STS Gold Telemetry System
User Guide

Version 1.0.2

August 17, 2009

Solinst ®

Levelogger ®
Model 3001

1 Introduction to STS Telemetry and Leveloggers

Solinst STS Telemetry Systems provide an economical and efficient method to access remote data instantly. They provide two-way communication between field located dataloggers and a Home Station computer.

STS Gold Telemetry Systems are designed specifically for the high quality Levelogger series of dataloggers. Up to four Solinst dataloggers can be connected to one STS Remote Station, in any combination of the Levelogger Gold, Levelogger Junior, Barologger, or Rainlogger.

STS Systems operate on two basic schedules. A linear "Sample Rate" is set, at which the STS Controller at the Remote Station records a real-time reading from each attached datalogger. A "Report Rate" is set to establish the frequency that the data is sent from the Remote Station to the Home Station Computer. Optionally, dataloggers themselves can be set up to record and store data independently of the STS System. This provides a reliable back-up if circumstances require it.

Remote Station   Home Station PC
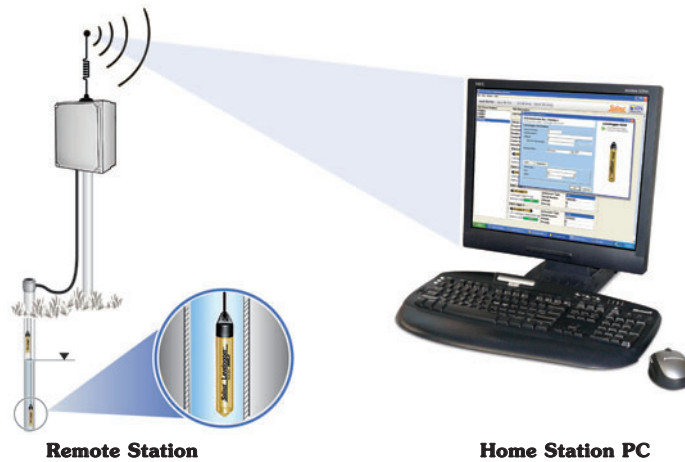
STS Systems can be set up using CDMA or GSM digital cellular, or radio communications. Using digital CDMA or GSM, the data is 'pushed' from the Remote Station to the Home Station using IP (Internet Protocol), and therefore, dial-up or timing issues are not a problem. The STS Controller stores data in its memory until it has been successfully uploaded by the Home Station computer.

STS Telemetry Systems come with standardized hardware options, and STS Gold Software which allows easy setup, operation, and management of data. Features such as alarm notification, remote diagnostic reporting and firmware updating make it easy to maintain your system, while simplifying data collection.

This manual focuses on configuration, programming, and installation of STS Gold Telemetry Systems using CDMA, GSM, and radio communications. It also discusses the various options to power the Systems. It includes instructions for installing and using STS Gold Software to set up data collection schedules, manage data, perform remote diagnostic checks, and firmware updates. Also provided are References, a Glossary, and Appendices where various technical specifications are shown.

Figure 1-1 Levelogger Gold

Levelogger Gold

The Levelogger Gold is an absolute (non-vented) dataloggers, which measures total pressure and temperature and is ideal for monitoring groundwater and surface water. Water levels are displayed as temperature compensated pressure readings and can be barometrically compensated with the aid of a Barologger Gold.

Levelogger Gold Technical Specifications	
Level Sensor:	Piezoresistive Silicon in 316L Stainless Steel
Accuracy (Typical):	0.05% FS
Stability of Readings:	Superior, low noise, 6 times better than previously
Resolution:	0.002 to 0.0006% FS
Normalization:	Automatic Temp Compensation
Temperature Sensor:	Platinum Resistance Temperature Detector
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
Temp. Comp. Range:	-10 to +40°C
Battery Life:	10 Years - based on one reading/min
Clock Accuracy:	± 1 minute/year
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	40,000 of level and temperature
Memory:	Superior reliability EEPROM Slate, rollover and redundant backup of last 1200 readings
Communication:	Optical Infra-Red Interface, Serial at 9600 Baud, Conversion to RS232 or USB Computer Connection
Size:	7/8" x 6" (22 mm x 154 mm)
Weight:	6.3 oz (179 grams)
Backwards Compatibility:	Full
Corrosion Resistance:	Zirconium Nitride (ZrN) Coating
Other Wetted Materials:	316-L Stainless Steel, Delrin, Viton
Sampling Modes:	Linear, Event and User-Selectable with 30 separate line items
Measurement Rates:	0.5 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius and or per 1000 ft/300 m change in elevation)

LT Models	Full Scale (FS)	Accuracy (typical)	Resolution
F15, M5	16.4 ft., 5 m	± 0.010 ft., 0.3 cm	0.001% FS
F30, M10	32.8 ft., 10 m	± 0.016 ft., 0.5 cm	0.0006% FS
F60, M20	65.6 ft., 20 m	± 0.032 ft., 1 cm	0.0006% FS
F100, M30	98.4 ft., 30 m	± 0.064 ft., 1.5 cm	0.0006% FS
F300, M100	328.1 ft., 100 m	± 0.164 ft., 5 cm	0.0006% FS

Table 1-1

Figure 1-2 Barologger

Note:
Only one Barologger is required for a 20 mile (30 km) radius, as long as elevation differences are within 1000 ft. or 300 m.

Barologger Gold

The Barologger Gold uses algorithms based on air pressure only. It measures and logs changes in atmospheric pressure, which are then used to compensate water level readings recorded by a Levelogger Gold, or a Levelogger Junior.

Models	Full Scale (FS)	Water Fluctuation Range	Accuracy (typical)	Resolution
Barologger	0.05%	Air Only	± 0.003 ft., 0.1 cm	0.002% FS

Table 1-2

Levelogger Junior

The Levelogger Junior provides a low cost alternative for measuring groundwater and surface water levels and temperature. The Levelogger Junior is compatible with all Levelogger Gold accessories.

Figure 1-3 Levelogger Junior

3001 Junior Technical Specifications	
Level Sensor:	Piezoresistive Silicon in 316L SS
Ranges:	F15/M5, F30/M10
Accuracy (typical):	0.1% FS
Resolution:	0.028%, 0.021%
Normalization:	Automatic Temp Compensation
Temperature Sensor:	Platinum RTD
Accuracy:	± 0.1˚C
Resolution:	0.1˚C
Temp Compensation Range:	- 10˚C to 40˚C
Battery life:	5 Years
Clock Accuracy:	± 1 minute/year
Operating Temperature:	- 20˚C to 80˚C
Memory:	Non-volatile EEPROM, FRAM back-up
Maximum # Readings	32,000 sets of readings
Communication:	Optical Infra-Red to USB or RS232
Size:	7/8" x 5.5" (22 mm x 140 mm)
Weight:	154 g (5.4 oz)
Wetted Materials:	316L Stainless Steel, Delrin®, Viton®
Sampling Mode:	Linear, SDI-12, Real Time View (from 0.5 sec to 99 hrs)
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius and or per 1000 ft/300 m change in elevation)

Junior Models	Full Scale (FS)	Accuracy (typical)	Resolution
F15, M5	16.4 ft., 5 m	± 0.020 ft., 0.6 cm	0.028% FS
F30, M10	32.8 ft., 10 m	± 0.032 ft., 1.0 cm	0.021% FS

Table 1-3

1.1 Level

The Levelogger Gold and Levelogger Junior use a high quality piezoresistive silicon pressure transducer packaged in a 316L stainless steel housing. It gives high accuracy and high stability. The Levelogger Gold body is coated with Zirconium Nitride (ZrN) to give corrosion resistance. All Leveloggers measure total or absolute pressure. When the Levelogger is operating in open air, it is recording barometric pressure and converting that pressure reading to its water level equivalent above the datalogger's pressure zero point of 950 cm (31.17 ft). When submerged, it is recording the combination of barometric pressure and water pressure. The Levelogger converts the total pressure reading to its corresponding water level equivalent. Actual water level is obtained by compensating for barometric pressure. The best method to compensate for barometric pressure is to employ a Barologger above the water level, somewhere on site, to obtain records of barometric pressure. Although the STS Software does not support this, the Levelogger Software includes a Barometric Compensation Wizard, which guides the user through the automated process of barometric compensation. Manual methods can be employed to determine the absolute water level using barometric records collected on-site or available from a local weather station (i.e. Airport). Water level readings from the Levelogger Gold and Levelogger Junior models are temperature-compensated.

1.1.1 Pressure Calibration

The Levelogger Gold and Levelogger Junior are calibrated against a range of set reference points to an accuracy of 3 decimal places. The units of pressure are in pounds per square inch. The conversion factor for pounds per square inch relates to pressure as follows:

$$1 \text{ pound per square inch} = 0.0689476 \text{ bar}$$
$$= 703.070 \text{ Kg/m}^2$$
$$= 6.895 \text{ kPa}$$
$$= 2.31 \text{ ft. } H_2O @ 4°C.$$

During the calibration procedure, the Levelogger is fully submerged in a highly accurate water bath. The bath is set to 15°C and allowed to stabilize. The pressure is then calibrated to six separate pressure points covering the entire range of pressure for that particular Levelogger to check for any non-linearity. The process is repeated again at 35°C to check for temperature effects. Once complete, the Levelogger is only approved after all specifications for accuracy, precision, stability, and hysteresis have been met.

1.2 Barologger

The Barologger Gold is designed for use in air only. It has a specific range and firmware algorithms based on air pressure rather than water pressure. This makes the Barologger less accurate if used in water, but more accurate if used as intended, in air. Using a Barologger is the most accurate and convenient method of obtaining atmospheric pressure. When programmed with the same sampling parameters as the Leveloggers on site, a Barologger can avoid barometric data time lags and any errors introduced due to moisture buildup, kinking, or damage to vented cables. The Barometric Compensation Wizard in the Levelogger Software simplifies the adjustment of the level measurements for barometric pressure changes, by using the synchronized data from all Leveloggers on site and the site Barologger.

Figure 1-5 Levelogger and Barologger in Well

1.3 Temperature

Levelogger Gold and Levelogger Junior, record temperature compensated water levels. Groundwater and surface water temperature measurements are particularly important in situations where temperatures may fluctuate significantly, and when temperature is used in determining liquid level, viscosity, and hydraulic conductivity. Temperature monitoring is vital in the calculation of certain temperature dependent contaminant reaction rates. A Platinum Resistance Temperature Detector is used to accurately compensate for temperature changes within the range of -10 to +40°C. The Leveloggers will record temperature in its thermal range of -20 to +80°C, but outside the range of -10 to +40°C compensation will be less accurate.

1.4 Total Rainfall

The Solinst Rainlogger is designed to count the tips of an external tipping-bucket rain gauge within a user defined sample interval and output the total rainfall over that sample interval. The Rainlogger can store 40,000 sets of readings. The Rainlogger is designed to be compatible with the Solinst Levelogger series of products.

2 STS Gold Software

The Home Station computer requires STS Gold Software. The software provides an easy-to-use graphical interface to set up remote sites, specify communication intervals, define sampling rates for attached dataloggers, determine alarm settings, and perform remote diagnostic tests and remote firmware updates. Collected data is stored and viewed using the software; it can also be exported for use in other programs.

2.1 System Requirements

The minimal hardware and software requirements for software installation and operation are:

Hardware	Software
Memory: 256MB or more	OS: Windows 98, ME, 2000 or XP
Display: VGA: 800 x600 pixels, 256 colour	
Ports: RS232 Serial Port and/or Internet connection with IP address	
Hard Drive space: 64MB	

Table 2-1

2.2 Software Installation

Place the STS Gold CD in the CD ROM drive or download the software from www.solinst.com/Downloads/ and save to hard drive.

1) Open Windows Explorer and double-click the setup.exe icon.

2) At this point Windows will prompt you through the remainder of the installation process.

3) Restart the computer after installation is completed. Default Directory is <C:\Program Files\Solinst\STS_Gold>

3 Home Station Configuration

To Start the STS Software, click on [icon] icon, or click the Start button and select:

Programs > Solinst > STS_Gold > STS_Gold_Admin

3.1 STS Administrator

After the STS Software has been started, the STS Administrator screen will open. From here, you can create new STS sites, edit existing sites, delete existing sites, and open site data.

<p align="center">**Figure 3-1 STS Administrator Screen**</p>

Note:
The alarm clock icon shown beside a datalogger on the Administrator Screen indicates that an alarm condition has been set for this datalogger. It does not mean an alarm condition has been met.

The Menu on the left of the screen lists each existing STS Site by their Serial Number (number located on the STS Controller). Selecting a site from the list will display information on the sites Remote Station Battery Strength, Remote Station Signal Strength, Last Update Time, and site details (including Project ID, Location, Number of Loggers, etc). Information for each datalogger connected to the site is displayed, including instrument type, and battery strength.

- **Last Update Time**, shows the last time the Remote Station contacted the Home Station.
- **Remote Station Battery**, percentage of strength left in the Remote Station battery.
- **Remote Station Signal Strength**, signal strength of the modem at the Remote Station.

- **Always On**, indicates that the Remote Station has been set to be always on or not.
- **Project ID**, your own identification system that you input.
- **Location**, specific site / location information you input.
- **Number of Loggers**, the number of dataloggers that are programmed to be connected to the Remote Station.
- **Comm Method**, indicates that the site is using either IP modem or radio communication.
- **Sampling Information**, shows the rate the STS Controller is polling the field located dataloggers for readings.
- **Site Status**, will show the status of the STS Controller at the Remote Station, i.e. "Logging", "Waiting for Update".

3.2 Create New Site

Selecting [**Create New Site**] opens the STS Information screen. It will also open when the software first starts. This is where you set up each site in your Telemetry network.

Figure 3-2 STS Station Information Screen

In this screen you will enter the Serial Number of the STS Controller, the unique name you choose to identify the site (Project ID), the Location of the site, and it allows you to set a start date and time to begin data collection. You can also restart data logging at a specific time if you have stopped the system previously.

- **Project ID**, input your own identification system.
- **Location,** input specific site / location information.

In the middle section of the screen, you will select whether you are using Radio or IP Modem as your communication method, and either a GSM or CDMA modem.

!   **Note:**
    If you choose a
    Sample Rate less than
    10 minutes or a
    Report Rate less than
30 minutes, you will need to
make sure you select your STS
site to be **Always On**. The
system will not "initialize", if you
do not select this when required.
By selecting **Always On**, you will
be using Remote Station power
continuously. Ensure you have
sufficient power supply.

!   **Note:**
    If you choose to set
    your System to
    Always On, the
    standard 12V battery
will last less than 2 days, before
recharging is required. See
Section 6.1 for a discussion of
optional power sources and
external recharging accessories.

You will also program your Data Collection Schedule. A Sample Rate and Report Rate is selected.

- **Sample Rate** is the rate the STS Controller collects a real-time reading from the attached dataloggers. Sample Rate can be set from 10 seconds to 99 hours.

- **Report Rate** is the rate at which stored data is sent from the STS Controller to the Home Station computer. With each report to the Home Station, the Remote Station time and Home Station time are synchronized, and battery and signal strength at the Remote Station is sent along with the data collected from the dataloggers. It can be set from 1 minute to 1 week.

If you select a Sample Rate of less than 10 minutes or a Report Rate less than 30 minutes, you will check **Always On**. Checking this will ensure the STS Remote Station is continuously running and the modem and STS Controller are ready to collect and send data. With less frequent Sample and Report Rates, you do not need to check Always On. The Remote Station will be idle between data sampling and reporting to conserve battery power. More frequent Sample and Report Rates do not allow sufficient time for the modem to shut-down and "wake-up" between data collection and send events.

Radio Scheduling

If you select Radio as your communication method, the STS Station Information Screen will expand to include the Radio Schedule section. This section allows you to configure a Report Rate and a Report Duration for your Radio Remote Stations. This is important if multiple Radio Remote Stations will be reporting to one Home Station Computer. Setting up a schedule will avoid conflicts that may occur if more than one Remote Station contacts the Home Station at the same time (see Figure 3-3).

Figure 3-3 STS Station Information Screen and Radio Scheduling

Note:
An error will occur if the Report Duration is a longer time span than the Report Rate.

- **Report Duration** is the span of time that a Radio Remote Station will be in contact with the Home Station during the transfer of data from the STS Controller.

- **Report Rate** is the rate at which stored data is sent from the STS Controller to the Home Station computer. You will also select which communication port your radio is connected to at the Home Station.

> **Example:** If you have three Radio Remote Stations reporting to one Home Station Computer, all with a Report Rate of 15 minutes, you will want to set a Report Duration of 5 minutes (or less) for each Remote Station. This ensures that each Remote Station has enough time to send the data within the 15 minutes allotted on the Home Station.

After all STS Information is entered, select Next to open the Levelogger Setup window.

3.3 Assigning Dataloggers to Remote Station
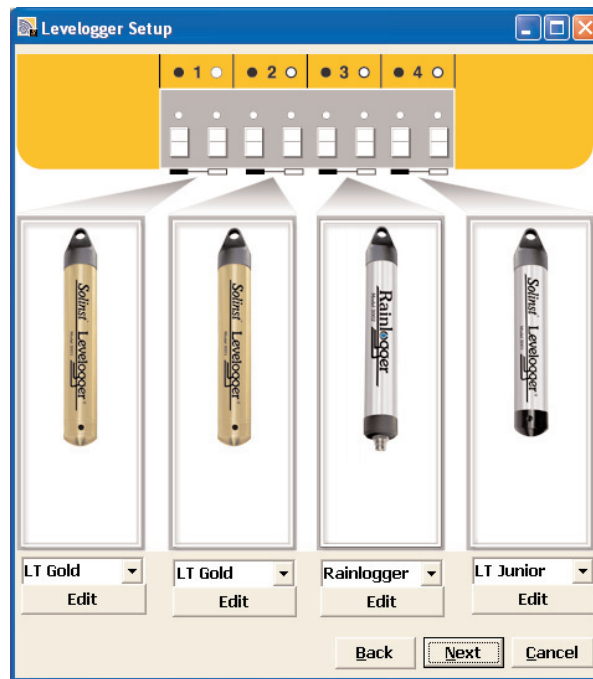
Figure 3-4 Levelogger Setup Window

The Levelogger Setup window allows you to enter the type of datalogger that will be connected to each of the four positions on the STS Distribution Box. After selecting the datalogger type from the drop down menu, an image of the selected datalogger will be displayed.

If there are not four dataloggers connected, select "NONE" from the drop-down menu for each of the positions on the Distribution Box with no datalogger connected. Initialization will not be successful if a datalogger type is selected, but is not physically attached to the Distribution Box.

Select Edit to begin entering data collection information for the datalogger.

3.3.1 Levelogger Information Settings

Note: If you want your datalogger to record and store readings in its internal memory, independent of STS operation,

select ▶

Note: To stop the Levelogger from independently logging,

select ⬤

Note: The Rainlogger **must** be set to record independently with a Sample Rate. It will not take real-time readings.

Note: The Levelogger's serial number will auto-fill once the system is initialized.
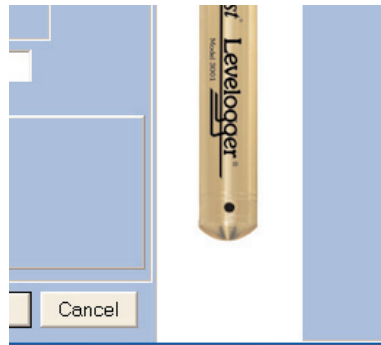
Figure 3-5 Levelogger Information Window

The Levelogger Information window includes Levelogger Serial Number, Well Location, Altitude, Density Adjustment, Sample Rate, and Memory Mode Selection.

If you want your datalogger to record and store readings in its internal memory, independent of STS operation, select ▶, and fill in the Sample Rate and Memory Mode Selection fields. The Rainlogger must be set in this mode.

If you do not require independent logging, select ⬤, and the STS Controller will only collect a real-time reading from the Levelogger at the scheduled STS Sample Rate. There is no need to enter a Levelogger Sample Rate.

- **Serial Number**, your Levelogger Serial Number will display after the System is initialized.
- **Well Location,** input specific site / location information.

- **Density Adjustment** is used to adjust the range of the Levelogger based on the sample fluid density. The range for the density adjustment is from 0.9 kg/L to 1.1 kg/L. Uncheck the Density Adjustment field to disable the Density Adjustment function.

- **Altitude** in feet or meters above sea level, at which the logger is actually deployed, is input in the altitude field. Water column equivalent pressure decreases with altitude at a rate of approximately 1.2:1000 in the lower atmosphere below 5000 m. You can compensate for this by entering an elevation between -1000 ft below sea level and 16,400 ft (or -300 m and 5000 m) above sea level. The readings will then be automatically compensated for elevation.

- **Sample Rate**, is linear. Linear refers to a set time interval between collection of readings. Sample Rate can be any number from 0.5 seconds to 99 hours. The Rainlogger can be set to sample from 5 minutes to 99 hours. The time unit and number of time unit intervals between each reading are set up in the Sample rate fields. The Levelogger Gold and Barologger Gold can store 40,000 readings of level and temperature. The Levelogger Junior can store 32,000 readings. The Rainlogger can store 40,000 sets of rainfall level and 5 minute peak intensity readings.

- **Memory Mode Selection**, there is a choice of Continuous Logging (wrap around) or Slate Logging. In Continuous Logging the new log is started at the end of any previous log and continues logging, eventually recording over the first logged data. As one of the download options is to 'Append Data', Continuous Logging can be a preferred choice when logging long-term. In Slate Logging the new log is also started at the end of any previous log, but will stop recording after 40,000 readings, so that the beginning of the current log will not be written over.

3.3.2 Setting Up Levelogger Measurement Parameters

In the lower portion of the Levelogger Information screen is the window for setting channel parameters. The software will detect the available channels when the Levelogger Information settings are read.

For the Level Channel, you can set the following parameters:

- **Identification** describes the measurement parameter of the channel and has already been configured as 'level'. The Level Channel monitors water column equivalent pressure. The Identification field will be the data column heading and graph line name when viewing the data.

- **Units** refers to the channel's units of measurement. There are three units of measure available for the user to select: cm, m or ft. When the user changes the unit, the value of the range and altitude will change according to the Unit Conversion formula. Note that when a metric unit is used, the unit of altitude is meters. When feet are the Level Channel units, feet are the units of altitude.

- **Offset** refers to an offset correction, such as the distance between the tip of the Levelogger and the monitoring well cap or static water level. It is recommended that the value of 0.00 be used for offset as this keeps all subsequent readings relative to the tip of the Levelogger. The offset range for Levelogger Gold, the Levelogger Junior and Barologger Gold units is -1000 to 16400 ft or -300 m to 5000 m.

The Temperature Channel includes the following parameters:

- **Identification, and Units**
- The Temperature Channel has been pre-configured by Solinst in °C and cannot be changed.

Figure 3-6 Temperature Channel

Note:
Readings can be corrected or offset with respect to a specific reference elevation or datum for a much wider spectrum of numeric Offsets as part of the Data Compensation Wizard in the Levelogger Software.

Rainlogger Measurement Parameters

The RainFall Channel will provide the total rainfall depth within the sample interval. It does so by multiplying the number of tips within the interval by the tipping bucket's calibration factor. The calibration factor is the amount of rainfall depth (mm, in) per tip. The calibration factor should be indicated on a label on the tipping bucket device or in the manufacturer's documentation. Input the calibration factor in mm or inches in the **Rainfall Calibration Constant** field.

The MaxRainFall Channel does not require any setup or user input. The readings in Channel 2 are of maximum 5 minute peak intensity within the sampling interval. This rainfall intensity value is derived by subdividing the sample interval into 5 minute sub-intervals and temporarily recording the number of tips in each 5 minute sub-interval. The Peak intensity reading is calculated by multiplying the number of tips in the 5 minute interval with the largest number of tips by 12 and presenting peak intensity/hr.
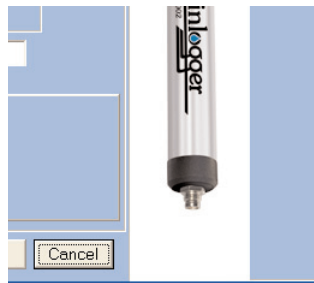
Figure 3-7 Rainlogger Settings

After filling out the required fields, click Save Settings to apply the information. The Levelogger Setup window will again be shown.

Continue entering information for each of the attached Leveloggers. When each logger has been programmed, click Next on the Levelogger Setup window. The Alarms Setup window will open.

Note:
Alarm messages will be sent when the battery at the Remote Station drops below 9 Volts, only if you set up an e-mail to receive alarms messages. (See Figure 3-8).

Note:
The value entered in the "for__times" field sets the number of times an alarm condition is met for a parameter, before an email is sent. Example, if you input 3, then only on the third time that the alarm condition is met, will an e-mail be sent.

Note:
The frequency that alarm conditions can be reported is based on the Sampling Rate set for the Remote Station.

Note:
Ten is the maximum number of alarm notifications that can be sent to your email address after an alarm condition is met.

3.4 Setting Up Alarms

The Alarm Setup window allows you to set specific alarm conditions for each of the attached dataloggers.

For each channel parameter (level, temperature, rainfall level) you can set a "High Limit", "Low Limit", and "% Change" alarm. The "High Limit" sets a value, that if exceeded by a Levelogger reading, will result in an alarm condition being met. The "Low Limit" alarm condition is met when a reading taken by the datalogger goes below the set value. A "% Change" alarm condition is met when a reading taken by the datalogger changes by the set percentage, from the last recorded reading.

By entering a value in the "for__times" field, you can set how many consecutive readings, which meet an alarm condition, must be met before an actual email notification is sent. If set as 1, you will be notified the first time an alarm condition occurs.

Figure 3-8 Alarm Setup Screen

Note:
Contact your IT Department if you do not know your user name, password, or the SMTP Server your Home Station Computer is using to send an outgoing email.

Note:
Multiple email addresses can be notified of alarms by entering each address, separated by a comma ",".

In the bottom section of the window you enter an email address to receive messages if an alarm condition is met. An SMTP (Simple Mail Transfer Protocol) must be set up. Click **Setup** to do this. The outgoing mail SMTP server used by the Home Station Computer will have to be entered to enable an alarm message to be sent to the desired email address. You will enter the email address you want alarm messages sent to, and your user name and password. Click 'OK' when finished.

By entering your email, you will also receive alarm messages when the Remote Station Battery goes below 9 Volts.

Figure 3-9 SMTP Setup

You will also set the maximum number of notifications to be sent to the address after an alarm condition has been met, or until it has been reset in the software. A maximum of 10 emails can be sent for one alarm condition.

Selecting **Test** ensures the address entered is correct, by sending a test message to your email account.

After you have entered settings for each datalogger, as desired, click Finish. The STS Administrator screen will again be shown, with all of the entered information shown for the STS Site.

3.5 STS Communication Agent

The STS Communication Agent is included with the STS Gold Software package. The STS Communication Agent is an information window that will display all communication activity that has occurred between a Remote Station and the Home Station. This application is used to view activity, and monitor communication. The serial number of each STS Remote Station will be shown to indicate which communication has come from that site. Each report will be time and date stamped. By clicking the Save icon, you can save the log file on your Home Station computer for your record or for diagnostic purposes.

The Communication Agent will also display the progress during a Remote Firmware Upgrade (Section 8 discusses Remote Firmware Upgrades).

The Communication Agent will open automatically, when the STS Gold Administrator has been started. The Communication Agent can be left open, and minimized even after the STS Gold Software Administrator has been closed. The STS Gold Communication Agent should always remain open when the STS System is in operation, but if it is closed the log files can be retrieved from the following location:

<C:\Program Files\Solinst\STS_Gold\log>

To open the STS Communication Agent, click ![icon], or click the Start button and select:

Programs > Solinst > STS_Gold > STS_Gold_Com
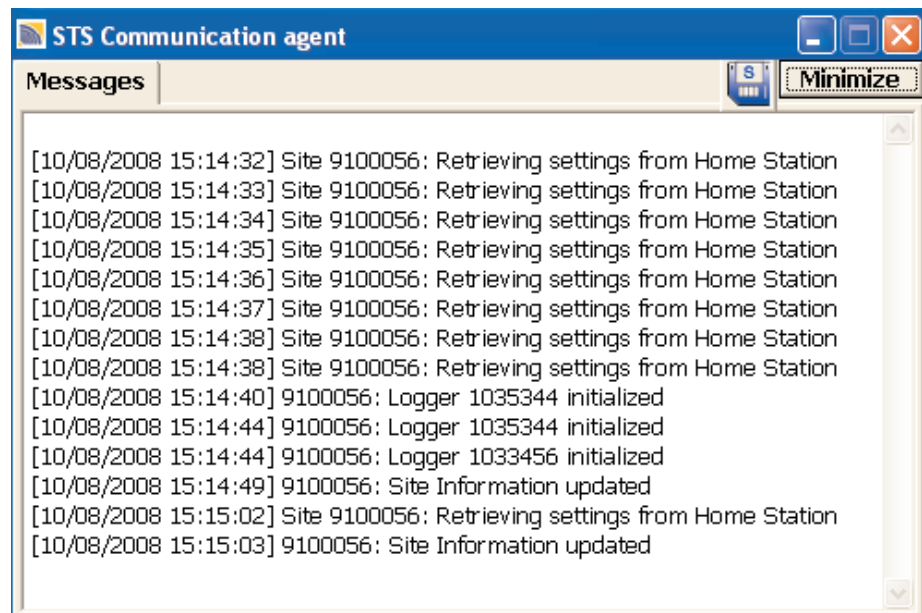
Figure 3-10 STS Communication Agent

4 Home Station Hardware Setup

CDMA/GSM

When using a CDMA or GSM digital cellular modem for remote communication, an Internet connection with a static IP address is required at the Home Station computer (the Remote Station requires a dynamic IP address). This is set up by your local service provider.

Radio

When a radio modem is used for remote communication, a second radio modem and antenna are connected to the Home Station computer through the RS-232 serial port. Solinst supplies a DB9 cable and an AC/DC Adaptor to connect a power source to the Home Station radio. The radio must have the same settings programmed as the radio used at the Remote Station. See Section 5.7 for setup instructions.

5 Remote Station Hardware Setup

STS Telemetry Systems come with standardized equipment configurations. The STS Controller, Distribution Box, 12 Volt sealed lead-acid battery, selected modem with antenna (optional high gain antenna also available), and all of armoured conduit, and 3 NPT weatherproof fittings. Leveloggers, Direct Read Cables and Reader Cables to be used with the System are purchased separately. The following figures show standard setups and cables for Remote Stations using GSM, CDMA, and radio modems.

Battery Cable
(#108836)

8 A SLO-BLO Fuse
(#107755)

Connection to
Distribution Box

+ve Battery Connection

-ve Battery Connection

Connection to
Distribution Box

**MD8M
Controller Cable**
(#108831)

**Modem
Serial Cable**
(#108832) or
(#106811)

9-Pin RS-232
Connection to Modem
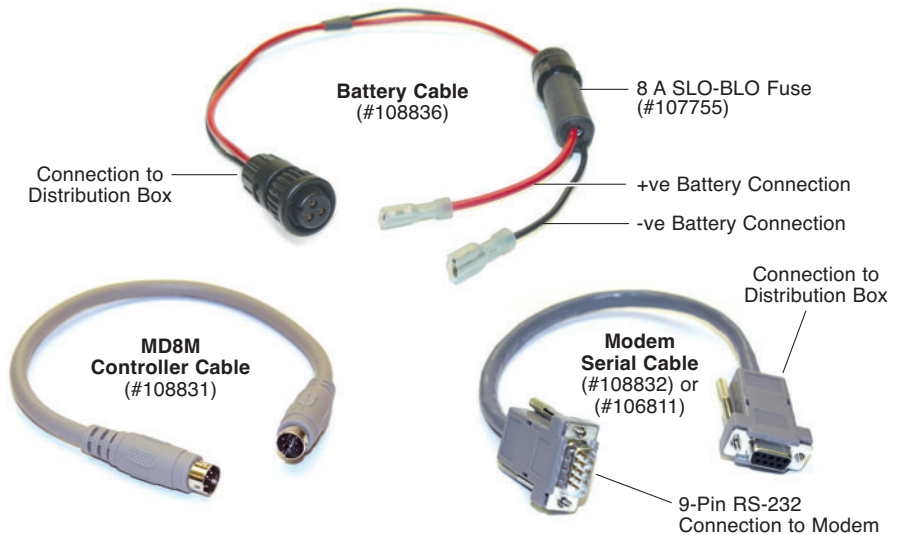
Figure 5-1 Standard Remote Station cables common to all setups

The three Remote Station setups use the same cables to connect the STS Controller, Battery, and Modem (Serial Cable) to the Distribution Box. The Modem Power Cables for each setup are different, and are shown in Figures 5-2, 5-4, and 5-6.

Connections
to Modem

Connection to
Distribution Box

**Figure 5-2
GSM Modem Power Cable
(#108845)**

STS
Controller
(#108707)

Antenna

GSM Modem
(#108862)

STS
Distribution Box
(#108762)

Battery
(#105720)

Levelogger
Reader Cable
(#108854)

NEMA 4X
Enclosure
(#108827)

Armored Protective
Conduit (#108892)
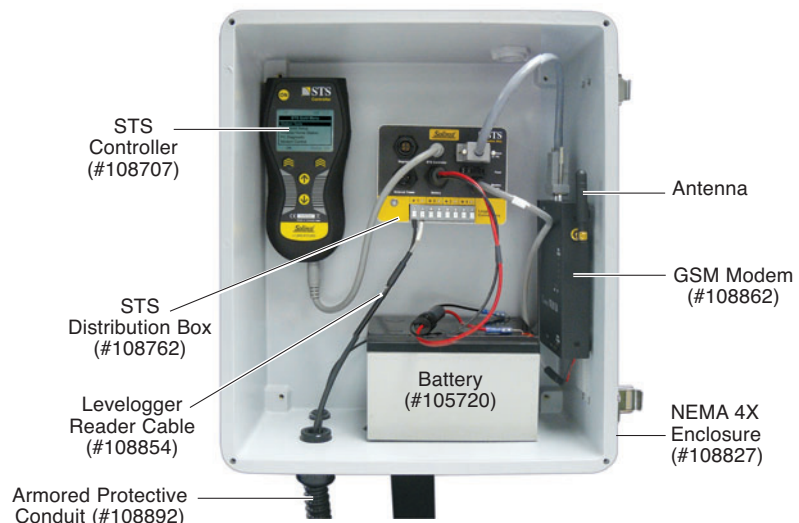
Figure 5-3 STS Remote Station Setup using GSM (North American System #108846)

Connection
to Modem

Connection
to Distribution
Box
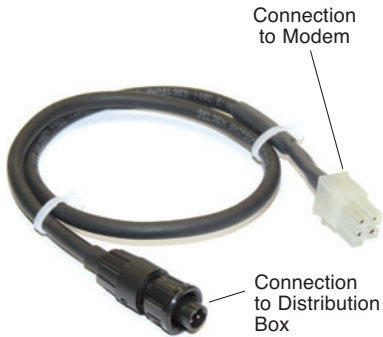
**Figure 5-4
CDMA Modem Power Cable
(#108843)**

STS
Controller
(#108707)

Antenna
(#108852)

CDMA Modem
(#108839)

STS
Distribution Box
(#108762)

Levelogger
Reader Cable
(#108854)

Battery
(#105720)

NEMA 4X
Enclosure
(#108827)

Armored Protective
Conduit (#108892)

Figure 5-5 STS Remote Station Setup using CDMA (#108738)

Connection to
Distribution Box

Connection to Modem

**Figure 5-6
Radio Modem Power Cable
(#108903)**

STS
Controller
(#108707)

Antenna
(#108950)

Radio Modem
(#108895)

STS
Distribution Box
(#108762)

Levelogger
Reader Cable
(#108854)

Battery
(#105720)

NEMA 4X
Enclosure
(#108827)

Armored Protective
Conduit (#108892)
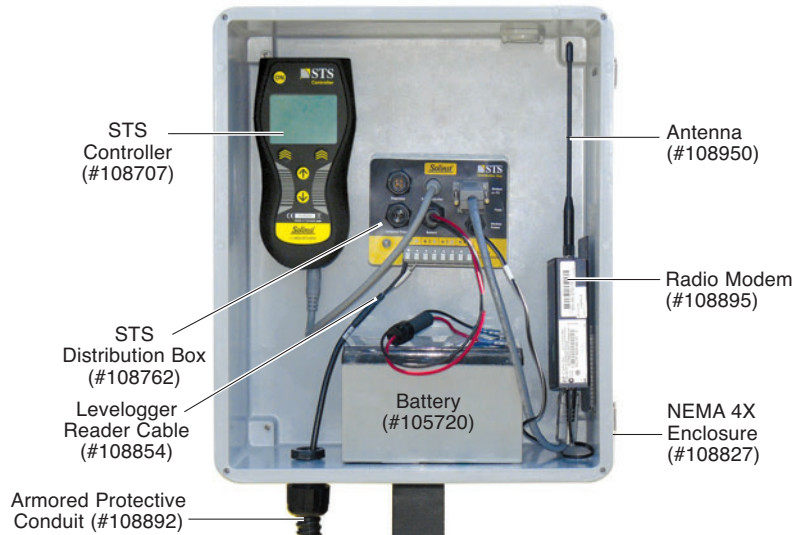
Figure 5-7 STS Remote Station Setup using Radio (#108887)

Radio Telemetry Systems require a Radio Home Station Assembly (#109051), which contains a second radio (#108895), antenna (#108950), serial cable (#106811) for connection to the Home Station Computer, and an AC/DC power adaptor (#109056).

ON — Power On

Confirm Selection

Scroll Up

Scroll Down

Figure 5-8 STS Controller

5.1 STS Controller

The STS Controller powers-up the Remote Station for initial set up and testing. It collects, stores, and sends data from the remote dataloggers to the Home Station computer. The STS Controller is attached to the Distribution Box at the labeled connection using the cable provided.

Up to 8MB of data is stored in the STS Controller's non-volatile memory, until a specified time when the Controller 'sends' the data to the Home Station, where all the accumulated data is uploaded. If there are cellular service disruptions, the STS Controller will store all the data internally until it has been successfully uploaded to the Home Station computer.

The STS Controller features a powerful 32-bit ARM processor, an LCD interface and a five-button keypad to simplify in-field setup and data monitoring. Stored data can be downloaded via USB or RS-232 ports to a laptop or computer. Firmware updates to the Controller can be uploaded from a laptop or desktop PC using the USB port. Remote firmware updates via the Home Station computer to the Controller is also an option.

```
 |||||                          ⎓⎓⎓  12:30
 ┌─────────────────────────────────────┐
 │          STS Gold Menu                │
 ├───────────────────────────────────────┤
 │  Station Tests                        │
 │  STS Gold Setup                       │
 │  Initialize Home Station              │
 │  PC Diagnostic                        │
 │  Modem Control                        │
 └───────────────────────────────────────┘
      OK                Status: Idle
```
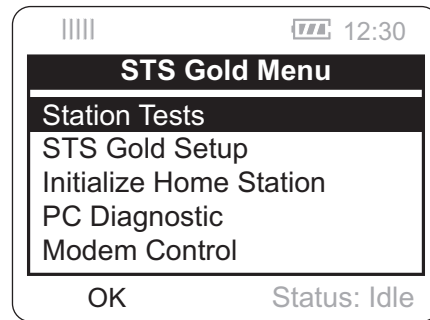
Figure 5-9 STS Controller Main Menu

Figure 5-9 shows the main menu of the STS Controller. The top left icon indicates the signal strength of the modem, the battery indicator shows the strength remaining in the 12V battery, and the text in the bottom right corner describes the status of the STS Controller.

- **Idle** – indicates that the Controller is idle and waiting for initialization.

- **Init** – shows that the Controller is going through the initialization process (initialization is discussed in Section 5).

- **Logging** – indicates that the Controller is collecting data from dataloggers.

- **FUT. ST** – indicates that the STS has been programmed with the future start option.

There are five menu items on the STS Controller, which are scrolled through using the arrows on the keypad and selected using the chevron button as indicated on the screen:

- **Station Tests** – verify the connection with the Home Station, view real-time readings from each of the attached dataloggers, and check the battery voltage.

- **STS Gold Setup** – used to setup the STS Controller. You can change the contrast of the LCD screen and restore the original factory settings. You can view STS Gold Information, including STS Firmware Version and available memory.

- **Initialize Home Station** – used to contact the Home Station and initialize the STS System (this process is discussed in Section 5).

- **PC Diagnostic** – used to perform a diagnostic test on the STS Controller through the serial port.

- **Modem Control** – used to turn the modem on or off.

See the *STS Gold Remote Station Quick Start Guide,* on the inside of the STS NEMA 4X enclosure, for a complete view of all menu items.

5.2 Distribution Box

The STS Distribution Box has an independent 16-bit processor to monitor the battery, control the modem power, perform Built-In-Test (BIT) functions and select the Levelogger communication channels.

The Distribution Box has labeled connections for the STS Controller, the standard 12V sealed lead-acid battery, the modem and modem power. The two-wire connectors for four dataloggers are also clearly indicated on the Box. There are two other connections reserved for alternative power sources, these options will be discussed in Section 6.1.

Figure 5-10 Distribution Box

Note:
To remove the Reader Cable connector pins from the Distribution Box, press the white plugs above each connection into the Distribution Box, while pulling the connector pins out.

Note:
If the LED indicator is not flashing green or red, the 8A SLO-BLO fuse may need to be checked. This could mean no power is going from the battery to the Distribution Box.

There is a LED indicator on the bottom left of the Distribution Box. Under normal operation, the LED will flash green every minute. The LED will flash red if a failure is detected. The following are possible errors that may have occurred:

1) The battery voltage is too low (i.e. < 9V).

2) The Distribution box fuse has blown.

3) The internal regulator voltage is out of tolerance.

4) Program Memory test failed.

5) Electrically Erasable Programmable memory test fail.

It is suggested to do the following if a red LED is shown:

1) For a System using the standard battery only, you most likely need to recharge or replace the battery.

2) For a System using a solar panel, check the solar panel and regulator connections. Check the output voltage on the solar panel (It should be 13V or more in order to recharge the battery). If it is greater than 17V, it may be an indication that the battery is disconnected. The battery must be connected.

3) For a System using an AC Charger, check the output voltage on the charger. It should be approximately 14.5V.

4) Pull the fuse out of the Distribution Box and check it. Replace it, if it is broken. Replacement fuses are available from Solinst.

The LED will flash green if the error has been corrected. If none of the above actions correct the error, check all connections in the STS Remote Station. If the LED is still red, contact Solinst for further assistance (errors 3,4, or 5 may have occurred).
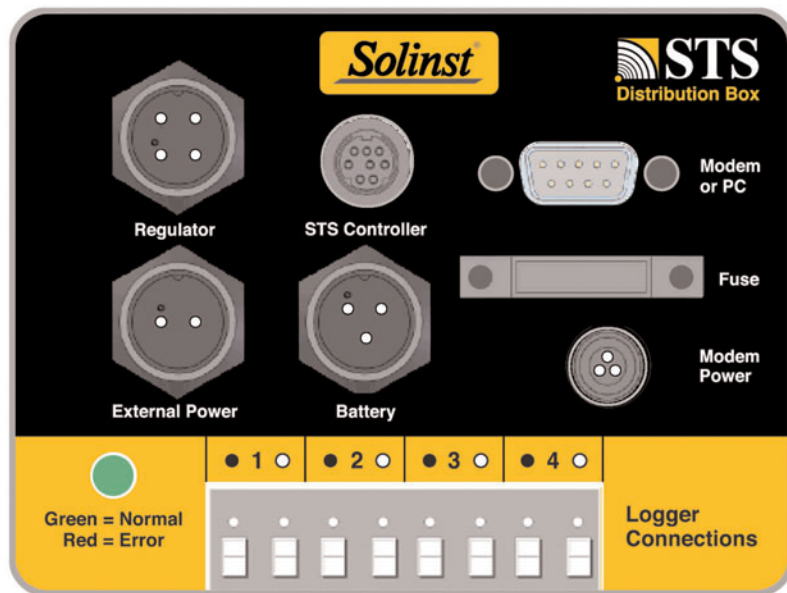
Note:
To remove the Reader Cable connector pins from the Distribution Box, press the white plugs above each connection into the Distribution Box, while pulling the connector pins out.

Note:
It is required to use the standard 12 Volt battery that comes with the system, even if using an additional external power source.

5.3 Connecting Dataloggers

Up to four Solinst dataloggers can be connected to one STS Distribution Box. Dataloggers are connected to the Distribution Box using Reader Cables, which connect to a Direct Read Cable threaded onto the datalogger. The Reader Cables are attached to the Distribution Box using a two-wire connection. The black and white circles shown at the connections on the Distribution Box indicate which colour wire from the Reader Cable to connect. Simply push the connector pins on each wire into the appropriate opening. The Reader Cables are protected outside the enclosure using armored conduit. Levelogger installation options are discussed further in Section 6.2.

The dataloggers are programmed using STS Software. The software provides the option of setting the dataloggers to record and store readings in their internal memory, independent of STS operation. This provides reliable back-up data if the STS System were to fail, or it provides supplementary data if an alarm condition is met and more data is desired. Data can be downloaded directly from the dataloggers. Please refer to the *Levelogger Gold User Guide* for data downloading instructions.

Alternatively, dataloggers can be connected without programming an independent recording rate. The STS Controller will take a real-time reading from the datalogger at the scheduled sampling interval.

Connect to Direct Read Cable with Datalogger Attached

Connector Pins to Distribution Box
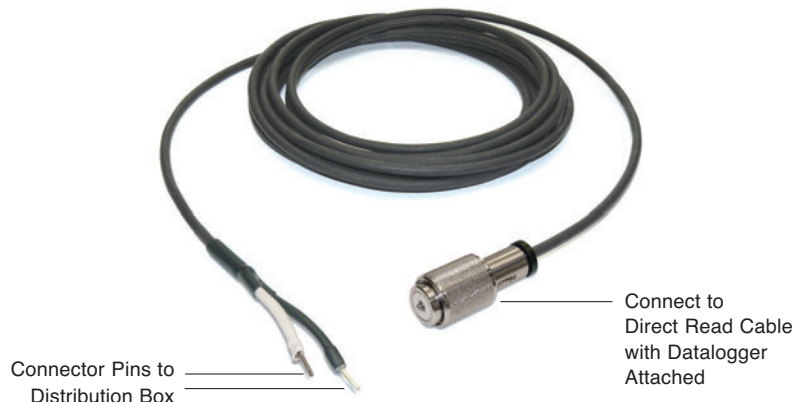
Figure 5-12 Reader Cable (#108854)

5.4 Power Source

STS Gold Telemetry Systems come standard with a 12V sealed lead-acid battery. The battery is connected to the "Battery" connection on the Distribution Box, and connected to the positive and negative connections on the battery. The red wire is connected to the positive terminal on the battery, and the black wire to the negative terminal. You may have to remove covers on the battery terminals before attaching the wires. An optional battery connection cable may also be used for a larger battery if desired.

There are also connections for an AC/DC battery charger or solar panel. Setting up alternate power sources is discussed in Section 6.1.

Estimated battery life of the standard 12V battery is based on the frequency of the Sample and Report Rates you set using the STS Software. These estimates are discussed in Section 6.1.

![Solinst logo]

Figure 5-13 CDMA Modem

5.5 Setting Up CDMA Modems

The standard CDMA modem used for STS Gold Telemetry Systems is the IP-4200 Blue Tree CDMA Modem (CDMA-1xRTT Programmable Modem). There are connections for the modem and modem power located and clearly labeled on the Distribution Box. The modem comes with a dual band dipole antenna to be attached to the modem, using the SMA coaxial adaptor provided.

An account must be set up with a local CDMA cellular service carrier. You will need to request a CDMA account with the packet data service option. To activate the modem, a password, user name, the Master Lock Code, Phone Number (MDN) and the MIN/MSID are received from the CDMA service carrier. The service carrier will ask for the modem ESN (number located on the bottom of the modem).

BlueVue Device Manager software is required to configure the modem. It can be downloaded from the Blue Tree website at:

http://www.bluetreewireless.com/support/downloads/software

Install the software on the PC that will be used to program the modem.

Activating the Modem

The following are the steps required to activate the modem:

1) Ensure that the modem is connected to a power supply (the STS Remote Station can be used with battery, Distribution Box and STS Controller all connected, or direct AC/DC power). Turn the modem on using the Modem Control menu on the STS Controller.

2) Connect the modem to the PC using the RS-232 cable provided.

3) Start the BlueVue Device Manager software on your PC. Click on *Tools > Settings > Connection* tabs.

4) Select *Local Configuration.* Click on *Serial* port and select the the COM port to which the modem is connected. Click *OK*. The Modem Diagnostic page will automatically be displayed.

5) Receive Strength Indicator (RSSI) value should be > -100 dBm (shown on top-right of screen, below signal strength icon.). "Cleanness" of signal (Ec/Io) should be > -15 dB (value found in the *Advanced* tab should be divided by -2).

6) Click on *File > Activation* to display the *Modem Activation* page.

7) Enter the Master Lock Code, Phone Number, and MIN/MSID provided by the service carrier. If a MSID is not provided, assume it is the same as the Phone Number. Click *Submit*.

8) To confirm that the modem was activated correctly, go to *File > Diagnostic* and ensure the Phone Number reported from the modem matches the one provided by the carrier. This may take a few minutes.

WAN Settings

1) Click on *File > WAN Settings*.

2) Enter "#777" as the *Dial String*. The *User Name* and *Password* are both entered as "X", unless they are provided by the service carrier. Select *Always On*. Click *Refresh*.

3) On the Modem Diagnostic page, under the Modem IP Information, the WAN IP that the carrier has assigned will be displayed.

Modem Configuration

1) Click on *File > Configuration*. There are seven tabs in the *Modem Configuration* page. Figure 5-14 shows the *General* and *Serial IP* tabs in the *Modem Configuration* page.

Ⓐ Select "Serial IP" as the *Operation Mode*

Ⓑ Enter the Home Station IP Address

Ⓒ Enter "49152" as the *Port*

Ⓓ Select "TCP" as the *Protocol*
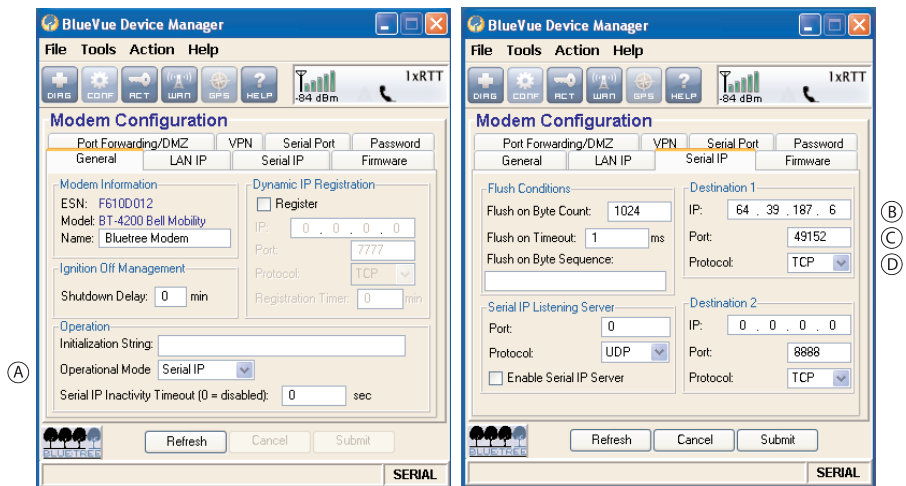
Figure 5-14 BlueVue Device Manager Modem Configuration Screens

2) In the *General* tab, select "Serial IP" for the *Operational Mode*. Click Refresh.

3) In the *Serial IP* tab, under *Destination 1*, enter the Home Station *IP Address*, the *Port* should be set at "49152" and the *Protocol* drop-down menu should be set to "TCP". *Flush Conditions, Serial IP Listening Server* and *Destination 2* should be left blank. Click Refresh.

4) In the *Serial Port* tab, settings are applied to enable communication with the STS Controller. The following settings should be entered:

- Baud Rate: 115200 bits/second
- 8 data bits
- No parity
- 1 stop bits
- No Flow Control
- Do not check *Disable RS-232 Sleep Mode* and *Ignore DTR*.

When finished click *Refresh*. The Modem is now configured and ready to be connected to the STS Distribution Box using the serial cable and power cables provided.

Note:
The IP Address assigned to the Home Station computer can be determined from your Internet Service Provider, IT Department or through accessing the *Command Prompt* of the Home Station PC.

Go to *Start > Run* and enter "cmd" (Windows XP) or "command" to open the *Command Prompt*. Enter the command "ipconfig", and the Home Station PC IP Address will be displayed.

Figure 5-15 GSM Modem

Note:
There is no software required to configure the GSM modem. The modem must be set up using an Ethernet connection to a PC.

Note:
If more support documentation is required to setup the GSM modem, please visit: www.digi.com/support/ and select Digi Connect WAN IA from the "Select a product" drop-down menu to browse various support documents.

5.6 Setting Up GSM Modems

The standard GSM modem used for STS Gold Telemetry Systems is the Digi Connect WAN IA™. There are connections for the modem and modem power located and clearly labeled on the Distribution Box. The modem comes with a dual band dipole antenna.

An account must be set up with a local GSM cellular service carrier. To activate the modem, you will require an IP Address supplied by the service carrier to be assigned to the modem.

The following are the steps required to set up the GSM modem:

1) Attach the antenna to the modem.

2) Insert the SIM card into the modem.

3) Connect the Ethernet Cable (null modem cable) from the modem to your PC.

4) Use the STS Remote Station, which includes the battery, STS Controller, and Distribution Box to connect the modem to a power supply, or use direct AC/DC power. Connect the modem to a power supply or turn the modem on using the Modem Control menu on the STS Controller.

5) After the connection has been established, you should see the message as shown in Figure 5-16 at the bottom right of your PC screen. Double-click the network icon.
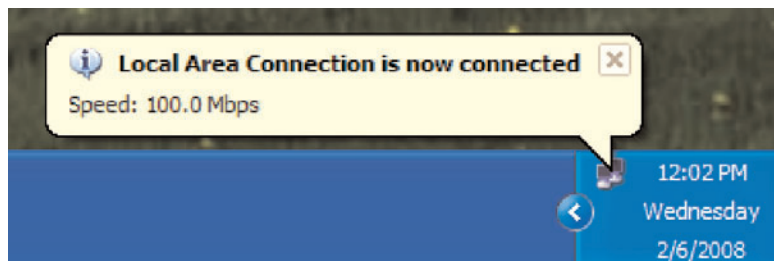
Figure 5-16 Local Area Connection Confirmation

6) In the *Local Area Connection Status* window, the Support tab should display the same Default Gateway and Subnet Mask, as shown in Figure 5-17. The IP Address does not have to match, but it should begin with 192.168.1.XXX (XXX is any number between 2 and 255), thus matching the Default Gateway. Close the window.
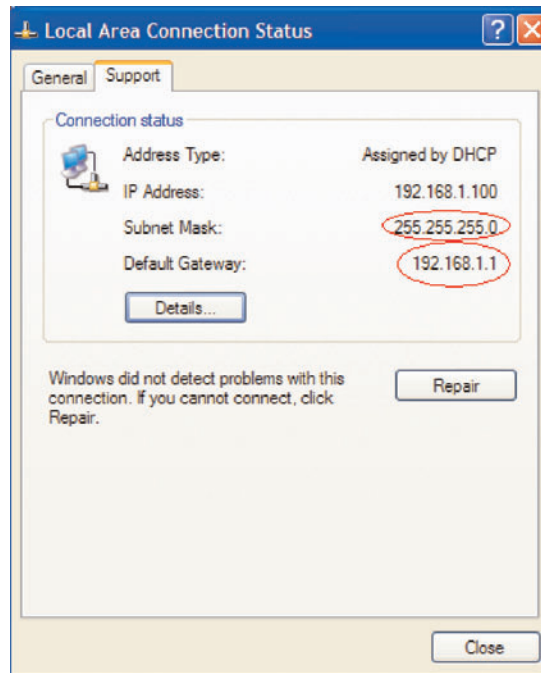
Figure 5-17 Local Area Connection Status Window

7) Open your web browser and enter the IP Address "192.168.1.1" in the URL address bar. The main configuration menu of the modem will be displayed.

8) Select "Mobile" under the *Configuration* menu.

9) Make sure the *Service Provider* selected is correct, and the *Service Plan/APN* is set to "internet.com". Click on "Serial Ports" under the *Configuration* menu and click on the Port that is available. This should be Port 1 by default.

10) In the *Port Profile* window, select "TCP Sockets" and click Apply.

11) Make sure the *Serial Port Configuration* matches the screen in Figure 5-18. Enter the IP Address provided by your Internet Service Provider in the IP Address field. The TCP Port should be set to "49152". When finished, click Apply.

Figure 5-18 Serial Port Configuration
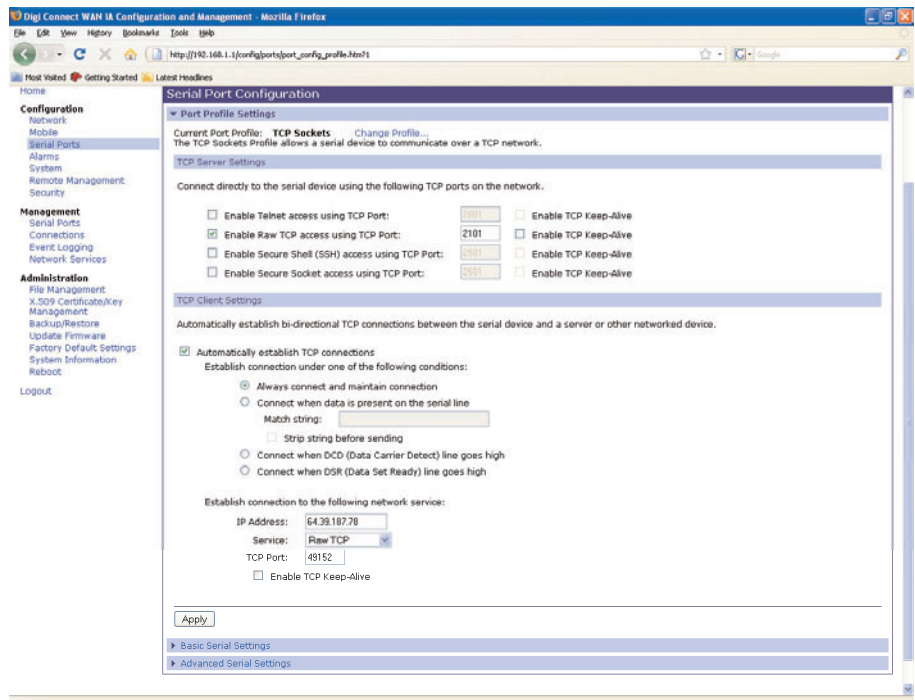
12) Select *Basic Serial Port Settings* to set up the communication parameters. The following settings should be entered:

- Baud Rate: 115200 bits/second
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

When finished, click Apply. The Modem is now configured and ready to be connected to the STS Distribution Box using the serial cable and power cables provided.

Figure 5-19 Radio Modem

Note:
X-CTU Software is required to configure the radio. It can be downloaded at: http://www.digi.com/support/ and type "X-CTU Software" into the Product Keyword window.

Note:
The X-CTU Software User Guide can also be downloaded at: http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=4&s=316 for further information regarding radio configuration and setup, and instructions for conducting a range test between radios.

5.7 Setting Up Radios

The standard radio used for STS Gold Telemetry Systems is the Digi XTend™ RS-232/RS-485 RF Modem, which operates at 900 MHz and has a line-of-sight of 20 miles (30 km). There are connections for the radio and radio power located and clearly labeled on the Distribution Box. The radio comes with a 6" half wave, (2.1 dBi) non-articulating antenna.

X-CTU Software is required to configure the radio. It can be downloaded from the Digi website at: http://www.digi.com/support/ by selecting "software" and "X-CTU" from the drop-down menus. Select "Diagnostics, Utilities, and MIBs" to begin the software installation.

The following are the basic steps required to configure the radio:

1) Install the software on the PC that will be used to program the radio.

2) Connect the radio to the PC using the RS-232 cable, and connect to a power source. The STS Remote Station can be used, with the STS Controller, Distribution Box, and battery connected, or direct AC/DC power. Use the STS Controller, Modem Control menu, to turn the modem on.

3) Launch the X-CTU Software.

4) Under the *PC Settings* tab, select the proper COM port.

5) The following settings should be applied to configure the selected COM port to enable communication with the STS Controller :

   • Baud: 115200

   • No Flow Control

   • 8 data bits

   • No parity

   • 1 stop bits

6) The Test/Query button is used to test the selected COM port and PC settings. If the settings are correct, you will receive a message saying communication with the radio is okay.

7) On the Radio itself, ensure DIP switch 1 and 5 are on, all the rest are off.

The radio is now configured and ready to be connected to the STS Distribution Box using the serial cable and power cables provided.

If further information regarding radio configuration and setup is required, the X-CTU Software User Guide can be downloaded at: http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=4&s=316
The User Guide also includes details on conducting a range test between the radio at the Remote Station and the radio at the Home Station.

5.8 Initialize Your System

After all settings in the STS Gold Software are programmed and all connections are made at the Remote Station, the STS Controller is used to "Initialize" the STS System. Initializing the system applies all of the settings programmed in the software, to the STS Controller and the attached dataloggers. If all the hardware components in the Remote Station and dataloggers are properly connected, the STS System will begin operation, and data collection starts at the programmed time.

The system can be initialized in the office or in the field, whichever suits the application. Initialization can be performed more than once as required. The STS System can be initialized in the office for a quick check, and again when it is installed in the field. With each initialization, the Home Station time is synchronized with the Remote Station time of the STS Controller.

Initialization Instructions

1) Once all physical connections are made in the STS Remote Station , the "ON" button of the STS Controller is pressed to power-up the Remote Station. The LED on the Distribution Box should blink green to indicate the Remote Station is configured properly, and the STS Controller main menu should appear.

2) Use the 'Modem Control' option on the STS Controller to turn the modem off. Disconnect the battery from the Distribution Box. Wait a few seconds, then re-connect the battery. The LED on the Distribution Box should blink green again. Turn the STS Controller back on and use it to power up the modem. The green light on the modem should flash to indicate that it is working.

3) At the Home Station, shut down, then restart the STS Administration Software and the STS Communication Agent. After the software has been restarted, the STS Administrator Screen should show the message "Waiting for Update" in the Site Status field.

4) Before completing the initialization process, perform a station test to ensure the Home Station and Remote Station are communicating properly. Use the 'Station Tests' option on the STS Controller to 'Test HS Connection'. If the test is successful, begin the initialization process.

Note:
STS Gold Administrator and Communication Agent Software must be running on the Home Station computer during the initialization process. The computer must not be in sleep mode.

Note:
You can also use the 'Station Tests' option on the STS Controller to test the connection of each datalogger and the battery level of the remote station before initializing.
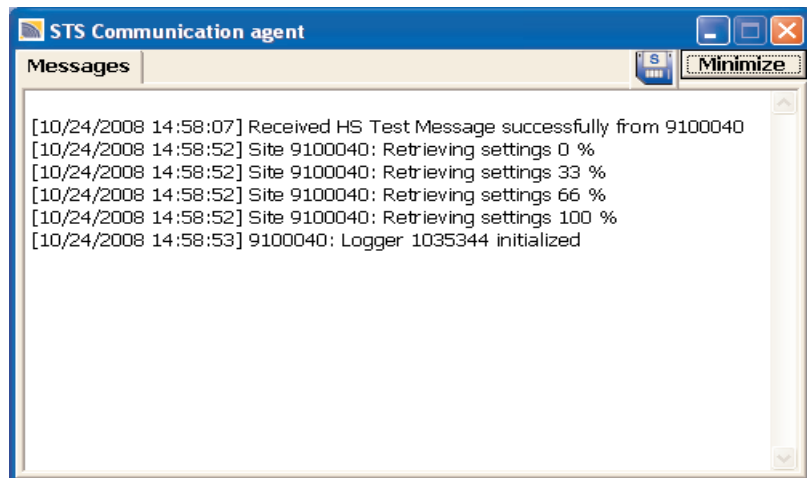

Figure 5-20 STS Communication Agent Showing a Successful Home Station Test

Note:
After you select "Initialize Home Station", the STS Controller may ask if you want to stop the dataloggers from recording, if you have previously set them to start logging. This is a precaution, as the internal battery will be used if the dataloggers are set to record independent of the STS System.

5) The initialization process is started by simply selecting "Initialize Home Station" on the STS Controller menu. STS Software must be running on the Home Station computer during the initialization process, and the computer must not be in sleep mode.

6) The initialization process should only take a few minutes. During the process the status of the STS Controller will change from "Idle" to "Init". If initialization is successful, a message will be given and the STS Controller status will change from "Init" to "Logging" or "FUT.ST". The System will start collecting data at the specified time. Figure 5-12 shows a successful initialization process as it appears on the STS Communication Agent.

Figure 5-21 STS Communication Agent Showing a Successful Initialization

See the *STS Gold Remote Station Quick Start Guide,* on the inside of the STS NEMA 4X enclosure, for a complete view of the STS Controller screens as it appears during the station test and initialization process.

6 Configure Your Remote Station in Field

Ensure you have connected all hardware components in the STS Remote Station. To make sure everything is connected properly and working correctly, you may want to initialize and test the system before you bring it to the field.

The NEMA 4X enclosure can be mounted anywhere that suits your application. Four bolts are provided with the STS System to connect the enclosure to a user-supplied bracket and mast, or any support that suits your needs.

Radio Location Considerations

When using radio communication, you must take extra care when locating the STS Remote Stations. RF Radios communicate with each other via "line-of-site". They must be able to "see" each other in order to have effective communication. The RF path between radio antennas should not be through trees or parallel or perpendicular to the sides of flat buildings. An more sensitive antenna may be required to increase signal strength in some applications.

A range test can be performed prior to installation, between the Home Station radio and the Remote Station radio. The Range Test Application is included in the X-CTU Software used to setup the radios. Instructions for conducting the test can be found at: http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=4&s=316 You will require a serial loopback adaptor for the radio at the Remote Station.

Cellular Signal Strength

Received Signal Strength Indicator (RSSI) is the measure of RF signal strength between the Remote Station modem and a base station, expressed in dBm. The signal strength should be no less than -100 dBm (considered weak coverage), -50 dBm is considered to be full signal strength.

A site survey can be performed prior to installation, to determine the signal strength on site. This can be done using a cellular device. There is a useful document prepared by wpsantennas.com outlines how to perform a site survey with various cellular devices: http://www.wpsantennas.info/pdf/testmode/FieldTestModes.pdf

You can determine the RSSI for the CDMA modem using the BlueVue Device Manager Software. When the modem is connected to a PC, with the software running, the top right corner of the software window will display the RSSI value. If the software is downloaded to a field laptop, you can determine the signal strength on site.

For GSM modems, a general indication of the signal strength can be determined from the number of LEDs that light up on the modem:

> 0-1 LEDs (-101 dBm or less) = unacceptable coverage
>
> 1-2 LEDs (-100 dBm to -91 dBm) = weak coverage
>
> 2-3 LEDs (-90 dBm to -81 dBm) = moderate coverage
>
> 4 LEDs (-80 dBm or greater) = good coverage

Note:
The radio used for the STS System has a line-of-site of 20 miles (30 km).

Signal strength can be increased by adding an optional antenna, or by simply relocating the Remote Station to an area with maximum signal strength on site.

<u>**Optional Antennas**</u>

Solinst has an optional antenna available for use with CDMA, GSM, and Radio modems, if greater range is required. In North America the CDMA/GSM antenna operates in 824-896 MHZ and 1850-1900 MHz frequencies. This dual band, omnidirectional antenna is a unity gain, 1/4 wavelength, and connects to the modem via a 12' cable and SMA connector. An optional 900 MHz 5 dBi antenna is also available for the Radio. Antennas mount using a mini magnet on the base, outside the enclosure. In order to accommodate the antenna cable, the NPT plug on the top of the enclosure will need to be removed (using an Allen Key), and a weathertight fitting, supplied by Solinst, threaded in its place.

6.1 Optional Power Sources

STS Gold Telemetry Systems come standard with a 12 Volt sealed lead-acid battery, which only requires one connection to the Distribution Box. The life-time of the battery varies depending on the frequency of your Sample and Report Rates. The following are estimates based on the standard 12V/12Ah battery, with four dataloggers connected to the System. With only one datalogger connected to the Distribution Box, battery life estimates will be approximately 10% longer.

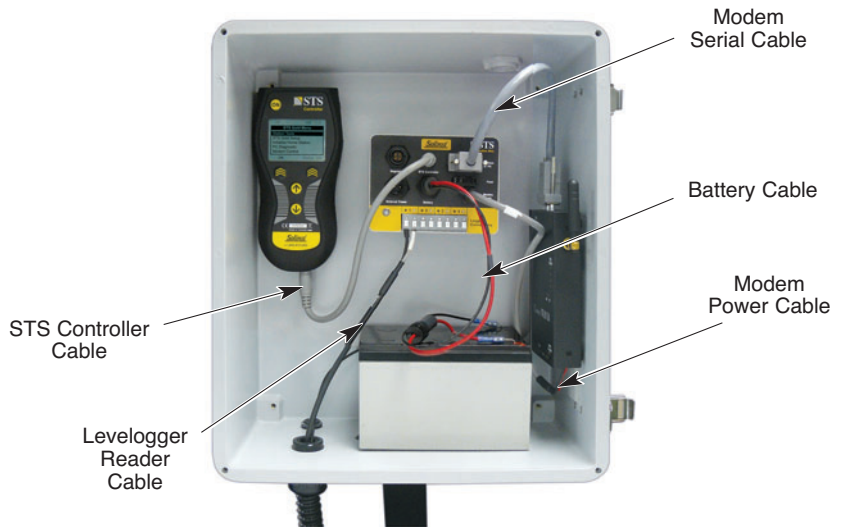| Sample Rate	Report Rate	Battery Life
Every 5 Minutes	Every Hour	30 - 40 Days
Every 15 Minutes	Every 6 Hours	4 - 6 Months
Every 5 Minutes	Every 12 Hours	5 - 7 Months
Every 15 Minutes	Every 24 Hours	12 - 14 Months
Every 15 Minutes	Every 7 Days	13 - 15 Months

Table 6-1 Battery Life Estimates

The battery life estimates assume the Controller and Modem are NOT set to be "Always On". If used for more frequent data collection, with both Controller and Modem "Always On", the battery life will be less than 2 days. (A larger 60 AHr battery would last about 6 days) Therefore, external power or a solar panel is required for continuous recharging of the battery.

External power and charge accessories are available for the STS Remote Station. A solar power connector package is available from Solinst, to be used with a user supplied solar panel. The package includes an External Power Cable to attach to a user-supplied solar panel and a Regulator, to handle the current from the solar panel. (Figure 6-5 shows connection for the solar power connector package). An AC Power/ Battery Charger Assembly is also available from Solinst. The Assembly comes with a battery charger and cables for connection to the 'Regulator" terminal on the Distribution Box and to an AC power source to provide current for battery charging (See Figure 6-2).


Figure 6-1 Weathertight NPT Fittings (#108830)

Note:
It is recommended to use the standard 12 Volt battery that comes with the system, even if using an additional external power source.

Connection to
Regulator Input on
Distribution Box

Battery Charger

Figure 6-2 Battery Charger Assembly (North American #108848)

Modem
Serial Cable

Battery Cable

Modem
Power Cable

STS Controller
Cable

Levelogger
Reader
Cable

Figure 6-3 Standard Remote Station Setup

Figure 6-3 shows the standard connection to the 12V sealed lead-acid battery. If you choose to use a larger battery, a larger cable is available from Solinst (#108981).

Connection to
Solar Panel

External Power
Cable

NPT Fitting

Regulator

Connection to
Distribution Box

Connection to
Distribution Box
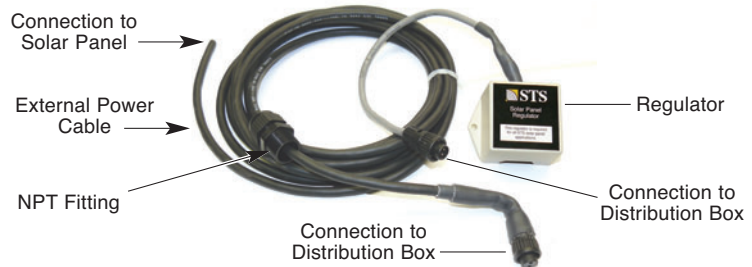
**Figure 6-4 Solar Power Connector Package (#108988)**

Note:
If using a solar panel, you must ensure output is a minimum of 13V open circuit, in order to effectively recharge the 12V battery.

Note:
The Solar Panel Regulator supplied by Solinst must be connected to the Distribution Box. It is recommended that you select a solar panel without a regulator.

Figure 6-5 shows connections for a solar panel.
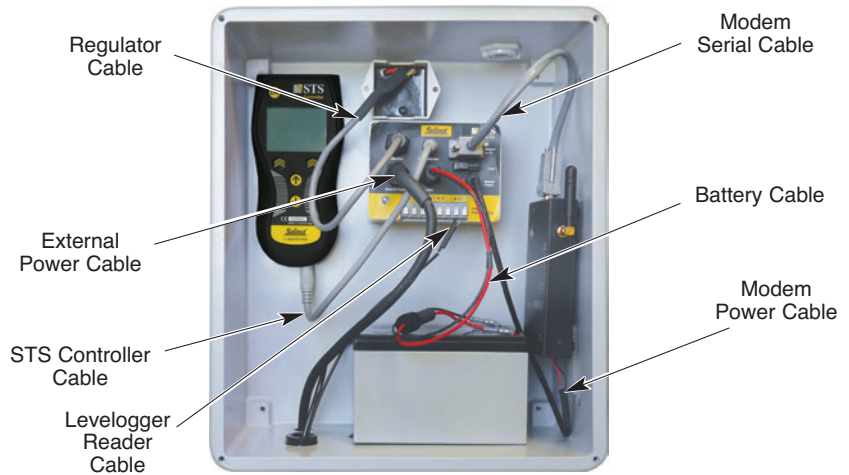
Figure 6-5 Remote Station Setup with Connections for a Solar Panel

The solar panel is user-supplied. The panel must output a minimum of 13V open circuit in order to effectively re-charge the standard 12V battery. As a guideline, the solar panel should be at least 15 Watts. Higher wattage panels are also suitable, as a Regulator is supplied as part of the solar panel connector package provided by Solinst. The Regulator supplied must be used, even if the solar panel you are using has a built-in regulator. Therefore, when choosing a suitable solar panel, it is recommended to use one without a built-in regulator. Below are more guidelines for a proper solar panel:

Generator Connector: Max V in = 35VDC, Max Current = 3A

Regulator Connector: Max V in = 35VDC, Max Current = 3A

Max V out = 10-16VDC, Max Current = 3A

Battery Connector: Max V in/out = 7-15VDC, Max Current = 3A

Modem Connector: V Modem = Battery V in/out, Max Current = 3A
(5A fused)

To accommodate the External Power Cable through the enclosure, the second NPT plug on the base of the enclosure will need to be removed (using an Allen Key), and a weathertight fitting, supplied by Solinst, threaded in its place.

6.2 Levelogger Deployment

Many options exist for installation of the Levelogger, but essentially these installation methods can be classified into two broad categories: free suspended or fixed installations.

1) In free suspended installations, the Levelogger is hung via Direct Read Cable from a well cap.

2) In fixed installations the Levelogger is fixed in place by a compression fitting, a clamping mechanism or simple metal straps, with a Direct read Cable connected.
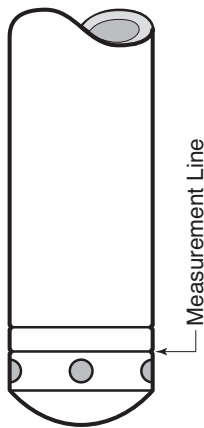
Prior to commencing the discussion of installation techniques several general points related to Levelogger installation should be made. First, it is recommended that the Levelogger be installed in a vertical orientation. However, inclined or horizontal installation is acceptable. The level sensor in the Levelogger is indicated by the machined line about the body of the datalogger just above the pressure access holes. The pressure transducer is oriented in a plane normal to the long axis of the body and detects pressure directed along the plane of the long axis (Fig 6-6). In vertical orientations, the sensor detects pressure above the pressure transducer line, where as in non-vertical orientations, the pressure zero point is proportional to the angle of inclination.

Care should be taken to avoid dropping the Levelogger against a hard surface. Further, the pressure transducer can be damaged if the datalogger is over-pressurized by submergence greater than its level range. The Levelogger is warranted to pressures up to 150% of its full scale level range, however accuracy can not be guaranteed beyond its full scale.

Other important considerations when installing the Levelogger in pressurized or intermittently pressurized locations such as pressure vessels, pressurized pipes, pulse flow conditions, drop structures or near hydraulics works, is to keep in mind the potential effect of water or steam hammer and hydraulic jump. Water hammer is caused by an abrupt alteration of flow direction resulting in pressure surges. Steam hammer occurs when steam enters a cold pipe partially filled with water. The hammer effect has the potential to significantly increase hydraulic pressure possibly exposing the pressure sensor to pressures beyond its maximum rating. Hydraulic jump is a phenomenon that occurs when water is 'lifted' or 'ramped' by velocity or flow obstructions. Hydraulic jump causes turbulence and creates non-representative head conditions in the water column. Care should be taken to avoid logger installation at points susceptible to hydraulic jump.

Figure 6-6 Levelogger Transducer Measurement Line and Dimension

Figure 6-7
Levelogger Connection to STS
Remote Station

Direct Read Cable Assembly Installation

The dataloggers are installed using a Direct Read Cable threaded onto a Reader Cable, which is connected to one of four terminals on the STS Distribution Box.

One of two NPT plugs in the base of the Remote Station enclosure will need to be removed (using an Allen Key), a weathertight fitting threaded in its place. The Reader Cables are fed through armored protective conduit (supplied with the STS System) and into the base of the Nema 4X Enclosure through the weathertight fitting. The two wires at the end of the Reader Cable are inserted into the labeled terminals on the STS Distribution Box. A nut is threaded onto the fitting to anchor and seal the protective armored conduit to the STS enclosure. A Direct Read Cable with the datalogger connected is threaded onto the other end of the Reader Cable.

Specially designed Direct Read Wellheads can be used to deploy Leveloggers in a well. The Direct Read Cable threads to the Levelogger, while the socket at the opposite end of the Cable fits into the Direct Read Wellhead. The Reader Cable threads onto the Direct Read Cable at the wellhead. A hole may be drilled into the side of the wellhead and a fitting threaded in the hole. Reader Cables are fed through the fitting, and a nut threaded to the fitting to seal the other end of the protective armored conduit to the wellhead.

Contact Solinst directly for more details regarding specially designed wellheads.

Figure 6-8
Protective Armored Conduit and
NPT Fitting on the STS Enclosure

Figure 6-9 Levelogger and Barologger in Well

> **!** **Note:**
> The Barologger Gold should not be used to monitor water, as the internal mathematics for temperature compensation are based on air rather than water.

Barologger Installation

The Barologger is a Levelogger with a small range of 4.92 ft (1.5 m) adequate to monitor the fluctuations that occur in barometric pressure. The Barologger's readings are used to barometrically compensate Levelogger readings. Typically, Barologger readings range from 1 – 3.3 ft (30 – 100 cm) when the Barologger is programmed with its operating altitude. Failure to input the correct altitude will result in incorrect readings and may cause the pressure transducer to go out of range. It is strongly recommended that the altitude input be accurate to ≤10 m. When the Barologger is programmed at its operating altitude, its readings can be used to directly compensate for barometric pressure, the readings of any Levelogger programmed at the Levelogger's operating altitude. As a rule of thumb, a Barologger can be used to compensate all the Leveloggers in a 20 mile (30 km) radius.

To monitor barometric pressure correctly, the Barologger should never be submerged. In well installations, it is recommended that the Barologger be suspended in one of the monitored wells above the high water point (Figure 6-9). For best reading accuracy, the Barologger should be installed in a similar thermal environment to that of the Levelogger. In groundwater wells, the Barologger should be suspended beyond the frost line and deep enough to avoid large temperature fluctuations. In surface water applications, the Barologger is best deployed in a dry well – a well embedded in the bottom of the water body, but sealed at the base from water entry and vented to the atmosphere. If a dry well cannot be installed, the Barologger can be installed on a float in the stilling well.

Figure 6-10
Installation in Freezing Liquid

6.2.1 Installation in Extreme Thermal and Marine Environments

Freezing or High Temperature Conditions

Levelogger installation at submerged depths that may be at risk of freezing during the monitoring session is not recommended without taking adequate precautions to avoid transducer damage. When water freezes it expands approximately 9% by volume. 9% expansion can equate to extreme pressure as demonstrated in Example 6.1. Therefore, solid freezing has the potential to damage the pressure transducer, which is rated to withstand up to 150% of its depth fluctuation range. Pressures beyond this threshold may damage the transducer. With certain precautions, the Levelogger can be used in freezing liquid environments. If monitoring shallow water bodies or groundwater zones susceptible to freezing, the easiest way to avoid transducer damage is to lower the transducer to a point in the water column below the frost line or ice formation depth. In water bodies such as shallow streams, wetlands or ponds where freezing may penetrate to the bottom, install the Levelogger in a vented stilling well imbedded into the bottom of the water body beyond the frost line. In cases where the above noted precautions cannot be taken and the Levelogger must be installed in the freezing zone, it is recommended that the datalogger be placed inside two elongated silicon, rubber or latex balloons, the balloons be filled with a non-toxic, non-corrosive anti-freeze solution and sealed (Figure 6-10). Place the balloons in a section of perforated, 1.25" (30 mm) ID pipe and install the datalogger in the monitored water. The antifreeze solution will protect the Levelogger from ice expansion at the pressure transducer, yet transmit any pressure fluctuations that occur. Please note that a similar installation protection can be used when the Levelogger is monitoring liquids which are incompatible with its wetted materials. The operating temperature range for Leveloggers is -20° - 80°C (-4° - 180°F). At the opposite end of the thermal scale, exposing the Levelogger to temperatures beyond 80°C may damage the thermistor and otherwise affect the Levelogger.
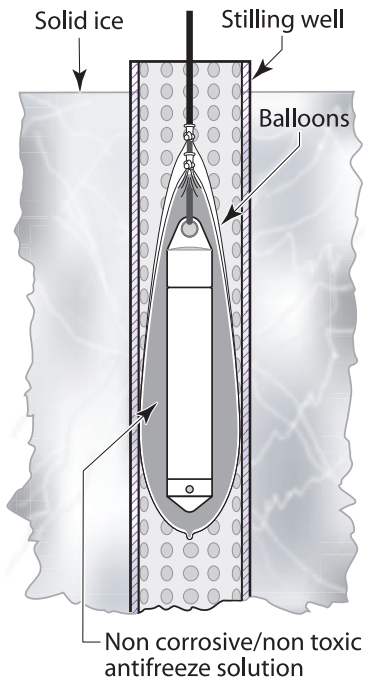
Example 6.1 Solid Freezing Effects

The pressure exerted by the physical expansion or ice crystallization process on a retaining or enclosing contact surface is related to the temperature gradient over which the process occurs. For example, liquid freezing at -22°C, can create expansion pressures of 22 kg/cm2 or 313 psi or the equivalent of 721 ft or 220 m water column depth.

Marine or Brackish Installations

When installing the Levelogger in salt or brackish water or in a liquid having a specific gravity (density) different than fresh water, the density difference is compensated for by checking the Density Adjustment checkbox in the Levelogger Information window and inputting the density of the monitored fluid. See Section 3.3 for details in compensating the Levelogger for fluid density differences.

The Levelogger Gold can be used for monitoring in salt or brackish water. If using a Levelogger Gold in a continuous salt/brackish monitoring scenario, the stainless steel body of the datalogger can be protected in a manner similar to the freezing protection method described earlier in this Section. The Levelogger can be placed in balloons and the balloons filled with non-corrosive/ non-toxic fluid. As pressure changes, the fluid encasing the datalogger will transmit the pressure differential to the datalogger's pressure transducer. Care must be taken in the selection of the balloon material or filling fluid such that the balloon material prevents diffusion of salts across the concentration gradient or that the filling fluid is comprised of polymeric molecules too large to diffuse out of the balloon material.

6.2.2 Rainlogger Installation

The rain gauge connected to the Rainlogger is supplied by the customer and is a reed-switch type gauge most commonly known as a tipping-bucket rain gauge. The rain gauge connector is 3-pin (Figure 6-11) and connects to the 3-pin cable supplied with the Rainlogger. Longer cables up to 30 m (100 ft) can be supplied when the Rainlogger is ordered.

The connector cable has a blue and brown wire, which are connected by splicing to the tipping bucket device. As the tipping bucket is just an electrical switch, it does not matter to which terminal on the tipping bucket the blue or brown wire is connected. Longer, exposed cables should be protected from rodents and vandalism by cable armoring or installation within electrical conduit. The other end of the Rainlogger is connected to a Direct Read Cable, which is threaded to the STS Reader Cable, and is connected to the STS Distribution Box.

Direct exposure to rainfall should be avoided, and the Rainlogger should not be submerged. When logging, the logging lamp on the Rainlogger will flash every log interval.

3 Pin Rain
Gauge Connector

**Figure 6-11
The Tipping Bucket Rain Gauge
Connector of the Rainlogger**

7 Accessing Your Data

Data received in each report from the STS Controller is placed in an Access database on the Home Station computer. New data is appended to the existing database.   The program will save data downloaded to the following default directory: <C:\Program Files\Solinst\STS_Gold\db>
STS Gold Software can be used for a quick check of the latest readings. Data can also be exported using the STS Software as .lev or .csv files for use in other programs.

To view data from a specific site, click [Open Site Data] on the STS Administrator screen. Select the site from the list that opens and click OK.
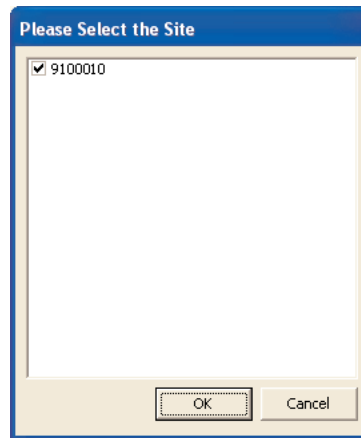
Figure 7-1
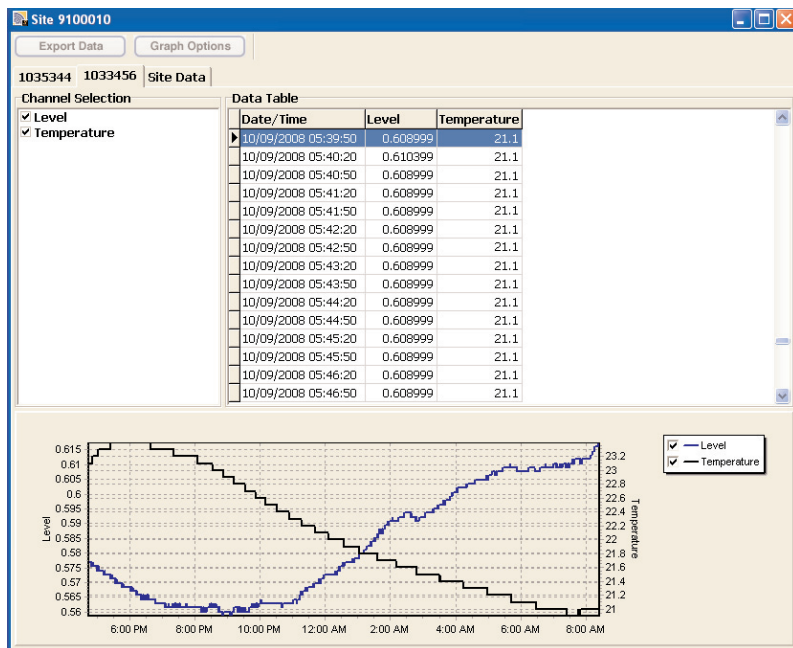
Figure 7-2 STS Site Data Screen

The data will be displayed in a table at the top of the window, the bottom portion of the window will show the data graphed. Data from each datalogger is shown in a separate tab (identified by serial number), Remote Site Data, including battery voltage is also displayed in a separate tab.

7.1 Graphing Options

Click the Graph Option icon to open the Graph Option Dialog. The Graph Dialog is shown in Figure 7-3.

The **Line** Option is used to adjust the style and colour of the line in the graph for each channel. The user can also select the shape of the data marker or remove the data marker.

The **Title and Axis** Option is used to enter the title of the graph and change the Y axis label or user selected scale. Check the Best Fit box to enable the software to determine the best fit scale. If the Best Fit box is not checked, the user has to enter a maximum and minimum value of the selected channel. The X axis is logging time.
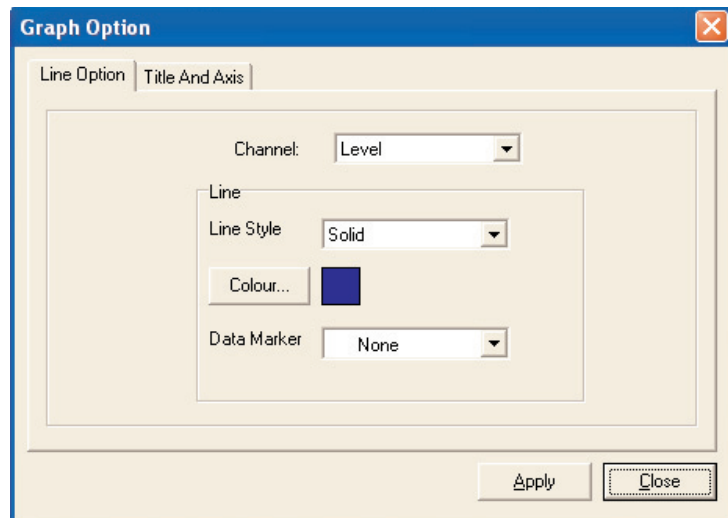
Figure 7-3 Graph Option Dialog

7.2 File Export

Data can be exported in *.csv (comma separated value) or *.lev (Levelogger) file formats by clicking "Export Data" while viewing the site data. The *.csv file format is supported and can be imported by most spreadsheet programs, *.lev files can be imported by Levelogger Software, where data compensations are performed.

Clicking will display a drop down menu where you can select to export as a *.csv file or *.lev file.

Exporting as a *.csv file will export all of the data from the selected site. You can save this file where you choose and give it a unique file name.
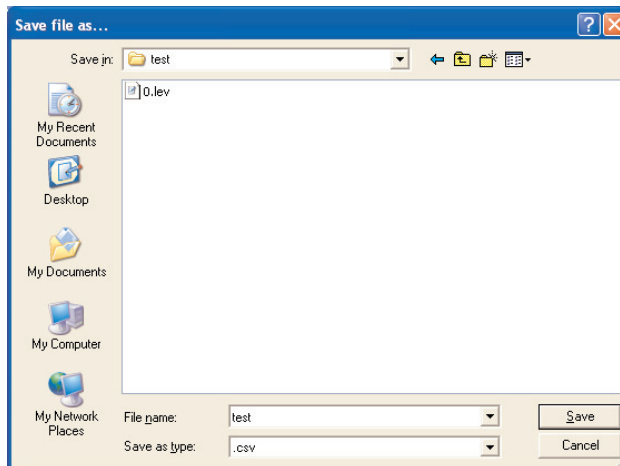
Figure 7-4

Exporting as a *.lev file, allows you to select a specific Levelogger File. Choose the desired file from the list. The file name will include the datalogger serial number, and can be saved in a Folder of your choice. This file can be imported by the Levelogger Software, where barometric and other compensations are performed.
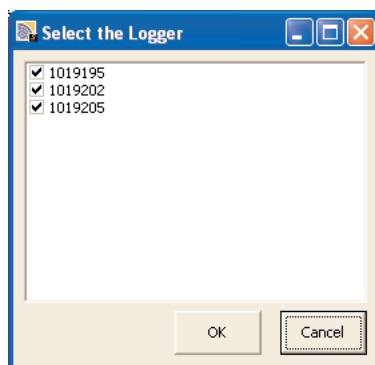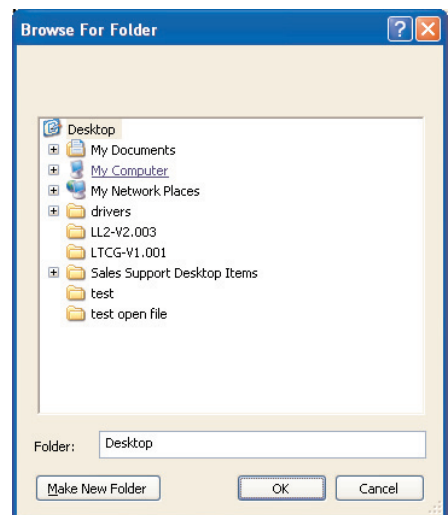

Figure 7-5

Figure 7-6

7.3 Data Compensation

After exporting a *.lev file from the STS database, the file can be imported into Levelogger Software where data compensation can be performed.

Open the imported files in the Levelogger Software, and click on the Data Compensation icon, to start the data compensation wizard application.

In the first window of the wizard, the user identifies the currently opened file type. There are two file types: Barometric files (data that is retrieved from a Barologger) and Submerged Levelogger files (data that is retrieved from Levelogger Gold or Levelogger Junior). After the selection of the file type, click Next and the Data Compensation selection window will open.

There are four data compensation options available: Barometric Compensation, Manual Data Adjustment, Density Adjustment and Barometric Efficiency.

- **Barometric Compensation** requires the Barometric file and the submerged Levelogger file and simply involves subtraction of the barometric reading from the Levelogger reading. If there is an inconsistency of the time stamp between the Barometric file and the Submerged Levelogger file, a linear approximation on the barometric data will be performed.
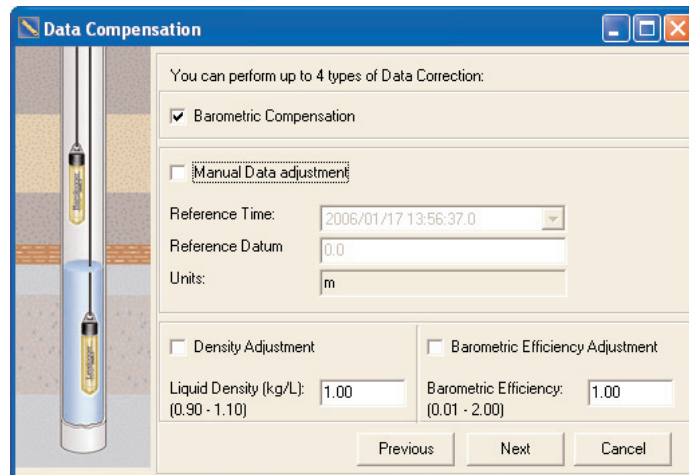

Figure 7-7 Data Compensation Window - Compensation Selection

- **Manual Data Adjustment** allows the user to enter a manual water level measurement as a reference datum or field zero, which all Levelogger water level readings can then be adjusted to. If the reference datum is above water level (e.g. top of well casing), the datum must be input as a negative value. If the reference datum is below water level (e.g. sea level), a positive value is input. The date and time of measurement of the reference datum must be recorded and input to complete the adjustment. The program computes a correction factor based on the time-stamped reference datum, and adjusts all the data in the selected file after barometric, density, and other data compensations are performed.
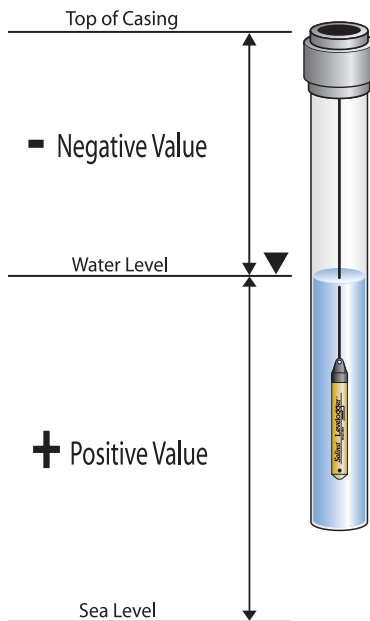
- **Density Adjustment** corrects the range of the level channel in the data file based on a user input adjustment of fluid density. The density range can be set from 0.90 to 1.10.

- **Barometric Efficiency Adjustment** is used to proportionally adjust Barologger data in relation to a particular Levelogger. Barometric efficiency is often expressed as a percentage or proportion. The input field is proportional and has a default value of 1.00. For more information about Barometric Efficiency, see Section 11.1.3. The barometric efficiency can be set from 0.01 to 3.00.

  The compensated data will be saved in a new *.lev file. The default file name will be the <Submerged Levelogger file name> with the word <compensated> added to the file name prefix. Alternatively, the user can name the compensated file. Do not change or delete the file extension.

Note:
If you have registered your STS Gold Software at: www.solinst.com/Downloads/, you will receive email notifications when new firmware is available. If not, it is recommended you routinely check for new firmware manually.

8 Remote Firmware Updates

STS Gold Software allows you to update the Remote Station firmware from your Home Station Computer. The Remote Station STS Gold Controller has been designed with firmware that is easy to update whenever useful new functions or other improvements become available.

Under the File menu on the STS Administrator Screen, choose 'Firmware Upgrade'. The STS Firmware Upgrade Window will display.
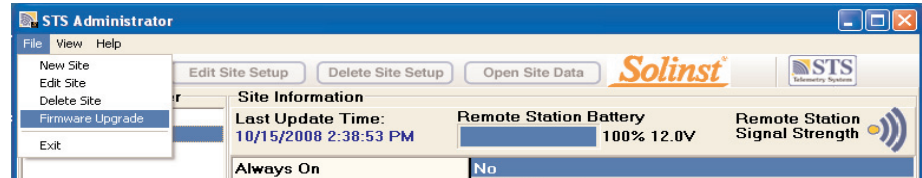

Figure 8-1

Note:
If you are using Radio communication, and your Home Station computer is not connected to the internet, you can download the firmware file onto another computer and copy it onto the Home Station computer. Enter the file location in the Firmware File Location Bar.

The latest firmware version is automatically retrieved from the Solinst server. Each Remote Station and its firmware version will be listed. Check the Sites that need to be updated, and click Apply.

You can also go to: www.solinst.com/Downloads/ and download the firmware version to your Home Station Computer. Copy the file location and enter it in the Firmware File Location Bar. Check the Sites to be updated, and click Apply.
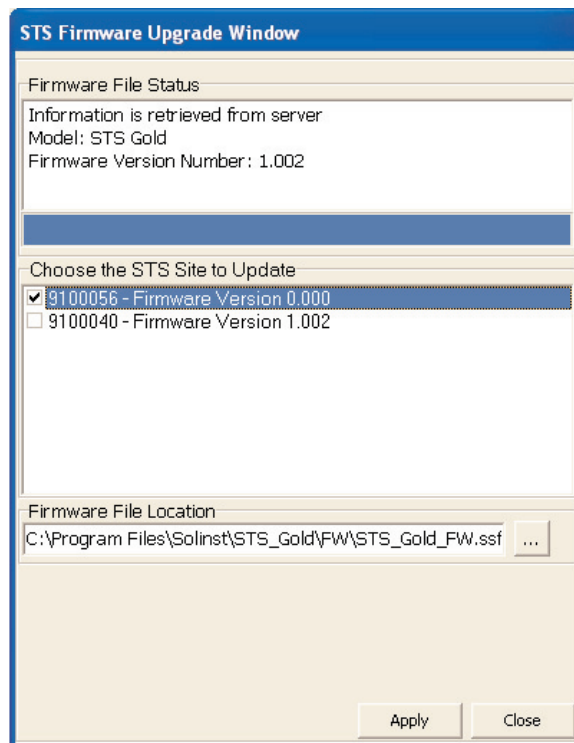

Figure 8-2 STS Firmware Upgrade Window

Note:
The new firmware will be uploaded to the Remote Station STS Gold Controller, the next time the Remote Station reports to the Home Station.

The Site Status Bar on the STS Administrator screen should indicate the upgrade is being performed. Also, the STS Communication Agent will display the progress of the upgrade and notify when it is complete (see Figure 8-3).

The new firmware will be uploaded to the Remote Station STS Gold Controller the next time the Remote Station reports to the Home Station.
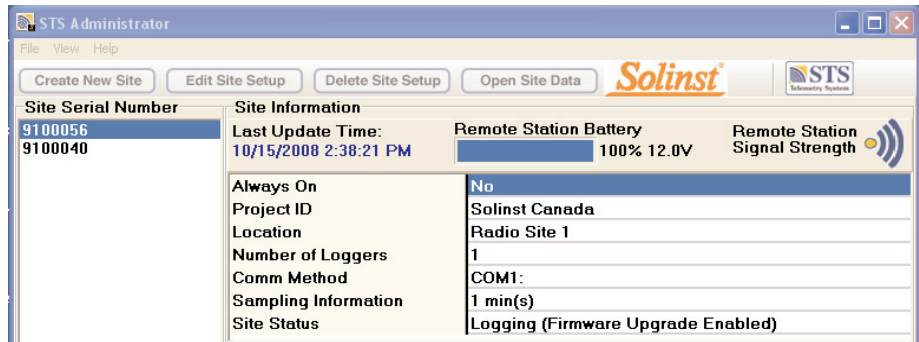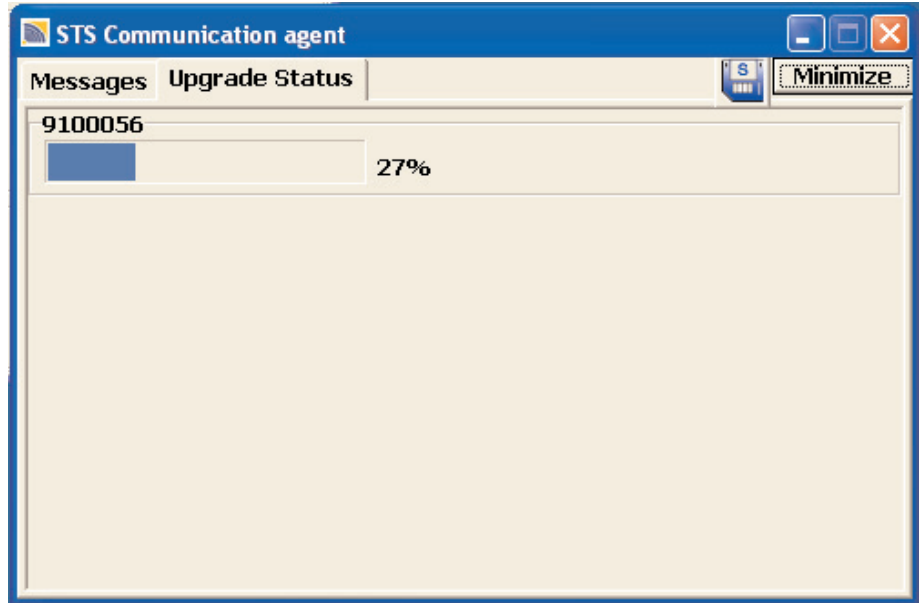
Figure 8-3 STS Communication Agent and Site Status Bar

9 Maintenance

It is suggested that battery re-charging be done on regular scheduled intervals, based on the battery life estimates shown in Table 6-1. Recharging is especially important in the fall, if the winter temperatures are cold. Replace existing lead-acid batteries every 3-5 years.

System Diagnostics

Each data report from an STS Controller to the Home Station, includes System information on battery level, signal strength, and datalogger status. This information can help maintain the System without having to visit the site. It can also help determine the cause, if a data disruption does occur.

If the Remote Station battery goes below 9 Volts, an alarm will be sent to a selected email address, if the Alarm Setup section in the STS Gold Software is used. (See Section 3.4).

<u>Glossary of Terms</u>

<u>CDMA</u> (Code Division Multiple Access) - A form of wireless communication, in which data is sent over multiple frequencies simultaneously, optimizing the use of available bandwidth. 800 MHz - 1.9 GHz.

<u>Dynamic IP Address</u> - A type of IP address that is temporarily assigned by a service provider, and can change as frequently as every hour.

<u>GSM</u> (Global System for Mobile Communications) - A form of wireless communication, in which data is digitized and compressed, and sent down a channel with two other streams of user data, each in its own time slot. 900 MHz or 1800 MHz.

<u>TCP/IP</u> (Transmission Control Protocol/Internet Protocol) - Is the basic communication protocol of the Internet.

<u>IP Address</u> - A unique identifier given to each IP network device.

<u>Line of Sight</u> - Between two radios communicating, the antennas must be able to "see" each other. There can be no interference from trees or buildings.

<u>MDN</u> (Mobile Directory Number) - Ten-digit telephone number assigned to your modem , including the area code (also just referred to as phone number)

<u>MIN/MSID</u> (Mobile Identification Number/Mobile Station ID) - A number given by a wireless operator, to identify a mobile user.

<u>RF</u> - Radio Frequency.

<u>RSSI</u> (Received Signal Strength indicator) - is the measurement of RF signal strength between the remote modem and a base station.

<u>SIM</u> (Subscriber Identity Module) - Stores data for GSM modems and phones, such as user identity, location, phone number, network, etc.

<u>SMA</u> (SubMiniature version A) - A coaxial Radio Frequency connector.

<u>SMS </u>(Short Message Service) - A communication protocol allowing short text messages sent between mobile telephone devices.

<u>SMTP</u> (Simple Mail Transfer Protocol) - The standard protocol for e-mail transmissions across the Internet.

<u>Static IP Address</u> - A type of IP Address that does not change over time.

<u>WAN</u> (Wide Area Network) - A geographically dispersed telecommunications network.

Note: Some definitions were sourced through Wikipedia.

References

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Appendix i) Technical Specifications

Specifications	Radio	Digital Cellular (CDMA & GSM)	Satellite
Why Use?	• smaller applications • closed loop network at any location in the world	• cellular coverage available • topography not suitable for radio • send data over the Internet	• too remote for cellular • send data over the Internet
System Differences	• free airtime, no long distance fees • you control the network • scheduled data transmission times • medium power needs	• monthly carrier fees • no scheduling conflicts for data transmission • low power needs	• satellite service available anywhere • no scheduling conflicts for data transmission • larger power needs
Suggested Applications	• monitoring mine sites • agricultural studies • landfill supervision • golf course management	• flood and stormwater management • watershed management • drought monitoring	• glacial melt monitoring • hard-to-reach, isolated areas
Remote Station Support	• 900 MHz radio • 20 mile (30 km) line of site • 115200 bits/sec	• CDMA or GSM IP enabled modem • dynamic IP Address • 115200 bits/sec	• IP enabled modem • dynamic IP Address • 115200 bits/sec
Home Station Support	• 2nd Radio required with RS232 connection • STS Software	• static IP Address • no extra hardware • STS Software	• static IP Address • no extra hardware • STS Software
Antenna	6" (15 cm) half wave, (2.1 dBi) non-articulating	Dual Band Dipole	Included
Optional Antenna	896-960 MHz	Dual Band, Omni Directional	N/A
No Data Hosting Fees	√	√	√
Remote Firmware Upgrades	√	√	√
Remote Diagnostic Reporting	√	√	√
Power	12V sealed lead-acid battery		
Clock Accuracy	+/ - 1 minute per year		
Operating Temperature	-20 to 50˚C		
Enclosure	Weatherproof NEMA 4X (fiberglass)		
External Power and Charge Accessories	• Solar power connection package (for user supplied solar panel) • AC power/battery charger assembly		

Digi XTend RS 232/RS-485 RF Modem	
Operating Frequency:	902 - 928 MHz
Operating Range:	20 miles (30 km)
Operating Temperature:	-40˚C to 85˚C
Data Rate:	115200 bps
Data Connection:	Female DB-9
Power Output:	1 mW - 1 W
Transmit Current:	900 mA
Receive Current:	110 mA
Idle Current:	17 mA
Enclosure:	Anodized Aluminum
Size:	2.75" x 5.50" x 1.13" (6.99 cm x 13.97 cm x 2.86 cm)
Weight:	0.61 lb (200 g)

More Technical Specifications for this modem can be found at:
http://www.digi.com/products/wireless/xtend.jsp

Digi Connect WAN IA GSM Modem	
Operating Frequency:	900/1800 MHz
Operating Temperature:	-30˚C to 70˚C
Data Rate:	115200 bps
Data Connection:	Male DB-9
Idle DC Power Consumption:	1.2 W
Max DC Power Consumption:	3.4 W
Size:	3.35" x 5.25" x 0.97" (8.51 cm x 13.33 cm x 2.47 cm)
Weight:	1.0 lb (450 g)

More Technical Specifications for this modem can be found at:
http://www.digi.com/products/cellulargateways/digiconnectwanfamilyspecs.jsp

Blue Tree IP 4200 CDMA-1xRTT Programmable Modem	
Operating Frequency:	800/1900 MHz
Operating Temperature:	-40˚C to 85˚C
Data Rate:	115200 bps
Data Connection:	Female DB-9
Peak Output Power:	0.327 W @ 1900 MHz, 0.247 W @ 800 MHz
Transmit Current:	182 mA (average)
Idle Current:	62 mA
Enclosure:	Extruded Aluminum
Size:	6.5" x 4.0" x 1.6" (16.6 cm x 10.0 cm x 4.0 cm)
Weight:	1.1 lbs (498 g)

More Technical Specifications for this modem can be found at:
http://www.bluetreewireless.com/products/wireless/details.asp?id=36