Ocean Systems Test and Evaluation Program

Field Installation Guide

Greenspan EC3000 Conductivity/Temperature Sensor

Version 2.0

September 2014

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

NOTICE

Table of Contents

Field Installation Guide **1**

Table of Contents **3**

List of Figures **4**

Introduction 5

1.0 System Overview **6**

1.1 Sensor Description 6

1.2 CO-OPS' Existing CT Sensors and Wells 7

1.3 Greenspan Installation Considerations 8

1.4 Cable Modifications 10

1.5 Sensor setup 11

2.0 Field Deployment and Maintenance Instructions **13**

2.1 Initial Installation 13

2.1.1 Notify Local Contact 13

2.1.2 Safety Precautions 13

2.2 Installation Instructions 13

2.3 Sensor Wiring Instructions 14

2.4 XPERT Software Setup Instructions 16

2.5 Data Recording 19

2.6 Confirmation of Data Recording/Transmission 19

References 23

List of Appendices **24**

Appendix A How to Configure the DCP Graphical Setup for a Greenspan EC3000 Conductivity/Temperature Sensor **A-1**

Appendix B Packing List **B-7**

Acronyms and Abbreviations **B-8**

List of Figures

Figure 2-1. Greenspan EC300 CT Sensor.......... 6
Figure 2-2. Greenspan EC300 CT Sensor with A) shroud in place and B) shroud removed.......... 7
Figure 2-3. A) FSI CT sensor housed in Delrin® clamp. B) The top of a CT well showing locking mechanism for line/pulley system. C) The brass collar that catches the Delrin® clamp at base of well. 8
Figure 2-4. Loop calibrator.......... 9
Figure 2-5. SDI-12 converter.......... 10
Figure 2-6. Greenspan EC3000 sensor cabling; red line shows where cable will be cut.......... 11
Figure 3-1. Typical CO-OPS system with Aquatrak controller.......... 14
Figure 3-2. A) The old terminal strip with the Aquatrak cable connected and B) the new terminal strip. 15
Figure 3-3. (A) New terminal strip with Aquatrak cable reconnect and (B) new terminal strip with Aquatrak and Greenspan cables connected. 15
Figure 3-4. SDI-12 converted mounted on the wall of the enclosure. 16
Figure 3-5. Xpert connect screen.......... 17
Figure 3-6. Xpert access selection. 17
Figure 3-7. Xpert Setup Access screen.......... 18
Figure 3-8. Final graphical setup for a Greenspan CT sensor, which is configured by CIL/SIL prior to deployment.......... 18
Figure 3-9. Click the Start button. 19
Figure 3-10. Select Log tab. 20
Figure 3-11. Confirm that data are being recorded.......... 20

Introduction

The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) has used conductivity/temperature (CT) sensors on a select number of National Water Level Observation Network (NWLON) and Physical Oceanographic Real-Time (PORTS®) stations since 1991. There are now 20 CT sensors in operation at CO-OPS stations; the data from these sensors are used to calculate water salinity and specific gravity (relative density), which are important tools for safe navigation, especially in the determination of ship draft.

Before an instrument can be used operationally, it must undergo testing by CO-OPS' Ocean Systems Test and Evaluation Program (OSTEP). CO-OPS/OSTEP chose the Tyco Environmental Systems Greenspan EC3000 SDI-12 CT sensors for testing, not only because they are a less expensive and potentially reliable replacement for Falmouth Scientific, Incorporated (FSI) sensors that transition out of operation for servicing and repair, but also because Greenspan CT sensors have been used operationally in CO-OPS' systems.

An analog version of the Greenspan CT sensor (EC250) was tested and evaluated by OSTEP in 2006. The sensor performed well, and several sensors were put into operation for a time. When the CO-OPS Chesapeake Instrument Laboratory (CIL) switched to a new version of the Sutron Data Collection Platform (DCP), compatibility issues were encountered with the Greenspan EC250. As a result, the sensors were removed from operation and have not been used since 2008.

Following testing and evaluation, the Greenspan EC3000 was approved for operation by CO-OPS leadership in January 2013. In June of 2014, **the name of instrument was changed from EC3000 to "MP-47 with Conductivity and Temperature".** This was merely a marketing change—instead of having separate model names based on parameters selected (EC3000 referred to electrical conductivity, the model name now refers to the base instrument (MP-47) and the desired parameters are specified by name (Conductivity and Temperature). The MP-47 is a multiparameter water quality sensor with the option of up to 4 parameters selectable from the following: Pressure, pH, ORP, conductivity, temperature, turbidity, ODO.

The purpose of this document is to guide the lab preparation and field installation of the EC3000 at CO-OPS stations.

1.0 System Overview

1.1 Sensor Description

The Greenspan EC3000 (fig. 2-1) is a toroidal conductivity/temperature (CT) sensor that measures the electrical conductivity of water using two wire coils (or 'toroids'). An electrical current is introduced in one coil and an electromagnetic field that surrounds the adjacent coil is generated. The coils are now inductively coupled, and the current flow between them is proportional to the conductance of the surrounding water. The main benefit of a toroidal system is its robustness and resistance to biofouling. Its main drawback is the partly external nature of the electromagnetic field, which leads to interference issues if deployed too closely to nearby objects. Greenspan has avoided this problem by introducing a simple shroud (fig. 2-2), which is a cap that attaches to the end of the sensor over the toroidal sensing cell and contains the electromagnetic field. The shroud is open at the bottom and has holes in the top to allow water to flow to the toroidal sensing cell. Temperature of the sensor and sample solution is monitored by an onboard temperature sensitive device. The EC3000 is capable of both RS232 and SDI-12 communications and can operate using either internal battery power and recording or external AC power and a data collection platform (DCP). CO-OPS has tested and approved this sensor for use only with its SDI-12 communications.

Figure 2-1. Greenspan EC300 CT Sensor

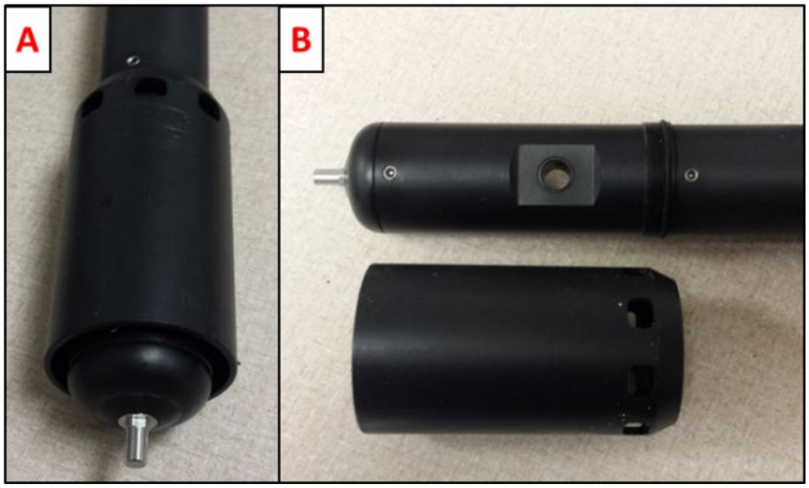


Figure 2-2. Greenspan EC300 CT Sensor with A) shroud in place and B) shroud removed.

1.2 CO-OPS' Existing CT Sensors and Wells

The Falmouth Scientific, Incorporated (FSI) OEM Digital CT sensor (predecessor to the Teledyne RDI Citadel) has been a CO-OPS standard for many years. At CO-OPS National Water Level Observation Network (NWLON) and Physical Oceanographic Real-Time System (PORTS®) stations that currently employ an FSI CT sensor, the sensor is housed in a 4-in PVC well mounted to a dock or other fixed structure. The base of the well extends below the water surface to just above the required sensor depth, and the top of the well extends to above the fixed structure, where it can be easily accessed for servicing. The sensor body is fitted with a Delrin® clamp (fig. 2-3A) through which a piece of line is run. The line is part of a pulley system that allows the clamp and sensor combination to be raised and lowered from the top of the PVC well (fig. 2-3B). A brass collar (fig. 2-3C) at the base of the well inhibits the passage of the Delrin® clamp and allows the exposure of the sensor to the water column at the requisite measurement depth.

Figure 2-3. A) FSI CT sensor housed in Delrin® clamp. B) The top of a CT well showing locking mechanism for line/pulley system. C) The brass collar that catches the Delrin® clamp at base of well.

1.3 Greenspan Installation Considerations

While the Greenspan EC3000 is approximately the same size as the FSI, there are several differences that need to be considered when the EC3000 is installed on *existing infrastructure* (described in section 3.2):

- **Shroud:** The Greenspan comes with a shroud that contains its electromagnetic field, thereby limiting interference with nearby objects. In CO-OPS' existing CT wells, the brass collars (permanently affixed at the base of the well) are not large enough to accommodate the shroud. In these cases, the sensors should be deployed without the shroud **BUT** must be factory calibrated without the shroud in place. See bullet 3 for more information on calibration. (Also note that it is easy to cross-thread the shroud, take care when putting it in place.)
- **Antifouling:** The Greenspan should be painted with antifouling paint before being calibrated. Plastic netting can also be placed over the end of the sensor to limit fouling in the toroidal sensing cell.
- **Calibration:** The Greenspan must be *factory calibrated*[1] in the same mode it will be deployed (i.e., with or without shroud). If possible, the plastic netting should also be in place during calibration (if it is going to be used), but this is not

[1] As an alternative to factory calibration, the initial sensor calibration could potentially be carried out at the Chesapeake Instrument Laboratory (CIL) or Seattle Instrument Laboratory (SIL) (after painting, with or without shroud in place and with netting in place) using calibration solutions. Given the cost of calibration solutions and the quantity required, investigation is underway as to whether this would be cost-effective.

required, since lab tests show that the netting does not have a significant effect on the sensor readings.

A “loop calibrator” (fig. 2-4) is provided with each instrument and must be used only with that particular sensor. The loop calibrator can be used to check calibration and to calibrate the instrument if needed. The sensor should be returned to CIL/SIL once a year for inspection and calibration with the loop calibrator (see page 36 of the Greenspan EC3000 manual [2] for this procedure). The instrument should be compared with the reference sensor in the test bath before and after calibration. In the event that an instrument is not holding calibration, it should be returned to the factory for inspection/repair. This is different than the FSI maintenance protocol (which involves automatic annual factory calibration) and represents a potential cost savings in long-term maintenance.

Figure 2-4. Loop calibrator

- **Size of SDI-12 converter/cable permanently attached to sensor housing:** The Greenspan cable comes with an SDI-12 converter. The fitting for this converter is permanently attached to the sensor cable (fig. 2-5) and is too large to fit through the existing conduit used for the FSI sensors. Since the cable is also permanently attached to the sensor housing at the other end, cutting and splicing the cable will be necessary (see section 2.4 *Cable Modifications*.)

Figure 2-5. SDI-12 converter.

- **Sensor diameter:** The Greenspan is slightly smaller in diameter than the FSI. A strip of PVC shower pan liner (or something similar) should be wrapped around the sensor before tightening the Delrin® block. Alternatively, the sensor can be wrapped with tape (duct, PVC, electrical).

If using new infrastructure:

- It is recommended that the shroud be used; however, the brass collar that fits at the base of the well must have a larger inner diameter than those used on existing CT wells with the FSI CT sensor. (Also, the sensor must be factory calibrated with the shroud in place in this case.)
- The SDI-12 converter will fit through a 1.5-in conduit, including the conduit LB joint on the well, but NOT the conduit elbow joint that is used at the tide house in some installations. Installation plans should not include this elbow joint. In this way, the SDI-12 converter can be run all the way into the housing and the cable will not have to be cut and spliced.

1.4 Cable Modifications

In order to use the Greenspan EC3000 at stations with existing conduit, the cable must be modified before being sent to the field for installation. This section describes the modifications that will be made by CIL/SIL.

The sensor cable will be cut near the SDI-12 converter connector as shown in fig. 2-6, and connector pins will be added to the wires on both sides of the cut.

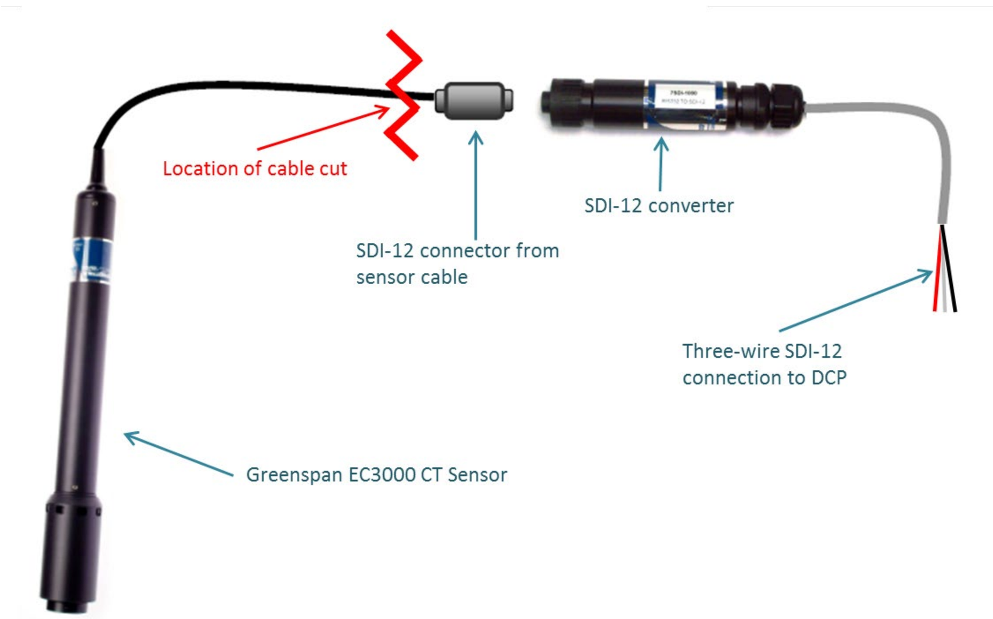


Figure 2-6. Greenspan EC3000 sensor cabling; red line shows where cable will be cut.

1.5 Sensor setup

There should be no need to connect to the sensor if it has been left with its default outputs configured. These can be checked, if necessary, by logging into SensorMate software (H:\OSTEP\CT\Greenspan\software). After connecting to the sensor, click on "Setup Sensor", then go to the "Schedules" tab. Under the main schedule, make sure all of the parameters are checked: Ext Batt, Temperature, EC_Raw, EC_Norm, Salinity.

To configure the sensor with the correct SDI12 address, the following command can be sent when it is hooked up to the DCP: **A8!** For more information about SDI12 commands, refer to the SDI12 manual (H:\OSTEP\CT\Greenspan\manual).

2.0 Field Deployment and Maintenance Instructions

2.1 Initial Installation

2.1.1 Notify Local Contact

Contact the CIL or SIL team lead one week prior to the installation to arrange a point of contact (POC) to be available after the installation.

2.1.2 Safety Precautions

Personnel must comply with all CO-OPS Field Facility Safety Rules (draft 4/7/04) and NOAA Safety Rules (draft 4/1/03). NOAA and CO-OPS Safety Procedures require that hard hats, safety reflective vests, safety shoes, and climbing gear be worn by all persons at all times while on bridges. Hard copies of this safety information can be found in the CO-OPS Chesapeake facility library or on the CO-OPS common drive at: \\Co-ops-s-ssmc1\common\CO-OPS_Com\Field_Safety_Manual and on the Chesapeake common drive (H) in a folder called Field_Safety_Manual.

2.2 Installation Instructions

The following section provides installation instructions based on the following assumptions:

- The Greenspan sensor will be installed at a location using existing infrastructure.
- The sensor has been painted, then factory calibrated without the shroud in place.
- The cable has been modified as shown in section 2.4 (*Cable Modifications*).

1. Wrap the sensor with several layers of PVC tape and place it into the Delrin® block.
2. Tighten the screws until the sensor is secure.
3. Feed the end of the sensor cable (with flying leads) down through the top of the well and out through the conduit LB.
4. Then, feed the cable through the conduit and into the tide house.
5. Lower the sensor into the well using the line/pulley system attached to the Delrin® block.
6. When the block reaches the base of the pipe, ensure that it is well-seated in the brass collar.

7. Secure the line at the top of the PVC well in the locking mechanism (see fig. 2-3B).

2.3 Sensor Wiring Instructions

In most CO-OPS water level station systems, the Xpert data logger is integrated into a larger watertight box with a separate SDI-12 terminal board extended down from the data logger itself to allow more room and easy access to where the SDI-12 wires need to be connected. The example for a typical CO-OPS system with an Aquatrak controller installed is shown in fig. 3-1.

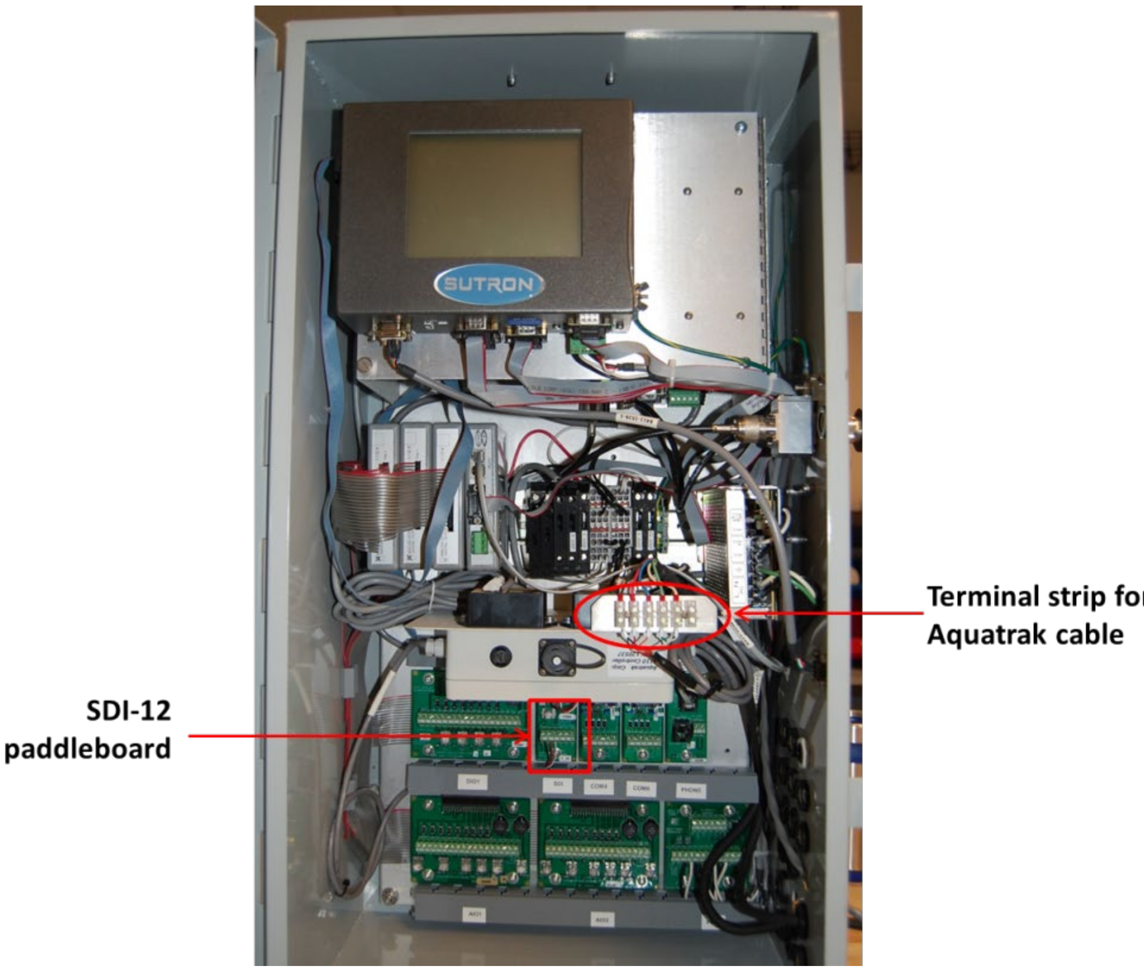


Figure 3-1. Typical CO-OPS system with Aquatrak controller

1. **Disconnect the Aquatrak controller and replace terminal strip**

   To accommodate the Greenspan cable, a new terminal connector strip that contains at least 12 connectors needs to be installed. Figure 3-2 shows close-up views of A) the old terminal strip with the Aquatrak cable connected and B) the new terminal strip.

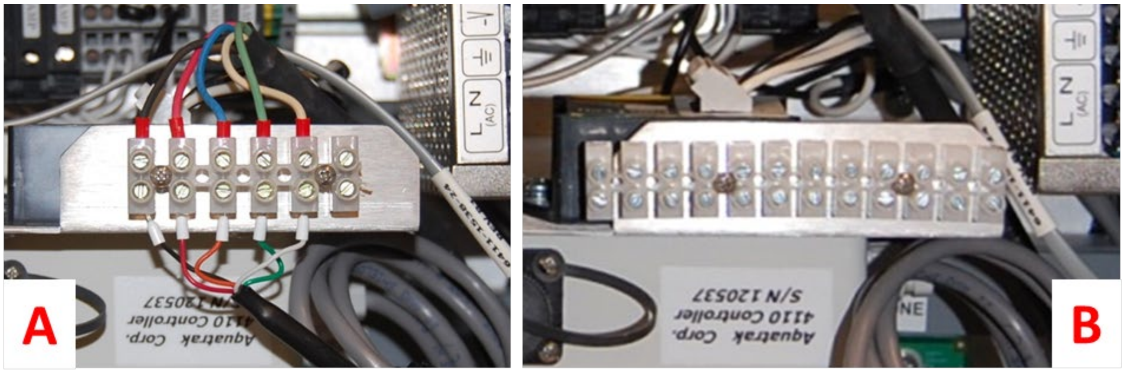


Figure 3-2. (A) The old terminal strip with the Aquatrak cable connected and (B) the new terminal strip.

2. **Wire the sensor cable to the terminal strip**

   The flying leads from the cable connected to the sensor will be brought into the tide house and wired to the new terminal connector. Figure 3-3 shows A) the new terminal strip with the Aquatrak cable reconnected and B) the new terminal strip with both Aquatrak and Greenspan cables connected.

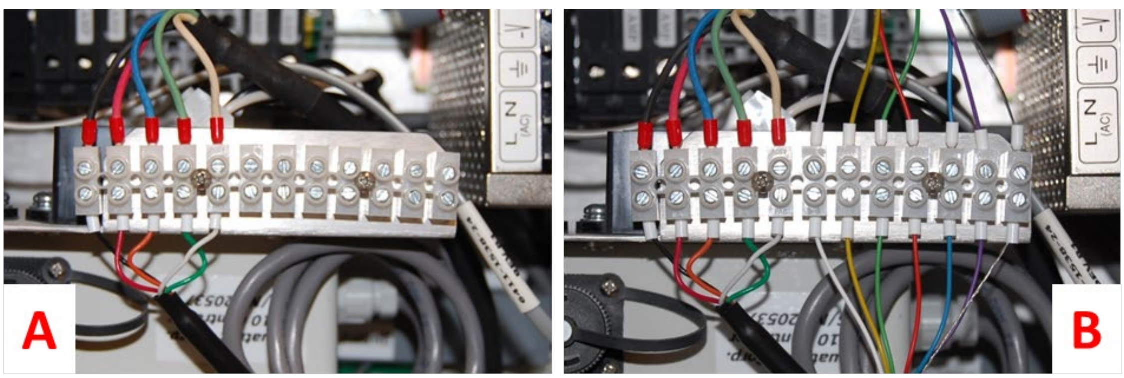


Figure 3-3. (A) New terminal strip with Aquatrak cable reconnect and (B) new terminal strip with Aquatrak and Greenspan cables connected.

3. **Mount the SDI-12 converter and wire it to the SDI-12 paddle board**

   The Greenspan sensor's SDI-12 cable (from the SDI-12 converter) consists of three colored wires with the following functions:

   Black: Ground
   Red: +12V Power
   White: SDI-12 Data in/out

   The SDI-12 converter will be mounted on the left wall of the enclosure using a mounting bracket (fig. 3-4) and the three wires connected to the SDI-12 paddle board (fig. 3-3) in outlets 8 (Ground/Black), 9 (Power/Red), and 10 (Data/White). The Aquatrak controller will likely be wired to outlets 5, 6, and 7.

Figure 3-4. SDI-12 converted mounted on the wall of the enclosure**.**

2.4 XPERT Software Setup Instructions

Once the sensor is connected to the DCP via SDI-12 interface and the DCP is powered on, connect the computer to the DCP via an RS232 cable.

1. Start Xterm software on the laptop. You may need to change the COM port using the drop-down menu on the upper left corner of the graphical user interface (fig. 3-5).

2. Under the **Hardware** box, select **Direct**.

3. Type the username and password (provided by CIL/SIL) and click **OK**.

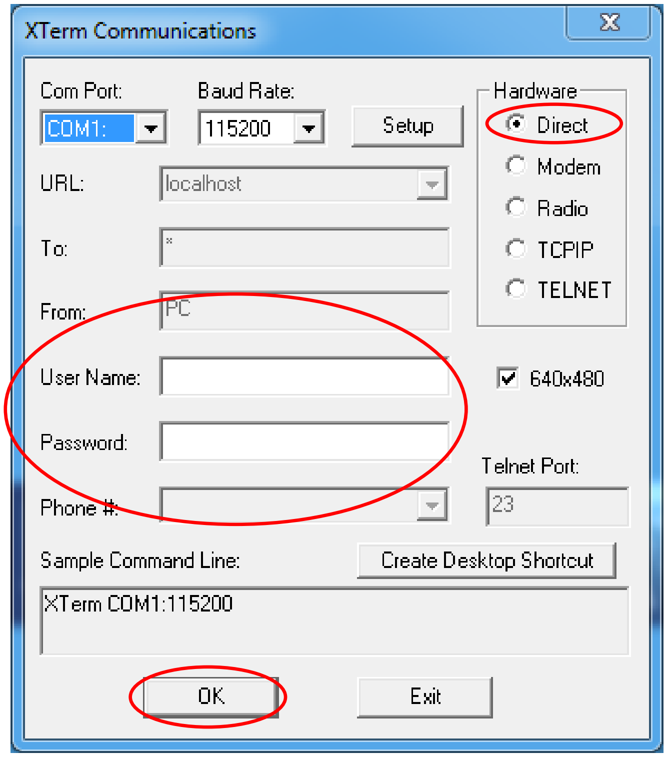


Figure 3-5. Xpert connect screen.

4. You will be prompted to select from two access types. Click the **Setup Access** button (fig. 3-6).

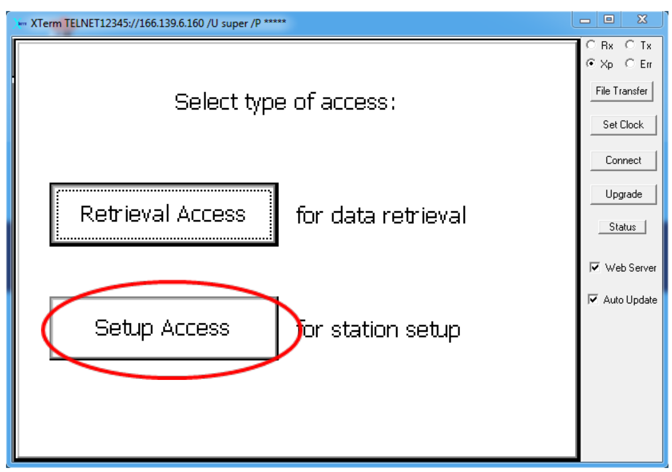


Figure 3-6. Xpert access selection.

5. After the **Setup Access** button is selected, the screen shown in fig. 3-7 will appear. Click the **Setup** tab to begin configuring the new sensor.

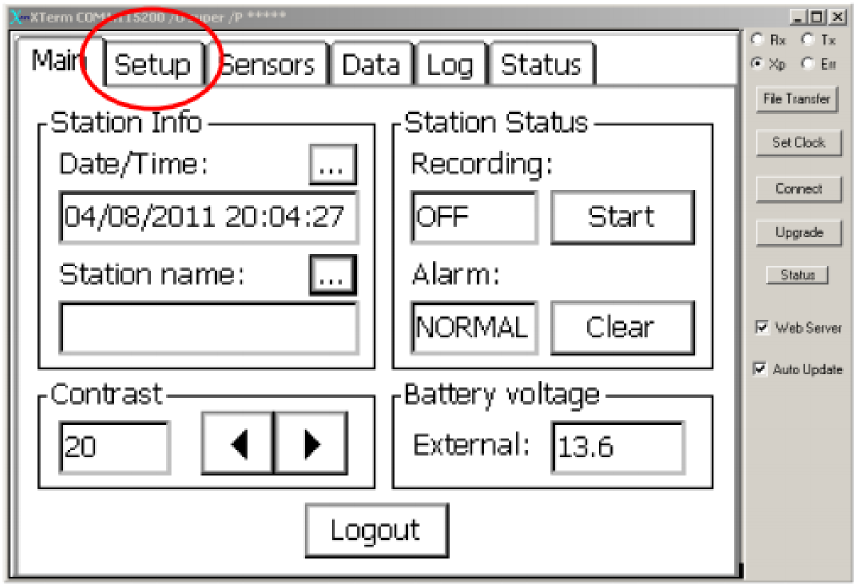


Figure 3-7. Xpert Setup Access screen.

NOTE: In most cases, by the time a Greenspan CT sensor and DCP are sent to the field, either CO-OPS CIL or SIL has configured all DCP setups. Figure 3-8 illustrates the final graphical setup for a Greenspan CT sensor that was previously configured by CIL or SIL. However, if the graphical setup must be programmed on the DCP, steps required for the graphical setup for a Greenspan CT sensor can be found in appendix A. If the interface is already configured, the only thing needed to complete the field installation is to start sensor recording and confirm that the sensor is recording and transmitting data. Both steps are described in the following paragraphs (sections 3.5 and 3.6).

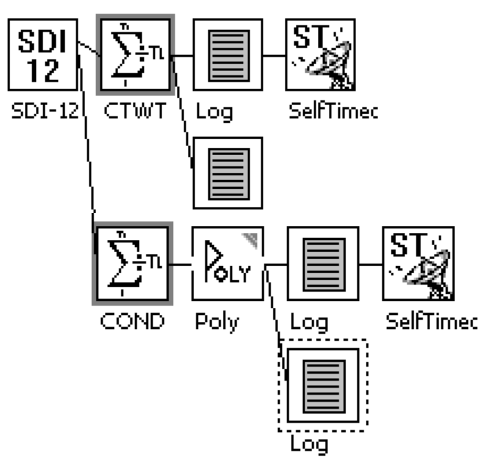


Figure 3-8. Final graphical setup for a Greenspan CT sensor, which is configured by CIL/SIL prior to deployment.

2.5 Data Recording

After connecting the sensor to the DCP via the SDI-12 interface, make sure the DCP is powered on. To start recording, connect the laptop to the DCP via RS232 cable and open Xterm software.

- In Xterm, return to the **Main** tab under the **Setup Access**. Click the **Start** button (fig. 3-9); the hour glass icon will appear. It may take a minute or two for recording to start.
- Once the **Recording** box next to the start button reads **ON** (or **ON+TX** if GOES transmissions are enabled), the sensor should be recording.

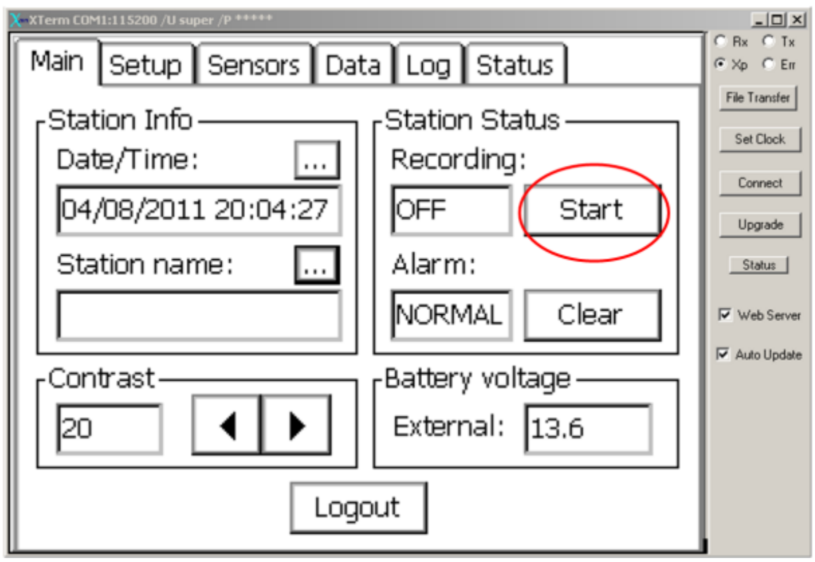


Figure 3-9. Click the Start button.

2.6 Confirmation of Data Recording/Transmission

Once you have completed all of the previous procedures and steps, the Greenspan sensor should be installed and recording to the DCP. The final portion of the installation process involves conducting several checks to ensure that the sensor/DCP system is recording and transmitting 6-minute real-time data.

1. **Check SSP log file on Flash Disk and SD Card**

   After starting the sensor recording, check the ssp.log file to confirm that the sensor is measuring realistic conductivity and temperature values, and that data are being recorded to the DCP log files.

   - In the Xterm **Setup Access** screen shown in fig. 3-10, select the **Log** tab. The screen in fig. 3-11 will appear.

- Use the **Select Log**: drop-down menu shown in fig 3-11 to select the **\Flash Disk\ssp.log** (if it is not already displayed). Confirm that reasonable conductivity and temperature values are being measured and that values are being reported every 6 minutes. Note that the sensor outputs units of uS/cm, but CO-OPS reports units of mS/cm. To convert from uS/cm to mS/cm, divide by 1000.

- Repeat the above step to confirm recording in the **\SD Card\SSP.log**.

- Return to the **Main** screen by clicking the **Close** button (lower right, fig. 3-11), and log out of the DCP [fig. 3-12]. Close Xterm and disconnect the laptop-to-DCP cable.

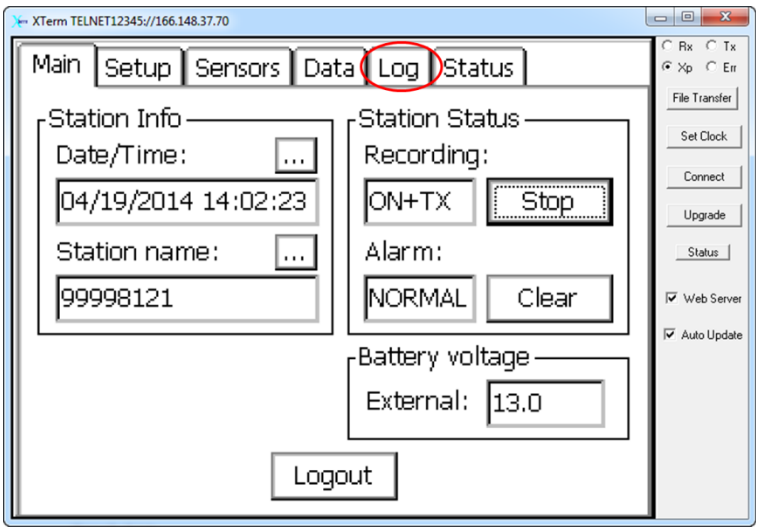


Figure 3-10. Select Log tab.

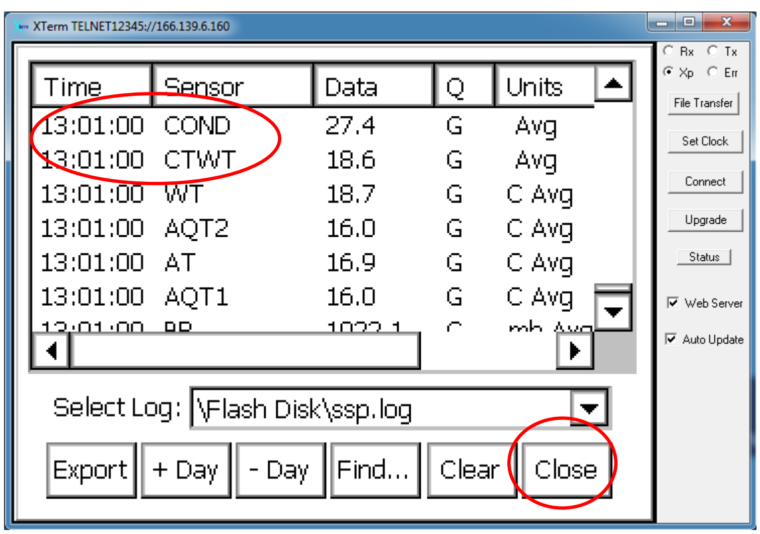


Figure 3-11. Confirm that data are being recorded.

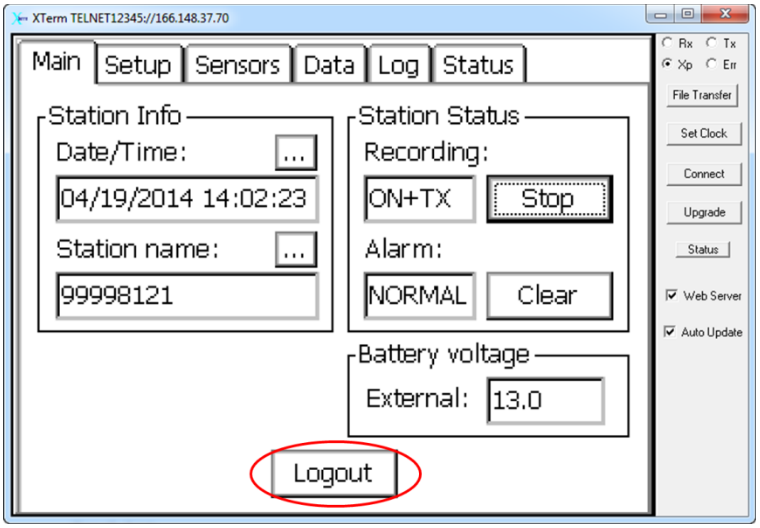


Figure 3-12. Select Logout button.

2. Call CIL or SIL to Confirm Transmission of Real-Time Data

After the installation is complete, contact the identified CIL/SIL POC and request that s/he confirm that the sensor data are being transmitted and ingested. Have the following information ready to provide when calling:

- Station ID
- GOES ID
- IP modem address
- Station location, name, and approximate latitude/longitude

References

[1] Greenspan EC3000 OSTEP Test and Evaluation Report (http://intranet.nos-tcn.noaa.gov/media/wikidocs/OSTEP/CT_Sensor/CT_T&E_Report_Draft_011713.pdf)

[2] Greenspan EC3000 manual (H:\OSTEP\CT\Greenspan\manual)

List of Appendices

Appendix A. How to Configure the DCP Graphical Setup for the Greenspan EC3000 Conductivity/Temperature Sensor

Appendix B. Packing List

Appendix A
How to Configure the DCP Graphical Setup for a Greenspan EC3000 Conductivity/Temperature Sensor

This appendix describes how to configure the Xpert software setups on the DCP for the Greenspan EC3000 CT sensor using the Xpert's **Graphical Setup Tool**:

(1) Go to **Setup Access** (fig. A-1)**.**
(2) Select the **Setup** tab.
(3) Expand the **Graphical Setup** menu.
(4) Select the **[New]** button.

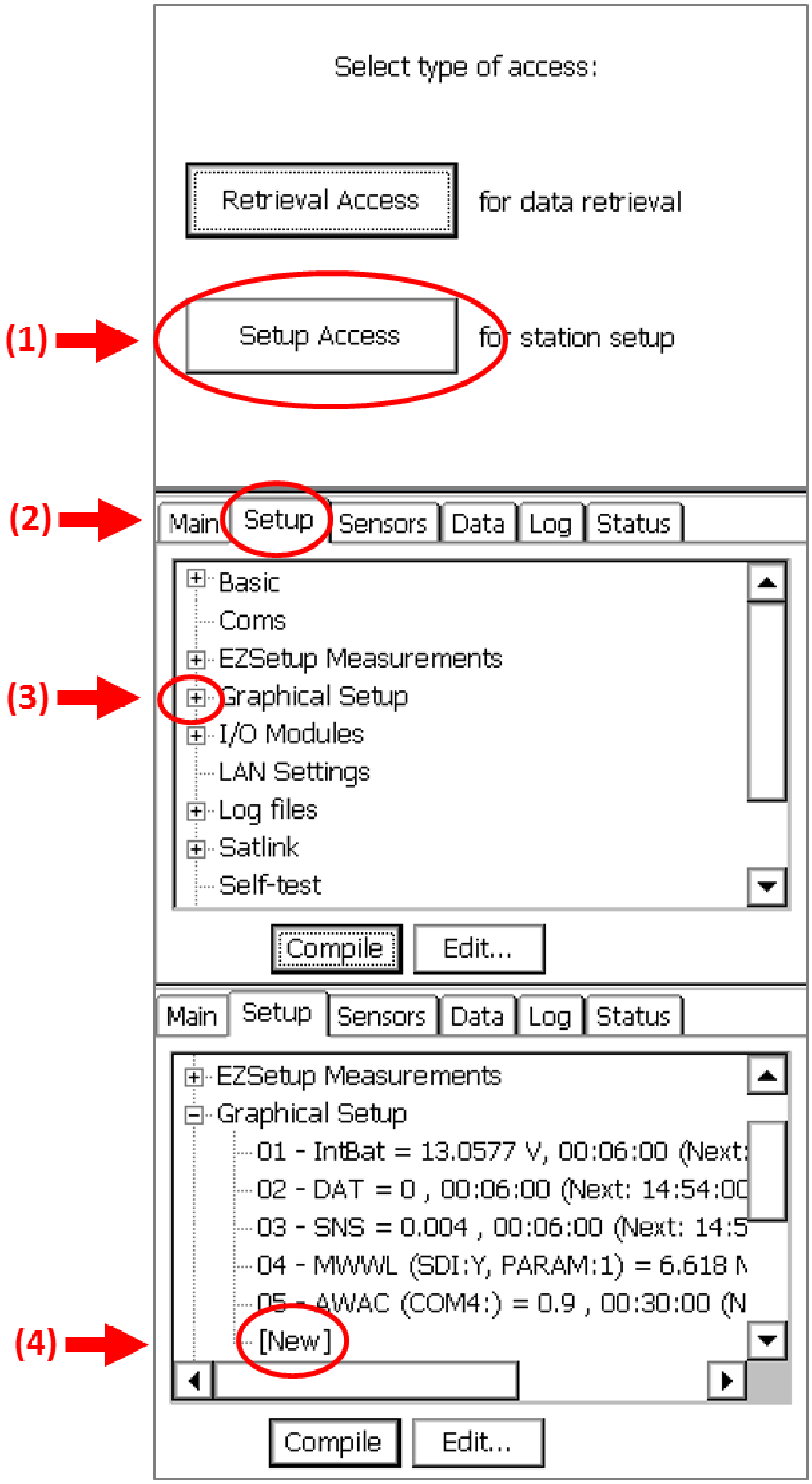


Figure A-1. Add a new graphical setup.

(5) After starting a new **Graphical Setup**, the DCP setups for the Greenspan CT sensor can be configured by adding a series of graphical objects, or 'blocks' and then 'wiring' them together using the **Graphical Setup Tool**. From a new graphical setup window, new blocks can be added as follows:

a) Select the **add** button.

b) Select a block **category type**.

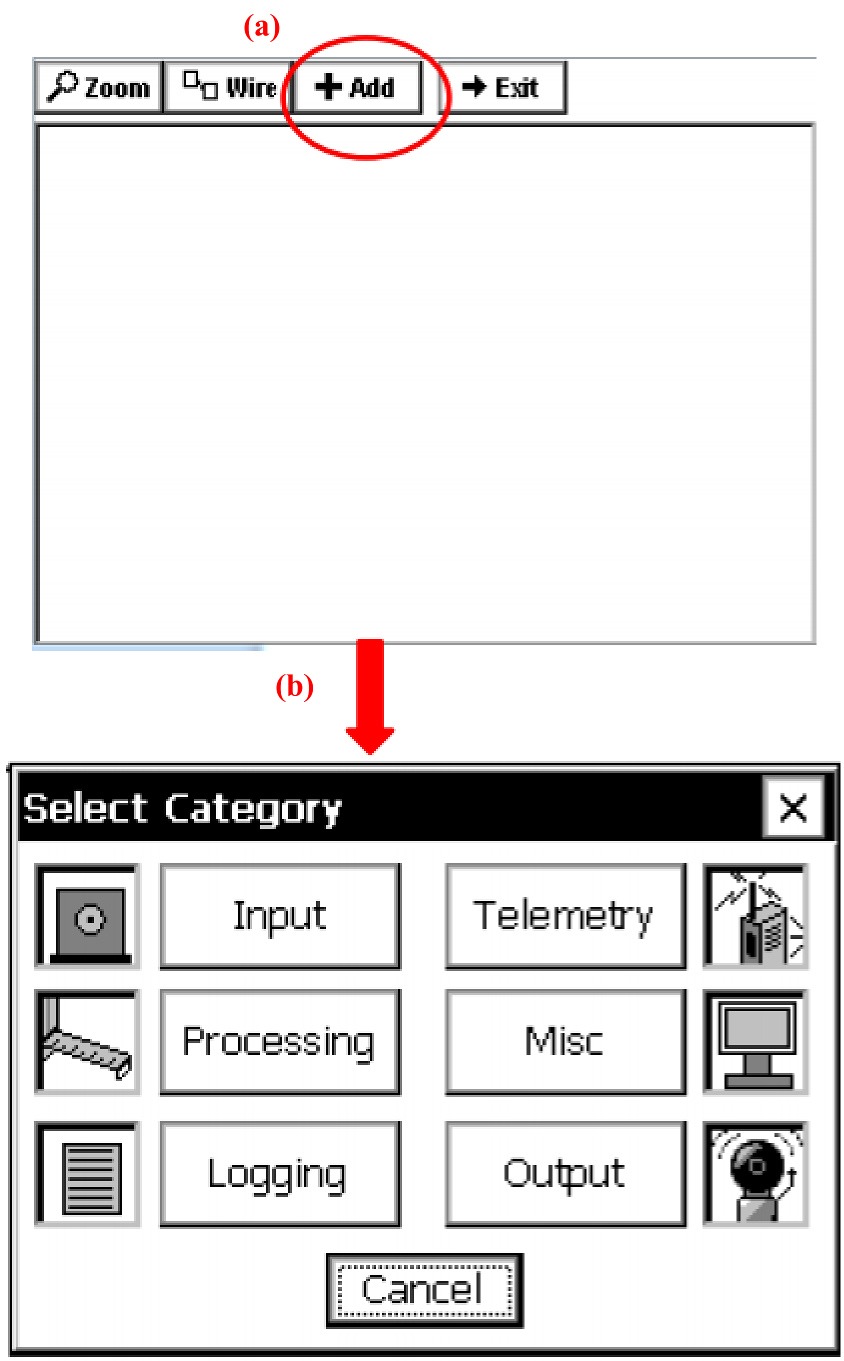
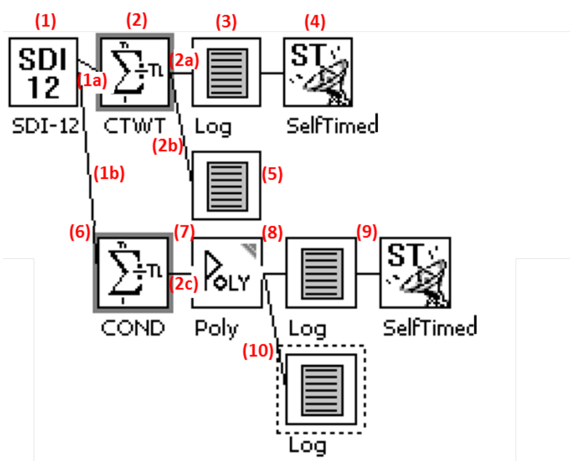
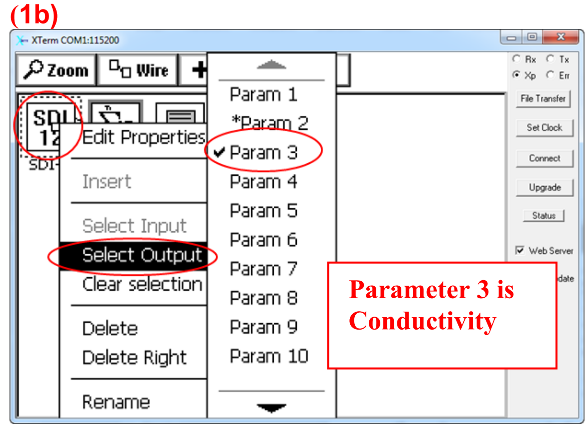


Figure A-2. Add new category blocks.

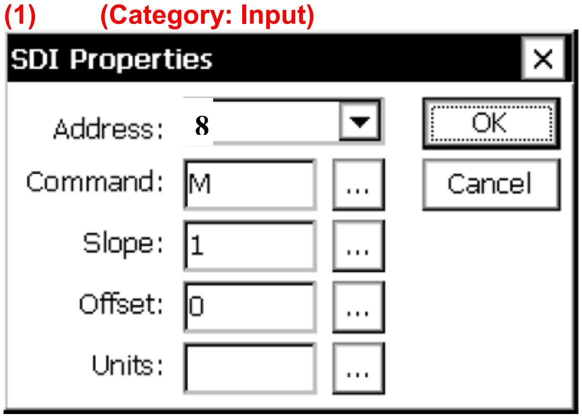
Greenspan CT Wired Block Diagram and Individual Block Properties



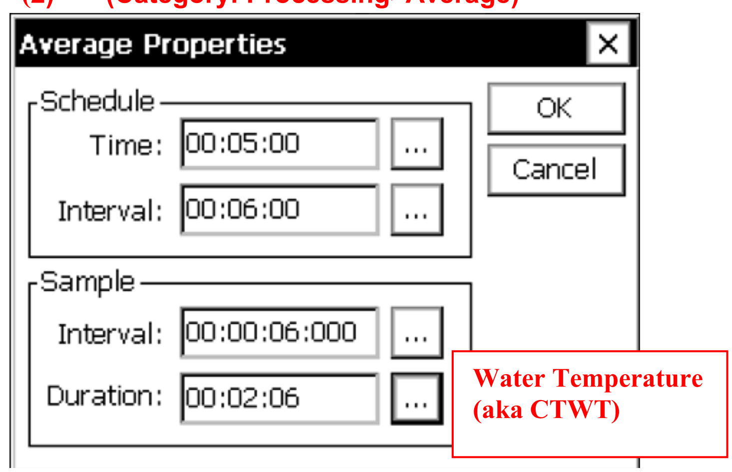
(1b)



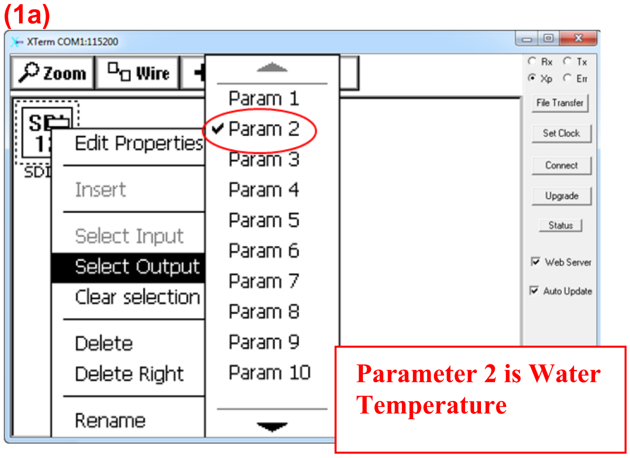
(1) (Category: Input)



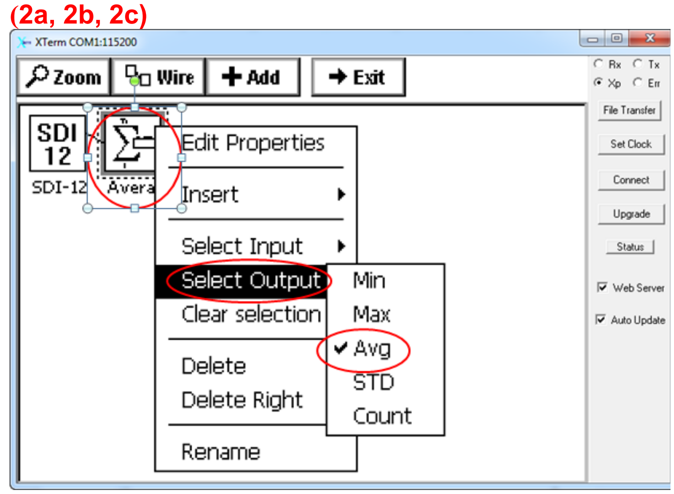
(2) (Category: Processing>Average)



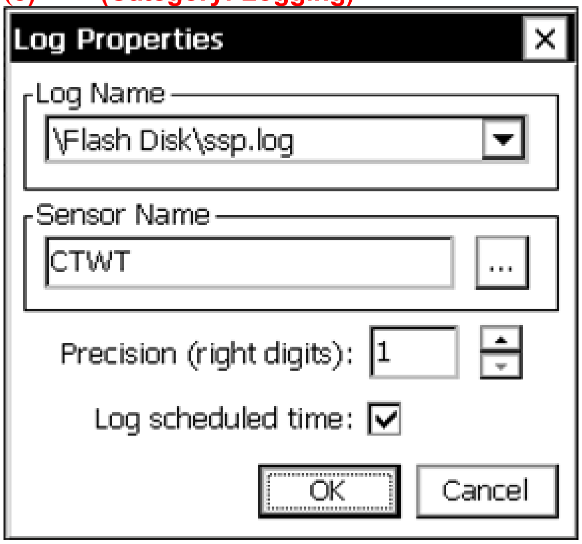
(1a)



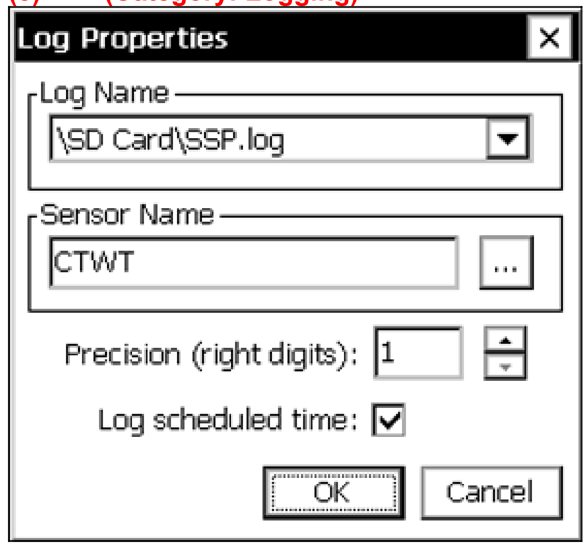
(2a, 2b, 2c)



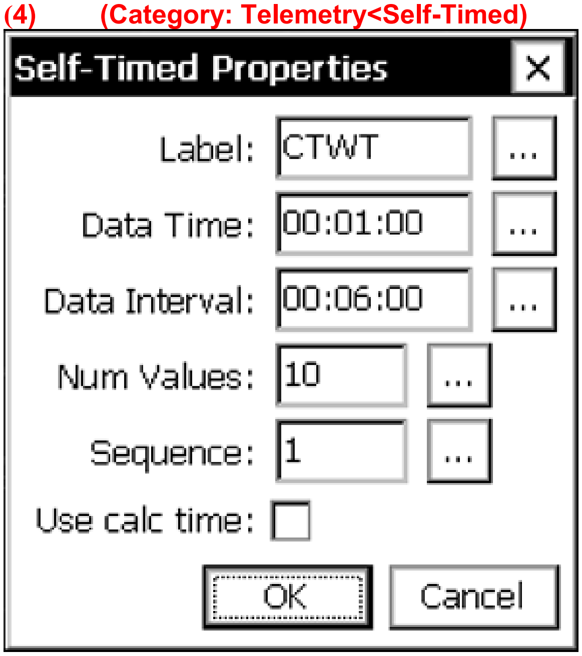
(3) (Category: Logging)



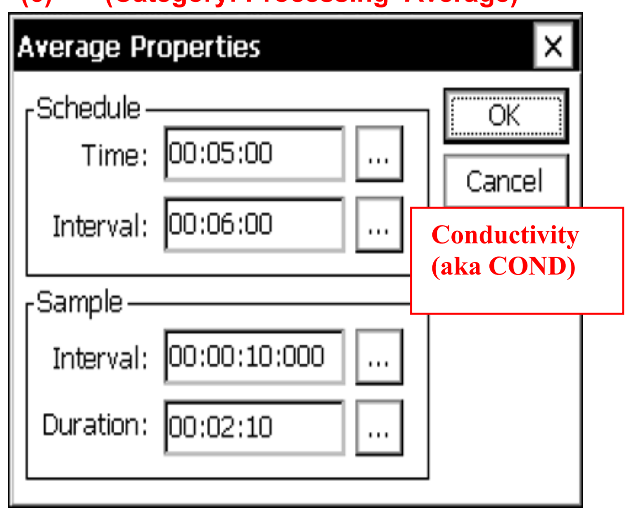
(5) (Category: Logging)



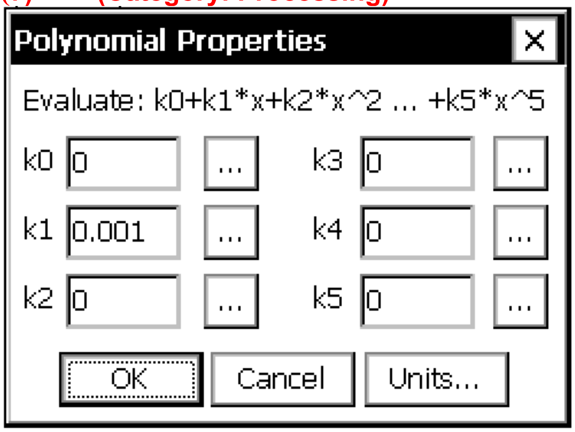
(4) (Category: Telemetry<Self-Timed)



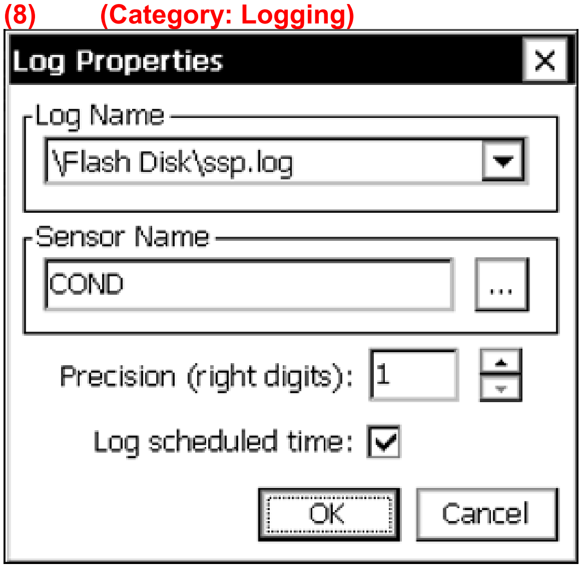
(6) (Category: Processing>Average)



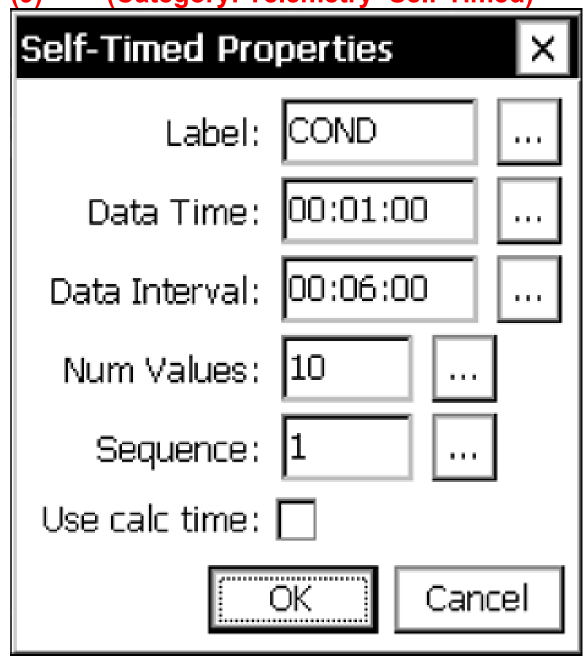
(7) (Category: Processing)



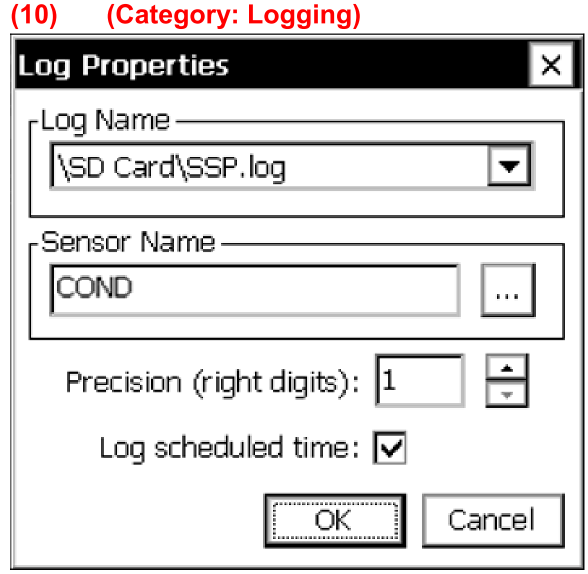
(8) (Category: Logging)



(9) (Category: Telemetry>Self-Timed)



(10) (Category: Logging)



Appendix B
Packing List

Tools
Measuring tape
Snake
Greenspan CT sensor + SDI-12 converter
Laptop with Greenspan software
Delrin block
Duct tape / PVC shower liner
Amsteel line
Wire crimping kit
New terminal strip
Mounting bracket for SDI-12 converter
Punch kit

Acronyms and Abbreviations

AC	alternating current
CIL	Chesapeake Instrument Laboratory
CO-OPS	Center for Operational Oceanographic Products and Services
CT	conductivity/temperature
DCP	data collection platform
FSI	Falmouth Scientific, Incorporated
GOES	Geostationary Operational Environmental Satellite
inch	in
I/O	input/output
IP	Internet protocol
NOS	National Ocean Service
NOAA	National Oceanic and Atmospheric Administration
NWLON	National Water Level Observation Network
POC	point of contact
PORTS®	Physical Oceanographic Real-Time System
PVC	polyvinyl chloride
SDI	serial digital interface
SIL	Seattle Instrument Laboratory