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**NexSens SDL-C
Submersible Controller
with SDI-12 Output
Sensor Interface Manual
Revision 08.06.02**

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About NexSens Technology, Inc.

NexSens software and real-time data logging systems are designed to simplify the setup and operation of environmental monitoring networks. NexSens products automate much of the tedious programming, data collection, and manual data processing common with other systems.

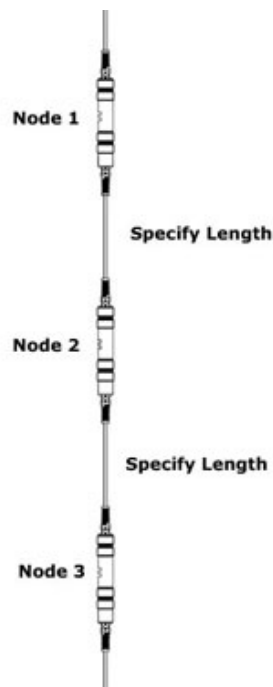
iChart is an easy-to-learn, easy-to-use Windows-based software program designed to interface with the industry's most popular environmental monitoring sensors and systems. A large multi-vendor instrument library makes setup quick and easy. iChart automates much of the tedious programming, data collection and manual data processing common with other environmental data collection systems.

Technical

For information on the sensorBUS product line, view our brief technology report on the web:
http://www.nexsens.com/systems/environmental_sensor_network.htm

Specifications

| | |
|-------------------------------|--|
| SDI-12 Compliance | v1.3 |
| Interface | SDI-12, PC RS232, Modbus RTU RS485, Modbus RTU RS232 |
| Default SDI-12 Address | 0 |
| Available Sensors | SDI-12, NMEA0183, RS485, RS232, 4-20mA, mV, T-NODE, and pulse input. |
| Operating Temperature | -20°C to 60°C |
| Material | Blue tint polycarbonate and PVC |
| Diameter | 6 inches |
| Length | 18 inches |
| Memory Size | 2 MB |
| Power Requirements | 8 AA-size Alkaline Batteries or External 10.7 V to 16 VDC |
| Power Consumption | 3 mA sleep, 8 mA processing, 36 mA analog reading + 5mA for RS232 or RS485 connection + sensor power consumption |



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Wiring

To output data in SDI-12 format from an SDL-C, (3) pieces of equipment are required:

- SDL-C SDI-12 controller
- UW-FL flying lead cable
- Data logger to log SDI-12 readings

Connecting to an external logger/SCADA system...

Using a NexSens part # UW-FL, the SDL-C can communicate via SDI-12, or Modbus RTU RS232 or Modbus RTU RS485:

| Color | SDL-C Signal | Logger/SCADA system | | |
|--------|-----------------|---------------------|--------|---------|
| | | RS232 | SDI12 | RS485 |
| Green | RS485.A | - | - | RS485.A |
| Blue | RS485.B | - | - | RS485.B |
| Brown | SDI-12 | - | SDI-12 | - |
| Red | 12V output | - | - | - |
| White | RS232.Tx | Pin 3 | - | - |
| Yellow | 12V input | +12VDC | +12VDC | +12VDC |
| Black | Ground | Pin 5/ Ground | Ground | Ground |
| Orange | RS232.Tx | Pin 2 | - | - |

Note: the red wire is a +12V output and should not be used.

Making sensorBUS connections...

sensorBUS connections are user-assembled using UW underwater cables and sensors. Underwater cables are sold in lengths from 0.5 meters to 50 meters (UW-0.5 – UW-50) and the specified length is the measured distance from one T-Node temperature element to the next corresponding temperature element.



To assemble a sensorBUS assembly:

- Check to make sure there is an O-ring on each end of the connections. There should be (1) O-ring in a groove on the plug side of the connection and (1) O-ring on the inside of the receptacle well.
- After connecting each sensor and underwater cable assembly, connect a blank plug to the bottom element or cable to completely seal off all connections (if the sensor does not already seal the connection off). This plug can be found on the connector port of the SDL where the sensors are connecting to.



Configuring the Controller

Before the controller can be used to output SDI-12 data from sensors connected to it; it must first be setup with the specific sensors connected to it. In this section we will go over making a T-NODE string connection to the SDL-C.

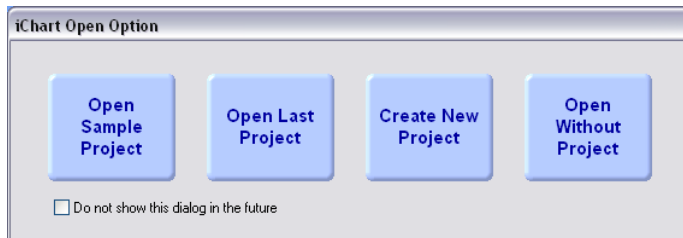
Step 1 – iChart and Sensor connection

After the T-NODEs have been connected together and then to the controller (see the T-NODE quick start guide for information on wiring these sensors) and the controller powered, it is ready to be configured by iChart software. An iChart CD should have come with the controller or a 30 day trial version is available for download at:

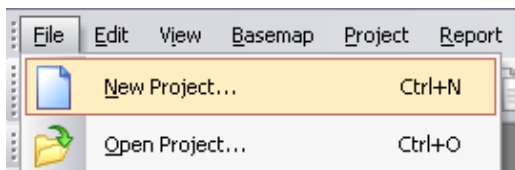
<http://www.nexsens.com/support/downloads.htm>

Connect the controller to a COM port on your computer using an UW-DB9 cable (ordered separately).

Run iChart software and select “Open Without Project”



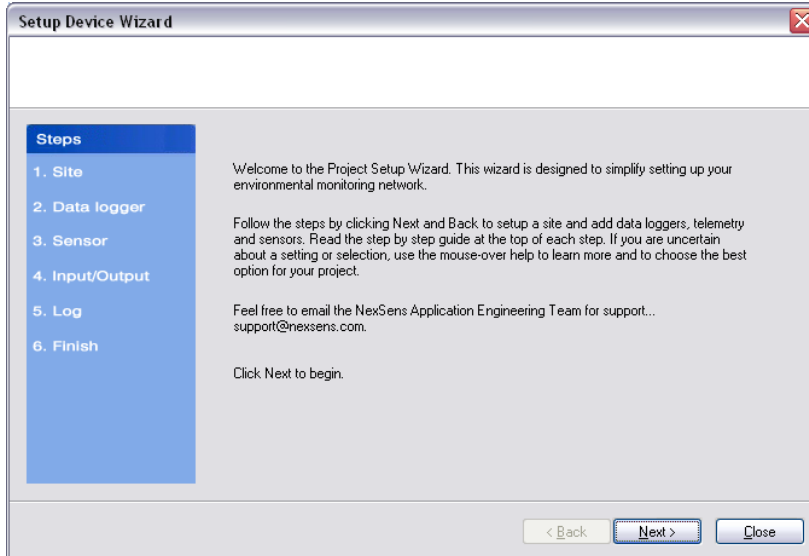
Then select **File | New Project**.



Enter a project name and click **Save**.

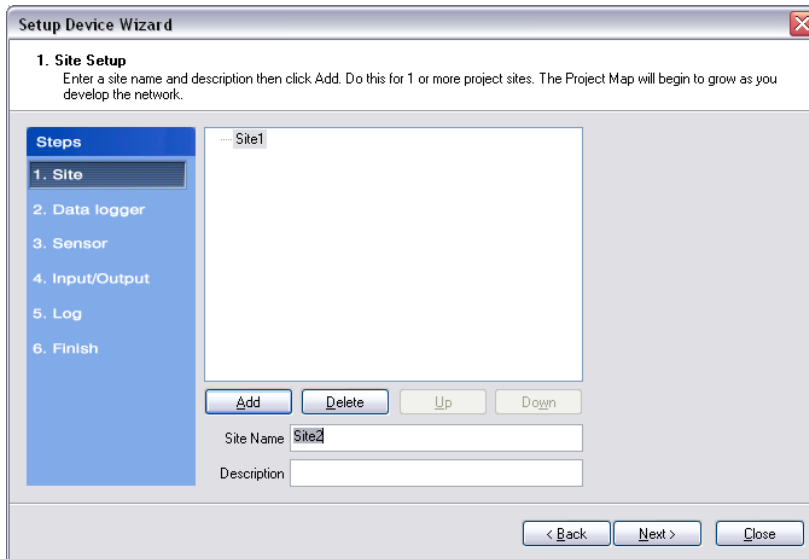
Setup Device Wizard

The Setup Device Wizard will begin. Click **Next** to continue.



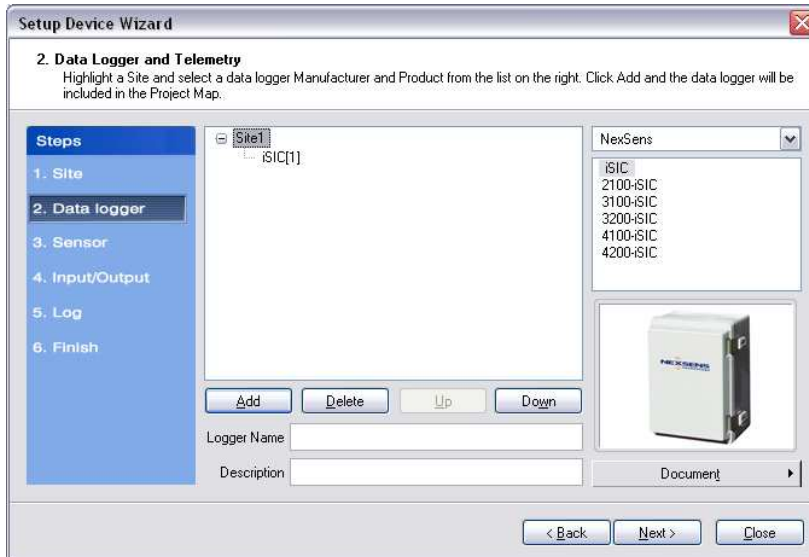
Step 1 – Site Setup

The first step is to create a site for data loggers and sensors to be located in. If this is an existing project, sites may already exist. Enter a **Site Name** and click **Add**.



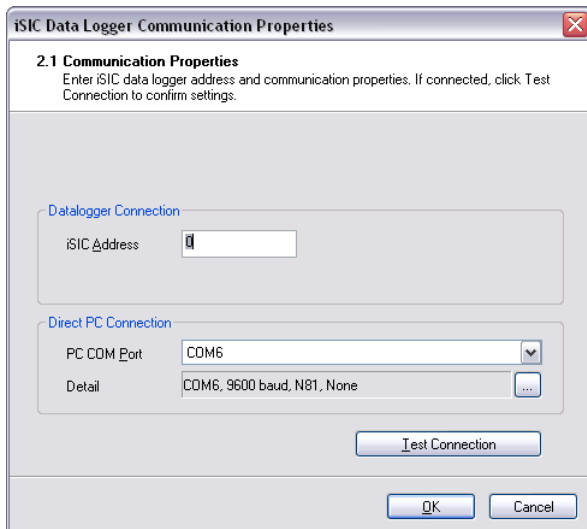
Step 2 – Data Logger & Telemetry

The next step is to add the data logger(s) to the sites created in the previous step. Select a site to add a data logger to. Then select **iSIC** from the data logger model number from the list at right and click **Add**.



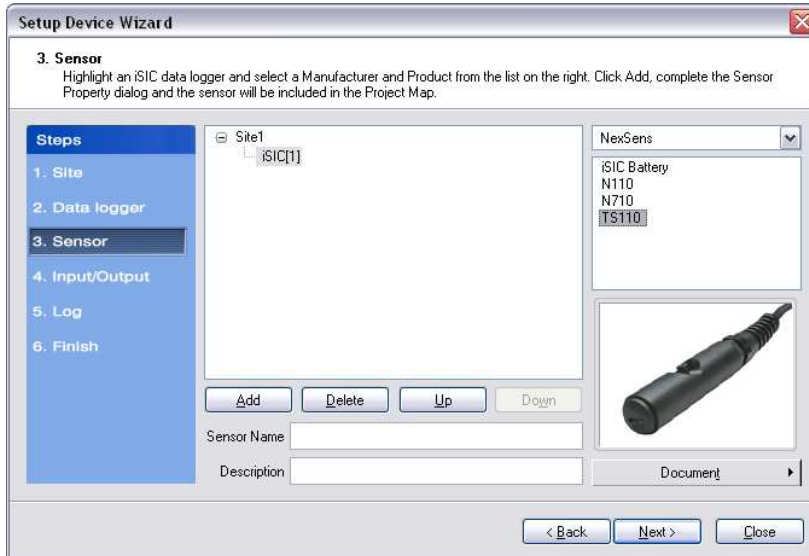
The **iSIC Data Logger Communication Properties** dialog box will appear. Enter the iSIC address and select the PC COM Port that the data logger is connected to.

- The iSIC address is default '1'. If unknown, enter '0' and click **Test Connection** to determine the address. Note: this address is different than the SDI-12 address of the controller.
- The PC COM Port drop-down menu is the list of available COM ports iChart detected on the computer.

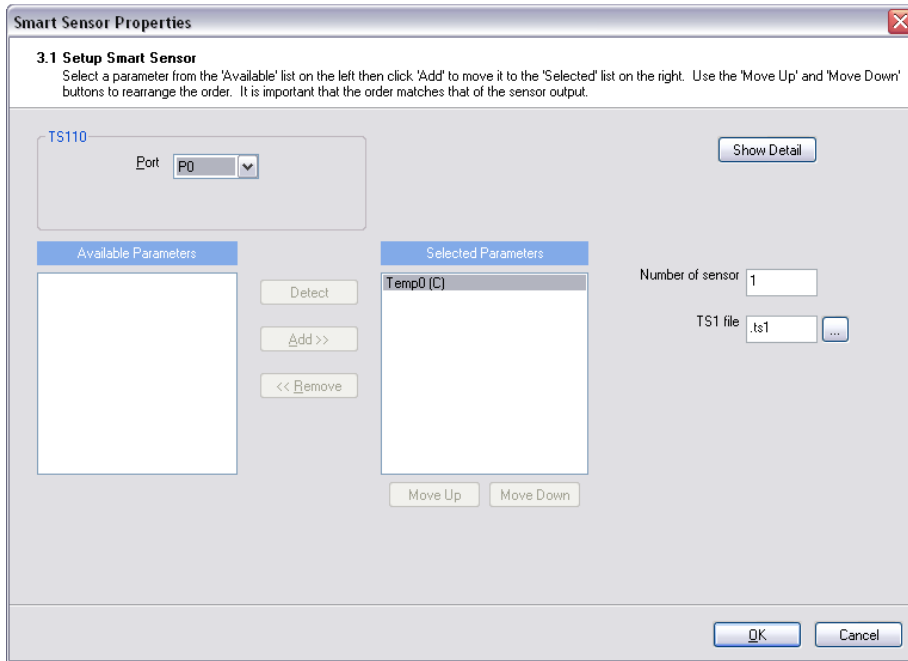


Step 3 – Sensor

After selecting a data logger, click **Next** and select **NexSens** from the drop-down list of manufacturers. Then select the **TS110** model number and click **Add**.

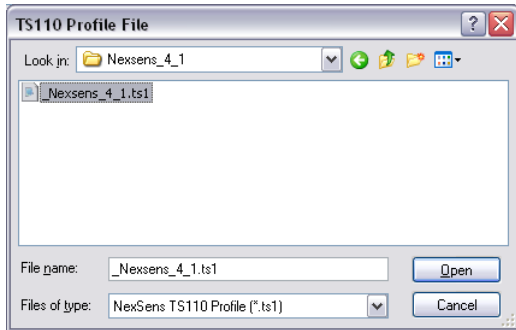


The **Sensor Properties** dialog box will come on the screen.



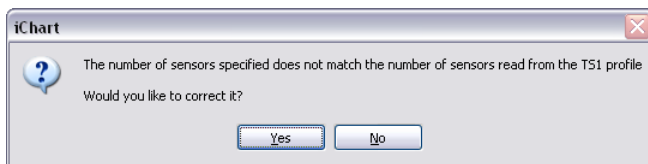
Click on the '...' next to the TS1 file text box.

This will open the **TS110 Profile File** dialog box. This file is located on the TS110 profile CD that came with your temperature string. If you can no longer have the CD or are otherwise unable to find the ts1 file, contact NexSens for the original file.



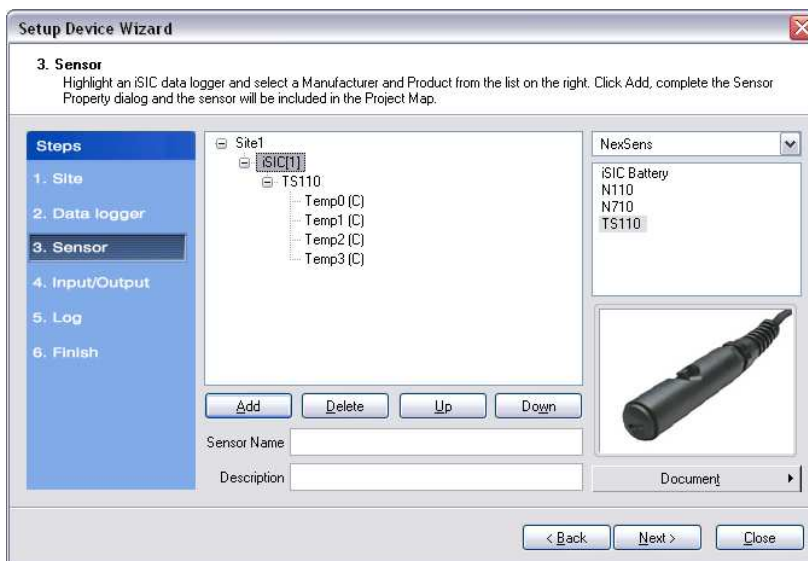
This file calibrates the sensor readings as well as provides the sensor order for the software. This file is required for proper operation. See "Temperate Calibrations" section for more information.

After clicking open, iChart will adjust the number of temperature readings on the **Available Parameters** to match the ts1 file.



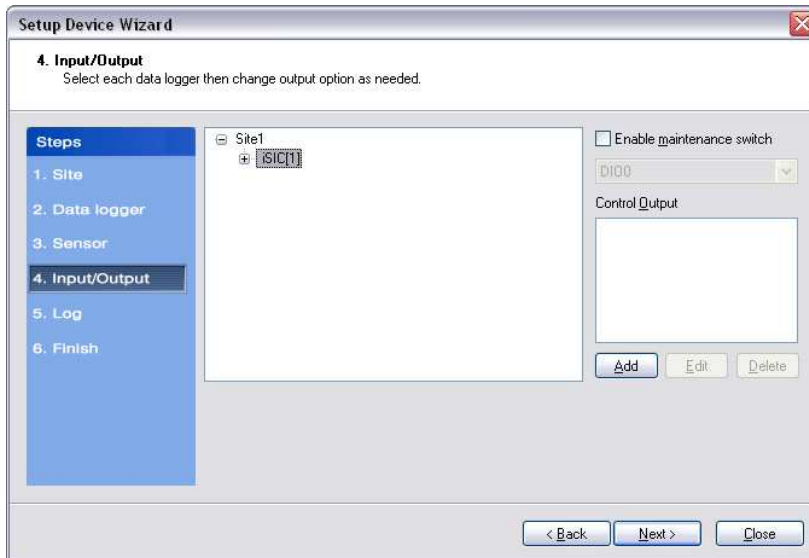
Click **Yes** to continue.

Back on the main screen, click **OK** and the sensor will be added to the selected data logger. More sensors can be added at this time by selecting the sensor manufacturer and then sensor model number from the drop down menu on the right. Click **Next** when finished adding sensors.



Step 4 – Input/Output

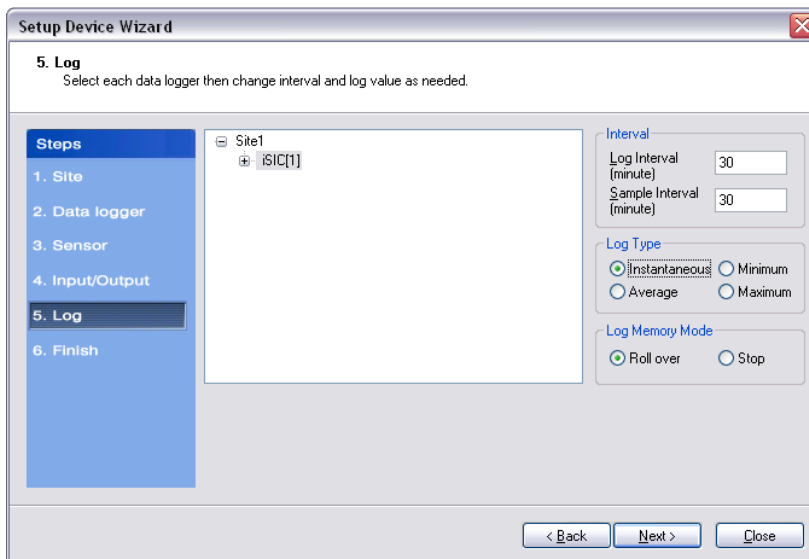
No input or output controls are functional in SDI-12 mode. Click **Next** to continue. See the iSIC manual, section **4.4.2 iSIC Controls** for more information on this functionality.



Step 5 – Log

It is recommended that a 1 minute sample and log interval is selected when setting up a data logger for SDI-12 for testing purposes. This allows you to make sure you are receiving good readings from the sensors after a few minutes in the lab.

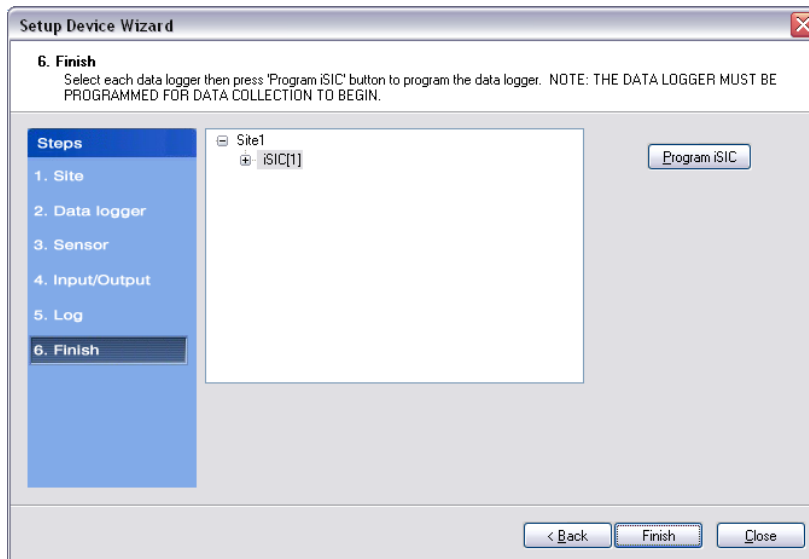
After receiving a few readings, the data logger should be set to a 0 minute log and sample interval.



Step 6 – Finish

All data loggers and sensors must be programmed before data collection can begin.

- Select an iSIC data logger and click the '**Program iSIC**' button. Before programming an iSIC:
 - The iSIC must be powered and connected to the computer.
 - The TNODE string must be connected to the 'T' port of the SDL.
- Click **Finish** when programming is complete.



This wizard can always be revisited by selecting **Project | Setup Device Wizard** if you would like to program an iSIC at a later time or need to setup other sites, data loggers, and sensors.

Step 7 – Retrieve an Initial Data Set and Use the Instrument Within iChart

After your sensor has been added to the database, the main instrument control screen will appear.

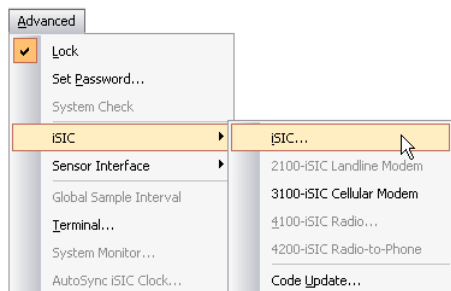
Important: All parameters are initially displayed with blank values until after the first log interval has passed and data has been interrogated. Once data has been retrieved from the iSIC, these fields will show the most recent data set recorded by the instrument. By default, iChart will automatically interrogate devices five minutes after every hour.

After receiving a few readings, the data logger should be set to a 0 minute log and sample interval. This can be done by:

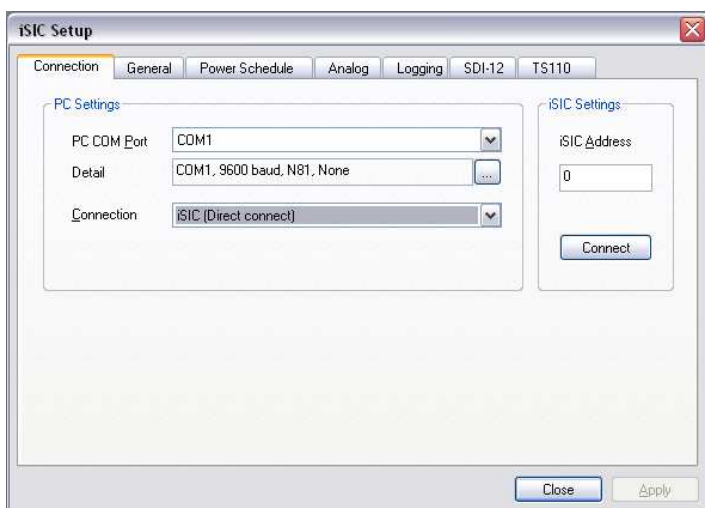
- **Select "Project | Setup Device Wizard"**
- **Click Next until the Log tab.**
- **Enter 0 for both sample and log**
- **Click Next and then Program iSIC**
- **Click Finish when complete**

After readings have been verified and the controller has been set to a 0 minute sample and log interval, it can now be switched into SDI-12 output mode.

Connect directly to the controller DB9 connector and run iChart. Select **Advanced | iSIC | iSIC** from the iChart menu.



The **iSIC Setup** dialog box will appear.

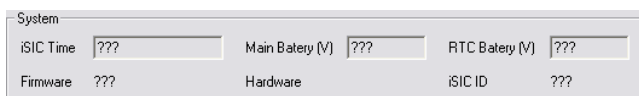


Check to make sure the **COM Port** field has selected the correct COM port the direct connect cable is attached to. If it is not, click on the **Change COM Port, Baud...** button and select the correct COM port from the menu. By default the iSIC Data logger will use 9600 baud, N81 (No parity, 8 data bits, 1 stop bit). The address can be left as **0** and the connection should be set to **Direct connect**.

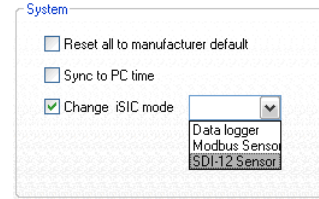
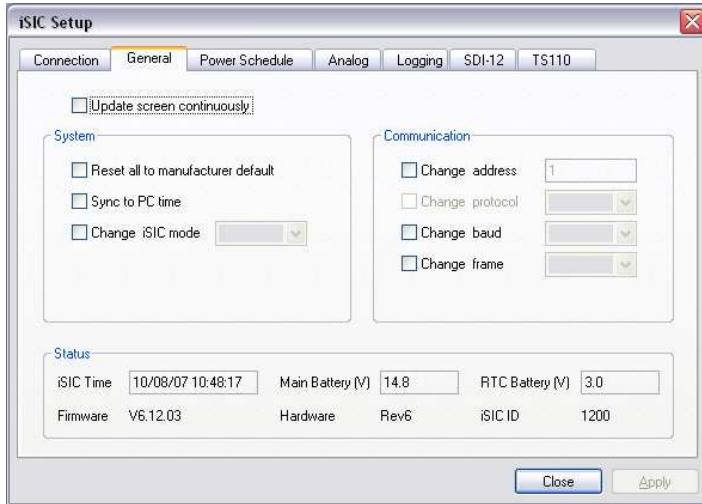
Next, click **Connect** and go to the general tab.



iChart will read the current configuration settings of the iSIC. This will take a few seconds. After the above screen goes away, if there are all ??? on the bottom of the general tab, hit **Close**. Then simply reset power to the iSIC (by removing power and then reapplying it) and try again. Also double check to make sure you have selected the right COM port and communication settings.



After iChart has successfully read the status information, it will be displayed on the bottom of the screen



Here you will be able to setup the iSIC for SDI-12 output. Place a check mark next to **Change iSIC mode**, select **SDI-12 Sensor** and click **Apply**.

Connecting an SDL-C to a PC

A SDL-C controller is configured to communicate over SDI-12 instead of direct to a PC. Before beginning these steps, connect the SDL-C to the PC using an UW-DB9 (ordered separately).

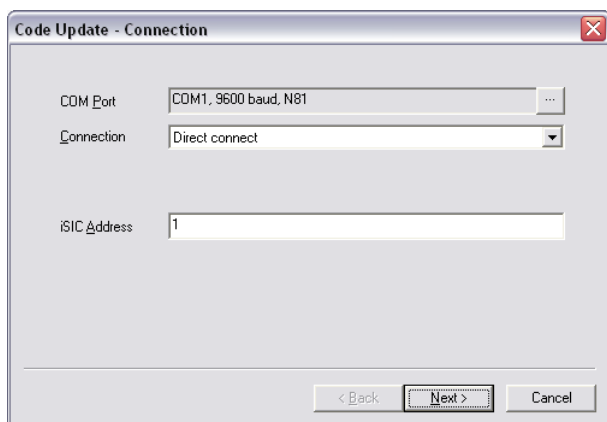
To configure the SDL controller to communicate directly to a PC instead of over SDI-12:

1. First run iChart and select **Help | Check For Updates** and get the latest version of software from the NexSens website.
 - If iChart software is not on the computer it can be downloaded here:
 - <http://www.nexsens.com/support/downloads.htm>
1. Open iChart and select **Edit | Preferences**.
 - From the **GUI** tab, place a check box in **Enable Advanced Interface**
2. Next, select **Advanced | Terminal**. Connect the data logger to a COM port on your computer and then select that COM port in the dialog box and direct connect as the connection type. Click connect and you should see a white window appear.
 - Power the iSIC (or cycle power by disconnecting and then reconnecting power)
 - After seeing the word "NexSens" enter **<Esc>+2+3+2**
 - You should see a message that ends with %RS232
 - If you see %SDI12, cycle power again and try entering **<Esc>+2+3+2**
3. Close the white window and select **Advanced | iSIC | iSIC**
 - Select the COM port the iSIC is connected to and click connect. Click on the general tab to make sure you can see a firmware version and battery voltage.
 - Place a check in the **Change protocol** check box.
 - Select **Direct** from the drop down menu and then click **Apply**.
4. Close the **iSIC Setup** dialog box and cycle power to the iSIC by cycling power. The iSIC is now setup to communicate directly to a PC instead over spread spectrum radio telemetry. To switch back to SDI-12 follow the instructions in the previous section for SDI-12 configuration.

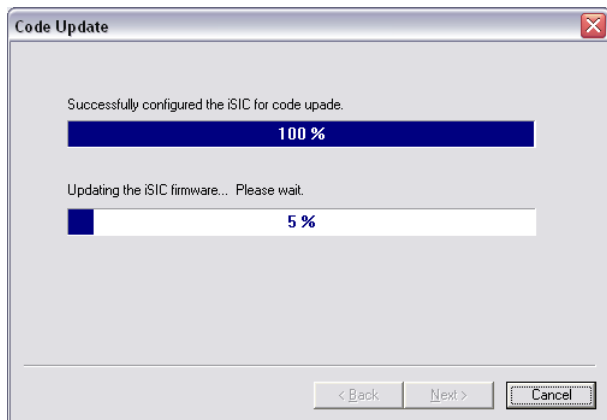
Updating SDL-C firmware

Updating the firmware on an SDL-C controller requires two steps:

- Configuring the controller to communicate directly to a PC
 - Updating the firmware and switching back
1. First follow the steps in the previous section to get the latest version of iChart and configure the controller to communicate directly to a PC
 2. After obtaining the latest software, you can then perform a code update on an iSIC data logger. Select **Advanced | iSIC | Code Update** to open the **Code Update**



3. Select **Direct Connect** as the connection type and address 1 as the iSIC address. (Note: this address is different than the SDI-12 address used by the controller).



4. When iChart is finished updating the iSIC firmware, click **Done** and switch the controller back to SDI-12 mode of operation.

Troubleshooting SDI-12 communication

If at some point the controller no longer responds to SDI-12 commands there are a few steps to follow to troubleshoot the connection:

1. First, make sure the SDI-12 address being used by the data logger to communicate with the SDL controller is correct.
2. Disconnect any other SDI-12 sensors from the data logger and try communicating with the SDL controller.
3. Next cycle power to the SDL by disconnecting and then reconnecting the power signals. After cycling the power wait a few moments for the SDL to restart and iChart to connect to it. You should see a green flashing light on the SDL.
4. If no light flashes after a few seconds, make sure the power input is between 10.7 to 16V and is connected securely to the controller.
 - a. Yellow is +12VDC
 - b. Black is Ground
 - c. Brown is SDI-12
5. If a light is seen and the controller still does not respond to SDI-12 commands after the cycling of power, follow the steps of updating firmware to see if the controller can be directly connected to a PC.

SDI-12 Commands

SDI-12 is a form of serial data communication designed for environmental data acquisition systems such as the SDL-C. SDI-12 protocol is a means of transferring measurements taken by digital sensors to a data logger for data collection and storage.


Sensors that adhere to SDI-12 protocol have a subset of commands that are consistent with every other SDI-12 sensor. These commands are used to identify the instrument, start a measurement, get data, etc.

At a user specified interval (the log or sample interval), the data logger sends the measurement command to the instrument. The SDI-12 sensor will then start taking a measurement and let the data logger know when it will be done doing so. When the sensor has finished taking a measurement the data logger will ask the sensor for the data. The sensor will return its data in a data string.

0+79.5+0.008+0.988+0.92

One thing SDI-12 protocol does not do is tell the user what parameter and unit of measurement each returned value is. This information therefore has to be specified in the software. This information is stored in the data logger.

Every SDI-12 sensor has a certain number of standard SDI-12 commands. Some sensors have extended commands that are only for that particular sensor. See the sensor manufacture's manual for more information.

 **Note** The list of standard SDI-12 commands is available in the SDI-12 protocol specification which is available from the SDI-12 Support Group here:

<http://www.sdi-12.org/>

SDI-12 Command Grammar:

a – Sensor Address

The first character of every command is the controller address. Likewise, the first character of every response is the address as well. The default controller address is ASCII '0'.

Only addresses ASCII '0' through ASCII '9' are allowed.

b – New Sensor Address

The new sensor address character is used in the change address command to specify the new address the controller should switch to. ASCII '0' through ASCII '9' are valid values of the new sensor address.

? – Wildcard Address

The wildcard address of ASCII '?' may be used in the place of a sensor address. '?' can be used in place of the SDI-12 address for any SDI-12 command (NOT just the address query command).

Implementation of Controller Specific SDI-12 Commands:

Identification:

Command: "aI!"
Response: "allccccccmmmmmmvvvxx<cr><lf>"

ll, the 2 digit supported SDI-12 version, ie: "13"
cccccc, the 7 digit manufacturer name, ie: "NexSens "
mmmmmm, the 6 digit model number, ie: "iSIC "
vvv, the 3 digit major and minor firmware version number, ie: "613"
xx, the two digit build firmware version number, ie: "01"

Measurement:

Command: "aM!" or "aMC!"
Response: "atttn<cr><lf>"

ttn, the 3 digit number of seconds until the requested measurement is ready
n, the single digit number of parameters returned by the measurement. 'n' is NOT limited to '0' to '9' as in the specification. It can be '0' to '-'. The number of parameter is computed by subtracting n by '0', i.e. '-' - '0' = 10 parameter, 'D' - '0' = 20 parameters, etc.

Concurrent Measurement "aC!" or "aCC!"

Responds with number of parameter nn is NOT limited to 20 as in the specification. It can be from 00 to 99.

Request Data "aD0" ... "aD9"

Responds with the maximum number of decimal places is 5. It is truncated as needed to meet the maximum of 7 character defined in the specification.


Extended Commands:

XMODE=LOGGER

Switches the controller power-up mode from "SDI-12 sensor" to "data logger". After responding to this command, the controller still stay in SDI-12 mode. It will not switch to new mode until power has been reset. Issue the XRESET command to reset to new mode immediately without cycling the power.

XRESET

Soft resets the controller

 **Note** The list of standard SDI-12 commands is available in the SDI-12 protocol specification which is available from the SDI-12 Support Group here:

<http://www.sdi-12.org/>