



## SDI-12 Interface Cable

April 10, 2008

**Solinst**<sup>®</sup>

Built for:

**Levellogger**<sup>®</sup>  
Model 3001

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**1 Introduction**

SDI-12 (Serial Data Interface at 1200 Baud) is a communications protocol designed to allow the interfacing of a number of low power analog sensors with a common SDI-12 reader or data logger. The Solinst Levelogger Gold, Levelogger Junior, Barologger Gold, and Rainlogger are able to act as SDI-12 Sensors in an SDI-12 Network simply by using the Solinst SDI-12 Interface Cable.

The SDI-12 Interface Cable converts SDI-12 commands to the Solinst communications protocol for Solinst Leveloggers. The SDI-12 Interface Cable provides a hardware and protocol conversion interface between a Solinst Levelogger and an SDI-12 network.

**1.1 Compatibility**

The SDI-12 Interface Cable is compatible with Levelogger Firmware:

- Levelogger Gold: V1.017 and up
- Levelogger Junior: V2.000 and up
- Rainlogger: V1.000 and up

**1.2 SDI-12 Interface Cable**

Solinst 2-wire signals are converted to SDI-12 signals by the Solinst SDI-12 Interface Cable. One end of this cable has three wires which connect to an SDI-12 data logger. These wires are colour-coded according to Table 1-1. The other end of the cable terminates in a Direct Read connection. This connects to the top of a Direct Read Cable for connection to a Solinst Levelogger. The Solinst Levelogger has a self-contained battery and does not use +12V DC power. The SDI-12 Interface Cable circuitry requires the 12V connection. The current draw is nominally around 15 - 25 mA at 12V DC.

Wire Colour	SDI-12 Function	Connection
Red	12 Volt Line	+12V DC at SDI-12 Data Logger
Black	Ground Line	Ground at SDI-12 Data Logger
White	Serial Data Line	SDI-12 Data at SDI-12 Data Logger

**Table 1-1 SDI-12 Interface Cable Wire Definitions**

The communication settings for the Solinst SDI-12 Interface Cable hardware comply with the SDI-12 standard at 1200 baud, 1 start bit, 7 data bits, 1 parity bit (even parity), and 1 stop bit.

Technical Specifications	
Standard Compliance	SDI-12 Standard, Version 1.3, July 18, 2005
+12V Input	9.6V-16.0V
Supply Current	15-25 mA
Direct Read (green) Cable - Max Length	1500 ft
SDI-12 Cable Length	200 ft
Environmental	IP-65

### 1.3 LED Status

There are two LEDs on the SDI-12 Interface Cable, one Yellow LED, and one Red LED.

- The Yellow LED flashes whenever the Levelogger replies to a data logger command on the SDI-12 network. The Yellow LED does not flash when it receives a command, only when it replies to a command.
- The Red LED flashes whenever there is a failure to read from the attached Levelogger. It also flashes if any part of the Built-In Test (BIT) fails. The BIT is executed when the SDI-12 Interface Cable is powered up, or after the user executes the BIT with the Start Verification Command (aV!). See Table 5-1 for a description of the BIT.
- When the SDI-12 Interface Cable is powered up, both the Red and Yellow LEDs flash once together at the same time, to indicate that unit has received power and the firmware is starting up (this process only takes 1-2 seconds).
- If communication with the Levelogger has failed or the Levelogger has been disconnected from the SDI-12 Interface Cable, and commands are being sent to the SDI-12 Interface Cable by the SDI-12 data logger, the Red LED will flash indicating an error.

If the Red LED flashes, check the following:

- 1) The Levelogger is properly connected to the Direct Read Cable and that the Direct Read Cable is properly attached to the SDI-12 Interface Cable, at the surface.
- 2) The three wires from the SDI-12 Interface Cable are properly connected to the SDI-12 data logger/network (see Table 1-1).
- 3) The voltage being supplied to the SDI-12 Interface Cable is correct (should be 12V DC).
- 4) The BIT may have failed. If this is not corrected by doing any of the above, the user should contact Solinst directly.
- 5) If the red LED flashes during a measurement being taken from the Levelogger, retry the measurement first, then check all connections and the voltage.



Note: To check if the Built-In Test (BIT) has failed, see Section 5.10 for details.



Note: See *Levelogger Gold User Guide* (version 3.2.1 or higher) for detailed

Levelogger Operating Instructions.



Note: Independent recording is only an option. The Levelogger will be using its internal

battery if programmed to record independently. If the Levelogger is connected to the SDI-12 network without programming an independent sampling rate, the Levelogger will not use its internal battery.

## **2 Levelogger Independent Recording Option**

Solinst Leveloggers have the ability to record and store readings in their internal memory, independent from the SDI-12 network, while connected to an SDI-12 data logger. Before connecting the Levelogger to the SDI-12 Interface Cable and data logger, it can be programmed and started using Solinst Levelogger Software.

All standard sampling options provided by Solinst Levelogger Software are available while the Levelogger is operating as an SDI-12 sensor. The Levelogger can be set to record at a user-defined sampling rate; event, linear, and scheduled sampling modes are available using the Levelogger Settings Window. This allows the Levelogger to provide back-up data if the SDI-12 network fails. The Levelogger stores the data in its internal EEPROM memory, until it is downloaded.

### **2.1 Data Downloading and Programming in Field**

If the Levelogger has been programmed to record on its own independent schedule, data can be downloaded from the Levelogger using a laptop PC or Leveloader Gold, and PC Interface Cable in the field. Temporarily disconnect the Levelogger from the SDI-12 Interface Cable, preferably in between recordings by the SDI-12 data logger. Connect a laptop or Leveloader to download the independently recorded data.

If the Levelogger is disconnected from the SDI-12 network, and the SDI-12 data logger tries to communicate with the Levelogger, the Red LED will flash as described in Section 1.3. This does not disrupt the SDI-12 data logger or the rest of the sensors in the network. The Red LED will stop flashing once the Levelogger is reconnected.

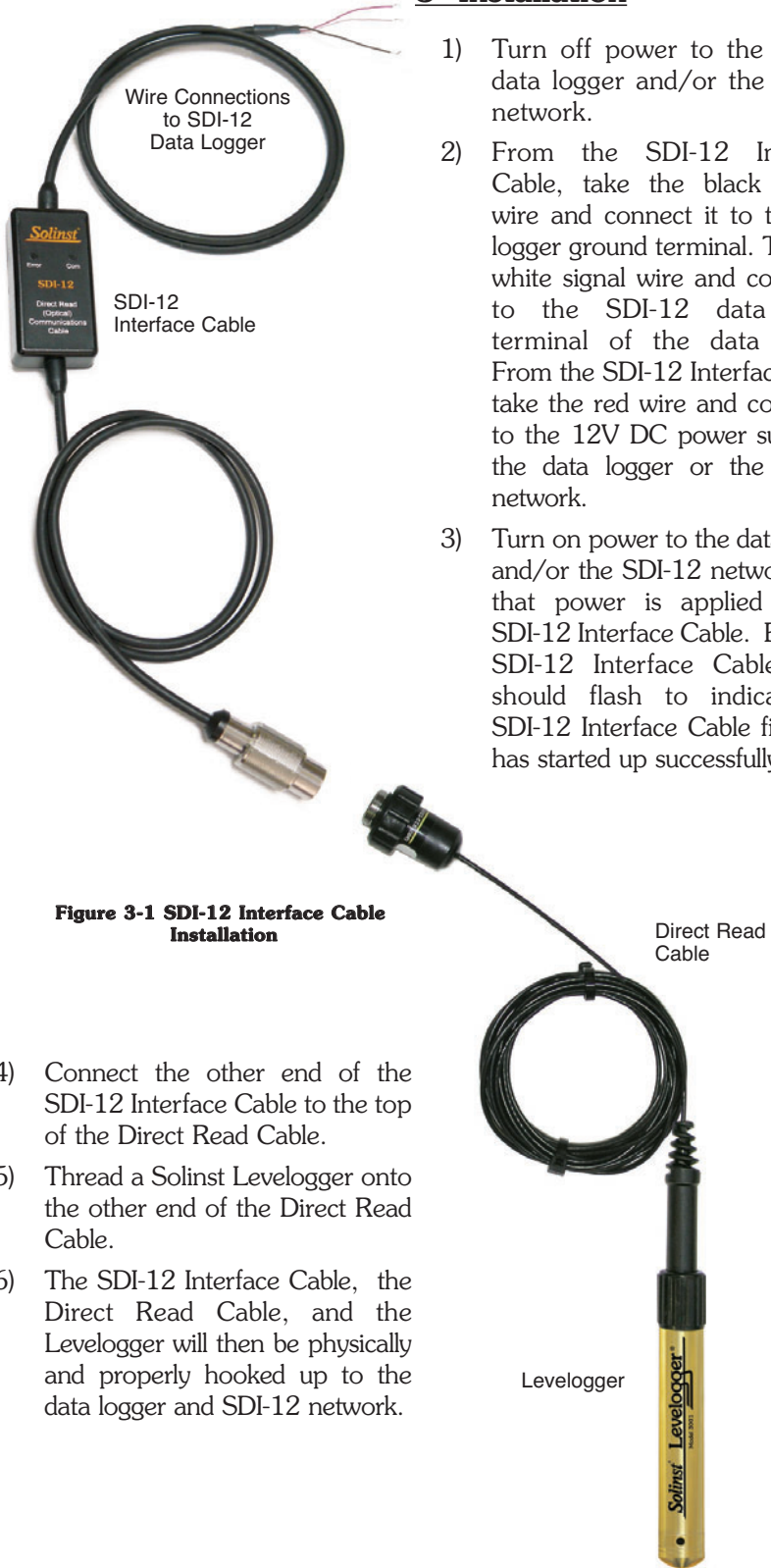
After the data download is complete, the Levelogger is easily connected back into the SDI-12 network without disruption. The Levelogger is automatically verified when reconnected. See Section 4.2.



Note: See *Levellogger Gold User Guide* (version 3.2.1 or higher) for detailed Levellogger installation instructions.

**3 Installation**

- 1) Turn off power to the SDI-12 data logger and/or the SDI-12 network.
- 2) From the SDI-12 Interface Cable, take the black ground wire and connect it to the data logger ground terminal. Take the white signal wire and connect it to the SDI-12 data signal terminal of the data logger. From the SDI-12 Interface Cable take the red wire and connect it to the 12V DC power supply of the data logger or the SDI-12 network.
- 3) Turn on power to the data logger and/or the SDI-12 network such that power is applied to the SDI-12 Interface Cable. Both the SDI-12 Interface Cable LEDs should flash to indicate the SDI-12 Interface Cable firmware has started up successfully.



**Figure 3-1 SDI-12 Interface Cable Installation**

- 4) Connect the other end of the SDI-12 Interface Cable to the top of the Direct Read Cable.
- 5) Thread a Solinst Levellogger onto the other end of the Direct Read Cable.
- 6) The SDI-12 Interface Cable, the Direct Read Cable, and the Levellogger will then be physically and properly hooked up to the data logger and SDI-12 network.



Note: Each SDI-12 Interface Cable and connected Levellogger must have a unique device address on an SDI-12 network. In order to ensure that no devices have the same address, all other devices on the SDI-12 data logger/SDI-12 network may have to be disconnected and re-addressed, then reconnected.



Note: For explanations of the SDI-12 Supported Commands used to communicate with the Solinst Levellogger, see Section 5.

## **4 Operation**

Once the SDI-12 Interface Cable, Direct Read Cable, and Levellogger have been installed and powered up, one can start issuing SDI-12 commands. It is good practice to do the following:

### **4.1 Setting the SDI-12 Address**

The Solinst SDI-12 Interface Cable and connected Levellogger have an SDI-12 device address which can be set to any value from “0” to “9”, “A” to “Z”, or “a” to “z”, giving a total of 62 unique addresses. The default address for Solinst Levelloggers is “0”. This address identifies the Levellogger on an SDI-12 network. Any SDI-12 equipment capable of changing SDI-12 addresses may be used to change a Levellogger’s SDI-12 address.

- 1) The SDI-12 Interface Cable and Levellogger default address is set to ASCII “0”. If you have more than one Levellogger connected to your data logger or SDI-12 network, or if there is already a connected device with the address “0”, use the Change Address Command (aAb!) to change the device address.

### **4.2 Activation and Verification**

- 2) Make sure other SDI-12 devices are not being addressed and communicating at the same time on the SDI-12 network.
- 3) Using your SDI-12 data logger and its SDI-12 software, issue an Acknowledge Active Command (a!), to test if the device address is correct and you can communicate with the newly installed SDI-12 Interface Cable and Levellogger.
- 4) Issue the Start Verification Command (aV!) and later read it with the Send Data Command (aD0!) to verify the Levellogger and the SDI-12 Interface Cable are operating without errors.
- 5) Use the Send Identification Command (aI!) to verify the name and model of the Levellogger matches that of the Levellogger you have just installed. Execute this command 2-3 times to ensure the Levellogger identification information gets read and registered with the SDI-12 Interface Cable.
- 6) Execute the Start Concurrent Measurement Command (aC!) and later retrieve the measurement with the Send Data Command (aD0!), to ensure the Levellogger is connected and properly taking measurements.
- 7) If the above steps are successful, you may program the data logger to automatically issue commands to the SDI-12 Interface Cable and Levellogger, to take measurements and record them.

### **4.3 Changing Levelloggers**

If a new Levellogger is attached to the SDI-12 Interface Cable, use the Start Verification Command (aV!) to initialize the new Levellogger on the SDI-12 network.

Alternatively, a new Levellogger initialization will be automatically performed after the first few SDI-12 commands are received by the SDI-12 Interface Cable and the newly attached Levellogger.

## **5 SDI-12 Supported Commands**

Please refer to the document: *SDI-12: A Serial Digital Interface Standard for Microprocessor-Based Sensors, Version 1.3, July 18, 2005*, prepared by the SDI-12 Support Group (Technical Committee), for a complete description of the SDI-12 protocol.

The following commands are supported by the Solinst SDI-12 Interface Cable.

### **5.1 Acknowledge Active Command (a!)**

This command is used to ensure that a Levelogger is responding to the SDI-12 data logger. A typical command/reply would be: **0!0**<CR><LF> where the “0”s represent the Levelogger address and <CR> represents a carriage return (Hex 0D) and <LF> represents a line feed (Hex 0A). All replies from SDI-12 Leveloggers are terminated with <CR><LF>. All data logger commands are terminated with an exclamation mark “!” character.

### **5.2 Address Query Command (?!)**

Using a question mark (?) as the address character, causes the Levelogger to respond with the acknowledge active command (a!) where “a” represents the Levelogger address. A typical command/reply would be: **?!0**<CR><LF>. The bold-faced characters are sent to the Levelogger; the normal type-face is the Levelogger's reply. In this case the Levelogger address is “0”. You can only use (?!), the address query command to find out what the Levelogger's address is, if there are no other Leveloggers connected on the SDI-12 network.

### **5.3 Send Identification Command (a!)**

This command is used to query Leveloggers for their SDI-12 compatibility level, model number, and firmware version number. A typical command/reply would be: **0!** 013SOLINST M20 10 1.000 1017687<CR><LF> where the first “0” is the Levelogger address, “13” represents SDI-12 V1.3 protocol support, “SOLINST ” identifies the Levelogger manufacturer, “M20” defines the Levelogger range, “10” is the hardware identifier, “1.000” specifies the current firmware version, and “1017687” represents the Levelogger's serial number.

### **5.4 Change Address Command (aAb!)**

This command changes the Levelogger's address. A typical command/reply would be: **0A9!9**<CR><LF> where the first “0” is the current Levelogger address and the “9” is the address to be changed to. The Levelogger replies with a “9” to indicate that its address was successfully changed.

### 5.5 Start Measurement Command (aM!)

This command tells the Levelogger to take a measurement. However, the measurement is not returned after this command. Instead, the time and number of measurements that can be expected will be replied. For example: **0M!00102<CR><LF>** where the first “0” is the Levelogger address, the next three digits “010” represent the time in seconds it will take the Levelogger to take the readings, and the final “2” indicates how many readings will be returned. When the measurement is ready, a Service Request “0<CR><LF>” is issued back to the data logger. The Solinst Levelogger will return a temperature and level measurement, which are always able to be read after the specified time. After that, the data logger can issue the send data command “ODO!” to retrieve the measurement data. Other start measurement commands such as aM1 to aM9 are reserved for future use.



Note: Checksum is a form of redundant test, which is used to check for any errors in the data.



Note: The actual units in use are not reported to the SDI-12 data logger while the Levelogger is in SDI-12 mode, but it is possible to change level units using the Solinst Levelogger PC software.

### 5.6 Start Measurement Command with Checksum (aMC!)

This command is identical to the aM! command with the exception that a three-character checksum is returned before the <CR><LF> as part of the Send Data Command reply. The aMC1 to aMC9 commands are reserved for future use.

### 5.7 Send Data Command (aD0!)

This command is used to get groups of data from the Levelogger. An aD0! command is issued by the data logger after a M, MC, C, CC, or V command. The Levelogger responds by sending the data. For a Solinst Levelogger, this is currently two data items: temperature and level measurements, and possibly a third measurement depending on the type of Levelogger. A typical command/reply is:

**ODO!0+24.2981+0.35212<CR><LF>** where the temperature is “+24.2981” in Degrees Celsius and the level is “+0.35212” in meters.

In response to a checksum request i.e. MC, CC; a typical command/reply is: **ODO!0+24.2981+0.35212MQ\_<CR><LF>** where the temperature and level are as before, and the final “MQ\_” is the checksum. The aD1 to aD9 commands are reserved for future use.

### 5.8 Start Concurrent Measurement Command (aC!)

This command is similar to the start measurement command, except a concurrent measurement is taken. Like the start measurement command, a send data command is required to retrieve the data. For example: **0C!000302<CR><LF>**. The reply indicates that two readings (temperature and pressure) are available after 3 seconds. A ODO! command is then issued to read these Levelogger values. The aC1 to aC9 commands are reserved for future use.

**5.9 Start Concurrent Measurement Command with Checksum (aCC!)**

This command is similar to the Start Concurrent Measurement with the addition of a checksum. For example: **0CC!000302<CR><LF>** would then, after 3 seconds, reply to the aD0! command as follows:

**ODO!0+24.6038+0.34513L<DEL>j<CR><LF>**. Where “L<DEL>j” is the checksum for the two measurement values “+24.6038 + 0.34513. The aCC1 to aCC9 commands are reserved for future use.

**5.10 Start Verification Command (aV!)**

This command tells the Levelogger to return a verification (self-test) code in response to a subsequent aD0! command. In this case, the Solinst Levelogger returns a non-zero time because the self-test execution verifies all internal memory checksums and these operations take about 3 seconds. A typical session would appear as follows:

**0V!00031<CR><LF>** indicates that one status reading will be ready within 3 seconds.

**0<CR><LF>** is a service request from the Levelogger within 3 seconds to indicate that the BIT operations are complete and the verification code is available.

**ODO!0+000** is the send data command from the SDI-12 master device to obtain the BIT verification code of “+000” which indicates that no faults were found. The possible fault codes are shown in Table 2. All the decimal representations of the individual faults are summed to arrive at the resultant BIT verification code. An included bit in a certain bit position means the corresponding test has failed.

Code Bit Position	Decimal Representation	Test Meaning
0	1	Read Write Solinst Levelogger
1	2	Solinst SDI-12 Interface Cable FRAM Memory Test
2	4	Solinst SDI-12 Interface Cable Memory Checksum Test
3	8	Solinst SDI-12 Interface Cable Voltage Test
4	16	N/A
5	32	N/A
6	64	N/A
7	128	N/A

**Table 5-1 BIT Verification Fault Codes**

## **6 Trouble Shooting**

### **Levelogger Does Not Reply**

The most common cause is an SDI-12 command sent with a device address that does not correspond with the Levelogger you are trying to communicate with. In this case, the Levelogger will not reply.

Change the address of the SDI-12 command being sent to match the proper device address.

### **SDI-12 Recorder Receives Erroneous Replies**

Check to ensure all Leveloggers on the network have unique device addresses. Otherwise, there will be bus collisions, and erroneous data will be returned from the Leveloggers to the SDI-12 recorder. This will be indicated if two or more Yellow LEDs on separate SDI-12 Interface Cables flash at the same time, when only one SDI-12 command was sent.

Change the device address of the Levelogger with the duplicate address.

### **Recorder Receives Invalid Response to D command e.g. 0000<CR><LF>**

Retry the Command. The Levelogger may have been busy or the Levelogger is not connected to the SDI-12 Interface Cable.

If your recorder supports automatic retries, consider enabling that function. If necessary, check all connections in the field.

## **7 References**

SDI-12 Support Group (Technical Committee). *SDI-12: A Serial-Digital Interface Standard for Microprocessor-Based Sensors, Version 1.3, July 18, 2005.* Available [online]: <http://www.sdi-12.org/>