

MetSENS-Series

Compact Weather Sensors



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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

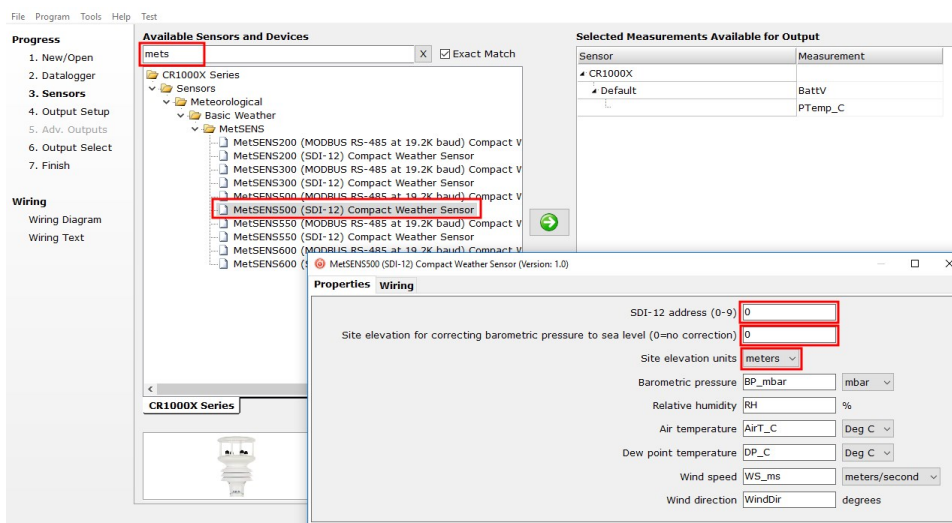
4. QuickStart

A video that describes data logger programming using *Short Cut* is available at:

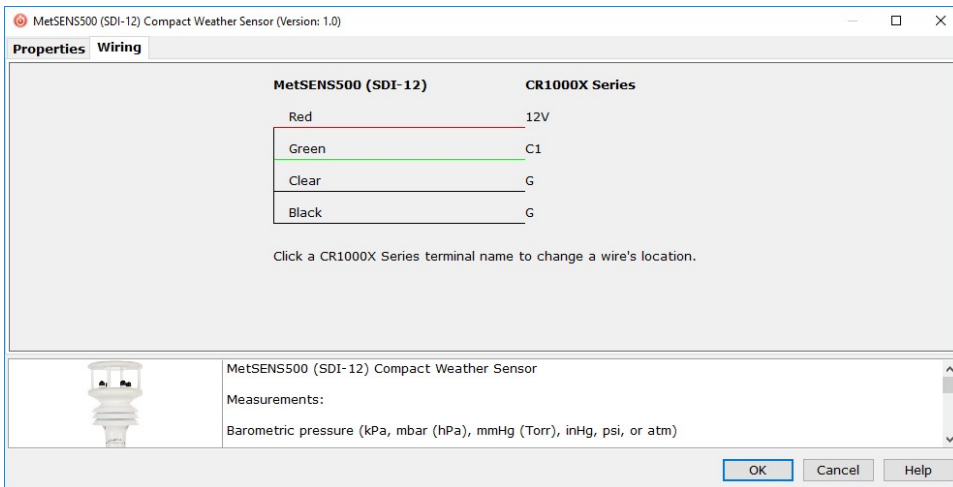
www.campbellsci.com/videos/cr1000x-data-logger-getting-started-program-part-3 . *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com . It is included in installations of *LoggerNet*,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

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

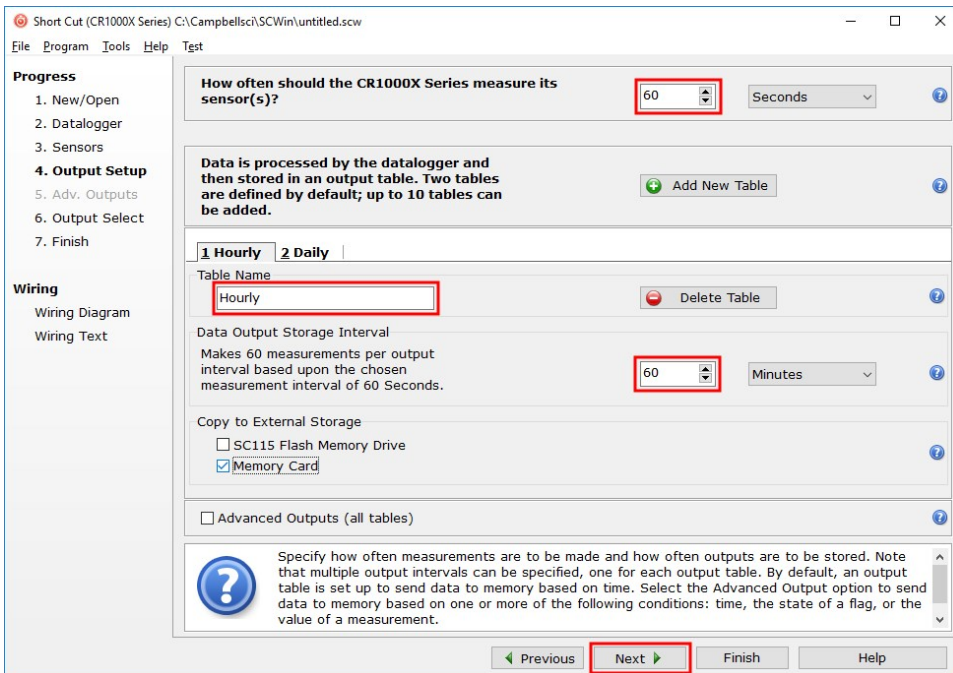
1. Open *Short Cut* and click **Create New Program**.
2. Double-click the data logger model.
3. In the **Available Sensors and Devices** box, type MetSENS or locate the sensor in the **Sensors > Meteorological > Basic Weather > MetSENS** folder. Double-click the appropriate sensor model and output. Type 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**.



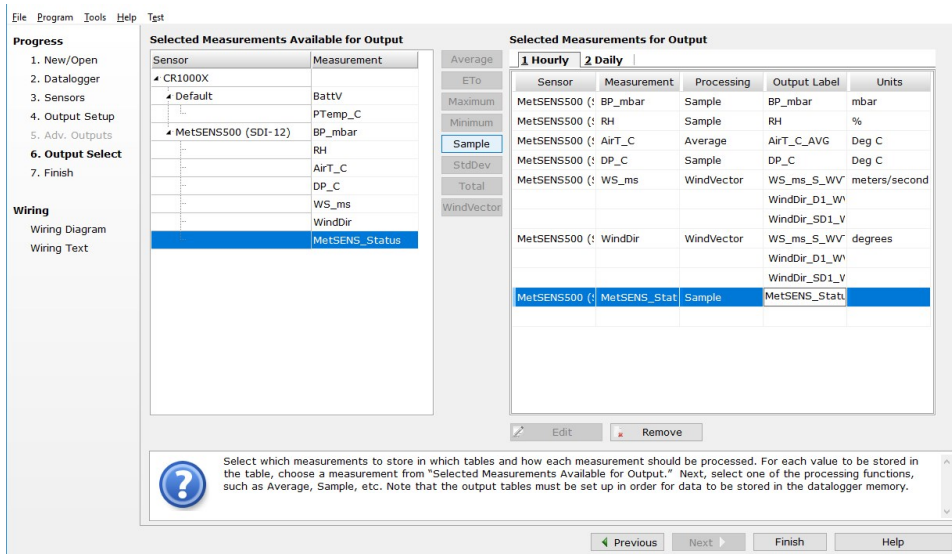
- Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.



- Repeat steps three and four for other sensors.
- 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
 - Compliance:** CE, RoHS; compliance documents available at:
 - www.campbellsci.com/metsens200
 - www.campbellsci.com/metsens300
 - www.campbellsci.com/metsens500

www.campbellsci.com/metsens550

www.campbellsci.com/metsens600

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)

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)	

Table 5-1: Measurements, weight, and dimensions

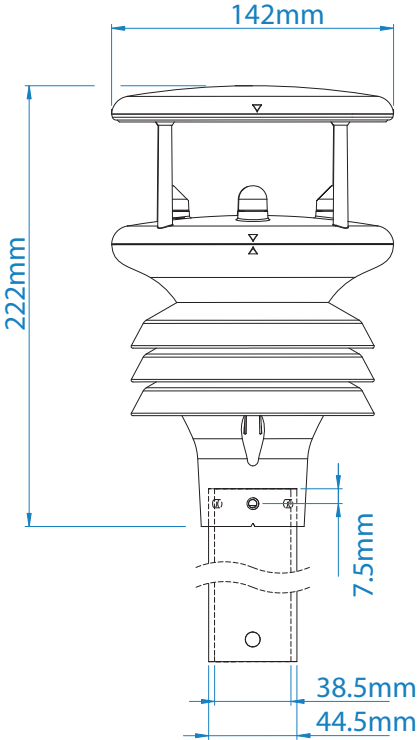
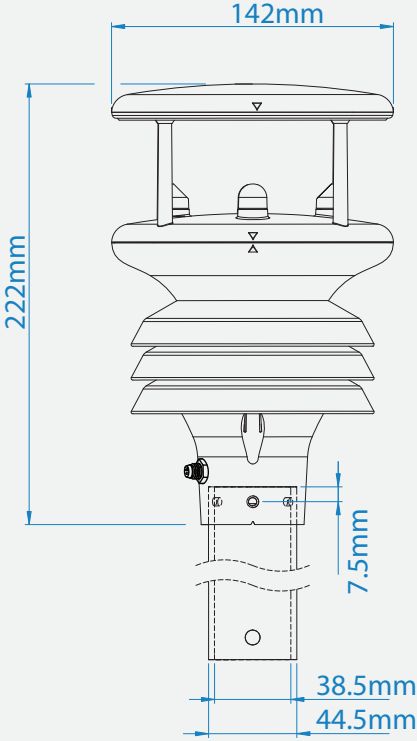
Model	Measurements	Weight	Dimensions
<p>MetSENS500</p>	<p>Air temperature Relative humidity Barometric pressure Wind speed Wind direction Compass</p>	<p>0.7 kg (1.5 lb)</p>	 <p>Technical drawing of the MetSENS500 weather sensor. The drawing shows a top-down view of the sensor head with a width of 142mm. A vertical dimension line indicates a height of 222mm from the top of the sensor head to the top of the mounting bracket. The mounting bracket has a height of 7.5mm. The base of the sensor has a width of 38.5mm and a diameter of 44.5mm.</p>
<p>MetSENS550</p>	<p>Air temperature Relative humidity Barometric pressure Wind speed Wind direction Compass Connector for the TE525METS or other rain gage</p>	<p>0.7 kg (1.5 lb)</p>	 <p>Technical drawing of the MetSENS550 weather sensor. The drawing shows a top-down view of the sensor head with a width of 142mm. A vertical dimension line indicates a height of 222mm from the top of the sensor head to the top of the mounting bracket. The mounting bracket has a height of 7.5mm. The base of the sensor has a width of 38.5mm and a diameter of 44.5mm. A connector for a rain gage is visible on the side of the mounting bracket.</p>

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)	

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

This section discusses the following:

6.1 Wiring	9
6.2 Programming	10
6.3 Siting considerations for wind measurements	13
6.4 Mounting	13

If you are programming your data logger with *Short Cut*, skip [Wiring](#) (p. 9) and [Programming](#) (p. 10). *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. 9)). 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.

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

¹Assumes the sensor directly connects to the data logger.

6.1.2 SDI-12 wiring

Table 6-2 (p. 10) provides wiring and pin-out information when using a MetSENS-series sensor with an SDI-12 output.

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

¹U 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. 10)).

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

¹Assumes 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. 20). 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 Master can retrieve the values stored in the Input Registers ([Modbus measurements](#) (p. 14)). To do this, the CRBasic program requires [SerialOpen\(\)](#) followed by [ModbusMaster\(\)](#). 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 [ModbusMaster\(\)](#) instruction has the following syntax:

```
ModbusMaster (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. 14)). **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. 17) 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 quotes (for example, "A"). Also enclose the **SDICommand** in quotes 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. 18)).

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

6.2.3 RS-232 programming

The RS-232 instructions are shown in [Table 6-4](#) (p. 12).

Instruction	Function
SerialFlush()	Clears the buffer.
Scan()	Establish a scan rate.
SerialOut()	Send command to the 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 the 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

This section discusses the following:

7.1 Modbus measurements	14
7.2 SDI-12 measurements	17
7.3 Status codes	19

7.1 Modbus measurements

The Modbus register map differs depending on the sensor model you are using.

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

Table 7-1: MetSENS200 RS-485 registers

Starting register number	Register count	Data format	Label	Units	Description
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 (see Status codes (p. 19))

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 (see Status codes (p. 19))

Table 7-3: MetSENS500 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

Starting register number	Register count	Data format	Label	Units	Description
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 (see Status codes (p. 19))

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

Starting register number	Register count	Data format	Label	Units	Description
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 (see Status codes (p. 19))

7.2 SDI-12 measurements

The MetSENS-series sensors respond to the SDI-12 commands shown in [Table 7-5](#) (p. 18). 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 returned¹

SDI-12 command (<i>a</i> is the SDI-12 address)	Values returned	Units	Response time
<i>aM!</i> or <i>aMC!</i>	<ol style="list-style-type: none"> Address (0 through 9) Relative wind direction Relative wind speed Corrected wind direction Status (4-digit code); see Status codes (p. 19) 	<ol style="list-style-type: none"> n/a ° m/s ° n/a 	3 s
<i>aM1!</i> or <i>aMC1!</i>	<ol style="list-style-type: none"> Address (0 through 9) Temperature Relative humidity Dew point Barometric pressure Status (4-digit code); see Status codes (p. 19) Wind chill Heat index Air density Wet bulb temperature 	<ol style="list-style-type: none"> n/a °C % °C hPa n/a °C °C kg/m² °C 	2 s
<i>aM2!</i> or <i>aMC2!</i>	<ol style="list-style-type: none"> Address (0 through 9) Relative wind direction Relative wind speed Status (4-digit code); see Status codes (p. 19) 	<ol style="list-style-type: none"> n/a ° m/s n/a 	3 s
<i>aM3!</i> or <i>aMC3!</i>	<ol style="list-style-type: none"> Address (0 through 9) Precipitation intensity Total precipitation Status (4-digit code); see Status codes (p. 19) 	<ol style="list-style-type: none"> n/a mm/hr mm n/a 	3 s
?!	Returns the SDI-12 Address		

¹Not all outputs are available for all sensors.

7.3 Status codes

NOTE:

For all factory repairs, customers must get an RMA number. Customers must also properly fill out a “Declaration of Hazardous Material and Decontamination” form and comply with the requirements specified in it. Refer to the [Assistance](#) page at the back of this manual for more information.

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.

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 the *CRBasic Editor*. By default, these files reside in the C:\campbellsci\SCWin folder.

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

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

NOTE:

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

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

Appendix B. SDI-12 sensor support

SDI-12, Serial Data Interface at 1200 baud, 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 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. 21).

Name	Command	Response ¹
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	allccccccmmmmmmvvvxxx...xx <CR><LF>
Start Verification	aV!	atttn <CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response set

Name	Command	Response ¹
Address Query	?!	a<CR><LF>
Change Address	aAb!	b<CR><LF>
Start Measurement	aM! aM1! . . . aM9!	attn<CR><LF>
Start Measurement and Request CRC	aMC! aMC1! . . . aMC9!	attn <CR><LF>
Start Concurrent Measurement	aC! aC1! . . . aC9!	attnn<CR><LF>
Start Concurrent Measurement and Request CRC	aCC! aCC1! . . . aCC9!	attnn<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>
Extended Commands	aXNNN!	a<values><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.

aI!	allccccccmmmmmmvvvxxx...xx<CR><LF>
a	Sensor SDI-12 address
ll	SDI-12 version number (indicates compatibility)

ccccccc	8-character vendor identification
mmmmmm	6 characters specifying the sensor model
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
Source: SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors (see References).	

B.1.3 Start verification command (aV!)

The response to a Start Verification command can include hardware diagnostics, but like the **aI!** command, the response is not standardized.

Command: **aV!**

Response: *attn*<CR><LF>

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

B.1.4 Address query command (?!)

Command **?!** requests the address of the connected sensor. The sensor replies 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 *attn*<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!** is issued, the data logger pauses its operation and waits until either it receives the 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. In this case make sure your scan interval is longer 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 3 characters appended before the <CR><LF>. This code is not returned in the data table but 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 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 (**M!**) 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 (**C!**) 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 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. 25)), 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 a **D** command that follows an **M!** or **MC!** command. A sensor may return up to 75 characters of data in response to a **D** command that follows a **C!** or **CC!** 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 by navigating to the **Tools** list in *PC400* or the **Datalogger** list in the **Connect** screen of *LoggerNet*.

Watch [videos/sdi12-sensors-transparent-mode](#)  from our website.

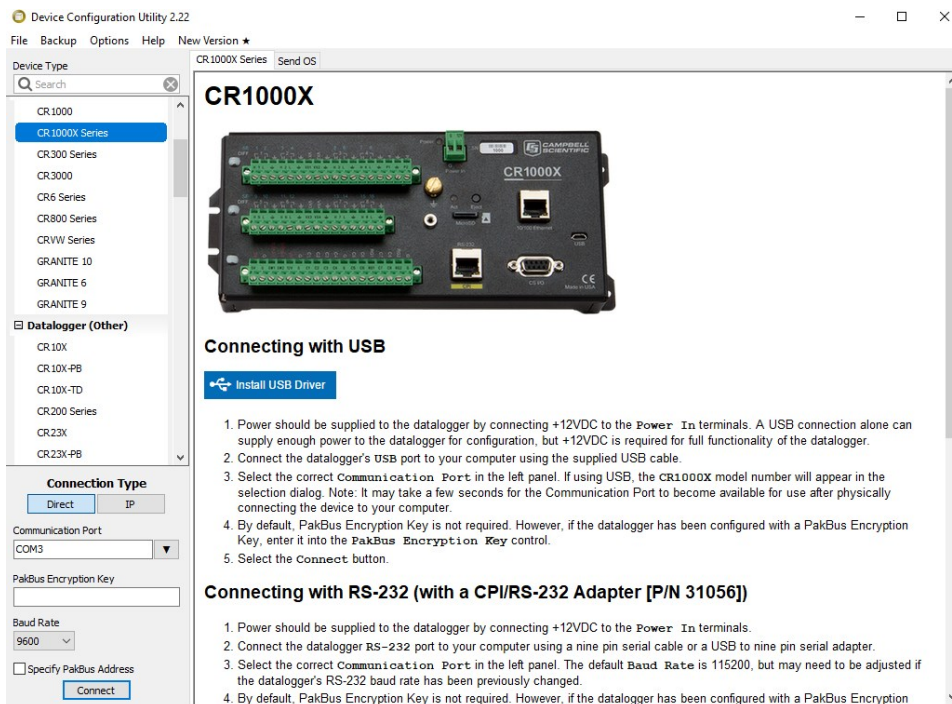
Data loggers from other manufacturers will also have a transparent mode. Refer to those manuals on how to use their transparent mode.

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. 26) are used with most Campbell Scientific data loggers.

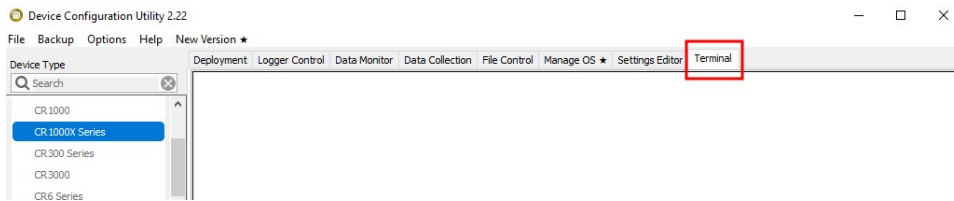
B.2.1 Changing an SDI-12 address

This example was done with a CR1000X, but the steps are only slightly different for CR6, CR3000, CR800-series, CR300-series, CR1000 data loggers.

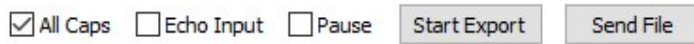
1. Connect an SDI-12 sensor to the CR1000X.
2. Open *Device Configuration* utility.
3. Under **Device Type**, type the data logger model and double-click on the model type. This example uses a CR1000X directly connected to the computer USB port.
4. Select the correct **Communication Port** and click **Connect**.



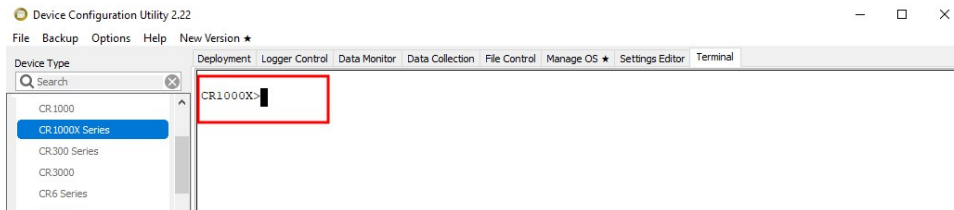
5. Click the **Terminal** tab.



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 CR6, CR3000, CR800-series, CR300-series, and CR1000 data loggers is similar to that shown for the CR1000X.

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General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

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

Elevated Work and Weather

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

Maintenance

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

Internal Battery

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

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