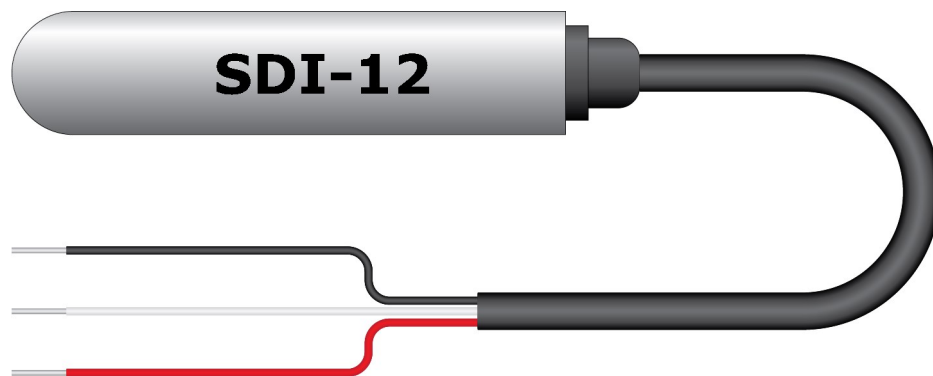




# SDI-12 Sensors

Troubleshooting tips



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# 1. Introduction

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SDI-12 is a 1200 baud communications protocol that supports many smart sensors, probes, and devices. The data logger supports SDI-12 communications through two modes: transparent mode and programmed mode. In transparent mode, users can easily set up and troubleshoot sensors by manually issuing commands and viewing the full sensor response. However, it is important to note that transparent mode does not record data. On the other hand, programmed mode automates much of the SDI-12 protocol and enables data recording.

In this document, we will discuss the steps to troubleshoot issues with an SDI-12 sensor. Follow these sections, in the order they appear, to diagnose and resolve problems.

## 2. Physical inspection

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Ensure that cables and connectors are securely attached to both the sensor and the data logger. Check for potential issues such as cable damage, broken wires or water damage. Additionally, inspect for corrosion on wires, contacts, and sensor elements. Depending on the sensor type, also look for any debris that might be present in either the sensor or filter.

## 3. Wiring

---

All SDI-12 sensors have at least three wires. Each must be connected to the correct data logger terminal. The wire functions and general data logger connections are shown in the following table:

Wire function	Data logger connection
SDI-12 signal	C, SDI-12, or U configured for SDI-12 <sup>1</sup>
Shield	G
Power	12V
Power ground	G

<sup>1</sup>C and U terminals are automatically configured by the measurement instruction.

Verify that your sensor wiring aligns with your wiring diagram. If you are not using an official wiring diagram, consult your sensor manual for a basic wiring reference. Additionally, ensure that the metal of the wires connecting to the data logger is in direct contact with the metal part of the terminal. In other words, avoid closing the data logger terminal on the wire insulation.

The second parameter of `SDI12Recorder()` indicates the terminal where the data wire must be connected. In the following example it is `C1`:

```
SDI12Recorder(SDIvalues(), C1, "0", "M!", 1, 0, -1)
```

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 `C` or `U` terminal. In this case, each sensor must have a unique SDI-12 address. Valid addresses are `0` to `9`, `a` to `z`, and `A` to `Z`.

Also, conflicts can occur when a control port pair is used for different instructions (`TimerInput()`, `PulseCount()`, `SDI12Recorder()`, `WaitDigTrig()`). For example, if `C1` is used for `SDI12Recorder()`, `C2` cannot be used for `TimerInput()`, `PulseCount()`, or `WaitDigTrig()`.

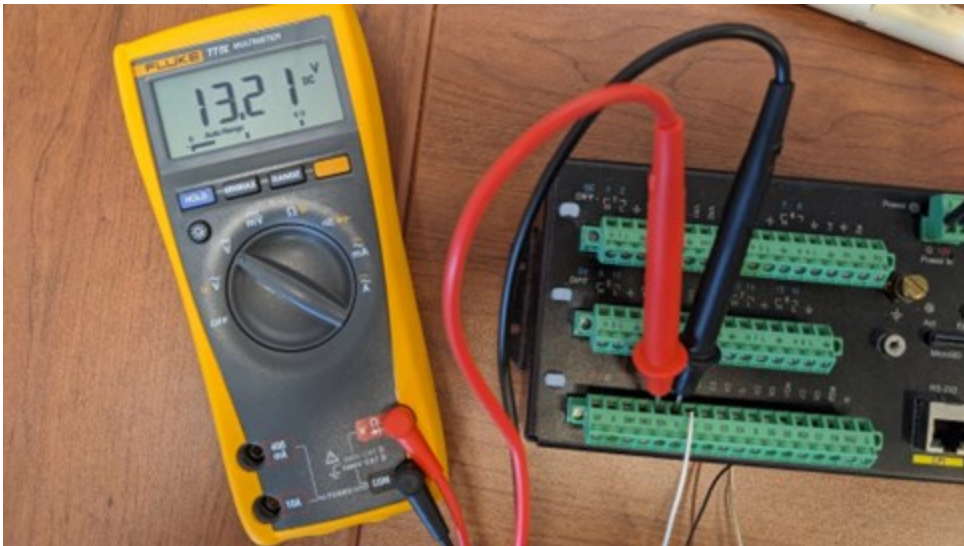
## 4. Power

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SDI-12 sensors require 12 VDC power. Typically, this power is supplied by the data logger **Power out 12V** terminal. Confirm that the power wire is connected to the **12V** terminal and not the switched **SW12V** terminal.

Using a multimeter, select the voltage setting and measure between the data logger **12V** and **G** terminals where the sensor is attached. Typically, a healthy reading will be slightly above 12 V. It is important to note that due to resistance, the measured voltage may be slightly lower than the actual voltage supplied. If the power is as low as 10.5 to 8 V, your data logger may not be providing adequate power to the sensor. If the voltage is below 5 V, this could indicate a grounding problem or a short in the SDI-12 sensor, suggesting a potential sensor failure.

If your initial reading is exceptionally low, in the range of 5 to 0 V, take a second reading with the sensor wires disconnected from the data logger. If the voltage with the wires disconnected measures around 12 V, this suggests that the sensor or the sensor wiring may have a short circuit or a grounding issue. This could indicate a faulty SDI-12 sensor.



## 5. Transparent mode

---


Using transparent mode through the data logger, you can manually interrogate and adjust SDI-12 sensor settings. Transparent mode is a valuable tool for troubleshooting SDI-12 systems because it facilitates direct communication with the sensor.

### TIP:

To use transparent mode, the current data logger program must contain an `SDI12Recorder()` instruction.

### NOTE:

Transparent mode may need to wait for commands issued by the programmed mode to finish before sending responses. While in transparent mode, the data logger program may not execute. Data logger security may need to be unlocked before transparent mode can be activated.

Transparent mode is entered while the computer is communicating with the data logger through a terminal emulator program, such as through *Device Configuration Utility* or other data logger support software. Keyboard displays cannot be used. Use the following instructions on how to communicate directly with an SDI-12 sensor using a terminal emulator. Or watch this video: <https://www.campbellsci.com/videos/sdi12-sensors-transparent-mode> .

1. Enter the data logger support software terminal emulator.
  - In *Device Configuration Utility* connect to your data logger and select the **Terminal** tab.
  - Or, in *LoggerNet* connect to your data logger **Main > Connect** and select **Datalogger > Terminal Emulator**. Click **Open Terminal** near the bottom of the window.
2. Press **Enter** until the data logger responds with the data logger name > prompt.
3. Type **SDI12** at the prompt and press **Enter**.
4. In response, the query **Select SDI12 Port** is presented with a list of available ports. Enter the port number assigned to the terminal to which the SDI-12 sensor is connected, and press **Enter**. For example, **1** is entered for terminal **C1**.
5. The response, **Entering SDI12 Terminal** indicates SDI-12 transparent mode is active.
6. If the process of entering terminal mode results in a failure, the current data logger program may not have a an **SDI12Recorder()** instruction in it.

See your sensor manual appendix, [data logger manual](#), or [www.sdi-12.org](http://www.sdi-12.org) for more information on using terminal commands.

## 6. Address

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All SDI-12 sensors have an address. Most come from the factory with **0** as the default. The data logger program queries each sensor based on its wiring location and assigned address. 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 **C** or **U** terminal. In this case, each sensor must have a unique SDI-12 address. Valid addresses are **0** to **9**, **a** to **z**, and **A** to **Z**.

The third parameter of **SDI12Recorder()** indicates the sensor address. In the following example the address is **0**:

```
SDI12Recorder(SDIvalues(), C1, "0", "M!", 1, 0, -1)
```

A sensor address can be determined, and changed, using SDI-12 terminal commands. Verify that the sensor address matches the third parameter in **SDI12Recorder()**. The following sections cover how to determine the sensor address and make changes if necessary.

## 6.1 How to query a sensor address

Once in transparent mode you can issue SDI-12 commands directly to the sensor. See [Transparent mode](#) (p. 3) for more information. Commands must follow the correct syntax of **address**, **command**, and a terminating **!**.

An active sensor responds to each command. Responses have several standard forms and terminate with **<CR><LF>** (carriage return–line feed).

If you do not know the sensor address, type **?!** and press **Enter**. The sequence will look similar to the following:

```
CR1000X>SDI12

1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 1
Entering SDI12 Terminal
?!
0
```

In this example, the sensor address is **0**.

If the sensor did not respond to the address query, it indicates that the sensor is not communicating with the data logger. This could be due to one or more of the following reasons:

- A wiring problem. See [Wiring](#) (p. 1).
- A terminal mismatch between the sensor and the data logger program. See [Wiring](#) (p. 1).
- A power issue with the data logger. See [Power](#) (p. 2).
- A timing issue, the data logger does not have time to respond. See [Verify measurement command](#) (p. 6).
- A failed sensor. Contact the sensor manufacturer.

## 6.2 How to change a sensor 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*.

### CAUTION:

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

The sequence will look similar to the following:

```
CR1000X>
CR1000X>SDI12
1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 1
Entering SDI12 Terminal
?!
0
0A2!
2
```

## 7. Verify measurement command

---

If the sensor has successfully responded to the address query, proceed by requesting a test reading from the sensor.

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* = 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



1. Enter transparent mode. See [Transparent mode](#) (p. 3) for more information.
2. Type **OM!** and press **Enter** to request a test reading from the sensor. **0** represents the address of the sensor and **M** represents the type of request you are making to the sensor. The command is completed with an **!**. The sequence will look similar to the following:

```
CR1000X>SDI12

1: C1
2: C3
3: C5
4: C7
Select SDI12 Port: 1
Entering SDI12 Terminal
OM!
00012
0
```

3. In this example the response to the M command is **00012**. It is interpreted as follows:
  - **00012**: The first 0 is the sensor address.
  - **00012**: The next 001 is the time to respond in seconds. 1 second in this example.
  - **00012**: The 2 is the number of measurement values to be sent.

## 8. Array size

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Many SDI-12 sensors respond with several values for each measurement command. Your sensor manual will describe what each value represents. To store multiple values, a variable array must be declared and used in the [SDI12Recorder\(\)](#) instruction. In the following example, the array named **SDIvalues** can hold two values.


```
Public SDIvalues(2)
SDI12Recorder(SDIvalues(),C1,"0","M",1,0,-1)
```

If the number of values your sensor is returning does not match the size of the array in your CRBasic program, your measurements will fail to record properly.

See [Verify measurement command](#) (p. 6) to determine how many values your sensor is responding with.

# 9. Watch command (sniffer mode)

---

The terminal-mode utility allows monitoring of SDI-12 traffic with the watch command (sniffer mode). Watch an instructional video: <https://www.campbellsci.com/videos/sdi12-sensors-watch-or-sniffer-mode>  or use the following instructions.

1. Enter the data logger support software terminal emulator.
  - In *Device Configuration Utility* connect to your data logger and select the **Terminal** tab.
  - Or, in *LoggerNet* connect to your data logger **Main > Connect** and select **Datalogger > Terminal Emulator**. Click **Open Terminal** near the bottom of the window.
2. Press **Enter** until the data logger responds with the data logger name > prompt.
3. Type **W** and then press **Enter**.
4. In response, select the number associated with **SDI-12**, and press **Enter**.
5. In response to the query **ASCII (Y)?**, type **Y** and press **Enter**.
6. SDI-12 communications are then opened for viewing. You should see something similar to the following:

```
16:12:00.059 T OM!
16:12:00.152 R 00012
16:12:00.240 R 0
16:12:00.248 T 0D0!
16:12:00.433 R 0+23.419+37.203
16:13:00.059 T OM!
16:13:00.152 R 00012
16:13:00.239 R 0
16:13:00.248 T 0D0!
16:13:00.433 R 0+23.419+37.230
16:14:00.059 T OM!
16:14:00.152 R 00012
16:14:00.240 R 0
```

7. A **T** or **R** appears after each time stamp indicating whether the message was transmitted or received by the data logger.
8. If you only have messages that are transmitted then the sensor is not responding. Verify the sensor address and wiring.
9. The following is similar to what you will see if the sensor is not responding:

```
12:24:00.142 T OM!  
12:24:00.225 T OM!  
12:24:00.321 T OM!  
12:24:00.404 T OM!  
12:24:00.487 T OM!  
12:24:00.583 T OM!  
12:24:00.666 T OM!  
12:24:00.749 T OM!  
12:25:00.059 T OM!
```

Notice that when the sensor fails to respond, the data logger retries by making multiple attempts to send its request before waiting until the next interval to try again.

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