
021:	Wind direction
000.01:	Wind speed
090	Corrected direction
+05.1	Supply voltage
0000	Status
└	ETX (End of String character; ASCII value 3)
36	Checksum (2 digit Hex Checksum sum figure calculated from the Exclusive OR of the bytes between, and not including, the STX and ETX characters)

MetSENS300

```
NODE, PRESS, RH, TEMP, DEWPOINT, VOLT, STATUS, CHECK
┐ Q, 1015.3,041,+022.0,+008.5,+05.1,0000,└ 36
```

Where,

┐ :	STX (Start of String character; ASCII value 2)
Q:	Node letter
1015.3:	Pressure
041:	Relative humidity
+022.0:	Temperature
+008.5:	Dewpoint
+05.1	Supply voltage
0000	Status
└	ETX (End of String character; ASCII value 3)

| 36 | Checksum (2 digit Hex Checksum sum figure calculated from the Exclusive OR of the bytes between, and not including, the STX and ETX characters) |

MetSENS500

```
NODE, DIR,SPEED, CDIR, PRESS, RH, TEMP, DEWPOINT, VOLT, STATUS, CHECK
˥ Q,021,000.01,090,1015.3,041,+022.0,+008.5,+05.1,0004,∟  36
```

Where,

˥ :	STX (Start of String character; ASCII value 2)
Q:	Node letter
021:	Wind direction
000.01:	Wind speed
090:	Corrected direction
1015.3:	Pressure
041:	Relative humidity
+022.0:	Temperature
+008.5:	Dewpoint
+05.1:	Supply voltage
0004:	Status
∟ :	ETX (End of String character; ASCII value 3)
36:	Checksum (2 digit Hex Checksum sum figure calculated from the Exclusive OR of the bytes between, and not including, the STX and ETX characters)

MetSENS550/MetSENS600

```
NODE, DIR, SPEED, CDIR, PRESS, RH, TEMP, DEWPOINT, TOTAL PRECIP, PRECIP INTENSITY,
 VOLT, STATUS, CHECK
˥ Q,021,000.01,090,1015.3,041,+022.0,+008.5, 00000.200,000.200,+05.1,0004,∟  36
```

Where,

˥ :	STX (Start of String character; ASCII value 2)
Q:	Node letter
021:	Wind direction
000.01:	Wind speed
090:	Corrected direction
1015.3:	Pressure
041:	Relative humidity
+022.0:	Temperature

0000.200:	Precipitation total	
000.200:	Precipitation intensity	
+05.1	Supply voltage	
0004	Status	
∟	ETX (End of String character; ASCII value 3)	
36	Checksum (2 digit Hex Checksum sum figure calculated from the Exclusive OR of the bytes between, and not including, the STX and ETX characters)	

Table 7-6: Default settings		
Setting	Setting	Setting
PROTOCOL: GILL	AVGLONG: 10[1]	SENSOR PRECIP: ON[3]
COMMS: RS232	SENSOR COMPASS: ON[1]	UNITS PRECIP: MM[3]
BAUD: 9600	COMPASSDECL: +000.0[1]	POWER: 0
NODE: Q	SENSOR TEMP: ON[2]	PUPMSG STATUS: ON
OUTFREQ: 1Hz	UNITS TEMP: C[2]	PUPMSG REPORT: ON
MSGMODE: CONT	SENSOR DEWPOINT: ON[2]	PUPMSG UNITS: ON
ASCTERM: CRLF	UNITS DEWPOINT: C[2]	MODBUS: RTU
ECHO : ON	SENSOR PRESS: ON[2]	MODADDR: 1
ALIGN: 0[1]	UNITS PRESS: HPA[2]	DATABITS: 8
SENSOR WIND: ON[1]	HASL: +00000.00[2]	STOPBITS: 1
UNITS WIND: MS[1]	HASTN: +00000.00[2]	PARITY: NONE
NODIR: 0.00[1]	SENSOR RH: ON[2]	MODTERM: 10
AVGSHORT: 60[1]	UNITS RH: %[2]	MODICT: 1000
[1] Not available for the MetSENS300		
[2] Not available for the MetSENS200		
[3] Only available for the MetSENS550 and MetSENS600		

7.4 Sensor status code

Modbus and some SDI-12 commands output a four-digit status code that indicates whether the sensor is working properly. The following table describes these codes.

Table 7-7: Status sensor code descriptions		
Code	Status	Condition
0000	OK	No fault conditions detected in measurement period
0001	Wind Measurement Fault	Wind sensor faulty
0010	Temperature Measurement Fault	Temperature sensor faulty
0020	Dewpoint Fault	If temperature and humidity are reporting correctly, this code indicates a main PCB fault.
0040	Humidity Fault	Humidity sensor faulty
0080	Pressure Sensor Warning	Pressure sensor reading not available/unit faulty
0100	Compass Fault	Invalid heading due to compass fault

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 *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, then save it. Click the **Advanced** tab then the **CRBasic Editor** button. Your program file will open in CRBasic with a generic name. 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.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder. Copy the wiring information found at the beginning of the .DEF file.

3. Go into the CRBasic program and paste the wiring information at the beginning of the program.

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. SDI-12 sensor support

Serial Data Interface at 1200 baud (SDI-12) is a protocol developed to simplify sensor and data logger compatibility. Only three wires are necessary—serial data, ground, and 12 V. With unique addresses, multiple SDI-12 sensors can connect to a single SDI-12 terminal on a Campbell Scientific data logger.

This appendix discusses the structure of SDI-12 commands and the process of querying SDI-12 sensors. For more detailed information, refer to version 1.4 (January 2019) of the SDI-12 protocol, available at www.sdi-12.org ⬚.

For additional information, refer to the SDI-12 Sensors | Transparent Mode and SDI-12 Sensors | Watch or Sniffer Mode ⬚ videos.

B.1 SDI-12 command basics

SDI-12 commands have three components:

- **Sensor address (a)** – a single character and the first character of the command. Use the default address of zero (0) unless multiple sensors are connected to the same port.
- **Command body** – an upper case letter (the "command"), optionally followed by one or more alphanumeric qualifiers.
- **Command termination (!)** – an exclamation mark.

An active sensor responds to each command. Responses have several standard forms and always terminate with <CR><LF> (carriage return and line feed). Standard SDI-12 commands are listed in Table B-1 (p. 25).

Table B-1: Campbell Scientific sensor SDI-12 command and response sets		
Name[1]	Command	Response
Acknowledge active	a!	a<CR><LF>
Send identification	aI!	allccccccccmmmmmmvvvxxx...xx<CR><LF>
Start verification	aV!	atttn <CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response sets		
Name[1]	Command	Response
Address query	`?!`	a<CR><LF>
Change address	`aAb!`	b<CR><LF>
Start measurement	`aM!` `aM1!...aM9!`	atttn<CR><LF>
Start measurement and request CRC	`aMC!` `aMC1!...aMC9!`	atttn <CR><LF>
Start concurrent measurement	`aC!` `aC1!...aC9!`	atttnn<CR><LF>
Start concurrent measurement and request CRC	`aCC!` `aCC1!...aCC9!`	atttnn<CR><LF>
Send data	`aD0!...aD9!`	a<values><CR><LF> or a<values><CRC><CR><LF>
Continuous measurement	`aR0!...aR9!`	a<values><CR><LF>
Continuous measurement and request CRC	`aRC0!...aRC9!`	a<values><CRC><CR><LF>
[1] Information on each of these commands is given in the following sections.		

B.1.1 Acknowledge active command (a!)

The acknowledge active command (`a!`) is used to test a sensor on the SDI-12 bus. An active sensor responds with its address.

B.1.2 Send identification command (aI!)

Sensor identifiers are requested by issuing command `aI!`. The reply is defined by the sensor manufacturer but usually includes the sensor address, SDI-12 version, manufacturer's name, and sensor model information. Serial number or other sensor specific information may also be included. Source: *SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors* (see References [p. 1]).

Command: `aI!`

Response: *allccccccccmmmmmmmvvvxxx...xx<CR><LF>*

Where

  a = sensor address

ll = SDI-12 version number (indicates compatibility)

cccccccc = 8-character vendor identification

vvv = 3 characters specifying the sensor version (operating system)

xxx...xx = Up to 13 optional characters used for a serial number or other specific sensor information that is not relevant for operation of the data logger

<CR><LF> = terminates the response

B.1.3 Start verification command (aV!)

The response to start verification (`aV!`) can include hardware diagnostics, but like the `aI!` command, the response is not standardized.

Command: `aV!`

Response: *atttn<CR><LF>*

Where

  a = sensor address

  ttt = time, in seconds, until verification information is available

  n = the number of values to be returned when one or more subsequent `D!` commands are issued

  <CR><LF> = terminates the response

B.1.4 Address query command (?!)

Command `?!` requests an address of the connected sensor. The sensor responds to the query with the address, *a*. This command should only be used with one sensor on the SDI-12 bus at a time.

B.1.5 Change address command (aAb!)

Multiple SDI-12 sensors can connect to a single SDI-12 terminal on a data logger. Each device on a single terminal must have a unique address.

A sensor address is changed with command **aAb!**, where *a* is the current address and *b* is the new address. For example, to change an address from *0* to *2*, the command is **0A2!**. The sensor responds with the new address *b*, which in this case is 2.

> **NOTE:**
> Only one sensor should be connected to a particular terminal at a time when changing addresses.

B.1.6 Start measurement commands (aM!)

A measurement is initiated with the **M!** command. The response to each command has the form *atttn<CR><LF>*, where

   a = sensor address

   ttt = time, in seconds, until measurement data is available; when the data is ready, the sensor notifies the data logger, and the data logger begins issuing **D** commands.

   n = the number of values returned when one or more subsequent **D** commands are issued; for the **aM!** command, *n* is an integer from 0 to 9.

When the **aM!** command is issued, the data logger pauses its operation and waits until either it receives data from the sensor or the time (*ttt*) expires. Depending on the scan interval of the data logger program and the response time of the sensor, this may cause skipped scans to occur. To avoid this, ensure that the scan interval is greater than the longest measurement time (*ttt*).

Table B-2: Example aM! sequence	
0M!	The data logger makes a request to sensor 0 to start a measurement.
00352<CR><LF>	Sensor 0 immediately indicates that it will return two values within the next 35 seconds.
0<CR><LF>	Within 35 seconds, sensor 0 indicates that it has completed the measurement by sending a service request to the data logger.
0D0!	The data logger immediately issues the first **D** command to collect data from the sensor.
0+.859+3.54<CR><LF>	The sensor immediately responds with the sensor address and the two values.

B.1.7 Start measurement commands with cyclic redundancy check (aMC! and aCC!)

Error checking is done by using measurement commands with cyclic redundancy checks (**aMC!** or **aCC!**). This is most commonly implemented when long cable lengths or electronic noise may impact measurement transmission to the data logger. When these commands are used, the data returned in response to **D!** or **R!** commands must have a cyclic redundancy check (CRC) code appended to it. The CRC code is a 16-bit value encoded within three characters appended before the <CR><LF>. This code is not returned in the data table but is instead checked by the data logger as it comes. The code returned is based on the SDI-12 protocol. See the SDI-12 communication specification for version 1.4 version 1.4 (January 2019) available at www.sdi-12.org ⧉ to learn more about how the CRC code is developed.

B.1.8 Stopping a measurement command

A measurement command (**aM!**) is stopped if it detects a break signal before the measurement is complete. A break signal is sent by the data logger before most commands.

A concurrent measurement command (**aC!**) is aborted when another valid command is sent to the sensor before the measurement time has elapsed.

B.1.9 Send data command (aD0! ... aD9!)

The send data command (**aD!**) requests data from the sensor. It is issued automatically with every type of measurement command (**aM!**, **aMC!**, **aC!**, **aCC!**). When the measurement command is aM! or aMC!, the data logger issues the **aD0!** command once a service request has been received from the sensor or the reported time has expired. When the data logger is issuing concurrent commands (**aC!** or **aCC!**), the send data command is issued after the required time has elapsed (no service request will be sent by the sensor). In transparent mode (see SDI-12 transparent mode [p. 29]), the user asserts this command to obtain data.

Depending on the type of data returned and the number of values a sensor returns, the data logger may need to issue **aD0!** up to **aD9!** to retrieve all data. A sensor may return up to 35 characters of data in response to an **aD!** command that follows an **aM!** or **aMC!** command. A sensor may return up to 75 characters of data in response to a **aD!** command that follows an **aC!** or **aCC!** command. Data values are separated by plus or minus signs.

Command: **aD0!** (**aD1!** ... **aD9!**)

Response: *a<values><CR><LF>* or *a<values><CRC><CR><LF>*

where

   a = the sensor address

   <values> = values returned with a polarity sign (+ or –)

   <CR><LF> = terminates the response

   <CRC> = 16-bit CRC code appended if data was requested with **aMC!** or **aCC!**.

B.2 SDI-12 transparent mode

System operators can manually interrogate and enter settings in probes using transparent mode. Transparent mode is useful in troubleshooting SDI-12 systems because it allows direct communication with probes. Data logger security may need to be unlocked before activating the transparent mode.

Transparent mode is entered while the computer is communicating with the data logger through a terminal emulator program. It is accessed through Campbell Scientific data logger support

software or other terminal emulator programs. Data logger keyboards and displays cannot be used.

The terminal emulator is accessed through Campbell Scientific *Device Configuration Utility* software.

Watch videos/sdi12-sensors-transparent-mode ▶ from our website.

Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

The following examples show how to enter transparent mode and change the SDI-12 address of an SDI-12 sensor. The steps shown in Changing an SDI-12 address (p. 30) are used with most Campbell Scientific data loggers.

B.2.1 Changing an SDI-12 address

This example was done with a CR1000X, but the steps are only slightly different for Granite-series, CR6, CR800-series, CR300-series data loggers.
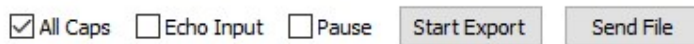
1. Connect an SDI-12 sensor to the CR1000X.

2. Open *Device Configuration Utility*.

3. Under **Device Type**, type the data logger model and double-click on the model type. This example uses a CR1000X directly connected to the computer USB port.

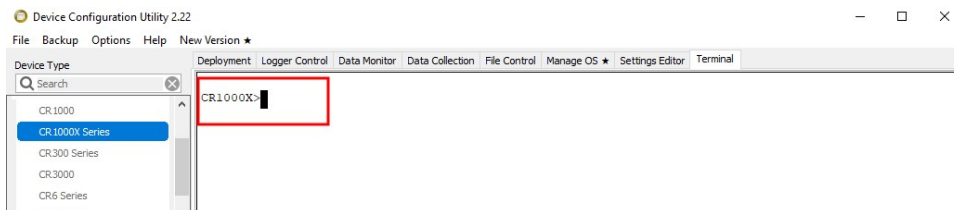4. Select the correct **Communication Port** and click **Connect**.
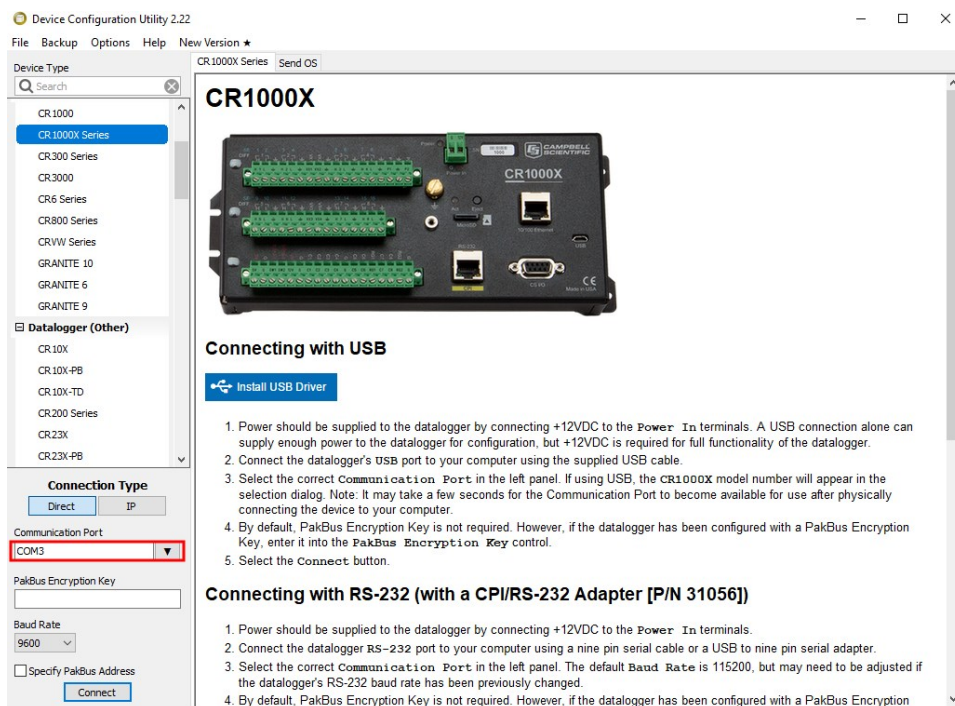
5. Click the **Terminal** tab.
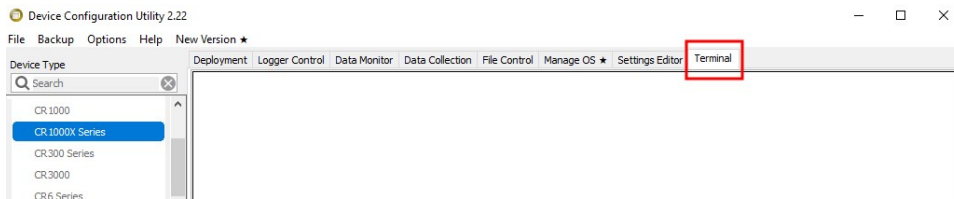
6. Select **All Caps Mode**.

7. Press **Enter** until the data logger responds with the data logger (**CR1000X>**) prompt.

8. Type **SDI12** and press Enter.

9. At the **Select SDI12 Port** prompt, type the number corresponding to the control port where the sensor is connected and press **Enter**. In this example the sensor is connected to C3. The response **Entering SDI12 Terminal** indicates that the sensor is ready to accept SDI-12 commands.

```
CR1000X>
CR1000X>SDI12
1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 2
```

10. To query the sensor for its current SDI-12 address, type **?!** and press **Enter**. The sensor responds with its SDI-12 address. If no characters are typed within 60 seconds, the mode is exited. In that case, simply type **SDI12** again, press **Enter**, and type the correct control port number when prompted.

```
?!
0
```

11. To change the SDI-12 address, type **aAb!**, where **a** is the current address from the previous step and **b** is the new address. Press **Enter**. The sensor changes its address and responds with the new address. In the following example, the sensor address is changed from 0 to B.

```
SDI12
SDI12>0AB!B
```

12. To exit SDI-12 transparent mode, click **Close Terminal**.

> **NOTE:**
> The transparent mode for the Granite-series, CR6, CR3000, CR800-series, CR300-series data loggers is similar to that shown for the CR1000X.

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Utility and Electrical
- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather
- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance
- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

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- Be aware of fire, explosion, and severe-burn hazards.
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