PRODUCT MANUAL

Sensor

CS211

Smart Enclosure Sensor

05/2025

RELIABLE MONITORING SINCE 1974

Campbell SCIENTIFIC®

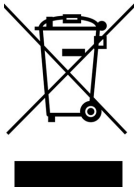
Please read first

About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country*.

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered.

Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility, per The Waste Electrical and Electronic Equipment (WEEE) Regulations 2012/19/EU. Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

Table of contents

1. Introduction

The CS211 Smart Enclosure Sensor enables both remote and onsite monitoring of internal enclosure conditions, such as temperature, humidity, and door status (open or closed). It also features a button that detects single and double presses to execute user-defined functions, and an LED to indicate if the enclosure desiccant needs to be replaced.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Although the CS211 is rugged, it should be handled as a precision scientific instrument.
- There are no user-serviceable parts inside the device. Any changes or modifications not expressly approved by Campbell Scientific may result in equipment damage and void the warranty.

3. Initial inspection

Upon receiving the CS211, carefully inspect the packaging and its contents for any signs of damage that may have occurred during transit. If any damage is found, file a damage claim with the shipping company.

Immediately verify the contents of the package against the accompanying shipping documentation. In the event of any discrepancies, contact Campbell Scientific for assistance.

Table 3-1 (p. 2) shows the components included with the CS211.

Table 3-1: CS211 components

Component	Quantity	Description	Image
CS211	1	Smart Enclosure Sensor	
CS211 cable	3	Connects CS211 to data logger 1x Brown (12V) 1x White (SDI-12) 1x Black (GND)	
Retro-reflective tape	1	Install inside enclosure door, directly opposite the CS211, to enable the optical door switch.	

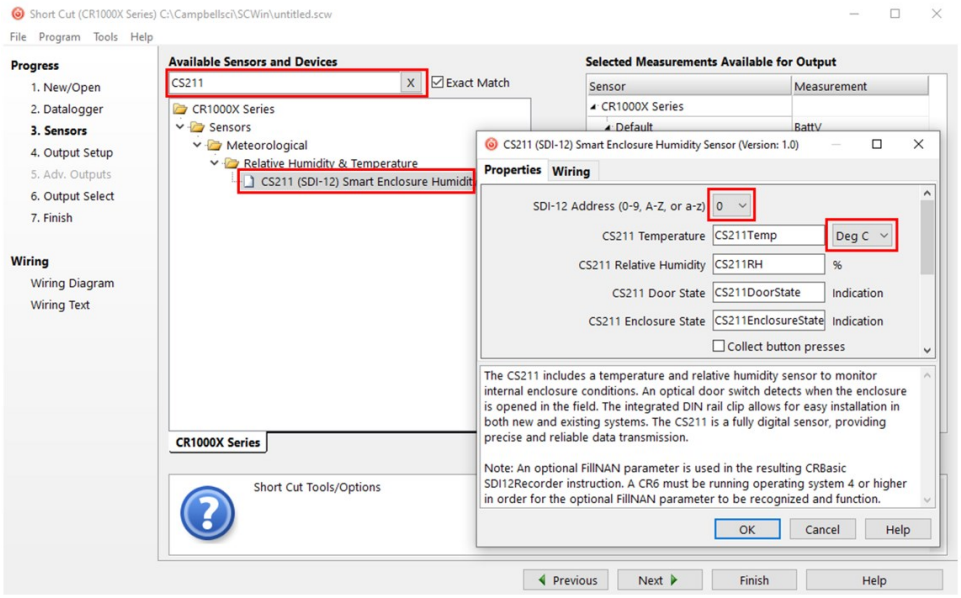
4. QuickStart

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***.

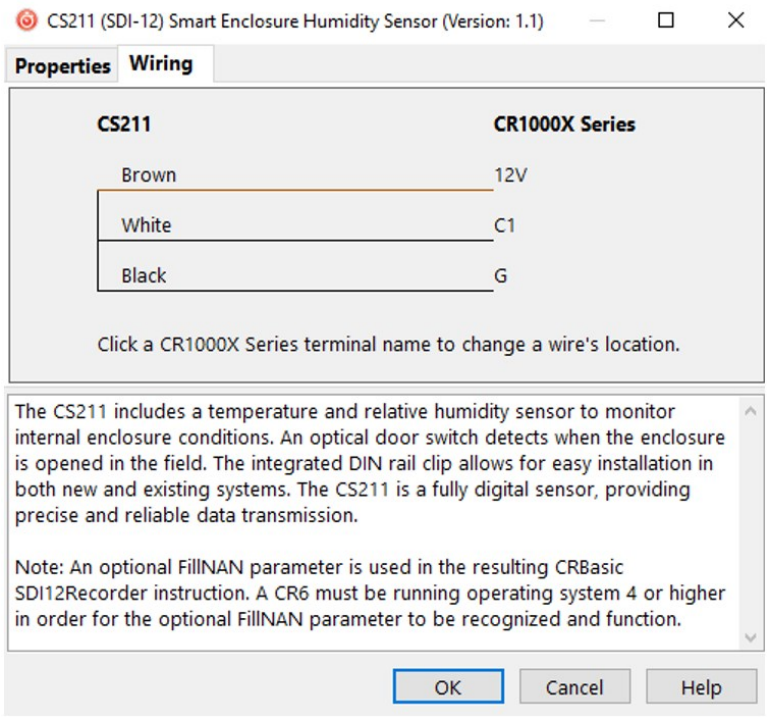
The following procedure shows how to use Short Cut to program the CS211.

1. Open ***Short Cut*** and click **Create New Program**.
2. Double-click the data logger model.

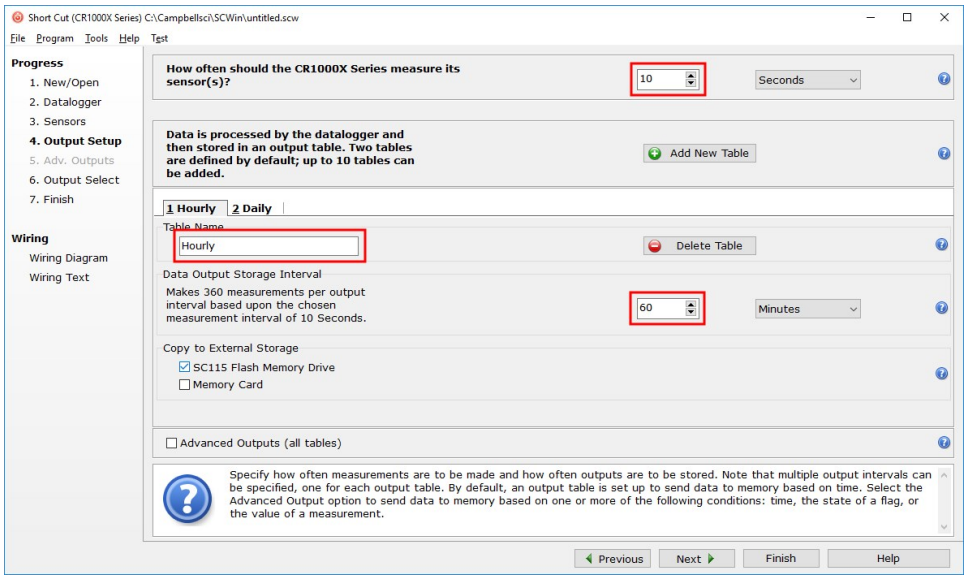
3. In the **Available Sensors and Devices** box, type CS211. You can also locate the sensor in the **Sensors** > **Meteorological** > **Relative Humidity & Temperature** folder. Double click the sensor model and output. Type the correct **SDI-12 Address** (default is 0). The temperature defaults to degree C. This can be changed by clicking the **Temperature** box and selecting one of the other options.



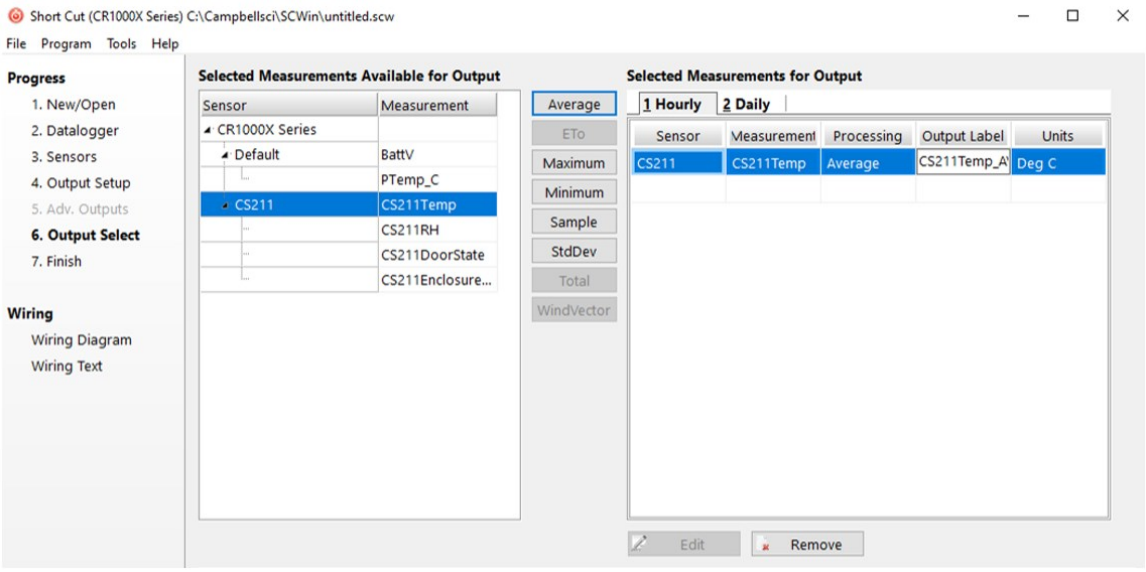
4. Click on the **Wiring** tab. Click **OK** after wiring the sensor.



5. Repeat steps three and four for other sensors you want to measure. Click **Next**.
6. In **Output Setup**, type the scan rate, a meaningful table name, and the **Data Output Storage Interval**.



7. Select the measurement and its associated output option.



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

5. Overview

The CS211 is a low-power smart enclosure sensor designed to monitor temperature and humidity levels inside enclosures. It features an optical door switch to detect door opens and closes and a multifunctional button that recognizes short, long (>1 second), and double presses for user-defined actions. Additionally, the CS211 includes an LED indicator to signal enclosure wetness and when desiccant needs to be replaced. This DIN rail mountable sensor is compatible with any SDI-12 data logger, providing a reliable way to monitor your equipment and maintain the accuracy of your measurements.

Figure 5-1. CS211 Smart Enclosure Sensor and accessories

Features:

- Reports enclosure state, which emulates a traditional desiccant indicator card that can be measured remotely via a data logger
- Detects door open close events without the need for additional hardware
- Multifunctional button to trigger customizable functions in the data logger program
- SDI-12 directly connects to a Campbell Scientific data logger

6. Specifications

Supply voltage:	7 to 28 VDC
Current consumption	
Average:	< 100 µA
Peak:	< 30 mA (approx. 5 ms every 5 s)
Operating temperature:	–40 to 60 °C
Measurement uncertainty	
Relative humidity:	±3% RH (10 to 90% RH) (at 25 °C)
Temperature:	±0.4 °C (–40 to 60 °C)
RH measurement range:	0 to 100% (non-condensing)
Dimensions:	80 x 59 x 15 mm (3.15 x 2.32 x 0.59 in)
Start Up Time:	3 s

7. Installation

If you are programming your data logger with ***Short Cut***, skip Wiring (p. 8) and Programming (p. 9). ***Short Cut*** does this work for you. See QuickStart (p. 2) for a ***Short Cut*** tutorial.

7.1 Mounting

The CS211 is designed to be attached to a DIN rail mounted inside an enclosure. To detach the CS211 from the DIN rail, use a small flat blade screwdriver to operate the yellow latch.

Figure 7-1. Yellow latch

Figure 7-2. CS211 clipped to DIN rail

The CS211 uses an optical sensor and the LED to detect if the enclosure is open or closed. To enable this feature, install the reflective tape inside the enclosure door, such that it is directly in front of the sensor when the door is closed.

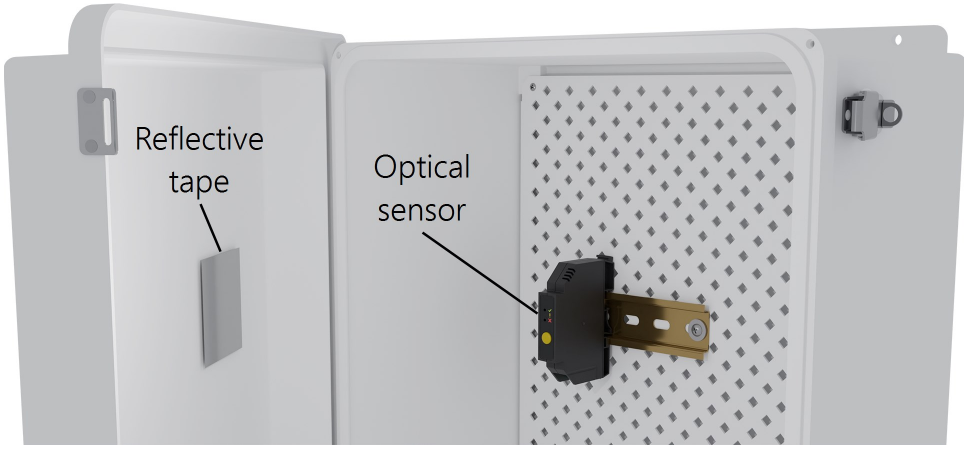


Figure 7-3. Example of installation of the reflective tape inside the enclosure door

7.2 Wiring

The CS211 comes with three 61 cm (24 in) long cables to connect from the screw terminals of the CS211 to the data logger. Contact Campbell Scientific if a longer set of cables is required.

Figure 7-4. CS211 3-pin screw terminal

Table 7-1 (p. 9) provides connections to Campbell Scientific data loggers. Connect the wires in the order shown in the table.

Table 7-1: SDI-12 wire color, function, and data logger connection

Wire color	Wire function	Data logger connection
Black	Power ground	**G**
White	SDI-12 signal	**C**, **SDI-12**, or CR6 **U** terminal configured for SDI-12[1]
Brown	Power	**12V**

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

> **NOTE:**
> Campbell Scientific recommends connecting the CS211 to a constant (non-switched) **12V** terminal. Switching power to the CS211 will reset some accumulative values stored in volatile memory. See SDI-12 sensor measurements (p. 10) for more information.

If multiple SDI-12 sensors are connected to a data logger, Campbell Scientific recommends using separate terminals when possible. However, multiple SDI-12 sensors can connect to the same data logger control (**C**) or universal (**U**) terminal. Each must have a unique SDI-12 address. Valid addresses are 0 through 9, a through z, and A through Z.

For CR6, CR1000X, and CR1000Xe 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 an SDI-12 sensor such as the CS211 is connected to **C3** on a CR1000X, **C4** cannot be used in the `TimerInput()`, `PulseCount()`, or `WaitDigTrig()` instructions.

7.3 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. 19). Programming basics for CRBasic data loggers are provided in the following section.

7.3.1 SDI-12 programming

Downloadable example programs are available at www.campbellsci.com/downloads/cs211-example-program.

The `SDI12Recorder()` instruction is used to measure a CS211. This instruction sends a request to the sensor to take a measurement and then retrieves the measurement from the sensor. See SDI-12 sensor measurements 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 range from 0 through 9, a through z, and A through Z. Alphabetical characters need to be enclosed in quotation marks (e.g., "A"). Similarly, the **SDICommand** should also be enclosed 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 8-1 (p. 11).

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

8. Operation

8.1 SDI-12 sensor measurements

Campbell Scientific data loggers follow the SDI-12 protocol and pauses its operation after sending the **M!** command, then waits until either it receives a response from the sensor, or the sensor timeout expires. A **C!** command follows the same pattern as an **M!** command with the

exception that it does not require the data logger to pause its operation until the values are ready. Rather, the data logger picks up the data with the **D!** command on the next pass through the program. Another measurement request is then sent so that data is ready on the next scan. The **R!** command directly reads the sensor measurements and outputs all its values.

Note that all CS211 measurements are available immediately after receiving an **M!**, **C!**, or **R0!** command. Using an **R0!** command collects the measurements without sending a **D!** command, requiring less time. This method is recommended for collecting data from the CS211.

> **NOTE:**
> SDI-12 sensor support (p. 20) describes the SDI-12 commands. Additional SDI-12 information is available at www.sdi-12.org.

Table 8-1: SDI-12 command list

Commands[1]	Values returned or function performed
*a***R0!**, or *a***M!**, or *a***C!**	1. Temperature (°C) 2. Humidity (RH) 3. Door state (indication) 4. Enclosure state (indication)
*a***R1!**, or *a***M1!**, or *a***C1!**	1. Temperature (°F) 2. Humidity (% RH) 3. Door state (indication) 4. Enclosure state (indication)
*a***R2!**, or *a***M2!**, or *a***C2!**	1. Single presses (count) 2. Double presses (count) 3. Long presses (count)
*a***R3!**, or *a***M3!**, or *a***C3!**	1. Door opens (count) 2. Wetness (ratio)
*a***I!**	*a*14CAMPBELLCS211 SN=*nnnnn* Where, *nnnnn* = serial number

Table 8-1: SDI-12 command list	
Commands[1]	Values returned or function performed
*a*V!	1. Software revision 2. Hardware revision
*a*XLOADOS *rrrrr* CPU:*CS211_OS_Vn.nn.xobj*! where *rrrrr* = baud rate; valid baud rates are 2400, 4800, 9600, 19200 *CS211_OS_Vn.nn.xobj* = OS name	Sends the new OS to the sensor; refer to Updating the operating system using XLOADOS SDI-12 command (p. 14)
[1]*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.	

NOTE:
Single presses, double presses, long presses, door opens, and wetness are accumulative values stored in volatile memory. If power is removed from the CS211, these values will be reset to zero.

8.1.1 Enclosure state and wetness ratio

Alongside direct temperature and humidity measurements, the CS211 also calculates a Wetness Ratio and Enclosure State to provide insights into the internal conditions of the enclosure over the past 24 hours (or since the device was last powered).

The Wetness Ratio represents the fraction of the last 24 hours during which the relative humidity has been above 80% RH. For example, a Wetness Ratio of 0.0 indicates that the enclosure has been dry for the last 24 hours and is sufficiently desiccated, while a Wetness Ratio of 0.5 indicates that the enclosure has spent approximately half of the last 24-hour period above 80% RH and is at a very high risk of condensation.

CAUTION:
Relative humidity higher than 80% will likely result in condensation inside the data logger enclosure, which can reduce the reliability and longevity of the data logger and its peripherals.

The **Enclosure State** can be read via SDI-12 and is also indicated by an LED color, providing on-site staff with a quick visual reference of the condensation risk based on the Wetness Ratio

over the past 24 hours. The LED flashes green, amber, or red to represent low, moderate, and high risk of condensation, respectively.

Table 8-2: Enclosure states

LED color	Enclosure state (SDI-12 value)	Description
Green (✔)	OK (0)	Desiccant working well Low risk of condensation (≤ 10% of last 24 hrs above 80% RH)
Amber (!)	Caution (1)	Desiccant close to exhaustion Moderate risk of condensation (≤ 30% of last 24 hrs above 80% RH)
Red (✖)	Alarm (2)	Desiccant exhausted High risk of condensation (> 30% of last 24 hrs above 80% RH)

This system is intended to help promptly assess internal conditions of an enclosure and take necessary actions to prevent condensation. If the Enclosure State reaches the Alarm level, Campbell Scientific recommends replacing the desiccant in the enclosure to preserve the system integrity. Once the desiccant has been replaced, the desiccant status can be reset by long pressing (>1 second) the button on the CS211 (see Button presses [p. 13]).

8.1.2 Button presses

A single, double, or long press (> 1 second) of the CS211 button can trigger events or change the data logger state. The indicator LED will flash purple in response to button presses: one short flash for a short press, two short flashes for double press, and a single longer flash for a long press.

A long button press is used to reset the Enclosure State and Status LED, which should be done when replacing the enclosure desiccant. The date that the desiccant was replaced can be recorded in the data logger table.

> NOTE:
> The `M2!` command returns the number of single, double, and long button presses since the last time the command was issued.

8.1.3 Optical door switch

The CS211 uses an optical sensor and LED to detect door opens and closes. A combination of ambient light and reflected light measurements are used to determine the state of the door. To ensure reliable operation, install the reflective tape inside the enclosure door directly opposite the CS211 (see Mounting [p. 6]).

The following table describes the different **Door States** and values. For more information about how the CS211 determines each **Door State**, see Enclosure door state (p. 26).

Table 8-3: Door switch states

Door state	Value	Description
Unknown	–1	Default on power up or when door reflectivity is poor. Unable to reliably detect the current door state.
Closed	0	High reflectivity, the door is closed.
Open	1	Increased ambient light or low reflectivity means the door is open.

If the CS211 is unable to detect enough reflected light while the enclosure door is closed, the **Door State** is Unknown (–1), check the installation of the reflective tape and ensure that there are no obstructions between the CS211 and the inside of the door.

> **NOTE:**
> If the CS211 is powered up with the door open, **Door State** will be unknown until the door is closed with the reflective tape correctly installed.

While **Door State** represents the current state of the door, **Door Opens** (**R3!**) can be used to get the total number of times the door has been opened since the last measurement, reducing the number of times the sensor needs to be polled by the data logger.

8.2 Updating the operating system using XLOADOS SDI-12 command

The SDI-12 extended command **XLOADOS!** sends the new operating system (OS) to the sensor.

> **NOTE:**
> Only the CR6, CR1000X, CR1000Xe and CR300-series data loggers are compatible with the **XLOADOS!** functionality.

Verify that the data logger has been updated to the latest OS to ensure compatibility.

If a compatible data logger is not available to update the sensor, send the sensor to the factory to have Campbell Scientific update the OS. A returned material authorization (RMA) and completion of the "Statement of Product Cleanliness and Decontamination" form are required.

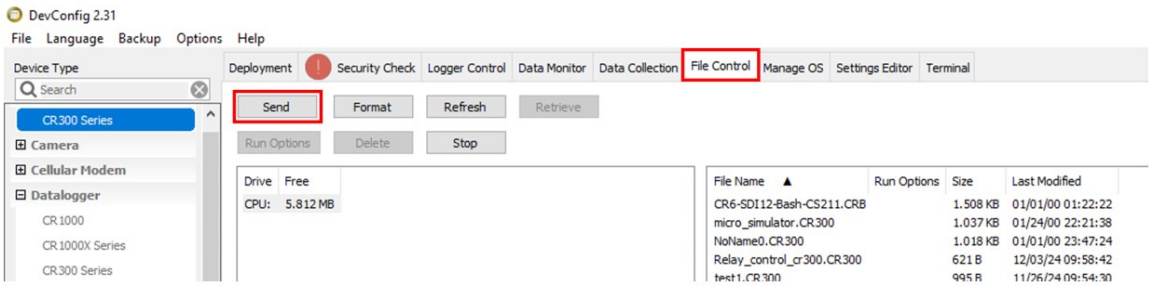
The data loggers require the following OS versions:

- CR6: OS 11 or newer
- CR1000X: OS 5.0 or newer
- CR1000Xe: OS 5.0 or newer
- CR300 series: OS 10.05 or newer

The **XLOADOS!** OS update process requires access to the data logger terminal. Campbell Scientific ***Device Configuration Utility*** is recommended.

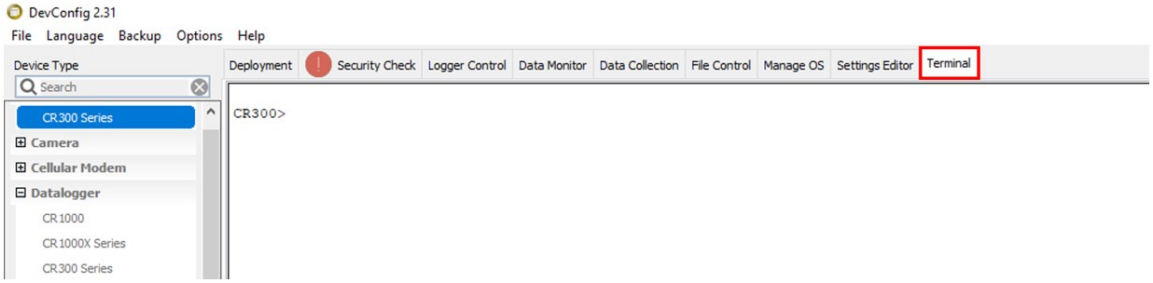
Although this update may be performed remotely, if the sensor is not communicating with the data logger, it must first be power cycled to regain communication and accept the new OS.

1. Download the update file from the Campbell Scientific website and run the self-extracting executable. The extraction takes only a moment, and a dialog box will indicate that the OS file has been saved on the computer in the C:\Campbellsci\Lib\OperatingSystems directory.
2. Upload the OS to the data logger CPU drive using ***Device Configuration Utility***.
    a. Connect to the data logger.
    b. Open the **File Control** tab
    c. Click **Send** and select the OS file from the **C:\Campbellsci\Lib\OperatingSystems** directory. File type may need to be changed to **All Files (*.*)** for the OS file to show up on the list.



    d. Verify that the file is now on the data logger CPU drive.
3. Connect the sensor to the data logger digital and power terminals. Note the terminal to which the sensor is connected.

4. Open a terminal interface to the data logger. Press **Enter** twice within the terminal window to get a command prompt.



5. Within the terminal, run the following commands:
   a. Type **SDI12** at the prompt and then enter the corresponding number assigned to the digital terminal to which the sensor is connected.
   b. Identify the SDI-12 address of the sensor by typing **?!** at the prompt.
   c. Verify that the responding sensor is the CS211 that you want to update by using the SDI-12 verify command *a***I!**. It should respond with the following:

      *a*14CAMPBELLCS211 SN=*nnnnn* (where *nnnnn* is the device serial number)

6. Send the OS to the sensor with the **XLOADOS!** extended command in the following format:

   <SDI-12 address>XLOADOS <baud rate> CPU:<OS name>!

   > **NOTE:**
   > A baud rate of 9600 is typically used. CR300-series data loggers are case sensitive, and the file name must match the name used in the command. The **All-Caps** checkbox on the bottom of the terminal window will need to be unchecked to allow lowercase letters.

7. When the OS update is complete, the file size, bytes sent, and the word **SUCCESS** are displayed. For example:

   ```
   file size 15782, bytes sent 15730SUCCESS
   ```

8. Verify that the OS was updated with the verify command **aV!**, followed by the **aD0!** command to read the results.

9. Maintenance and troubleshooting

9.1 Maintenance

The CS211 requires minimal maintenance. Periodically inspect the cabling for secure connections, physical or insect damage, and signs of moisture intrusion.

Dust or dirt on the optical window at the front of the CS211 may interfere with its operation. Keep the window clean by gently wiping it with a lint-free cloth.

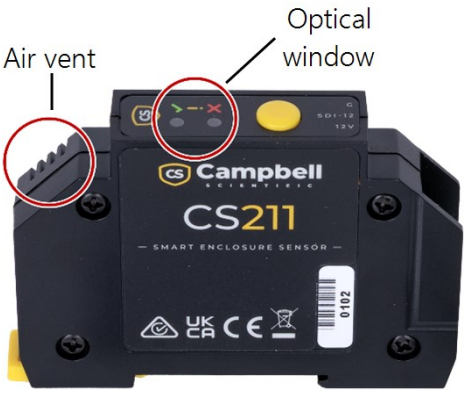


Figure 9-1. CS211 air vent and optical window

The air vent on the CS211 should also be inspected for obstructions, as poor ventilation could cause invalid temperature and RH readings. Figure 9-1 (p. 17) shows the optical window and air vent on the CS211.

> **NOTE:**
> Prolonged exposure of the CS211 sensor to high humidity levels (above 90% RH) may cause a long-term shift in the humidity readings. If you suspect such a shift, please follow the procedure outlined in RH sensor drying procedure (p. 25).

9.2 Troubleshooting

Symptom: Values are returned as NAN or –9999

- Verify the wiring of the sensor to the data logger.
- Use a digital voltage meter to check the power supply voltage to the sensor. It is recommended not to use a switched 12 V supply. However, if a switched 12 V terminal is used, temporarily connect the 12 V terminal of the CS211 to a non-switched 12 V supply for testing.
- Verify that the CS211 SDI-12 address matches the address entered for the `SDI12Recorder()` instruction. The default address is 0. The address can be verified or changed with the commands described in SDI-12 command basics (p. 20).

Symptom: The door open event is not recorded correctly, or door state returns –1 (Unknown)

- Check reflective tape is installed and ensure it is fitted as outlined in Mounting (p. 6). Misalignment or obstruction can affect the door sensors performance.
- Ensure the light sensor and LED windows on the front of the CS211 are clean and free of dust.
- Check power wiring. Note that this feature is only available when the device is powered continuously. Please check that the CS211 is connected to a reliable 12 V supply.

Symptom: LED status is not flashing

- Check the wiring of the device and ensure that the device has power.

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 and the SDI-12 Sensors Troubleshooting Tips application note.

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. 20).

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!	allccccccccmmmmmmmvvvxxx...xx<CR><LF>

Table B-1: Campbell Scientific sensor SDI-12 command and response sets		
Name[1]	Command	Response
Start verification	aV!	atttn <CR><LF>
Address query	?!	a<CR><LF>
Change address	aAb!	b<CR><LF>
Start measurement	aM! aM1!...aM9!	atttn<CR><LF>
Start concurrent measurement	aC! aC1!...aC9!	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>
[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. 23]).

Command: **aI!**

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

Where

a = sensor address

ll = SDI-12 version number (indicates compatibility)

cccccccc = 8-character vendor identification

mmmmmm = 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

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.2 References

SDI-12 Support Group. 2017 "*SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors – Version 1.4*." River Heights, Utah. https://sdi-12.org/specification.

Appendix C. LED patterns

The LED indicator on the CS211 will flash different colors based on different events. The following table describes each color and pattern.

Table C-1: CS211 LED patterns

LED color	Condition	Pattern	Description
Blue	On boot	1 flash	Boot OK
		12 flashes	Watchdog reboot has occurred
	OS update	3 flashes	OS update succeeded
		6 flashes	OS update failed
Purple	Single press	Single flash	A single press has occurred
	Double press	Double flash	A double press has occurred
	Long press	Long flash	A long press has occurred, and wetness ratio is immediately reset.
Green	Low condensation risk	Green flash every 5 seconds	Desiccant is OK
Amber	Moderate condensation risk	Amber flash every 5 seconds	Consider replacing desiccant (Enclosure state at caution level)
Red	High condensation risk	Red flash every 5 seconds	Replace desiccant and inspect enclosure for condensation (Enclosure state at alarm level)

Appendix D. RH sensor drying procedure

Prolonged exposure of the CS211 sensor to high humidity levels (above 90% RH) may cause a long-term shift in the humidity readings. If you suspect such a shift, this procedure outlines a process to dry the sensor.

> NOTE:
> This procedure is not intended to repair a damaged sensor. If the sensor is not functioning, has been exposed to contaminants, or has signs of water ingress, the CS211 and other equipment in the enclosure may be damaged. Contact Campbell Scientific for assistance.

Materials needed:

- CS211 Smart Enclosure Sensor
- 4905 4-unit desiccant bag (must be fresh)
- Small airtight container (sized to fit the CS211 and desiccant)

Steps:

1. Disconnect and remove the CS211 sensor from its enclosure.
2. Inspect the sensor for damage or signs of condensation.
3. Place the sensor and the desiccant bag inside the airtight container.
4. Seal the container and allow it to dry for a minimum of 24 hours (48 hours preferred)in a warm location with a temperature at or above 20 °C
5. Remove the sensor from the container and verify its proper operation.
6. Reinstall the CS211 sensor in the enclosure.
7. Check the enclosure's desiccant and replace it if necessary to reduce the risk of condensation.

Appendix E. Enclosure door state

The CS211 determines the state of the enclosure door using both reflected and ambient light measurements. The following state diagram describes the three different states of the door and events that determine each state.

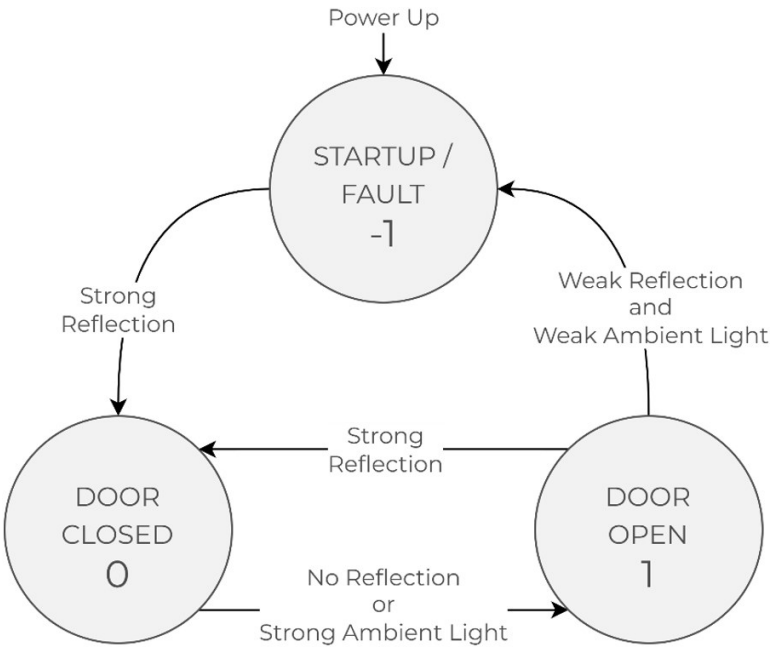


Figure E-1. CS211 door state diagram

As shown in the diagram, if the CS211 is unable to detect enough reflected light when the enclosure door changes from open to closed, the **Door State** will transition to Unknown (–1). If this occurs, check the installation of the reflective tape and ensure that there are no obstructions between the CS211 and the inside of the door.

Also, when the CS211 is powered up with the door open, the **Door State** will initially be Unknown (–1). Once the door is closed with the tape correctly installed, the **Door State** will transition to Closed (0).

Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.

2. The defect cannot be the result of misuse.

3. The defect must have occurred within a specified period of time; and

4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.

2. Batteries; and

3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country. For directions on how to return equipment, see Assistance.

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In the event of any conflict or inconsistency between the provisions of this Warranty and the provisions of Campbell Scientific's Terms, the provisions of Campbell Scientific's Terms shall prevail. Furthermore, Campbell Scientific's Terms are hereby incorporated by reference into this Warranty. To view Terms and conditions that apply to Campbell Scientific, Logan, UT, USA, see Terms and Conditions. To view terms and conditions that apply to Campbell Scientific offices outside of the United States, contact the regional office that serves your country.

Assistance

Products may not be returned without prior authorization. Please inform us before returning equipment and obtain a **return material authorization (RMA) number** whether the repair is under warranty/guarantee or not. See Limited warranty for information on covered equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country.

When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a "Declaration of Hazardous Material and Decontamination" form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. For details on decontamination standards specific to your country, please reach out to your regional Campbell Scientific office.

> NOTE:
> All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your regional Campbell Scientific office for details.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

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

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 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.

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.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

- Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

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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