

XL™ Series

Models

H-350XL™

H-500XL™

H-510XL™

H-522

H-522 - Plus



Owner's Manual

XL™ Series

Data Logger /
Data Collection Platform



Owner's Manual

Revision: 2.13 - 000

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User Agreement/ **WATERLOG[®] Warranty**

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This agreement accompanies a pressure measuring/data collection system comprising firmware, circuitry and other electronic equipment in an enclosed housing, and packaged together with written instructional materials. The packaged electronic circuitry and instructional materials herein are collectively referred to as the “PRODUCT.” The PRODUCT is made available from DESIGN ANALYSIS ASSOCIATES, INC., of 75 West 100 South, Logan, Utah 84321 (hereinafter referred to as “DESIGN ANALYSIS”), and contains information and embodies technology that is confidential and proprietary to DESIGN ANALYSIS, and the availability and use of the PRODUCT is extended to you, the USER, solely on the basis of the terms of agreement which follow.

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Chapter 1

Introduction

1.1 Introduction to the XL™ Series Data Logger

The XL Series of data loggers started with the H-350XL and the H-500XL and expanded from there to a total of five major products, that all use the same basic programming methods and other common features and functionality. The XL Series of data loggers / DCP's now includes the following products.

H-500XL	Basic XL Series data logger.
H-350XL	Basic XL Series data logger with built in pressure transducer.
H-510XL	Basic XL Series data logger with built in shaft encoder.
H-522Plus	Basic XL Series data logger with built in GOES HDR transmitter.
H-522	Same as H-522Plus but does not include the built in keypad / display.

Customer driven enhancements have vastly expanded the capabilities of the XL Series products since its introduction early in 2000. Below is a quick overview of the common features of all the XL Series data loggers followed by a list of differences for each product.

Uses, Functions, Features, and Attributes of the XL™ Series Data Logger / DCP:

- Operates over a wide temperature range: - 40°F to +140°F (- 40°C to +60°C).
- Easy to use program interface and push button keypad. Programming does not require an external device (i.e., a laptop computer), although all programming and data retrieval can be done through the serial port on a PC. (keypad and display not available on the H-522 model).
- Provides a bright, easy-to-read display with automatic power shut-off after 5 minutes.
- Four general purpose analog input channels.
- Switch closure event counter.
- AC frequency counter allows direct input for wind speed sensors, etc.
- Designed to output a 4-20 mA signal (No external module required).
- Three serial ports provide for easy installation of multiple serial devices.
- Complete serial interface provides both a command mode for automated use and a menu mode for human interaction. Both modes provide complete system programming and data retrieval.
- Built-in data logging functions which store the data in non-volatile internal memory.
- Common interface support for 100, 300, and 1200 Baud GOES Transmitters.
- Support for basic to complex math operations for non-linear sensors.
- Designed to be compatible with *all* SDI-12 data loggers, and sensors.
- Packaged in a sealed NEMA 4 enclosure.
- Built in BASIC language interpreter for user defined XL-Basic programs.

Additional Features with the H-350XL™ Model only:

- Precision pressure measurement of dry gas.
- Direct replacement of pressure measurement systems such as the mercury manometer or other industrial analog sensors.

Additional Features with the H-510XL™ Model only:

- Provides precision measurement based on shaft encoder technology. (Resolution 1/200 of revolution).
- Provides accurate water level ± 0.005 Post (SDI-12).
- Directly replaces ADR systems such as the Fisher Porter, Stevens, or other mechanical tape recorders.

Additional Feature with the H-522Plus Model only:

- Integrated with a HDR (High Data Rate) GOES radio Transmitter.

Additional Feature with the H-522 Model only:

- Same as the H-522Plus but does not include the built in keypad / display.
- Must be programmed through the serial port connected to a PC

1.2 Unpacking the XL™ Series Data Logger

You should have received the following items:

- The XL™ Series instrument
- 2-position power terminal block
- 18-position sensor I/O terminal block
- The XL™ Series Owner's Manual
- Wall mounting hardware for the XL™: (4) 10-32 screws, (4) plastic mounting tabs
- Communication cable
- NULL modem adaptor
- Gender changer

Note: *If the XL™ Series data logger was shipped on the H-250 mounting board or with other equipment, additional items may be included, depending on how the unit was purchased.*

1.3 Modes of Operation

The XL™ can operate as an SDI-12 sensor, as a data logger, or as a sensor and a data logger simultaneously. The XL™ is compatible with industrial equipment that does not support SDI-12

communications as well as common telemetry equipment. The XL™ Series is also specially designed to operate with the H-355 Gas Purge System (Bubbler) for high accuracy pressure measurement.

1.3.1 SDI-12 Sensor Mode

The XL™ will respond as a sensor to SDI-12 commands sent from an external data logger. During normal SDI-12 communication, an external data logger issues commands to sensors attached to the SDI-12 data bus. The command includes a sensor address and a command for the sensor to perform. All of the sensors attached to the bus will wake up and receive the command, but only the sensor with the matching address will respond to the command, and all of the other sensors will return to a low power mode. Details on the SDI-12 commands and responses supported by the XL™ can be found in Appendix B. When used as an SDI-12 sensor, the main setup options that may need to be changed are the XL™ sensor address and the data parameters that will be returned. In several applications, the factory defaults will allow the XL™ to be used as a sensor ‘out of the box’. Detailed information on the XL™ SDI-12 sensor setup is given in later chapters.

1.3.2 Data Logger / DCP Master Mode

This mode of operation allows the XL™ to log data at a user-defined interval. The data is stored internally in non-volatile memory. There are several ways to retrieve data from the XL™.

- The data can be copied to an industry standard ATA FLASH Memory Card.
- The data can be downloaded through the serial port of the XL™ to the hard disk of a PC, (via direct connection or modem connection).
- Data can be transmitted through the GOES system for near real time operation.

The data recorded to the internal memory is stored as ASCII text with a tabular format ready to be imported into a spreadsheet, a word processor, decodes, etc. Data options for downloading the recorded data to an external industry standard ATA FLASH memory card are explained in chapter 20. Information on accessing the XL™ through the serial port is given in chapter 4, and a detailed explanation of the GOES operations for retrieving data are given in chapter 16.

1.3.3 Operation Using Auxiliary Outputs

The XL™ can be setup to provide various outputs based on any of the sensor input values. The Sensor data can be output as a 4 to 20 mA signal, as a quadrature output signal, as ASCII text, or encoded in a special format for transmission using telemetry equipment. This allows the XL™ to be compatible with industrial equipment that does not support the SDI-12 protocol. The serial ports on the XL™ enable it to operate with a GOES Transmitter, a data or voice modem, an ALERT/IFLOWS radio system, etc. The Digital I/O pins may be configured as outputs in order to drive an external device through a relay, or to simulate a quadrature shaft encoder output.

1.3.4 Operation with the H-355 Gas Purge System (Bubbler)

The H-355 is a self-contained gas purge system designed to replace mechanical gas purge systems (Nitrogen tank and Conoflow). The XL™ interfaces with the H-355 via the RS-485 connector marked **Bubbler/Aux** on the front panel. The XL™ is used to adjust the operating parameters of the H-355. Refer to Chapter 23 in this manual and to the H-355 manual for a detailed description of the H-355 operation.

1.4 About this Manual

This manual will show you how to properly install and operate your XL™ Series Data Logger / DCP. The installation procedures and operational functions are very simple and easy to use. Please take time to read through the manual, it will help answer most questions you have concerning the XL™ Series Data Logger / DCP and its capabilities. The web page at <http://www.waterlog.com> will have manual updates and advanced sections of the manual in PDF format, allowing customers to print extra copies or newer versions of the manual.

1.5 Advanced Manual Sections

There are a few chapters of the manual that are only needed by a small set of users. To save paper, time and to avoid confusion, these chapters may not print using the main PDF file, but are still available on the supplied CD or from the web page. The following are examples of chapters that may be printed separately.

Appendix C Remote Operation (Command Mode)

This section discusses the command mode interface and list all the commands used to configure the system. Some users have programmed their own user interface on the PC using the commands so their users will only see the options that pertain to there applications.

Application Note: NOAA GOES Format

This application note discusses how the H-350XL is used when user mode is set to the NOAA mode. This mode is used for tidal studies and has a very specific GOES format for data transmissions.

1.6 Web Page Support

The web page at <http://www.waterlog.com> will provide ongoing support for the XL™ Series data loggers and DCP products. This includes advanced sections of the manual, new versions of the main manual, new firmware updates, brochures, technical notes, PC support software, etc. Also included is example XL-Basic programs and functions.

Chapter 2

Hardware Options and Installation

2.1 Mechanical Mounting

In this manual, referring to the XL is the same as referring to any of the XL Series data logger / DCP's. This chapter describes the basic procedure for installing the XL™. This includes all wiring and plumbing. For proper installation you will need:

- The XL™ mounting hardware
- Two open end wrenches (7/16", 9/16")(Model H-350XL™ Only)
- Small flat blade screw driver
- Power and communication cables
- The XL™ Series Owner's Manual

2.2 Front Panel Description

Figure 2-1A shows the wiring panel and illustrates the physical input and output features of the XL™ Series models H-350XL™, H-500XL™ and the H-510XL™ and briefly describes their purposes. Figure 2-1B shows the same wiring panel but for the H-522 and the H-522Plus. These diagrams will help show where you should make connections to your XL™ Series data logger / DCP.

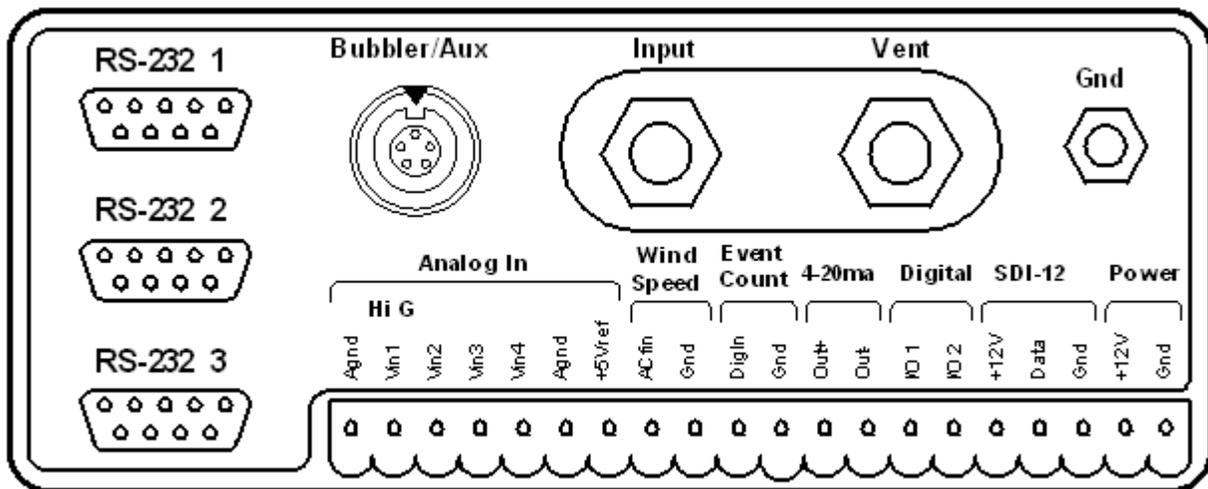


Figure 2-1A Models H-350XL™/H-500XL™/H-510XL™ Front Panel Description

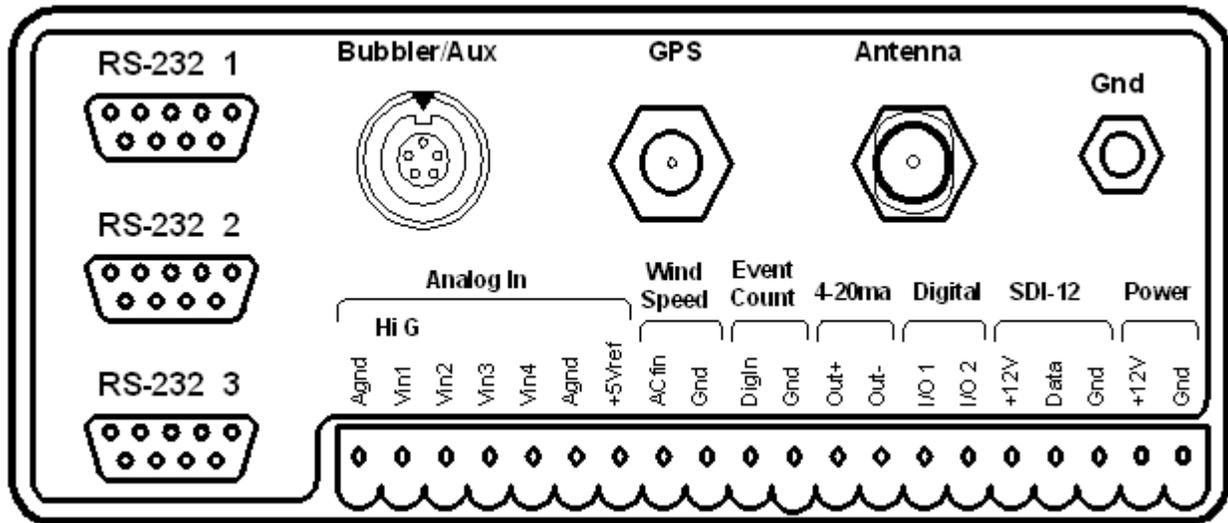


Figure 4-1B Models H-522/H-522+ Front Panel Description

2.2.1 Earth Ground Lug

Run a heavy gauge (14awg) wire from the GND lug of the XL™ to the Earth ground of the instrument shelter. If there is no Earth ground, one must be installed. This is most important in the protection of your electronic equipment. It insures the equipment will function properly. (PROPER GROUNDING IS A MUST!)

2.2.2 Pressure Reference Port (Vent) (H-350XL™ Model only)

In order to make accurate readings, the H-350XL unit must have a way to measure the atmospheric pressure. This port provides that function. The user never has to make connections to, or service this port.

Note: Model H-500XL™ and H-510XL™ only uses this location to secure the wiring panel to the main box using a large hex bolt.

2.2.3 Pressure Port (Input) (H-350XL™ Model only)

This is the pressurized line input port. The user will connect this line to the H-355 bubbler system or to the conoflow system. Make sure the pressure on this line does not exceed the limits of the sensor. The pressure range is listed on the serial number label on the side of the H-350XL.

Note: Model H-500XL™ and H-510XL™ only uses this location to secure the wiring panel to the main box using a large hex bolt.

2.2.4 GOES Antenna Output (Model H-522 and H-522Plus only)

This is the GOES antenna connector and uses an N-Type connector. The user will connect the GOES antenna cable to this connector.

Note: Always connect an antenna or a dummy load to this connector when testing the integrated GOES radio.

2.2.5 GPS Antenna connector (Model H-522 and H-522Plus only)

This is the GPS antenna connector. The user will connect the GPS antenna cable to this connector.

When using the H-522 or the H-522Plus the GPS receiver will be built into the GOES HDR radio. The H-522 and H-522Plus units shipping at this time have an Omnisat GOES radio from Signal Engineering built into them. The GPS receiver will turn on and try to acquire the time when power is applied to the unit. It will stay on until the time is acquired. Once the time is acquired the GPS receiver will turn off and schedule the next update to happen in 25 hours and 15 minutes. This non repetitive time prevents the GPS receiver from continually failing due to some external repeated condition. When the GPS receiver turns on to re-sync the time clock it will try to do so for 30 minutes before giving up and waiting for the next day. If it misses a single time sync the GOES radio will still transmit. The GOES radio will stop transmitting if seven consecutive GPS time syncs have been missed. On the seventh time sync attempt the GPS receiver will not power down after 30 minutes but will stay on trying to re-sync the time clock and will only power down after it is successful.

When an Omnisat GOES radio is used externally with other XL Series data loggers the same functionality will exist. This will be discussed in a later chapter.

2.2.3.1 Sample Installation for the Conoflow System (H-350XL only)

Figure 2-2 shows a typical H-350XL™ installation for water depth measurement using the Conoflow gas purge system. To install the H-350XL™, secure it to the wall of the instrument shelter or bench top using the provided mounting hardware. This will prevent it from moving or shifting and pulling on the wires and tubing connected to other equipment. The H-350XL™ should be mounted so moisture and dust will not settle on the main I/O panel. Normally vertically is the best with the main I/O panel facing down and the display keypad facing out.

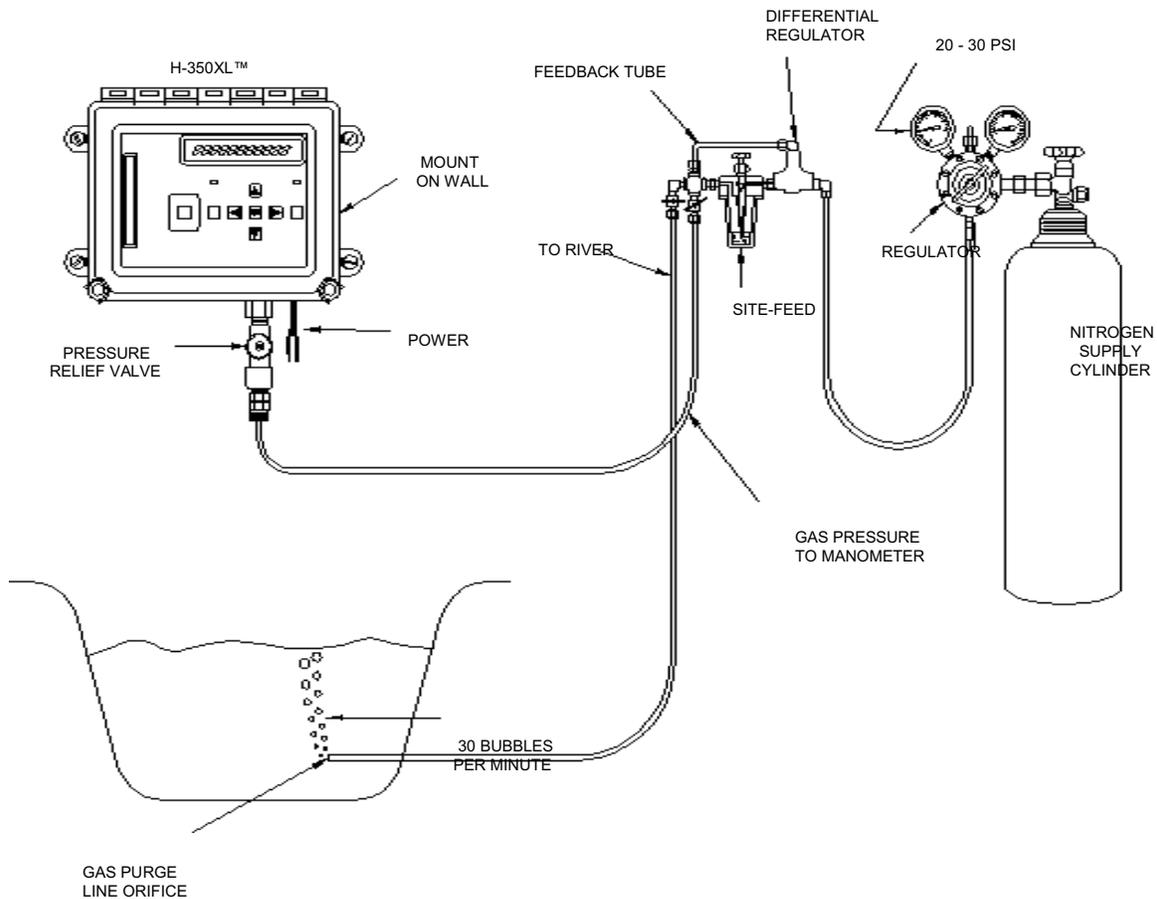


Figure 2-2 Conoflow Gas Purge Stream Gauge Installation

2.2.3.2 Making the Pressure Connection to the H-355 Bubbler System (H-350XL only)

Figure 2-3 illustrates the correct procedure for installing the pressure port fittings between the H-350XL™ and the H-355 Gas Purge System. Chapter 23 goes into more detail on the Gas Purge System. Refer to the manual provided with the H-355 for installation information.

Connect the pressure input line between the H-350XL™ and the H-355 bubbler system using the H-350XL™ Install kit, which includes all the required hardware. You will need a 1/8" NPT male tubing fitting for the pressure input port. It is recommended that you use 1/8" copper tubing. The proper ferrules must be used to insure there are no leaks. The male 1/8" NPT fitting screws into the pressure input port of the H-350XL™ connector panel shown in Figure 2-1. On the bubbler manifold you will need a corresponding tubing fitting. Generally, a 1/4" NPT female to 1/8" tubing fitting is required. The NPT threads of these fittings need a coat of Teflon tape or anaerobic thread dope. This helps in preventing leaks.

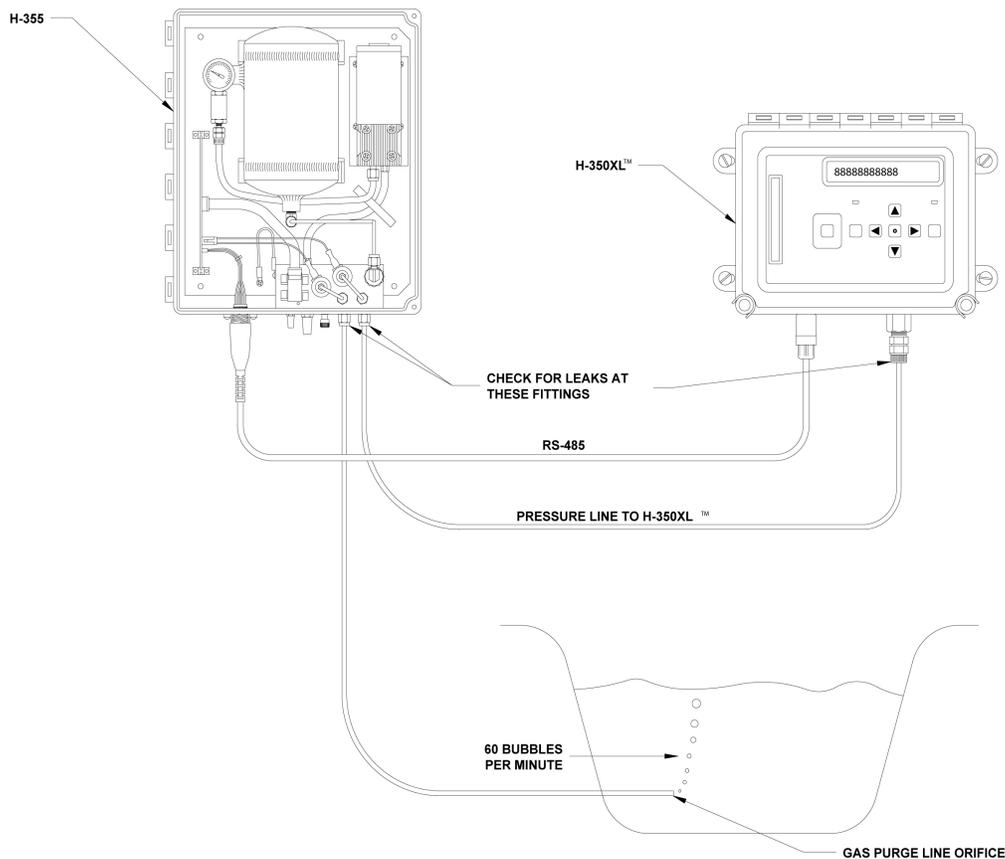


Figure 2-3. H-350XL / H-355 Combination Installation

2.2.6 Bubbler / Aux Port

Figure 2-4 is the Bubbler / Aux communication port, which is a 6-pin connector that interfaces with the H-355 Gas Purge System and other *WATERLOG*[®] products. The XL™ menu is setup to give the user full control of the H-355 system. As other auxiliary devices are developed to interface with the XL™, they too will be controlled through the XL™ menu system. This port uses RS-485 hardware for communicating with the auxiliary devices. This provides noise immunity and multi drop capability. As other devices are used, the cable will be daisy chained from one device to the next.

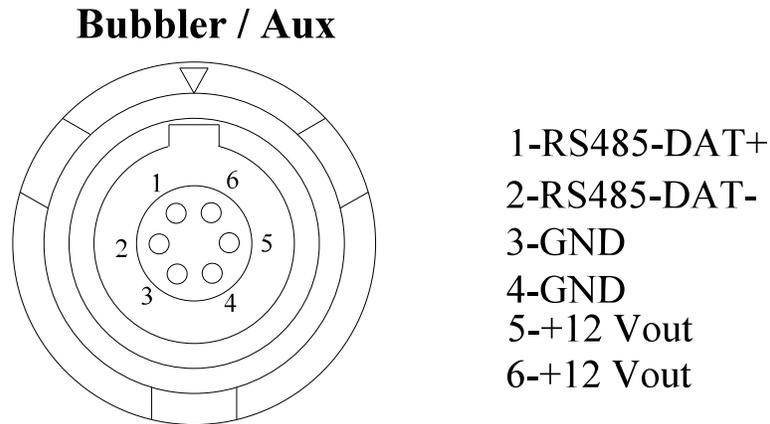


Figure 2-4 Bubbler / Auxiliary Output connector pin out

The H-355 is normally used with the H-350XL because it has the built in pressure transducer. However the H-355 may be used with any of the XL series data loggers and an H-350 Lite or similar sensor to collect water level data.

2.2.7 RS-232 Ports

The three RS-232 ports are used to connect to a PC, GOES Transmitter, modem, remote display, or other serial equipment for standard serial communications. These ports are configured as a DTE type of device. This means they will plug directly into a modem (a DCE type device), but will require a NULL modem adaptor if connected to a PC (a DTE type device). The NULL modem cable crosses the communication lines allowing two similar devices to communicate. Figure 2-5 shows the pin out for all three ports. See the chapter covering the serial ports for complete information on the port operations.

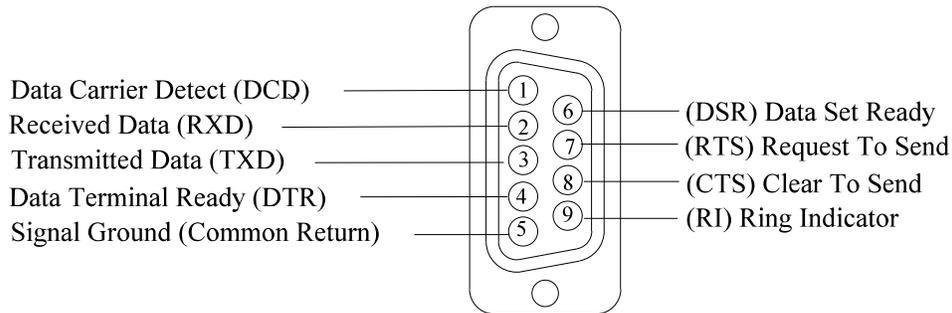


Figure 2-5 RS-232 Connector

SERIAL PORT PIN-OUT		
PIN	DIRECTION	NAME
1	Input	Data Carrier Detect (DCD)
2	Input	Receive Data (RD)
3	Output	Transmit Data (TD)
4	Output	Data Terminal Ready (DTR)
5		Ground (GND)
6	Input	Data Set Ready (DSR)
7	Output	Request To Send (RTS)
8	Input	Clear To Send (CTS)
9	Input	Ring Indicator (RI)

2.2.8 Analog Input Section

The first seven connections on the twenty pin terminal block are used for analog input functions. This includes four analog inputs, two analog grounds and one +5.00 volt excitation connection.

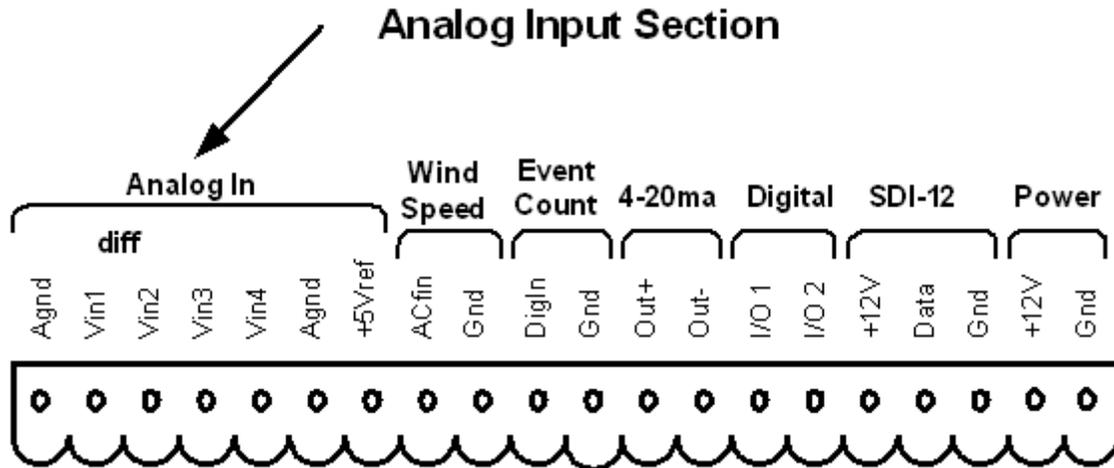


Figure 2-6 Analog Input Section

2.2.8.1 Analog Input Channels

There are four analog input channels labeled Vin1 to Vin4. The standard input range for all channels is 0 to 5 volts, and the optional range is 0 to 500 millivolts. The 500 millivolt range is used for sensors that produce millivolt outputs. For example, some solar radiation sensors have a full scale output of less than 500 millivolts. This type of sensor should be used with the 500 millivolt range. Channels 1 and 2 can also be used in a differential mode. The analog inputs use a 20 bit analog to digital converter.

2.2.8.2 Analog Grounds

There are two analog ground connection points. **In order to preserve signal integrity, it is important to use the analog grounds only for sensors connected to the analog section of the XL™.** The current flowing through an analog sensor is relatively small and normally very stable. This provides stable voltages produced by these sensors. If a digital sensor has its ground connection tied into the analog ground, the currents from the digital sensor will flow through the analog circuitry causing voltage level shifts and noise based on digital switching. There should be sufficient digital ground connection points for the digital sensors.

2.2.8.3 Switched +5.00 Volt Reference Excitation

The +5.00 Volt reference output is used for analog sensors requiring a precision reference voltage. The output current source maximum level is 10 milliamps. Exceeding this limit will cause the excitation to possibly sag, and result in possible data errors. The Analog to Digital converter uses this excitation for its reference to provide a ratio-metric relationship for sensors using the excitation. What this means is that if a sensor causes loading to the excitation and drags it down to 4.75 volts for example, then the A/D converter will use the 4.75 volts as its reference, and maintain a full scale input equal to the reduced excitation. To a point this will reduce errors in data when the excitation is used. If the excitation is being loaded down and some analog input channels are not using the excitation, but produce a voltage output on there own, then these inputs will have a much greater error.

2.2.9 Wind Speed Input (AC Frequency Input)

Pins 8 and 9 of the terminal block provide connection points for a low-level AC signal. Several wind speed sensors produce a low level AC sine wave directly compatible to this input.

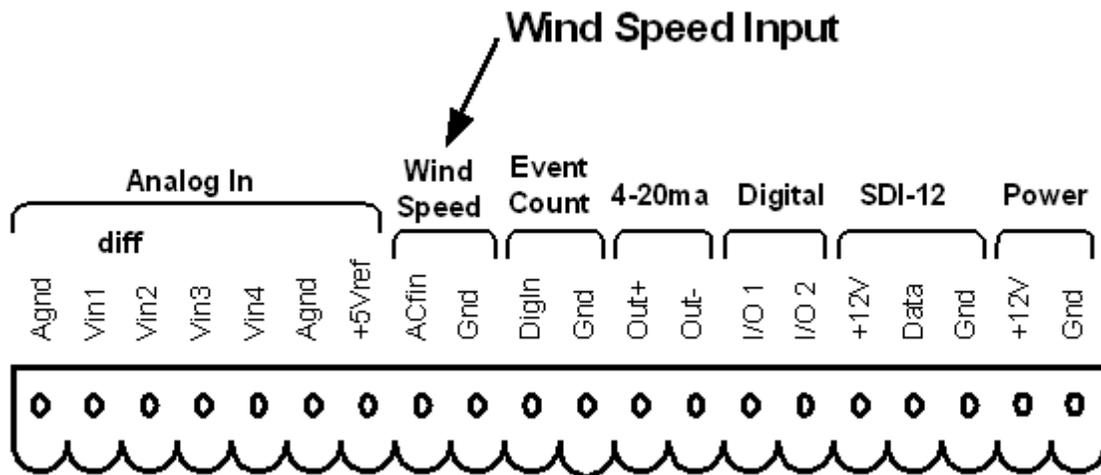


Figure 2-7 Wind Speed Input

The wind speed input is a frequency counter capable of accepting low-level signals in the range of ± 0.075 volts and greater, however, this input should not be exposed to signals greater than approximately ± 5.0 volts. The input signal must be bipolar, that is, the input signal must vary above and below the reference point or ground. Several wind speed sensors use a simple, propeller driven generator that produces an AC signal suitable for this input.

2.2.10 Event Counter Input

Pins 10 and 11 of the terminal block provide connection points for the digital event counter input.

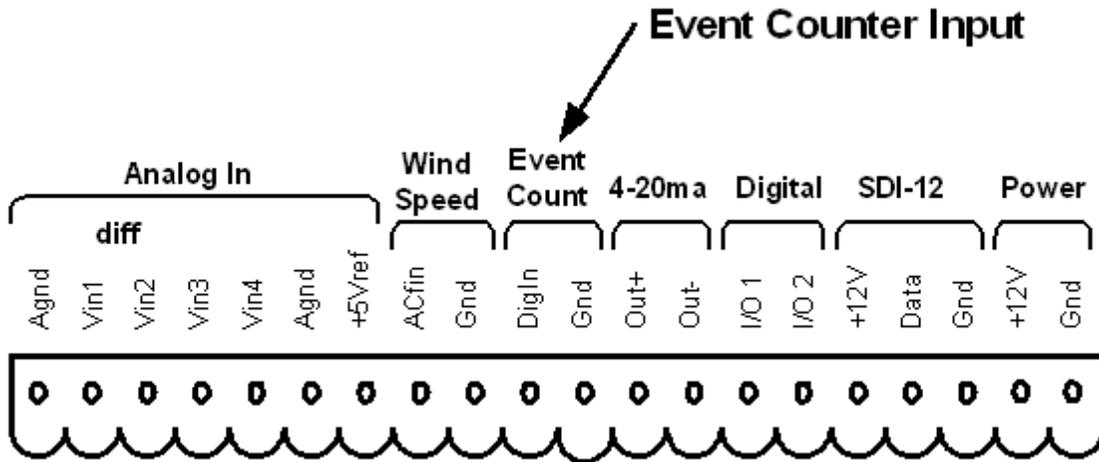


Figure 2-8 Event Counter Input

This input is normally used with a tipping bucket rain gauge. However, it can be used for other counter type of applications also. Transient protection is provided for this input to prevent damage from static discharge or over voltage conditions. This input is pulled high through a 51K Ohm resistor allowing a switch closure to ground to activate the counter. Figure 2-9 shows a simplified circuit for this input.

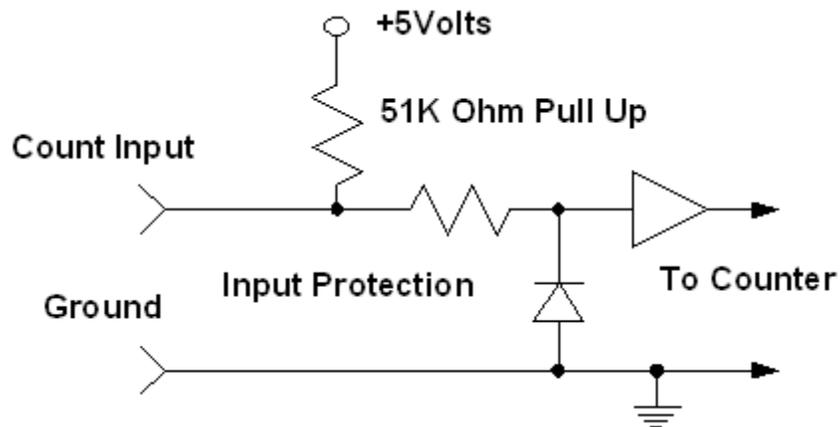


Figure 2-9 Event Counter Circuit

2.2.11 4 to 20 Milliamp Output

Pins 12 and 13 of the terminal block provide connection points for the 4 to 20 milliamp output signal.

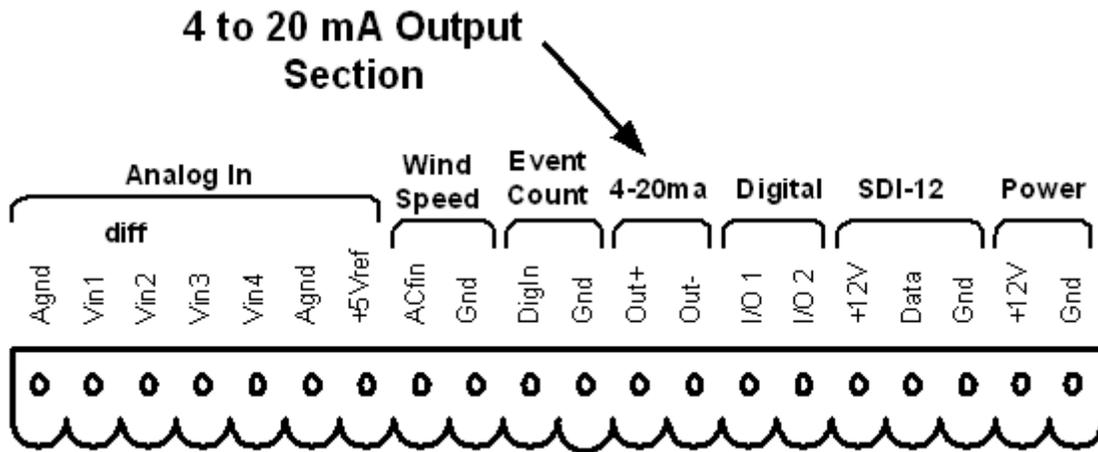


Figure 2-10 4 to 20mA Output Section

Several instrumentation applications use sensors that provide an industry standard 4 to 20 milliamp output signal. The XL™ Series data logger / DCP can output a 4 to 20 milliamp signal based on any of its inputs. For example, a user may want to connect a temperature probe to the XL™ and convert the temperature value into a 4 to 20 milliamp output. A temperature probe on Analog Channel 1 that produces a 0 to 5 volt output representing 0 to 100 degrees Celsius could easily be setup to produce a 4 to 20 milliamp output that represents the 0 to 100 degrees. The XL™ does not actually output a 4 to 20 milliamp signal, but rather controls the current in a loop that is powered externally. Figure 2-11 shows a basic connection diagram.

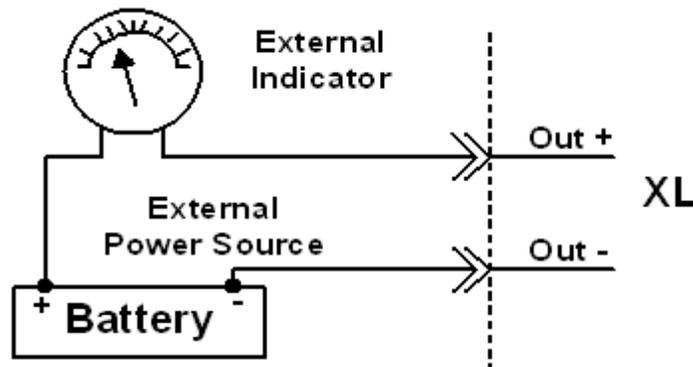


Figure 2-11 Basic 4-20 mA Wiring Configuration

2.2.12 Digital I/O 1 and 2

Pins 14 and 15 of the terminal block provide connection points for the two digital I/O signals. Notice there is no specific ground point for these signals. Use the digital ground pin of the event counter or the SDI-12 ground. **Do not use the analog grounds.**

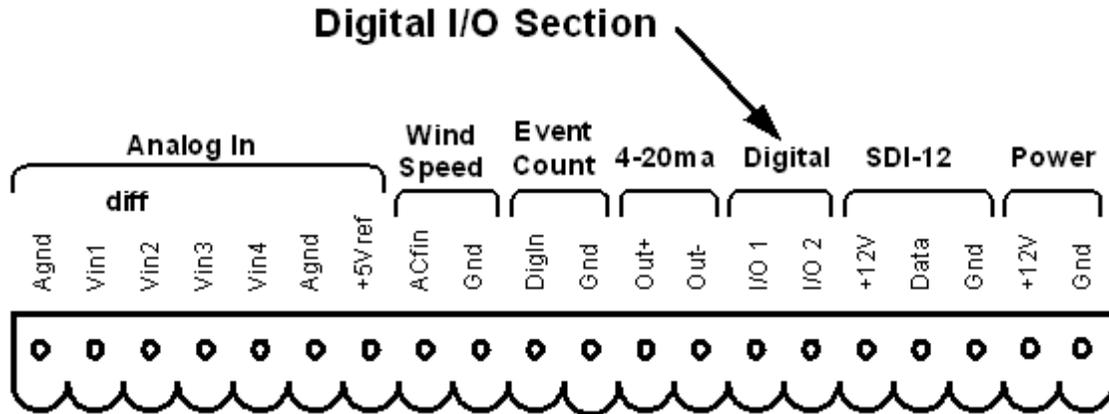


Figure 2-12 Digital I/O Section

The two digital I/O signals can be configured independently as inputs or as outputs. In the input mode, the signal has an internal pull up resistor of 51K Ohms. This allows a switch closure to ground to activate the input. It can also be driven using normal logic levels. As an output, the drive capability is limited by a 100 Ohm protection resistor. The output will still be about 4.0 volts with a 10.0 mA or less load. When both pins are configured as inputs, they may be used as a quadrature shaft encoder input. The two digital signals can also be used to simulate a quadrature shaft encoder. Figure 2-13 shows a simplified schematic of how these pins are configured.

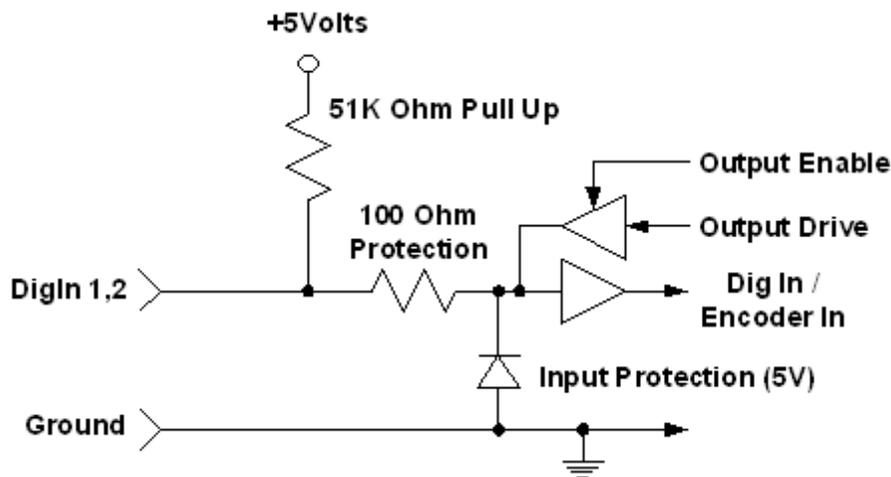


Figure 2-13 Basic Digital I/O Schematic

2.2.13 SDI-12 Section

Pins 16, 17, and 18 of the terminal block provide connection points for SDI-12 sensors and data loggers. The XL™ can be used as both an SDI-12 sensor and as an SDI-12 data logger. In either case these connections are made at the same place. The +12V power connection under the SDI-12 section is limited to about one amp so it may be necessary to connect the SDI-12 sensor power line directly to the battery or to main power.

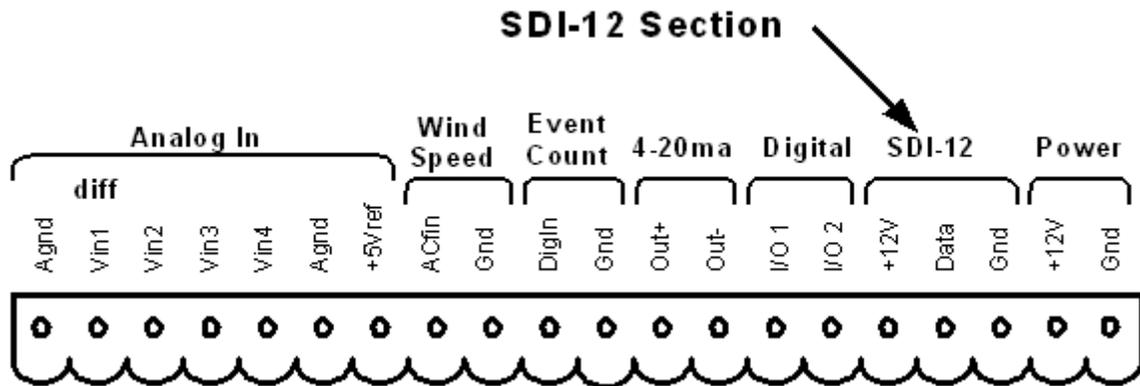


Figure 2-14 SDI-12 Section

If several SDI-12 sensors are to be connected to the XL™, it may be necessary to use an external terminal strip to provide enough connection points.

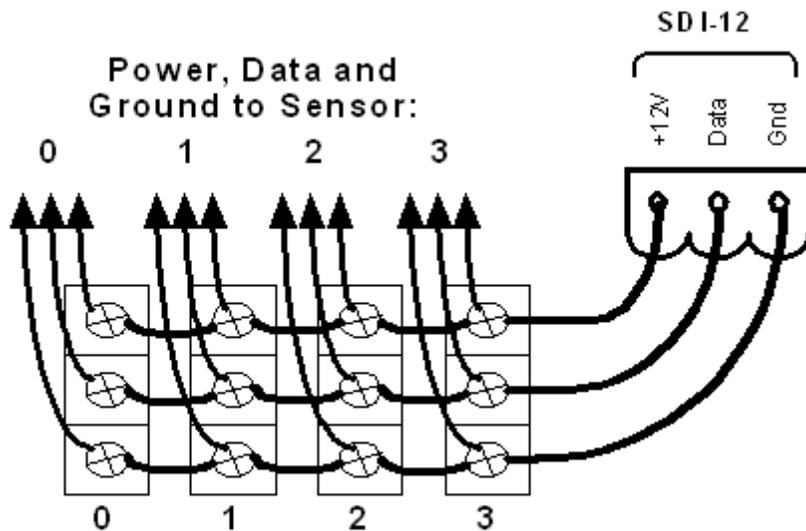


Figure 2-15 SDI-12 Expanded Connector System

2.2.14 Power Connections

The last two pins at the far right of the terminal block provide the main connection points for system power and ground.

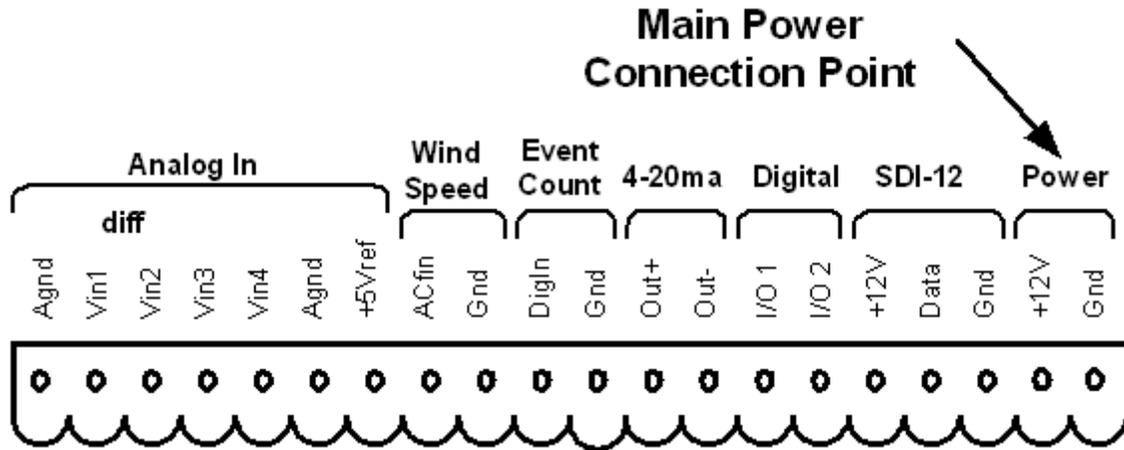


Figure 2-16 Main Power Connection Point

Note: When connecting to or removing the wires from these connection points, it is important to remove the terminal block from the XL™ first, or to have the other end of the wires disconnected from the battery. This helps prevent loose wires with live voltages accidentally come in contact with other I/O connection points.

2.3 Testing the Installation

After hooking up the battery, the Power light should begin flashing every 5 to 10 seconds. This indicates that the battery is providing 10 volts or more to the XL™. Press the display On/Off button and the display should come on, indicating the instrument is functional and ready to use.

You will find detailed user setup information and menu options that will allow complete test and verification of all sensor connections and operation in the next two chapters.

2.4 Hardware Revision Detection

As the XL series data logger has continued to evolve, changes and enhancements involve both the hardware and the firmware. The following list shows some of the major changes to the hardware and how to check as a user what revisions may affect you. For example if your application requires the +12Volt excitation to be switchable, then you must use board revision 3.1 or newer. The firmware can detect the board revision and if an old board is detected, then the menu option to set the +12Volt excitation mode will not be displayed because it has no affect. The table below shows the changes to the hardware over the life of the product.

Board Revision	Description
Rev 2.1	- Original board
Rev 2.2	- New Power down sequence from normal mode to low power mode. This change will not affect the user operation.
Rev 3.1	- New 24 bit A to D converter for the generic analog inputs and stage sensor. The older boards used a 16 bit A to D converter. - Added differential mode to analog inputs 1 and 2. - 500 millivolt range added to all generic analog inputs. - The 12 volt excitation is able to be turned on and off. - Able to use higher baud rates on the serial ports, now up to 115200 baud. The older board would only go to 19200.
Rev 3.3	- A new 16 bit DAC is now used for the 4 to 20 milliamp output option. The older boards used a 12 bit DAC. - A new internal comm port for H-522 and H-522Plus is used for the built in GOES radio. This allows com port 2 on the H-522 and H-522 Plus to still be used for other purposes.

From the built in keypad / display interface the user can see what board revision is in use. Under the 'System Status' menu is a status screen that will show the board revision, for example:

```
Hardware Rev = 3.1
```

Chapter 3

Using The Built In Keypad / Display

3.1 Overview

The XL™ series of data loggers is easy to set up and operate. The built-in display and keypad allow you to view and edit all of the configuration options. This chapter focuses on the operation of the built-in display and keypad. With a built-in keypad and display there is little need for external programming devices such as a laptop computer, but remote operations are supported as explained in chapter 4.

Note: The H-522 has no built in keypad / display, therefore options in this chapter will not apply to the H-522.

3.2 Keypad/Display Operation (Not available with model H-522)

The XL™ can be fully configured using the built-in keypad and display. The user can easily move through the different menus using the arrow keys. Changes are made using the ENTER key and the arrow keys. Most configuration changes are made from a pick list of valid options. Figure 3-1 shows an illustration of the XL™ keypad and display.

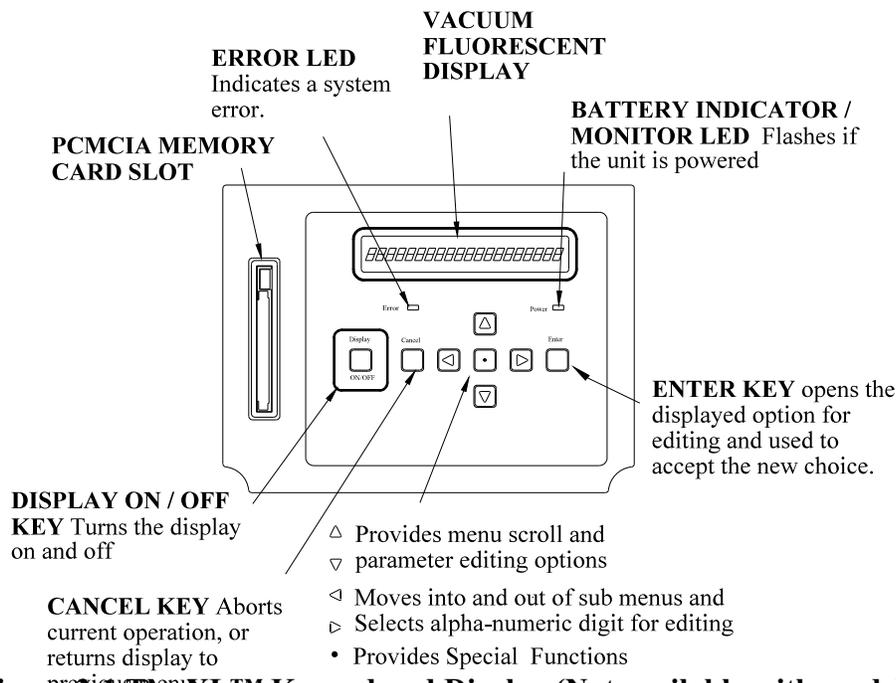


Figure 3-1 The XL™ Keypad and Display (Not available with model H-522)

BATTERY INDICATOR / MONITOR LED or POWER LED

The Power light flashes on and off to show that the XL™ is receiving proper +12V power. If the power source has failed or provides less than +10V, the power light will stop flashing. This is a visual indication that the system battery is low.

ERROR LED

The Error light is not used at this time.

MEMORY CARD SLOT

The memory card slot accepts an industry standard ATA PCMCIA FLASH Memory Card. When operated as a data logger, the XL™ stores the data internally in non-volatile memory. The data can be transferred from the internal memory to an ATA FLASH Memory Card for use in computers that have PCMCIA support. Most laptop PC's have PCMCIA support built into them, and desktop PC's can be equipped with PCMCIA card readers. PCMCIA card readers are available at most PC outlets or from Design Analysis. All XL™ firmware updates are uploaded from an ATA FLASH Memory Card using this memory card slot

ON / OFF Key

The ON/OFF key is used to turn the display on and off. This key will only turn the display off from the top level of the menu system. If the unit is on and in a submenu, this key, much like the CANCEL key, will cause the system to return to the previous menu screen in the menu system hierarchy until the HOME menu screen is displayed, at which time pressing the ON/OFF key will turn the display off.

Note: If the unit does not respond to a key press, it may be in the process of measuring. Wait a few seconds and try again.

To save power, the XL™ display will turn off automatically after **five minutes** of inactivity.

ENTER Key

The ENTER key has four functions:

- I. Pressing the ENTER key while displaying a status screen such as “Stage = 2.45” or “PtTemp = 23.65” will cause the H-350XL™ model to make a new measurement of the selected input and update the screen with the new reading.
- II. The ENTER key acts as a “YES” key on screens that are looking for a yes or no response. For example, pressing the ENTER key on the “Erase Data ?” screen will cause the erase process to start, but pressing the CANCEL key will abort the option.
- III. The ENTER key starts the editing process for fields that can be modified or

changed. These fields are surrounded by brackets such as [Option] . For example, the option “Logging [Off]” can be changed to “On” by pressing the ENTER key to start the editing process, and the text between the brackets starts to flash. In this case the “Off” flashes and the UP and DOWN arrow keys are used to select the “On” option, and the ENTER key is used to accept the change.

- IV. The ENTER key is used to accept edits or changes. For instance, if you changed the option “Stage Units [Feet]” to “Stage Units [Meters],” you would press the ENTER key to accept the change and the selection would stop flashing.

CANCEL Key

The CANCEL key has three main functions:

- I. The CANCEL key is similar to the Escape key on your computer. For example, if you are editing an option and decide not to make a change, pressing the CANCEL key will abort the change.
- II. The CANCEL key also works as a “HOME” key. If you are in a sub-menu and wish to return to the previous menu, press the CANCEL key. Pressing the CANCEL key several times will always take you to the beginning menu screen.
- III. The CANCEL key acts as a “NO” key on screens looking for a yes or no response. For example, pressing the CANCEL key on the “Erase Data?” screen will abort the option.

Arrow Keys

The UP, DOWN, LEFT, and RIGHT arrow keys have the following functions:

- I. The UP and DOWN arrow keys enable you to scroll from one menu to another. When you reach the bottom screen, the DOWN arrow key will no longer work. When you are at the top screen, the UP arrow key will no longer work.
- II. When moving through the menus, the LEFT and RIGHT arrow keys allow you to move into and out of sub menus. Screens that have an arrow (->) on the right side of the display have associated sub menus.
- III. The LEFT and RIGHT arrow keys let you move the cursor back and forth across the field when editing a numerical value such as the slope or the offset. The digit or blank space will flash to let you know the location of the cursor within the field. When editing numerical or character options, the UP and DOWN arrow keys let you move through the list of valid characters or options.
- IV. The UP and DOWN arrow keys enable you to scroll through the options within a menu. For example, if you want to change the XL™ logging option from [Off] to

[On], start the editing process by pressing the ENTER key, and then use the UP and DOWN arrow keys to choose the desired option. Once the desired option is selected, pressing the ENTER key will accept the change and the new option will be displayed.

DECIMAL (or Dot) Key

When editing an option screen with a pick list of valid options, the DECIMAL key lets you toggle between the first and last option in the list. This is very useful when you want to select an option near the bottom of a large list.

When first turned on and a status screen is displayed, pressing the DECIMAL key will cause the menu system to skip all the status screens and move directly to the first menu item past the status screens. This is handy if several status screens are used.

DISPLAY

The 1 line by 20 character display is used to view and edit all of the menu items. Each screen represents a unique menu item or system option. There are four types of menu screens: status screens, sub menu header screens, option screens, and table screens.

STATUS SCREENS

Status screens are normally used to display system information or sensor values. The user can select what values or information is used for status screens. The system will automatically update some status screens, such as the battery voltage. As the battery voltage level goes up and down the displayed value will go up and down automatically.

BATT = 13.2 Volts

There are a few status screens the user can have the system update. A screen that shows the stage value may be displaying a value that was measured several minutes earlier. Pressing the ENTER key will cause the system to take a new measurement and display the new value. When the ENTER key is first pressed the display will show the following screen indicating the ENTER key was acknowledged, and a measurement is in process.

Scanning...

The updated status value will be redisplayed once the measurement is complete.

Stage = 34.56

SUB MENU HEADER SCREENS

Screens that have an arrow (->) on the right side are classified as sub menu header screens. The sub menu may be entered by pressing the RIGHT arrow key. There may be several levels in a sub menu, and each sub menu relates to the header screen text. For example, the sub menu options of the main menu header screen “Scan Setup” relate to the scanning process.

Scan Setup	->	Scanning [Off]
		Scan Rate [HH:MM:SS]
		Next Scan = HH:MM:SS
		Nxt Scn At[HH:MM:SS]

OPTION SCREENS

Screens with brackets surrounding a system option ([Option]) are called option screens. The user can edit or change the option which will always be shown between the brackets. In some cases, the option inside the brackets may include several characters, but the editing process will only change one character at a time, such as with the time or the date value.

Time [12:34:42]

Pressing the ENTER key will start the editing process, and one of the characters in the brackets will begin to blink. The UP and DOWN arrow keys are used to change the blinking character, and the LEFT and RIGHT arrow keys are used to move to the next character. Pressing the ENTER key will accept the new value, or pressing the CANCEL key will keep the original value.

On some option screens, all of the text between the brackets will flash when the option is to be edited. The UP and DOWN arrow keys are used to select a valid option from a list specific for that option.

Baud Rate [9600]

Pressing the ENTER key will start the editing process and the text “9600” will start blinking. Use the UP and DOWN arrow keys to change between valid choices of 19200, 9600, 4800, 2400, 1200 or 300 baud, or use the DECIMAL key to toggle between the first and last option of the list. Press the ENTER key to accept the new value or the CANCEL key to stay with the original value. For these type of options, invalid entries are not possible.

TABLE SCREENS

Complex screens that look like both option screens and sub menu header screens are called table screens. The following table shows the menus used to define the logging report options.

Source 1 [Date] ->	Source 2 [Time] ->	...	Source 25 [None]
Header 1[] ->	Header 2[] ->	...	Header25[]
Log Rate 1[00:15:00]->	Log Rate 2[00:15:00]->	...	Log Rate25[00:15:00]
Digits 1 [2] ->	Digits 2 [2] ->	...	Digits 25 [2]
Col 1 Fn() [NOW] ->	Col 2 Fn() [NOW] ->	...	Col 25 Fn() [NOW]
Stat Scrn 01 [No] ->	Stat Scrn 02 [No] ->	...	Stat Scrn 25 [No]

The LEFT and RIGHT arrow keys let you to move through the table horizontally, and the UP and DOWN arrow keys let you to move through the table vertically. While moving through a table, pressing the CANCEL key will take the system back to the sub menu header screen used to enter the table. Options in the table may be edited as previously explained.

3.3 Familiarization

The best way to become familiar with the system is to explore the system options and features. Turn the unit on, move through the menus, and make changes to some of options in order to experiment with the system. Do not worry about mis-programming the unit, the “Reset Defaults” option will change the unit back to the factory settings.

3.4 Main Menu Description

The tables on the following pages show the main menu structure of the XL™. The main menu includes status screens, which allow the user a quick view at sensor data, and sub menu header screens that separate the main configuration options of the XL™ into their respective sections.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

This table represents the main menu of the XL™ Series DCP. The user can easily move through the menu using the UP and DOWN arrow keys. Pressing the CANCEL key repeatedly will cause the system to return to the top of this menu structure.

Menu items with the pointer (->) on the right side of the screen have a sub menu related to the displayed menu. Use the RIGHT arrow key to enter the sub menu.

Use the CANCEL key or the LEFT arrow key to return from the sub menu to the header screen in the main menu.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

← The shaded screen on the left is a user definable status screen showing the last measured stage value. When the display is turned on, this screen will be displayed (unless the user changes or disables the status screens). This screen is also considered the “HOME” position, as pressing the CANCEL key several times will always cause the system to return here.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->



The 25 log columns can be enabled as status screens. The user defined header text is the label used for the status screen. The default status screens the H-350XL report the last measured stage value, the last measured internal system temperature, and the current battery voltage. The other status screens are initially disabled.

Note: Depending on the XL™ Series Model the status screens by default will be different from each other. All the XL™ Series DCP's are programmable to use or disable the status screens.

Status screens are enabled or disabled in the logging options table, see chapter 15.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->



The “Sensor Input Setup” screen is a sub menu header screen as indicated by the arrow (->). Pressing the RIGHT arrow key will cause the system to enter into the sub menu for all of the sensor input setup options of the XL™. For example in the H-350XL™ model this menu would include defining how the pressure sensor will be used to calculate the stage value and defining how the temperature sensor will report its results. This menu also is used for defining the generic analog inputs, the counter input, etc.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options -> ←
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

The “Output Options” screen is a sub menu header screen. The sub menu options allow the user to indicate what to do with the data once it has been measured. The data can be saved to internal memory, sent to a GOES transmitter, sent to a printer or terminal through the serial port, or converted to a 4 to 20 mA signal and sent to other types of control equipment. Some of the options here are complex enough that they are described in a separate chapters dedicated to the application.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options -> ←
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

The “Data Options” screen is a sub menu header screen. The sub menu options allow the user to erase data, copy data to an external data card, view the data file, and see how many free bytes are still left in data memory or on the data card. For more information refer to the Data Options chapter.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

The “Scan Setup” screen is a sub menu header screen. The sub menu options allow the user to enable and disable scanning and define how often to scan the connected sensors.

NOTE: Scanning is the heart of the system. All major operations are based on scanning being enabled. Logging, GOES radio operations, ALERT radio operations, and several other options will only happen if scanning is enabled.



Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->

The “System Setup” screen is a sub menu header screen. The sub menu options under this heading are used to define generic system options such as the time of day, date, serial port settings, etc.



Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->



The “System Status” screen is a sub menu header screen. The sub menu options under this heading are used to view how the system is operating; if there have been any unexpected power resets, battery voltage levels, etc.

Stage = X.XX
PtTemp= XX.XX
BATT = XX.XX
Sensor Input Setup->
Output Options ->
Data Options ->
Scan Setup ->
System Setup ->
System Status ->
Accessory Setup ->



The “Accessory Setup” screen is a sub menu header screen. The sub menu options under this header allow the user to control accessory products connected to the XL™ such as the H-355 Bubbler system. The H-355 bubbler is discussed in a separate chapter.

Chapter 4

PC Menu Interface Operation

4.1 PC Menu Interface

All remote communications with the XL™ are through a command interface or menu interface using the first RS-232 Serial Port. **Note:** A NULL modem connector must be used between the PC and the XL™ for direct connections. If in the command mode, the command “MENU” is used to start up the menu interface allowing simple human access to the system options. To access the command or menu interface, the XL™ must be connected to a computer that is running some type of terminal emulation program. The terminal emulation program must use the same communication settings as used by the XL™. The default XL™ communication settings are shown below along with other valid options.

COMMUNICATION SETTING	DEFAULT XL™ SETTING	OTHER XL™ OPTIONS
BAUD RATE:	9600	300 to 19200 on hardware Rev A to M 300 to 115200 on hardware Rev N up.
DATA BITS:	8	None
STOP BITS:	1	None
PARITY:	None	None
DUPLEX:	Full	None
TERMINAL EMULATION:	VT-100, (VT-52 on older firmware versions)	None VT-52, VT-100
FLOW CONTROL:	Software (Xon / Xoff)	None or Hardware
STARTUP MODE:	Menu Mode (SW Rev 2.04) (Command mode on older Versions)	Command Mode, Menu Mode

Basically all options available through the menu interface are also available using the command interface or the built in keyboard and display. This chapter focuses only on the remote menu interface.

When the computer is connected (direct connection or modem connection), pressing any key will wake up the XL. If the XL is set to startup in menu mode then the main menu will be displayed.

If the startup mode is set to command mode, then pressing the ENTER key a few times will cause the command interface prompt to be displayed. This prompt appears as an arrow “->” on the left side of the screen. It may take a few key presses to “wake up” the XL™ and display this prompt. Once the prompt is displayed, the XL™ is ready to receive commands. If no commands are received in a five minute time period, the XL™ will turn off automatically and return to a low power mode. Enter the command “MENU” at the prompt to access the menu interface.

4.2 PC Menu General Operations

Each menu option is preceded with a letter or number that when pressed will activate the indicated option. The ENTER key **does not** have to be pressed after an option key is pressed. Some options will open a sub menu and others will allow the user to set or change a system parameter. When in a sub menu, pressing the ESC key will back up one menu. At the main menu the ESC key has no effect. Pressing the ENTER key or SPACE bar at any time will refresh the current screen.

At the bottom of each menu screen is an “Enter Option >” prompt. When an option key is pressed that allows a system parameter to be changed, any additional information for that option will be displayed after the prompt. There are two types of system parameter change options, first is an option that requires direct keyboard input like a file name or a column header label. The second is an option that has a pick list of valid options such as an input source option. This type of option allows the user to scroll through the valid options using UP and DOWN arrow keys. Pressing the ENTER key will select the option that is visible.

4.3 Main Menu Screen

The following shows what the “Main Menu” screen looks like. This may also include a user defined ‘welcome message’ on the top line of the display. The product here is shown as an H-350 XL but could be any of the XL series of products.

```
H-350 XL Main Menu
V - View Status
I - Sensor Input Options
D - Data Options
O - Output Options
S - Scan Options
C - Configure System
A - Accessory Setup
E - Enter Command Mode
X - Exit
Enter Option >
```

Each option in the main menu is a link to a submenu. Each section will be described in detail in a later chapter dealing with the specific menu items.

- V - View status:** Displays the main system status information.
- I - Sensor Input Options:** Used to configure the sensor input parameters such as slopes and offsets for the analog inputs, configure the Digital I/O modes, and SDI-12 sensor configuration.
- D - Data Options:** Allows the user to retrieve data from the unit, erase data from memory and perform other internal data and card operations.
- O - Output Options:** Defines if and how the data is stored internally, transmitted via GOES or displayed on remote displays, etc.
- S - Scan Options:** Defines when and how often the unit scans the sensors, and performs data output operations.
- C - Configure System:** Used to set basic system options such as time and date, site ID, serial port options and other system level options.
- A - Accessory Setup:** Configures system accessories such as the H-355 bubbler.
- E - Enter Command Mode** Exit the menu mode and enter the command mode immediately.
- X - Exit** Exit the menu mode and return to the low power sleep mode.

Chapter 5

Miscellaneous System Setup

5.1 Overview

The following menu structure represents all the sub menus under the “System Setup” header. General system options unrelated to input options or output options are normally found here. These options include setting the time and date, and defining a name for the site. Other options for saving and retrieving setup information or resetting the system to factory defaults are also found here.

Several of the options under this menu are big or complex enough that they are explained in their own chapter.

5.2 System Setup

Built in Menu Structure: System Setup Options Menu.

The order of options in the built in menu differs slightly than that of the PC menu options. The text below will follow the order of the PC menu.

System Setup	->	Time [HH:MM:SS]	
		Date [MM/DD/YY]	
		Date Fmt [MM/DD/YY]	
		Sync [Sync Disabled]	
		Sync Time Now?	
		Last Synced On DD/MM	
		Site ID [Site_ID]	
		Advanced Options ->	== See Section 5.4 ==
		Serial Port Setup ->	== See Chapter 6 ==
		SDI12 Sensor Setup->	== See Chapter 14 ==
		SDI12 Logger Setup->	== See Chapter 14 ==
		System Config Opts->	== See Chapter 7 ==
		Functions Options->	== See Chapter 21 ==
		XL-Basic Options->	== See Chapter 22 ==
		Update Firmware?	

PC Menu Screen: System Setup Options.

```
System Setup          (Esc to Return)

T - Time:           HH:MM:SS
D - Date:           MM/DD/YY
E - Date Fmt:MM/DD/YY
I - Site ID: Site_ID
A - Advanced Setup Options
M - SDI Sensor Mode Setup          (See chapter 14)
L - SDI Logger Mode Setup          (See Chapter 14)
P - Port Setup                    (See Chapter 6)
C - Configuration Files            (See Chapter 7)
R - Reset Defaults                 (See Chapter 7)
G - Sync Time Options
F - Functions Menu                 (See Chapter 21)
B - XL-Basic Code Menu             (See Chapter 22)
U - Update Firmware

Enter Option >
```

PC Interface View

Built In Display Screen

T - Time: HH:MM:SS

Time [HH:MM:SS]

This option is used to check or set the time clock used by the data logger. This is normally set to local time or to international standard time. This is the time used to tag each scan placed in the data file. This is a different time clock the one in the GOES radio. The GOES radio time clock is normally set automatically by a GPS system and must be set to international standard time. The display will be updated each second to allow easy viewing of the current time.

PC Interface View

Built In Display Screen

D - Date: MM/DD/YY

Date [MM/DD/YY]

This option is used to view or set the system date. The default format is MM/DD/YY, but it may be changed using the date format option if needed.

PC Interface View

Built In Display Screen

E - Date Fmt: MM/DD/YY

Date [MM/DD/YY]

This option is used to set the date format. The default format is MM/DD/YY, but it may be changed to other formats such as DD/MM/YY, YY/MM/DD, or DD/MM/YYYY. This format will be used when the date is logged to the data file.

I - Site ID: Site_ID

Site ID [Site_ID]

This option allows the user to enter in an eight character label that defines the site. This will also be used as the filename for data files and other files related to this site. A file extension will be added automatically when the file is created. Data files will have a numerical extension such as .000 .001 or .002 and so on up to .099. Configuration files will have a .CFG extension. A system log file will have a .LOG extension. Other file types will also exist using this variable as the file name.

Note: Since the ‘Site ID’ variable is used as a file name, it must not contain any imbedded blanks or wildcard characters (*) and must be left justified, in other words it must be a DOS compatible filename. Valid site ID labels may include letter, numbers, or the underscore. Spaces are not valid characters for the site ID as they will cause an error and may prevent a file from being opened.

U - Update Firmware?

Update Firmware

This option is used to update the operating system firmware. As new versions of software are produced, they will be placed on the web at www.waterlog.com. Users can download new or even older versions of the software. The file will be a ZIP file that normally will contain two files, first is a bin file that is the new firmware, and the second is a PDF or text file that will have documentation on it related to the changes in the firmware. The user should read the PDF file to make sure they understand the changes in the newer version of firmware. There may be no reason to update a unit if the new changes are not needed. It is not necessary to update every time a new version is released, however it is best not to let too many versions go by without updating. Each release may also fix small problems in the code that may or may not be listed in the update documentation. Also it is easier for the customer service group to help out on the newer versions of firmware. Here is a step by step list of the update process.

- 1 - The user downloads a zip file from the web page.
- 2 - Unzip the files and read the update overview file to see if the new options are needed or not.
- 3 - Load the bin file onto an ATA data card and insert the card into the XL.
Note: Do not put the zip file on the data card.
- 4 - Start the update process using the “Update Firmware” option as shown above.

- 5 - The XL will save a configuration file on the internal data card called update.cfg. Then the XL will list the files on the ATA card and allows the user to use the Up and Down arrow keys to select the desired bin file. Press the ENTER key to accept the selected file.
- 6 - The XL will erase the main program memory and then loads in the new firmware.
- 7 - When the new firmware is done loading the XL will initialize new variables. This makes sure any new variables associated with the new version of firmware is in an acceptable range. This actually resets every option to the factory default value.
- 8 - Last of all the XL will reload the update.cfg file to set up the unit as close to the same mode it was before the update started.
- 9 - The user should look over the settings to verify they look as expected.
- 10 - To make sure the new version was loaded correctly and to check the RAM run a checksum test and make sure it passes and that it indicates the stack is ok. If the checksum test fails try reloading the firmware again. If the stack is bad then cycle power to the unit and try the test again.

5.3 Time Sync Options

The new high data rate GOES Radio operations require very accurate time clocks. In most cases on board timers are unable to maintain the needed accuracies. In this case the XL™ and the GOES Radio can be synchronized via a GPS system.

The built in menu structure lists three optional screens for the time sync options but the PC menu has a separate menu for these same options.

PC Menu Screen: Time Sync Options.

```
Time Sync Options   (Esc to Return)

Last Sync On: 00/00
T - Time:         20:35:54
D - Date:         02/20/03
S - Sync:         Sync Disabled
N - Sync Time Now

Enter Option >
```

PC Interface View

Last Synced On: MM/DD

Built In Display Screen

Last Synced On MM/DD

There are several different time sync options and which one to use depends on the type of radio in use. Refer to the section below ‘S - Sync’ options to see if the time sync options should be used and how they will behave.

This is normally only used with older GOES radios that did not have GPS capabilities and is not needed with the newer radios.

This is a status screen used to see when the time clock was last synced. It will show the day and month only. If it is used, then most cases it will show the current day or one day ago which could still be within the last 24 hour period. If the date is a few days old then it indicates the system has not synced for a few days.

If this sync is disabled or the unit has never synced then this will show 00/00.

If the GOES radio has a built in GPS system, then this option is normally disabled and the GOES radio will still be syncing normally. This is the case with the Signal Engineering SE1200 and Omnisat radios, and the Microcom radio.

The time sync functionality is normally associated to the GOES radio operation. Keep in mind when using a Signal Engineering model SE100 or SE300 radio, the system will not stop transmitting based on no time sync. On a model SE1200 radio it must sync at least once every 7 days or transmissions will be stopped regardless of what baud rate is used.

PC Interface View

Built In Display Screen

T - Time: HH:MM:SS

Time [HH:MM:SS]

On the PC interface, this option is normally only used to see and verify the current time, yet it can be used to set the time also. Notice it is exactly the same as the time option in the menu one level up.

On the built in menu the normal “Time” option must be used to see if the time sync is working correctly.

If the user notices the time is not correct and a valid sync mode is selected, they can use the “Sync Now” option to cause the unit to sync immediately and use this option to verify it was successful.

PC Interface View

Built In Display Screen

D - Date: MM/DD/YY

Date [MM/DD/YY]

On the PC interface, this option is normally only used to see and verify the current date, yet it can be used to set the date also. Notice it is exactly the same as the date option in the menu one level up.

On the built in menu the normal “Date” option must be used to see if the time sync is working correctly.

PC Interface View

Built In Display Screen

S - Sync: Sync Disabled

Sync [Sync Disabled]

The accuracy of the time clock in the XL™ may not be as accurate as needed as it may vary a couple of seconds per day. If a GOES radio is part of the system the XL™ may be synced to the GOES clock which normally has less drift. It is also possible to sync to a GPS system that will be very accurate. If the time is synced to the GOES radio or to a GPS system, then the time of the XL™ will normally be set to international standard time. Valid sync options are as follows:

Sync Disabled: This is the default selection. The data logger will not sync to any time source. The time and date must be set manually. If the GOES radio is used and it has GPS options, then the radio may still be syncing to the GPS system but the logger is not.

Logger to GPS: This option syncs the logger clock only to the GPS system. In this case the GPS system must be the H-339 “Time Keeper” from Design Analysis. This selection will not update a GOES radio. This option is not widely used.

GOES to GPS: This option syncs the GOES clock only to the GPS. In this case the GPS system must be the H-339 “Time Keeper” from Design Analysis. This selection will not update the data logger time clock. This option is normally only used with older Signal Engineering GOES radios that did not incorporate a GPS receiver. This could not be used with the Telonic’s radios.

Both to GPS: This option syncs both the logger clock and the GOES clock to GPS. In this case the GPS system must be the H-339 “Time Keeper” from Design Analysis. This option is normally only used with older Signal Engineering GOES radios that did not incorporate a GPS receiver. This could not be used with the Telonic’s radios.

Logger to GOES: This option syncs the logger clock to the GOES clock. In this case the GOES radio may or may not be using a built in GPS system. In any case the time clock in the GOES radio is more accurate than the logger clock and in any case this will keep the two clocks the same. This is commonly used when the GOES radio utilizes a GPS receiver and the user wants to set the logger to the same time as the GOES radio. This would be international standard time.

Sync Each Scan: This is a test mode for the H-339 “Time Keeper” used in manufacturing and design. Normal applications should not use this mode.

When the sync option is selected, the time will be synched according to the option selected once daily following the first scan after midnight 12:00 AM (00:00:00 GMT).

PC Interface View

Built In Display Screen

N - Sync Time Now

Sync Time Now?

This option is used to force the system to sync the time immediately. This is normally used during an installation of a new site or on a site visit to see if the system is working properly.

5.4 Advanced System Setup Options

There are a few system options that are used or changed very seldom. Some of these options are added for very specific applications.

Built in Menu structure: Advanced system Setup Options.

System Setup ->	Advanced Options ->	SignOn Msg [#]
		Use PassWord [No]
		Password [#123]
		Sys TimeOut [300]Sec
		AutoOff Enabled
		Side Button Setup ->
		Excite Warmup [00]Sec
		+12VX On [Always]
		User Mode [Normal]

PC Menu Screen: Advanced System Setup Options.

```

Advanced System Setup Options:   (Esc to Return)

W - Welcome Message:   #
E - PassWord Enabled:  No
P - PassWord:          #123
T - System Timeout:    300
A - AutoOff Enabled:   Yes
B - Side Button Mode:  Hold to Update
U - User Mode:         Normal
D - Excitation Delay:  0
S - Switched Excitation On: Always

Enter Option >
  
```

PC Interface View

W - Welcome Message: #

Built In Display Screen

SignOn Msg [#]

The welcome or sign on message will be displayed on the top line of the main menu on the PC interface. On the built in menu it will be the first message displayed when it is turned on. This can be most any text message up to 20 characters long. If the first character of the sign on message is '#' then the option is disabled.

PC Interface View

Built In Display Screen

E - PassWord Enabled: No

Use PassWord [No]

There is a password option for the built in menu that is enabled using this option. When enabled the status screens will be accessible but any other options will be hidden until a valid password is entered.

PC Interface View

Built In Display Screen

P - PassWord: #123

PassWord [#123]

This option is used to set a password. The "#123" is a default that could be used if the user defined password is lost.

PC Interface View

Built In Display Screen

T - System Timeout: 300

Sys TimeOut [300]Sec

This is a timeout used to turn off the unit if the user leaves it idle. The default is 300 seconds. This can be set between 15 and 600 seconds.

PC Interface View

Built In Display Screen

A - AutoOff Enabled: Yes

AutoOff Enabled

This option is used to enable or disable the auto off feature. There may be a time that the user needs to keep the display on all the time so they can watch automatic updates of some system variable. On the built in menu pressing the Enter key will toggle this option.

PC Interface View

Built In Display Screen

B - Side Button Mode: Hold To Update

Side Button Setup ->

The side button can be programmed for different functions:

Hold To Update: When the unit is turned off, pressing the side button will turn it on then displays the value of the first item defined in the log report. Press and hold the button for a few seconds will cause the current value to be updated. Pressing the button and quickly releasing it will cause the next item defined in the log report to be displayed.

- Live Readings:** When the unit is turned off, pressing the side button will turn it on and display the value of the first item defined in the log report. The value will be updated automatically. Pressing the button causes the next item in the log report to be displayed. If the current sensor takes a long time to update such as an SDI12 sensor, then pressing the button may be ignored until the value is updated.
- Run Pgm BASIC1:** In this mode pressing the side button causes the unit to execute the BASIC-1 program.

PC Interface View

Built In Display Screen

U - User Mode: Normal

User Mode [Normal]

The user mode option has always been a part of the XL series data loggers but until recent versions has resided in a hidden menu, only accessible by the manufacture or select customers that need access to this option. The default setting for this option is ‘NORMAL’ which handles 95% or more of our users. There are a few applications that require special handling. There are some customers that have bought several hundred units and require a simple user mode for there organization. For these reasons the user mode option exists. Below is a quick description of the different user modes.

- Normal:** This is the most common used mode and used by over 95% of the users. The manual is also based around this mode.
- NOAA:** This mode is only used with the H-350XL. This mode is intended for NOAA when they or one of there contractors is running a PORTS application. NOAA uses a special measurement algorithm when measuring water levels. This basically is a 3 minute averaging technic this returns an average, standard deviation, and number of outliers. This also collects data at a 6 minute rate. In this mode the GOES data is also formatted based on there requirements. The GOES format uses binary data with ASCII tags to identify the data. This format requires special decoding. For complete information on this mode request the supplement “NOAA GOES Format”. Again, this is only valid on the H-350XL.
- LCRA:** This mode only applies to the H-350XL. This stands for Lower Colorado River Authority. In this mode whenever the H-350XL measures the stage, the resulting value is placed in the SDI-12 buffer so if the H-350XL is used as a sensor connected to an SDI-12 master, the master can collect the data at any time from the last measurement simply by issuing the data retrieval command, aD0!.
- NIWA:** NIWA is the leading provider of Atmospheric and aquatic data and services in New Zealand. The main difference here is the factory defaults are different than

when in the normal mode. These options may change from one version to another based on their desires.

- SRP:** SRP is Salt River Project, a major water management organization in Arizona that have bought large quantities of units. In this mode a couple of the menus have been changed for their needs.
- INSAT:** This is the mode required when used in India and transmitting data to the Indian satellite system.
- MSATG2:** This mode is used for the mid eastern satellite system generation two. The GOES radio currently manufactured by Signal Engineering can work for this network but must be set to handle the different frequency range. For more information on this mode request the supplement “Meteosat Operation”.
- MSAT_I:** This mode is used to set the GOES radio to use the international frequencies and is used with the original mid eastern satellite system. The GOES radio currently manufactured by Signal Engineering can work for this network but must be set to handle the different frequency range. For more information on this mode request the supplement “Meteosat Operation”.
- FIRELG:** This mode is intended for use by the Bureau of Reclamation, forest and range fire units. When the unit is in this mode and the unit is reset to factory defaults, several options are set based on their needs and are different from the normal settings.

PC Interface View

Built In Display Screen

D - Excitation Delay: 0

Excite Warmup [00]Sec

This option is used to delay the actual scan process for xx seconds after the excitations have been turned on. This is for both the +12 volt and the +5.0 volt excitation. The default is 00 seconds and it can be as long as 99 seconds. When set to 00 seconds there will still be about a half second delay in order to allow the excitations to stabilize.

PC Interface View

Built In Display Screen

S - Switched Excitation On: Always

+12VX On [Always]

This option is used to select when the +12 volt excitation should be turned on. The two options are “On Always” meaning never turn off. The other option is “On At Scan” meaning only turn on when the unit turns on to scan. On older hardware this excitation could not be turned off. This option may not be displayed when this version of firmware is used with older hardware.

Chapter 6

Serial Port Options

6.1 Introduction

The serial port setup options are found under the the “System Setup” or System Configuration” menu. Since the options for the serial ports are an integral part of the operation of the unit they will be discussed in their own chapter.

6.2 Serial Port Menus

Built in menu structure: Serial Port Options Menu

System Setup	->	Serial Port Setup	->	BaudRate Com1 [9600]
				BaudRate Com2 [9600]
				BaudRate Com3 [9600]
				StartUp 1 [Menu Mode]
				StartUp 2 [Menu Mode]
				StartUp 3 [Menu Mode]
				Flow Control [XXX]
				Char Delay [XXX]
				Line Delay [XXX]
				Emulation [XXXXXX]
				Quiet Mode [Off]
				QuietModeDur[XXX]

PC Menu Screen: Serial Port Options.

```
Port Setup          (Esc to Return)

B - Baud Rate, Com 1: 9600
                   Com 2: 9600
                   Com 3: 9600
S - StartUp Mode Com 1: Menu Mode
                   Com 2: Menu Mode
                   Com 3: Menu Mode
F - Flow Control: SW
C - Character Delay: 000
L - Line Feed Delay: 000
T - Terminal Emulation: VT-100
Q - Quiet Mode:      Off
D - Quiet Mode Duration:015

Enter Option >
```

PC Interface View

Built In Display Screen

B - Baud Rate, Com 1: 9600

BaudRate Com1 [9600]

This option sets the baud rate for the selected serial port. This can be serial port 1, 2 or 3. This is the baud rate that will be used when the port is used for the menu interface, command mode, BASIC programs and the auto print functions. There are some processes that use the serial ports that require a different baud rate and will override this selection. For example the ALERT radio only functions at 1200 baud, GOES is always 9600, and modbus must be set to 9600 or 19200 baud and is selected under the modbus options menu. Some older modems and some cell phone modems work best as slower baud rates such as 1200. Valid baud rates are 115000, 57600, 38400, 19200, 9600, 4800, 2400, 1200 and 300. Older units have hardware that only allow baud rates of 19200 and slower. The default baud rate is 9600 for all three serial ports.

PC Interface View

Built In Display Screen

S - Startup Mode Com 1: Menu Mode

Startup 1 [Menu Mode]

This option allows the user to select how the unit will start up when woken up over the serial port. The default mode is to start up in a menu mode but it may be desired to start in the command mode. When using the voice modem in the voice mode it must be in the command mode. Notice the three serial ports may be set up differently from each other as required by the application. Valid options are:

Menu Mode In this mode, when the unit is woken up by activity on the serial port the menu will be displayed on the connected PC screen. This is the easiest method to set up

and test the unit. This is the default startup mode.

Cmd N/Echo This is command mode with echo off. This mode is normally used for machine to machine application. There are no prompts used to indicate the unit is ready. Pressing the ENTER key three or four times will turn on the echo function and a prompt will be displayed.

Cmd W/Echo This is command mode with echo on. This is normally used when a user is hand typing the commands so that they can see what is being sent to the logger. In this mode a command prompt is displayed indicating the unit is ready to receive commands. The prompt is a simple arrow pointer “->”.

Network This is a very specialized mode. This is a command mode similar to the command mode with no echo. The prompt will never be displayed. In this mode the unit will only respond to commands that are intended for this unit. To isolate this unit from the others the site ID is used as part of the command and is placed in brackets. For example:

{site1}time?

This would cause the unit called site1 to respond with its time. Any other unit would not respond. Now the serial ports are normally used for point to point communications. In this mode it is point to multipoint or one PC communicating to two or more XL series data loggers. Normally this mode is only used with an RS232 radio connected to the serial port and the radio link is what provides or allows the multipoint functionality.

PC Interface View

Built In Display Screen

F - Flow Control: SW

Flow Control [SW]

Flow control is used to pace the data through the serial port. It is important not to send data faster than the receiving system can receive it. There are two types of flow control, software and hardware flow control.

Software flow control (SW) is also referred to as XON / XOFF. When this is enabled the receiving system will send a character (XOFF) to the XL™ instructing it to stop sending data until the receiving system can catch up. At the point the receiving system is ready it will send an XON to the XL™ indicating it is ready for more data. When software flow control is selected it will only be used during data transfers, not while navigating through the menus or by other processes that use the serial ports. Software flow control is the default selection.

NOTE: If using XMODEM protocol for data file transfers, software flow control should not be

used as a binary checksum value is calculated for each block of data and transferred with the data block. If the binary checksum value is the same as an XOFF command, then the system may stop the data transfer prematurely.

Hardware flow control uses two extra pins on the 9 pin connector. This is 'Request to Send' (RTS) and 'Clear to Send' (CTS). Normally a PC connected to the XL™ will turn on the CTS signal when it is ready to communicate and watches the RTS signal before it sends anything to the XL™. The same type of monitoring will be done by the XL™, It will not send anything to the PC if CTS is not on and will turn on RTS indicating to the PC it is ready.

NOTE: Hardware flow control should only be enabled on the PC when the XL™ is turned on. If hardware flow control is enabled on the PC and the XL™ is off, the PC will not be able to turn on the XL™ because the PC will wait for the RTS signal to go active before sending the wake up characters, and RTS will only go active when the XL™ is turned on over the serial port.

PC Interface View

Built In Display Screen

C - Character Delay: 000

Char Delay [000]

This sets a time delay between transmitted characters in milliseconds. Some modems, normally a radio modem, may require this type of control in order to pass valid data through the serial port. When using a modem everything may look fine and then all at once it looks like garbage. This may be an indication of overflowing a buffer in the modem and it was not able to warn the XL™ soon enough to prevent the problem and the data becomes junk. Try setting the character delay at 005 and then working up as needed. A combination of a character delay and the line delay may provide the best system operation. The default is 0.

NOTE: This only applies to com port 1 at this time.

PC Interface View

Built In Display Screen

L - Line Delay: 000

Line Delay [000]

This is a delay used at the end of each line of data sent out the active serial port. This is in milliseconds. This used in combination with the character delay may be required by some modem applications. The default is 0 indicating no delay.

PC Interface View

Built In Display Screen

T - Terminal Emulation: VT-100

Emulation [VT-100]

Terminal emulation is used to control computer screen operations like clearing the screen or

moving the cursor around to update different portions of the screen without having to redraw the complete screen. If the information on the screen appears to be from the XL™ but is displayed in abnormal places or intermixed with abnormal characters, then emulation is the most probable cause of the problem. The two emulation modes supported are VT-52 and VT-100.

PC Interface View

Built In Display Screen

Q - Quiet Mode: Off

Quiet Mode [Off]

This menu option is used to prevent the XL™ from echoing back characters received via the serial port for a certain duration of time specified in the quiet mode duration option. This option is helpful in preventing endless echo looping in applications such as communicating with a modem. The default is off, but if a modem is in use then it may be best to turn this on.

PC Interface View

Built In Display Screen

D - Quiet Mode Duration: 015

QuietModeDur [015]

This menu option sets the Quiet mode duration. When the Quiet mode is enabled and the unit is turned off through the serial port, the unit will not be able to turn back on via the serial port for this time period. This duration is entered in seconds and the default is 15 seconds.

6.3 Serial Port Hardware Description

The three RS-232 ports are used to connect to a PC, GOES Transmitter, modem, remote display, or other serial equipment for standard serial communications. These ports are configured as a DTE type of device. This means they will plug directly into a modem (a DCE type device), but will require a NULL modem adaptor if connected to a PC (a DTE type device). The NULL modem cable crosses the communication lines allowing two similar devices to communicate. Figure 2-5 shows the pin out for all three ports.

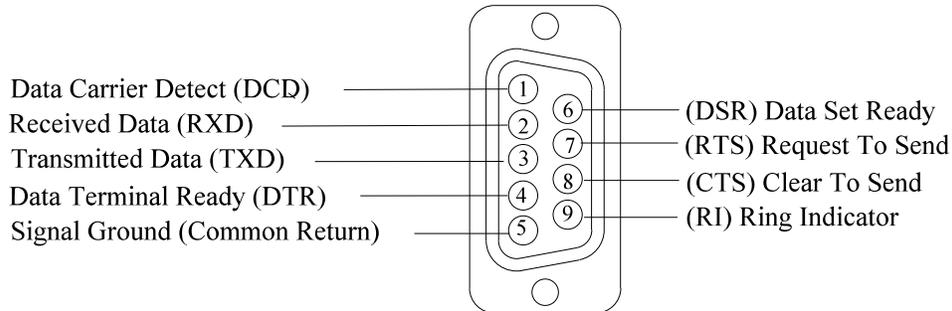


Figure 2-5 RS-232 Connector

SERIAL PORT PIN-OUT		
PIN	DIRECTION	NAME
1	Input	Data Carrier Detect (DCD)
2	Input	Receive Data (RD)
3	Output	Transmit Data (TD)
4	Output	Data Terminal Ready (DTR)
5		Ground (GND)
6	Input	Data Set Ready (DSR)
7	Output	Request To Send (RTS)
8	Input	Clear To Send (CTS)
9	Input	Ring Indicator (RI)

6.4 Serial Port Functions

The XL™ has three com ports that in some cases any com port can be used for a specific application and in other cases only a specific com port can be used for some functions. For example one of the uses of the RS-232 port number 3 is for MODBUS. If the user tries to use MODBUS on any other port but com port 3 it will not work. The following table lists each RS-232 port and its usage.

Com Port Function	Com 1	Com 2	Com 3	Com 5
Menu Interface (Direct connect)	X	New	New	
Command Interface (Direct Connect)	X	New	New	
Menu Interface (Modem connection)	X	New	New	
Command Interface (Modem Connection)	X	New	New	
ALERT Radio	New	X	X	
Alarm Call Out (All Modes)	X			
Alarm Call Out (Direct Connect Only)			X	
Modbus			X	
GOES		X		New(1)
SDI-12 Secondary Port (Master Mode)	X	New	X	
Auto Print	X	X	X	
Remote Display (From Menu)	X	X	X	
BASIC Print Command	X	X	X	
Basic Input Command (Numeric Only)	X	New	X	

X = Was functional in older versions of the firmware, (2.09 and older).

New = Now functional in this version of the firmware, (2.10 and newer).

Blank = Not a valid option.

New(1) = Com port 5 is only available on the new hardware (Hardware Version 3.3) and is only used on the H-522 and H-522 Plus using firmware version 2.10 or newer.

Note: On older hardware, (3.1 and older) the H-522 and H-522Plus have the GOES HDR radio built into the main box of the unit and internally connect to the RS-232 port number 2. The connector for this port is still physically placed on the outside of the box but is just there for mechanical reasons and is not connected internally. On the newer hardware, (3.3 and newer) the H-522 and H-522 Plus are connected to the new internal com port number 5 and com port 2 is usable again.

Chapter 7

System Configuration Files

7.1 Overview

The configuration files allow all the user setup information to be saved to a file and used later for any reason needed. Once a system is configured it is best to save the setup information so that it may be retrieved later if the system is replaced or duplicated. For example, when a unit has been programmed it may be desired to save the user settings to a file so other units may be quickly programmed the same way and then minor modifications made for site specific needs. The files can be created on the external data card, or to internal data memory.

7.2 Configuration Files Menus

One of the sub menu structures found under the “System Setup” or “Configure System” menu is the “Configuration Files” sub menu. These options are used to save and retrieve setup information, and to reset the unit back to the factory defaults.

Built in Menu Structure: Configuration Files Screens.

System Setup	->	System Config Opts->	Copy Setups to Mem ?
			Copy Setups to Card?
			Load From Memory ?
			Load From Card ?
			Reset to Defaults ?

PC Menu Screen: Configuration Files.

Configuration Files Menu	(Esc to Return)
C - Create CFG File	
S - Setup From CFG File	
Enter Option >	

C - Create CFG File

Copy Setups To Mem ?

When using the PC menu, this option is used to save a configuration file to the internal data memory or to the external data card. When the option is selected it will prompt the user to select either the internal data memory or the external data card.

When using the built in menu there are actually two different screens used to save the configuration file, one for the internal memory as shown above and one for the external data card. Both options work the same as far as how the file is created, the only difference is the location of the file saved.

The configuration file is an ASCII text file that may be viewed or printed as a hard copy listing of the options for the site. Several configuration files can be stored on a single card. The setup information will be saved in a file with the same file name as the Site ID option and a file extension of .CFG. This file may be transferred over the serial port using the standard file transfer options, or copied to the external card using the copy data option.

When the configuration file is saved to the data card can then be removed and placed in a PC and the file copied to the hard drive or printed for a hard copy of the setup information. Other XL series loggers can now be programmed the same as the unit that created the configuration file by using the "Setup From CFG File" or "Load From Memory" options listed below.

S - Setup From CFG File

Load From Memory ?

When using the PC menu, this option is used to select a configuration file from either the internal data memory or from the external data card. Use the Up and Down arrows on the PC keyboard to select the desired file and press the Enter key to start the loading or setup process. Once the setup process is complete the unit will have its user options set based on the contents of the configuration file.

When using the built in menu there are actually two different screens used to load a configuration file, one for the internal memory as shown above and one for the external data card. Both options work the same as far as how the file is retrieved, the only difference is the location of the file saved. Once the setup process is complete the unit will have its user options set based on the contents of the configuration file.

R - Reset Defaults

Reset To Defaults?

This option is used to reset all of the user options to the factory default values. Be careful using this option as all setups will be cleared. This will not affect data stored to the FLASH card, nor the time and date values.

NOTE: This option will not reset the H-355 bubbler options back to its default values.

7.3 Sample Configuration File

Below is a partial listing of a configuration file. The first few lines give some status information listing the product type and serial number. After the first few lines of status information is the actual setup information. Each line is actually a command used when the unit is in the command mode. Therefore any single line could be hand typed into the unit when it is in the command mode. With close inspection it is possible to relate each command to a user option in the menus. It is possible to hand edit this file but the entries must be exact and valid options used or the command will be ignored.

WaterLOG XL Configuration File

```
H-350 XL
Serial Number = S#001000
Firmware Version = 2.12c
SignOnMessage=#
SystemTimeOut=300
RemoteTimeOut=5
SiteID=Site_ID
UserMode=Normal
Com1BaudRate=9600
Com2BaudRate=9600
Com3BaudRate=9600
FlowControl=SW
TerminalEmulation=VT-100
CharacterDelay=0
LineFeedDelay=0
QuietMode=Off
QuietModeDur=15
DateFormat=MM/DD/YY
SyncTime=Sync Disabled
SDIAddress=0
SDITimeoutValue= 0.00
UserSDITimeoutRsp=0
SDIMeasurementType0=M
```

|
SDIMeasurementType9=M
SDIPort0=SDI-12
|
SDIPort9=SDI-12
SDIRedirect0=0
|
SDIRedirect9=9
SDIParameter1=Stage
SDIDigits1=2
|
SDIParameter9=None
SDIDigits9=2
Plus12VoltExciteOn=Always
ScanRate=00:10:00
ScanOffsetTime=00:00
ExcitationWarmupDelay=0
StageUnits=Feet
StageOffset=0.00
StageAverageTime=1
TemperatureUnits=Deg C
RemStageSource=None
RemStageSlope=1.00
RemStageOffset=0.00
CounterSlope=0.01
SumInterval=Daily
CounterMode=Off
CountRateWindowSize=15
CtrDebounceTime=5
FrequencySlope=1.000
FrequencyOffset=0.000
Analog1Slope=1.00
Analog1Offset=0.00
Analog1Samples=2000
Analog1Range=5.0V
Analog1DiffMode=Off
|
Analog4Slope=1.00
Analog4Offset=0.00
Analog4Samples=2000
Analog4Range=5.0V

Digital1Mode=Digital Input
Digital1PulseLength=1000

Digital1WarmUpDelay=250
Digital2Mode=Digital Input
Digital2PulseLength=1000
Digital2WarmUpDelay=250
EncoderSlope=0.010
EncoderOutSource=None
AutoPrint=Off
RemoteDisplayLabel=Stage =
RemoteDisplaySource=None
RemoteDisplayPort=3
mASource=None
mAMax=20.0000
mAmin=4.0000
VOICEMODEM=Comm-1
VoiceModemSource0=None
|
VoiceModemSource9=None
AlarmsEnabled=No
AlarmRetry=0
Alarm1Source=None
Alarm1Trig=> Set Pt
Alarm1SetPoint=1.000000
Alarm1ResetPoint=0.000000
Alarm1ComMode=Direct
Alarm1Label=All
Alarm1Number=
Alarm1SiteNum=0
|
Alarm10Source=None
Alarm10Trig=> Set Pt
Alarm10SetPoint=1.000000
Alarm10ResetPoint=0.000000
Alarm10ComMode=Direct
Alarm10Label=A10
Alarm10Number=
Alarm10SiteNum=0
ModbusMode=Off
ModbusBaudRate=19200
ModbusParity=Even
ModbusAddress=1
ModbusTimeOut=30
ALERT=Off
ALERTRadioType=H-264
ALERTTxOffsetTime=00:00:00

ALERT1Source=None
ALERT1ID=0000
ALERT1Range=20.47
ALERT1FmtType=NOW
ALERT1FixedTxdRate=8 Hours
ALERT1TriggerMode=Off
ALERT1TriggerPoint= 1.000
ALERT1HoldOff=15
ALERT1Override= 2.000

|
ALERT20Source=None
ALERT20ID=0000
ALERT20Range=20.47
ALERT20FmtType=NOW
ALERT20FixedTxdRate=8 Hours
ALERT20TriggerMode=Off
ALERT20TriggerPoint= 1.000
ALERT20HoldOff=15
ALERT20Override= 2.000

Logging=On
LogNewFile=None
LogDataFmt=Normal
LogWrap=Disabled
WrapBlocks=255
LogColumn1Source=Date
LogColumn1Header=MM/DD/YY
LogColumn1Rate=00:15:00
LogColumn1Digits=2
LogColumn1Function=NOW
LogColumn1StatScrn=No

|
LogColumn25Source=None
LogColumn25Header=
LogColumn25Rate=00:15:00
LogColumn25Digits=2
LogColumn25Function=NOW
LogColumn25StatScrn=No
GoesRadioType=SE-1200
GoesAddress=00000002
GoesSTBaudRate=100
GoesRRBaudRate=100
GoesSTChannel=000
GoesSTRate=01:00:00
GoesSTOffset=00:00:00

GoesSTWindow=65
GoesCenterData=Yes
GoesSTAppendBattery=No
GoesPreamble=Long
GoesSetupMode=Normal
GoesSTFormat=SHEF
GoesSTOrder=SCAN
GoesSTFirst=Newest
GoesSTSendSHEFCodes=No
GoesSTRedundantDataSets=1
GoesSTColumn1Source=None
GoesSTColumn1SHEFCode=
GoesSTColumn1Rate=00:15:00
GoesSTColumn1Format=XX.XX
GoesSTColumn1BinaryBytes=3
GoesSTColumn1BinaryDigits=2
GoesSTColumn1BinarySigned=Signed Mag.
|
GoesSTColumn20Source=None
GoesSTColumn20SHEFCode=
GoesSTColumn20Rate=00:15:00
GoesSTColumn20Format=XX.XX
GoesSTColumn20BinaryBytes=3
GoesSTColumn20BinaryDigits=2
GoesSTColumn20BinarySigned=Signed Mag.
GoesRRChannel=000
GoesRRRate=00:05:00
GoesRRColumn1Source=None
|
GoesRRColumn5Source=None
AutoPurge=Off
TimedPurge=0
FNT01=0
|
FNT40=0
DIGIOFNT1=0
DIGIOFNT2=0
GOESRTFNT=ana1>100
SideButtonMode=Hold to Update
Com3StartUpMode=Menu Mode
Com2StartUpMode=Menu Mode
Com1StartUpMode=Cmd N/Echo

Chapter 8

System Status Menus / Options

8.1 Status Options Overview

The status screens and options are mainly used to verify the operation and setup of the system. Many of the screens can be changed based on user settings allowing the user to see what is of interest to them.

Note: Depending on the XL™ Series in use, the default status screens settings will be slightly different.

8.2 Status Menus

Built in Menu Structure: Status Screens.

System Status	->	Battery = 12.3 Volts
		Min Battery = 11.6
		Max Battery = 13.7
		System Resets = 2
		Reset Stat Screens ?
		Firmware Ver = X.XXX
		Run Checksum Test ?
		Hardware Ver = X.X
		Serial # = S#XXXXXX
		Bubble Line Test?

The options that are in bold are only available using the built in menu.

PC Menu Screen: Status Options.

```
View Status Submenu (Esc to Return)

Time:      09:08:07   Log   Source/   Log
Date:      08:27:07   Col#  Header   Value
Scanning:  Off       ----  -
Next Scan: 00:06:53   1     MM/DD/YY 08/27/07
GOES Mode: Off       2     HH:MM:SS 09:08:07
FailSafe:  OK       3     Stage    7.34
Last GPS Sync: N/A   4     PtTemp   23.52
                        5     Battery  13.21

Battery:    13.21
Batt Max:   13.64
Batt Min:   12.23
System Resets 000

Site ID:    SiteID
Serial #:   S#001000
Version:    2.10

C - Checksum Test:
M - Measure
R - Reset Batt Max, Batt Min, & System Resets

Enter Option >
```

8.3 Status Screen Operations:

PC Interface View

Time: 09:08:07

Built In Display Screen

**Not Available In This Area Of
The Built In Menu**

This is the current system time. Notice this updates every second along with some other values on the screen. In this menu the time cannot be changed, only viewed.

PC Interface View

Date: 08:27:07

Built In Display Screen

**Not Available In This Area Of
The Built In Menu**

This is the current system date. In this menu the date cannot be changed, only viewed.

PC Interface View

Built In Display Screen

Scanning: Off

**Not Available In This Area Of
The Built In Menu**

This shows if scanning is turned on or off. This can only be viewed in this menu, not changed.

PC Interface View

Built In Display Screen

Next Scan: HH:MM:SS

**Not Available In This Area Of
The Built In Menu**

This is a count down timer until the next scan. If scanning is off then XX:XX:XX is displayed

PC Interface View

Built In Display Screen

GOES Mode: Off

**Not Available In This Area Of
The Built In Menu**

This identifies the current GOES Mode of operation. If no GOES radio is connected, N/A will be displayed.

PC Interface View

Built In Display Screen

Fail Safe: Ok

**Not Available In This Area Of
The Built In Menu**

This shows if the fail safe function of the GOES radio is ok or tripped. If it is tripped then the GOES radio will not transmit and the reset button on the GOES radio must be pressed and held for a few seconds to reset the radio.

PC Interface View

Built In Display Screen

Last GPS Sync: DD/MM/YY

**Not Available In This Area Of
The Built In Menu**

This shows the date of the last GPS time sync. If scanning or GOES is off then N/A is displayed

PC Interface View

Built In Display Screen

Battery: 13.12

Battery = 13.12 Volts

This screen displays the current voltage on the XL™'s +12V input.

OPERATIONAL NOTE:

The display draws more than 250mA which will pull extra current from the battery and may cause the reading to be slightly lower than if the battery is measured with a meter while the display is turned off.

PC Interface View

Built In Display Screen

Batt Max: 13.78

Batt Max = 13.78 Volts

Each time the XL™ measures the battery voltage it checks to see if the current voltage is less than the minimum value detected or greater than the maximum value detected and updates the min and max values if needed. Note that the battery voltage is not continuously monitored but is normally only measured once each scan. The battery voltage may briefly rise higher than the detected max value or drop lower than the min value and still not be detected.

This value is mainly provided as a diagnostic tool to help understand system performance and reliability. A high value may indicate a faulty regulator. See 'Reset Status Screens?' below for more information.

PC Interface View

Built In Display Screen

Batt Min: 12.34

Batt Min = 12.34 Volts

Each time the XL™ measures the battery voltage it checks to see if the current voltage is less than the minimum value detected or greater than the maximum value detected and updates the min and max values if needed. Note that the battery voltage is not continuously monitored but is normally only measured once each scan. The battery voltage may briefly rise higher than the detected max value or drop lower than the min value and still not be detected.

This value is mainly provided as a diagnostic tool to help understand system performance and reliability. If the minimum voltage is too low it may indicate that the battery is being undercharged. See 'Reset Status Screens?' below for more information.

When using the built in menu, pressing the ENTER key here will place the unit in a mode that

measures the battery at a fast rate allowing it to better detect voltage spikes. The normal battery monitoring screens measure the battery only a few times per second, but in the fast mode the battery is measured several times a second allowing it to have a better chance of detecting a voltage spike. This test is normally used when the battery is in question by entering this mode and then manually causing the bubbler system to purge which may cause a power surge on the system. When the bubbler turns on and the battery is weak, the voltage for example may drop from say 12.5 volts to 9.5 volts very quickly and then level off at 12.0 volts. The low voltage of 9.5 volts in this case may never be detected because it only last for only a few milliseconds, but can be severe enough to cause undetectable problems such as system resets or missed GOES transmissions. The screen would have the following message.

```
Fast Min Mode=XX.XX
```

PC Interface View

Built In Display Screen

System Resets: 002

```
System Resets = 2
```

This is a status screen that lists how many times the system has reset. A reset can be caused by several conditions, low battery and power spikes, power glitches, and power disconnects are the most common. See 'Reset Status Screens?' below for more information.

PC Interface View

Built In Display Screen

Site ID: SiteID

**Not Available In This Area Of
The Built In Menu**

This displays the system Site ID. The site ID is also used as the filename for the logged data. The system uses a DOS file system and since the Site ID text is used as the file name, it must fit the DOS format for file names. This means no spaces or periods or other non text characters.

PC Interface View

Built In Display Screen

Serial #: S#001000

```
Serial # = S#001000
```

This shows the instrument serial number. You may be asked to provide a serial number if you ever call in for technical assistance. This should be the same number as on the serial label on the side of the unit, yet the label may have worn off, or became hard to read.

PC Interface View

Built In Display Screen

Version: 2.10

Firmware Ver = 2.10

This is a status screen that displays the current software version of the embedded code. When calling the factory for assistance the technician may ask what version of code your unit has installed. This will aid the technician on how to better serve you. Also after doing a field upgrade it is a good idea to come here and verify the update process was completed as expected.

PC Interface View

Built In Display Screen

C - Checksum Test:

Run Checksum Test?

The XL™ can perform a checksum test on the firmware and display a Pass/Fail response. If the checksum fails, something has corrupted the firmware. In this case, you may need to download the firmware from a FLASH Memory Card to restore the integrity of the system. This test is normally used after a system update to make sure the new firmware was loaded correctly and is running properly. Consult the factory if this test persistently fails.

PC Interface View

Built In Display Screen

M - Measure

Not Available In Built In Menu

Pressing the M key will cause the XL™ to scan the sensors. The sensor data on the screen will be updated with the new values, but the data will not be logged to the data card. Some data values may update automatically.

PC Interface View

Built In Display Screen

R - Reset Batt Max, Batt Min, & System Resets

Reset Stat Screens?

This option is used to reset the minimum and maximum battery values to the current battery value and to reset the system reset counter to 0. The intended use of this option, the battery value screens and the system reset screens is to provide information on how the system is operating between field trips. The normal use is to reset the status screens at the end of a field trip, and then one of the first tasks of the next field trip would be to view these screens to see if any unexpected conditions occurred since the last trip. Ideally, the number of resets would still be zero and the max and min battery values would be within a normal operating range. A low minimum battery

voltage could indicate a weak charging system, a battery that is too small for the site, or bad wiring, etc. A low battery could also cause the system to reset. System resets normally indicate a problem with the battery voltage being too low, bad wiring, or poor power connections. Lightening and other external factors may also cause the system to reset. A high maximum battery voltage could indicate that the regulator is bad and that it is passing all of the energy from the solar panel to the system. The table below summarizes the different conditions and possible problems.

Battery Condition	System Resets	Possible Problems	Action
Battery Level = Ok Min Batt Level = Ok Max Batt Level = Ok	None	None, System is operating normally.	None
Battery Level = Ok Min Batt Level = Low Max Batt Level = Ok	None	The minimum battery value may indicate the charging system was not operational for awhile.	Make sure the solar panel is clean. If it is normally cloudy for several days, may need a bigger battery, or solar panel.
Battery Level = Ok Min Batt Level = Low Max Batt Level = Ok	Some	Low battery caused system resets.	Make sure the solar panel is clean. If it is normally cloudy for several days, may need a bigger battery, or solar panel.
Battery Level = Ok Min Batt Level = Ok Max Batt Level = Ok	Some	Bad wiring may be causing problems with power.	Check all power wires and connections for clean and tight connections, and proper wire sizes.
Battery Level = Ok Min Batt Level = Ok Max Batt Level = High	None	Charging system may be outputting too much voltage.	Make sure regulator is functioning properly. Overcharging the battery will damage the battery.

PC Interface View

Built In Display Screen

Log Col#	Source/ Header	Log Value
1	MM/DD/YY	08/27/07
2	Time	12:23:54
3	Stage	19.32
4	Batt V	12.79

Not Available In This Area Of The Built In Menu

When using the 'View Status' option on the PC menu, the middle and right hand side of the screen will display the last measured data values for each column of the log report options set to

log a sensor input. If the column is disable, (column source set to None) then the column number, header and data will not be listed. The column header text is used to identify the data. If the column header text is left blank then the text for the column source is displayed to identify the data. This section of the screen will change greatly based on the user settings, the more columns enabled the more information will be displayed on the screen.

PC Interface View

Built In Display Screen

Not Available Using PC Menu

Hardware Ver = 2.10

As the XL series data logger has continued to evolve, changes and enhancements involve both the hardware and the firmware. The following list shows some of the major changes to the hardware and how to check as a user what revisions may affect you. For example if your application requires the +12Volt excitation to be switchable, then you must use board revision 3.1 or newer. The firmware can detect the board revision and if an old board is detected, then the menu option to set the +12Volt excitation mode will not be displayed because it has no affect. The table below shows the changes to the hardware over the life of the product.

Board Revision	Description
Rev 2.1	- Original board
Rev 2.2	- New Power down sequence from normal mode to low power mode. This change will not affect the user operation.
Rev 3.1	- New 24 bit A to D converter for the generic analog inputs and stage sensor. The older boards used a 16 bit A to D converter. - Added differential mode to analog inputs 1 and 2. - 500 millivolt range added to all generic analog inputs. - The 12 volt excitation is able to be turned on and off. - Able to use higher baud rates on the serial ports, now up to 115200 baud.
Rev 3.3	- A new 16 bit DAC is now used for the 4 to 20 milliamp output option. The older boards used a 12 bit DAC. - A new internal comm port for H-522 and H-522Plus is used for the built in GOES radio. This allows com port 2 on the H-522 and H-522 Plus to still be used for other purposes.

Not Available Using PC Menu

Bubble Line Test?

This test is only available on the H-350XL™ Model. This option is used to test the orifice line for noise and stability. Bubbler line noise can be caused by several conditions, for example, a loose orifice line that is swaying with the water current, an orifice outlet that has an artificial pressure or vacuum based on unstable water current, or the bubble growing and releasing, etc.

Press the ENTER key to start the test. The screen will change displaying the following message.

Line Noise = +x.xxxx

When the test is first entered a normal measurement is made and the stage value is saved in two internal variables called MAX and MIN. Now the difference between the max and min is displayed. Since the first measurement saves the same value for both the max and min, the difference is 0.000. The initial measurement takes about 5 seconds as it also compensates for atmospheric pressure, and A/D offsets. The system then measures the stage repeatedly using the original atmospheric reading for compensation allowing for a 1 second measurement time. The MAX and MIN values are updated as new max or min values are detected and the difference between the MAX and MIN values is displayed on the screen. The difference between the MAX and MIN will be small and will not increase too much if the line noise is small, but will increase to a larger number if the line noise is significant. The displayed value is in the same units as set by the stage ‘Slope’ Coefficient which defaults to feet.

When installing a new orifice line use this option to test for possible orifice line positions. Temporarily position the outlet and run this test to see if the position is relatively quiet. Reposition the line if it is too noisy. After the line is repositioned pressing the Enter key will cause the H-350XL™ to take a new reference measurement, and start the process again.

Running this test with the orifice line disconnected will show how much noise the H-350XL™ sees internally. This test is used to see if a problem exists with the orifice line or with the H-350XL™. This value should be extremely small and is relative to the PSI range of the system in use. The following table list the approximate resolution for each PSI range and the bubble line test with the orifice line disconnected should be less than the resolution value. In most cases the bubble line test will give values less than the resolution even with the orifice line connected in a good installation.

PSI Range	Approximate Resolution
0 to 15 PSI	0.007 Ft
0 to 30 PSI	0.014 Ft
0 to 50 PSI	0.0233 Ft

Chapter 9

Scanning Options

9.1 Introduction

The scanning options in this menu acts like a master switch for turning off or on all automatic processes such as logging data and transmitting the data, etc. If scanning is disabled the unit will still function as a sensor. Options here also are used to set the rate data is collected and processed.

9.2 Scanning Menus

Built in Menu Structure: Scanning Options Menu.

Scan Setup	->	Scanning [Off]
		Scan Rate [HH:MM:SS]
		Next Scan = HH:MM:SS
		Nxt Scan At [HH:MM:SS]

PC Menu Screen: Scanning Options. Note: The items in bold are not available in the built in menu.

Scan Options	(Esc to Return)
Current Time:	HH:MM:SS
Next Scan:	HH:MM:SS
S - Scanning:	Off
R - Scan Rate:	HH:MM:SS
N - Next Scan At:	HH:MM:SS
F - Start A New File:	
Enter Option >	

9.3 Scanning Options

PC Interface View

Built In Display Screen

Current Time: HH:MM:SS

**Not Available In This Area Of
The Built In Menu**

On the PC menu the current time is listed as a status screen for convenience only. It is handy to know the current time as the scanning options are changed.

PC Interface View

Built In Display Screen

Next Scan: HH:M:SS

Next Scan = HH:MM:SS

This screen displays the amount of time to the next scan. It will count down from the current scan interval to zero (00:00:00). When the XL™ has scanning turned off, this screen will be displayed with “XX:XX:XX” for the time.

PC Interface View

Built In Display Screen

N - Next Scan At: HH:M:SS

Nxt Scan At=[HH:MM:SS]

This screen shows the time the next measurement process will take place. When scanning is turned on, the XL™ calculates the best time to start scanning based on the scanning interval and the current time. This process tries to keep the logged data or data being sent to the GOES radio synchronized to some logical time interval like on the hour for hourly scans or at 00, 15, 30 or 45 minute time marks for a 15 minute scan interval.

This time can also be changed based on user needs. Changing this time may cause logged values that are based on a log rate to be reported at times unexpected by the user, therefore it is best if possible to let the system decide when the first scan should be scheduled.

PC Interface View

Built In Display Screen

S - Scanning: Off

Scanning [Off]

The scanning process is the heart of the XL™ system. Turning on scanning will start the logging process (if enabled), will start GOES transmissions (if enabled), and all other major activities the XL™ was programmed to do.

PC Interface View

Built In Display Screen

R - Scan Rate: HH:MM:SS

Scan Rate [HH:MM:SS]

This screen displays the current scan rate. The scan rate can be set in the range of 1 second to 24 hours. If the scan rate is set faster than the time the XL™ takes to make one scan then the actual scan rate will be a multiple of the entered value. For example a 30 second scan rate will automatically turn into a 1 minute scan rate if the measurement process takes 35 seconds to complete.

PC Interface View

Built In Display Screen

F - Start a New File:

Not Available In Built In Menu

This option causes the unit to start a new data file on the next scan without having to turn scanning off. Using this option at the end of a site visit will cause all the data from that point on to be in a new file so that on the next visit all the data in the file will be that collected between the visits.

Chapter 10

Built In Stage / Remote Stage Setup

10.1 Stage Sensor and Remote Stage Overview

This chapter is divided into two main sections. The first section is for the built in pressure sensor used to measure a stage value and internal temperature value. This option is only available on the H-350XL.

The second section is for the remote stage setup. This option is in all XL series products.

10.2 Stage / Temperature Menus

Built in Menu Structure: Stage Options Menu. **(H-350XL™ and H-510XL Models Only)**

Sensor Input Setup->	Stage Setup	->	Stage [X.XXX]
			Offset [0.000]
			Stage Units[Feet]
			Averaging Time [001]
			Datum [0.000]

PC Menu screen: Stage / Temperature Options. **(H-350XL™ and H-510XL Models Only)**
Remote Stage Options. **(All XL Series Products)**

```
Stage, Temperature Setup (Esc to Return)

S - Stage: 0.29
O - Offset: 0.00
U - Units: Feet
A - Averaging Time: 1 Seconds

Temperature: 24.02
T - Temp Units: Deg C

R - Remote Stage: 00.00
1 - Source: XXXXXX
2 - Offset: 0.000
3 - Slope: 0.000

M - Measure

Enter Option >
```

10.3 Stage Options (H-350XL™ and H-510XL Models Only)

PC Interface View

Built In Display Screen

S - Stage: 0.00

Stage [0.000]

This option is used to view the last measured stage value. The value is enclosed in brackets that indicating the value can also be edited by the user. This allows the user to enter the desired stage value and the system will automatically calculate the offset required to obtain the user entered stage value. The correct stage value normally comes from a wire weight reading or staff gage.

PC Interface View

Built In Display Screen

O - Offset: 0.00

Offset [0.000]

This option screen allows the user to manually enter an offset value to adjust the final stage value in order to obtain a stage value relative to some reference point such as sea level. The default offset value of 0.000 can be manually changed by the user or automatically calculated by the H-350XL™. The following example, which refers to Figure 10.1, should make this clear.

Figure 3-1. Stream Site Showing Depth Relative to Sea Level

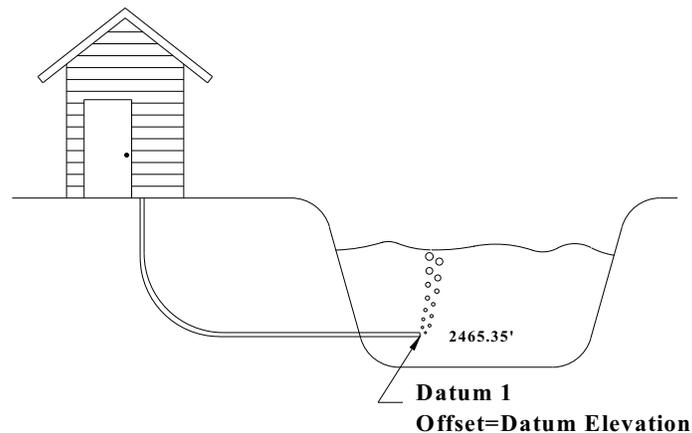


Figure 10-1 Stream Site Showing Depth Relative to Sea Level

A stream site of interest has its orifice output located 2465.35 feet relative to sea level. With the offset set to 0.00 a stage reading of 2.45 is measured indicating 2.45 feet of water above the orifice line output. Now by editing the offset to read 2465.35 and taking a new reading, a value of 2467.80 indicating the actual water level above sea level will be shown as the stage. The stage output value is relative to sea level.

U - Units: Feet

Units [Feet]

This option screen allows the user to choose the units for reporting the calculated stage value. The H-350XL™ actually measures the pressure (PSI) on the orifice line, but the default stage

reading is reported in feet. The conversion from PSI to feet is $PSI * 2.3067$ at ideal conditions. The table below gives a few standard conversions for ideal conditions.

Multiply PSI by (Slope Value)	To Obtain
1.0	PSI
2.3067 (This is the default)	Feet
0.70308	Meters
27.6804	Inches
User Entered Value	Desired User Units

Valid options for the units are Feet, Meters, Inches, or UserDef. If “UserDef” is selected, a prompt is displayed for the user to enter in a value for the slope. For example, if a user wants to see how close the water is to the top of the river bank in feet, meaning the value should get smaller as the water level rises towards the bank. The user selects “User Def,” and enters a slope of -2.3067. Using a negative value will cause the H-350XL™ to display decreasing values as the water level rises. The magnitude of 2.3067 is still valid to convert PSI to feet. This is done using the standard editing methods to change the slope.

A - Averaging Time: 001 Seconds

Averaging Time [001]

This option screen allows the user to select the duration of the H-350XL™ pressure measurement. The pressure used to calculate the stage is the average pressure over this averaging time. This value can be set from 1 second up to 360 seconds (6 minutes). The default value is 1 second. If the water level to be measured is rough or unstable, a longer averaging time could be used to give a more accurate reading. Some conditions may require an averaging time of 2 to 5 seconds, but others may need as long as 20 seconds. For applications dealing with tidal effect or other wave action, an averaging time of a few minutes may be required.

PC Interface View

Built In Display Screen

D - Datum: 0.000

Datum [0.000]

This value is only used when the unit is set to the NOAA mode. This is a site specific offset entered by the user and the value is transmitted as header information in the NOAA GOES data format. This value is used to help decode the NOAA data.

PC Interface View

Built In Display Screen

M - Measure

Not Available In Built In Menu

When using the PC menu, pressing the M key will cause the H-350XL™ to take a measurement of the internal stage and temperature sensors and the sensor used for the remote stage, then update the screen with the new values.

10.4 PtTmp Sensor Setup (H-350XL™ Model only)

Built in Menu Structure: Temperature Sensor Options

Sensor Input Setup->	PtTmp Sensor Setup->	PtTemp Units [Deg C]
----------------------	----------------------	----------------------

The PC menu for this option is shown above.

PC Interface View

Built In Display Screen

T - Temp Units: Deg C

PtTemp Units [Deg C]

This option is only available on the H-350 XL as it is the only XL series unit that has a built in temperature sensor used for compensation of the pressure sensor. The temperature setup option allows the user to select if temperature values from the built in temperature probe will be displayed and recorded in degrees Celsius or degrees Fahrenheit. This only affects temperature measurements made using the internal temperature sensor used for temperature compensation of the pressure sensor. This is not a good sensor to use as an ambient air temperature sensor as the temperature inside a gage house or enclosure may be several degrees different than the ambient air temperature. If other temperature sensors are connected to the H-350XL™ via the generic analog inputs or an SDI-12 input, they must be setup independently to produce the desired units. The default temperature units selection for the internal temperature sensor is Celsius.

10.5 Remote Stage Setup Overview

This submenu is used to define how the remote stage measurement from the remote stage sensor will be used. A remote stage sensor means that this reading is external to the H-350XL™. The user can define an initial stage value and have the offset calculated, or the user can define the offset and slope that will be applied to the remote stage measurement. This submenu is convenient to the user especially in the use of SDI-12 sensors. This submenu can be used in place of setting up the SDI-12 sensor's offset and slope manually by using the Extended Command option found in the SDI Transparent submenu. This submenu could also be used for other sensor applications.

10.6 Remote Stage Menus

Built in Menu Structure: Remote Stage Options

Sensor Input Setup->	Remote Stage Setup->	RemStage Src [None]
		Rem Stage [X.XXXX]
		Rem Offset [0.000]
		Rem Slope [1.000]

The PC menu structure for the remote stage options is shown above.

10.7 Remote Stage Options

PC Interface View

R - Remote Stage: X.XXX

Built In Display Screen

Rem Stage [X.XXX]

This shows the current value for the remote stage and also allows the user to enter a desired remote stage value and let the XL calculate the offset required to obtain that value. When the user enters in a stage value the XL will make a new measurement on the input selected as the remote stage source and calculate a new offset to produce the desired stage value entered by the user.

Note: The Remote Stage option is useful for those that do not want to program slopes and offsets into an SDI-12 sensor using the sensor manufactures extended commands to do so. In this case the slope and offset is stored in the XL. Be careful not to program the slope and offset in both the sensor and the XL unit. Normally the slope in the sensor would be set to 1.0 and the offset in the sensor would be set to 0.0.

PC Interface View

Built In Display Screen

1 - Remote Stage Source: None

RemStage Src [None]

This shows the current input source used for the remote stage and allows the user to change to a different input source. Normally the input source is one of the SDI-12 inputs but can be any of the other inputs also such as ANA1.

PC Interface View

Built In Display Screen

2 - Remote Stage Offset: 0.000

Rem Offset [0.000]

This option screen allows the user to enter an offset value to adjust the final remote stage value in order to obtain a stage value relative to some reference point such as sea level. The default offset value of 0.000 can be manually changed by the user or automatically calculated by the XL as discussed in the 'Rem Stage' section above. This offset value is stored in the XL, not in the sensor.

PC Interface View

Built In Display Screen

3 - Remote Stage Slope: 1.000

Rem Slope [1.000]

This option screen allows the user to enter a slope (multiplier) value that will be applied to the remote stage measurement in order to convert the value into desired units. This the first term in the equation: Value = Measured data * Slope + Offset. The default value is 1.00. This value is stored in the XL, not in the sensor.

PC Interface View

Built In Display Screen

M - Measure

Not Available In Built In Menu

When using the PC menu, pressing the M key will cause the XL to take a measurement of the internal stage and temperature sensors and the sensor used for the remote stage, then update the screen with the new values.

Chapter 11

Analog Inputs / 5 Volt Excitation

11.1 Analog Inputs Overview

The four generic analog input channels are configured as single ended inputs with a default range of 0.0 to 5.0 volts. A 5.00 volt switched excitation is also provided for sensors that require a precision power reference. The analog setup screens allow the user to make simple conversions from voltage to the desired units by defining a slope and offset for the analog input. The voltage from the input is multiplied by the slope value and added to the offset value to produce the final value.

11.2 Analog Menus

Built in Menu Structure: Analog Input Options.

Sensor Input Setup->	Analog 1 Setup ->	Analog 1 = X.XXXX
		Offset [0.0000]
		Slope [1.0000]
		A1 Samples [500]
		Range [5.0 V]
		Differential Md [Off]

Note: Menu screens for analog channels 2, 3 and 4 are the same as shown above for analog channel 1, except the ‘Differential Mode’ option is only available for channel 1 and 2.

PC Menu Screen: Analog Input Options.

Analog Input Setup (Esc to Return)			
Analog 1: 0.1916	Analog 2: 0.1908	Analog 3: 0.1953	Analog 4: 0.1889
A - Slope: 1.000	E - Slope: 1.000	I - Slope: 1.000	M - Slope: 1.000
B - Offset: 0.000	F - Offset: 0.000	J - Offset: 0.000	N - Offset: 0.000
C - Samples:500	G - Samples:500	K - Samples:500	O - Samples:500
D - Range: 5.0 V	H - Range: 5.0 V	L - Range: 5.0 V	P - Range: 5.0 V
X - Diff Mode: Off			
Enter Option >			

Note: Options and status information for all four analog channels is displayed on a single screen.

11.3 Analog Options

PC Interface View

Analog 1: X.XXX

Built In Display Screen

Analog 1 = X.XXX

Whenever the Analog menu is active on the PC menu all four analog inputs will be continuously updated. When using the built in menu the selected analog input will be continuously updated. These screens make it easy to see if the analog input(s) are working as expected. The displayed value may be in volts or some other value based on the slope and offset values. For example, if a temperature probe is connected to an analog input and the coefficients are set to convert voltage to temperature, this screen would display the temperature value.

PC Interface View

A - Slope: 1.000

Built In Display Screen

Slope [1.000]

Each analog input has slope and offset coefficient value used to perform a linear conversion for the analog input. This option allows the user to enter a slope (multiplier) value that will be applied to the measured voltage in order to convert the value into meaningful units. The default value is 1.000.

An example would be to convert voltage to wind direction. A simple wind direction sensor uses a continuous turn potentiometer excited by the 5.00 volt excitation so the output is 0 to 5 volts for a wind direction of 0 to 360 degrees. In this case the slope is 360 degrees / 5 volts = 72, so a slope of 72.0 and leave the offset at 0.00 will convert the voltage to a wind direction. Other examples for calculating slopes, offsets and two point calibrations are found in sections 11.4 and 11.5.

The final value is calculated as: $Results = Volts * Slope + Offset$

In the wind direction example: $Wind Dir = Volts * 72 + 0.0$

PC Interface View

B - Offset

Built In Display Screen

Offset [0.000]

This option allows the user to enter an offset value used in converting the voltage measured by the analog channel into meaningful units. This is used in conjunction with the slope to perform the desired conversion.

PC Interface View

Built In Display Screen

C - Samples: 2000

Samples [2000]

This option allows the user to change the number of samples that are averaged from the analog input when the analog channel is scanned. The user can change the number of samples to any number between 10 and 65000. The default value is 2000 which takes just less than a second for the 2000 readings to be measured and averaged together and return a result. If a large number of samples are selected, the scan process for that particular analog channel will take longer, whereas if the number of samples selected is a small number, the scan process will be much quicker allowing more frequent scanning.

PC Interface View

Built In Display Screen

D - Range: 5.0 V

Range [5.0 V]

All four analog input channels have a 0.0 to 5.0 Volt input range. A 0.0 to 500 mV range is also available on channel 1 on older units (PCB Rev 2.2 and older) and on all channels on newer boards, PCB rev 3.1 and newer. This 500 mV range is for sensors that produce a low level output voltage less than 500 millivolts.

PC Interface View

Built In Display Screen

X - Diff Mode: Off

Differential Md [Off]

Note: This mode is only available on PC board rev. 3.1 and newer (hardware rev. N and newer).

There are some analog sensors that send back a voltage on a single line that is referenced to ground. These are called single ended sensors and are the simplest to work with. A simple wind direction sensor that uses a continuous turn potentiometer is a good example of a single ended sensor. This sensor would be used with the differential mode turned off.

A differential sensor will have two signal lines referenced to each other, not to ground. A strain gauge would be an example of a differential sensor. In this case the differential mode would be turned on and the two signal lines would be connected to analog input 1 and 2. Now the reading returned from the sensor is the difference between the two analog inputs.

When the differential mode is enabled the voltage value returned for channel 1 is the voltage difference between channel 1 and 2 and does not matter where the voltage level is with respect to ground. The value returned for channel 2 will be the same as that returned for channel 1.

Even though when in the differential mode the value returned is not referenced to ground, the voltages on channel 1 and 2 must be between 0.0 volts and 5.0 volts with respect to ground. A voltage on channel 1 of 7.0 volts and a voltage on channel 2 of 4.0 volts both with respect to ground would not work because channel one is greater than 5.0 volts even though the difference is only 3.0 volts. A voltage on channel 1 of 4.5 volts and a voltage on channel 2 of 2.5 volts both with respect to ground would be ok since both channels are in range and the returned value would be 2.0 volts, $4.5 - 2.5 = 2.0$.

11.4 Analog Input Connections

The first seven connections on the twenty pin terminal block are used for analog input functions. This includes four analog inputs, two analog grounds and one +5.00 volt excitation connection.

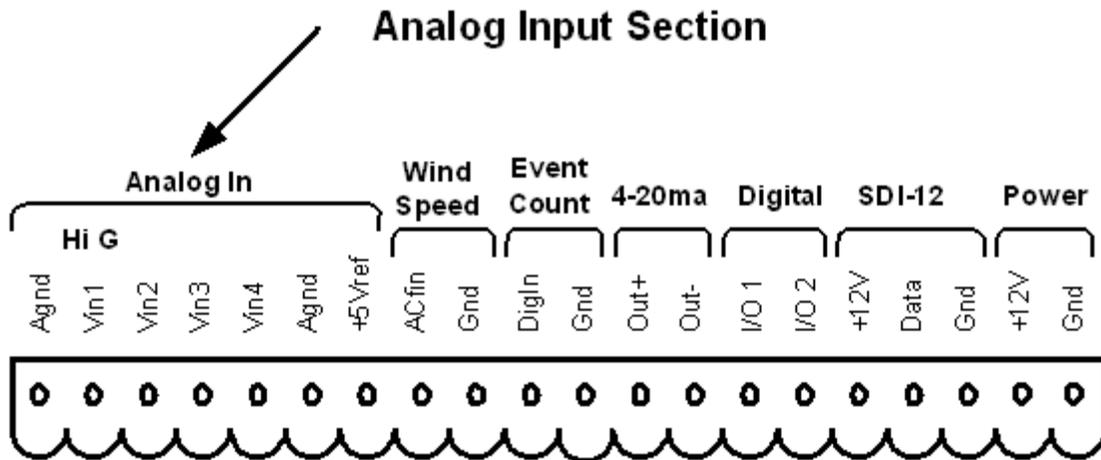


Figure 11-1 Analog Input Section

11.4.1 Analog Inputs and Analog Grounds Connections

The four analog input channels are labeled Vin1 to Vin4. There are two analog ground connections. **In order to preserve signal integrity, it is important to use the analog grounds only for sensors connected to the analog section of the XL™.** The current flowing through an analog sensor is relatively small and normally very stable. This provides stable voltages produced by these sensors. If a digital sensor has its ground connection tied into the analog ground, the currents from the digital sensor will flow through the analog circuitry causing voltage level shifts and noise based on digital switching. There should be sufficient digital ground connection points for the digital sensors.

11.4.2 Switched +5.00 Volt Reference Excitation

The +5.00 Volt reference output is used for analog sensors requiring a precision reference voltage. The output current source maximum level is 10 milliamps. Exceeding this limit will cause the excitation to possibly sag, and result in possible data errors. The Analog to Digital converter uses this excitation for its reference to provide a ratio-metric relationship for sensors using the excitation. What this means is that if a sensor causes loading to the excitation and drags it down to 4.75 volts for example, then the A/D converter will use the 4.75 volts as its reference, and maintain a full scale input equal to the reduced excitation. To a point this will reduce errors in data when the excitation is used. If the excitation is being loaded down and some analog input channels are not using the excitation, but produce a voltage output on there own, then these inputs will have a much greater error.

11.5 Analog Input Setup Examples

Example #1: A temperature probe with a 0 to 5 Volt output for a temperature range of -40° to +60° Celsius would have the following setup. The slope would be calculated as follows:

$$\text{Slope} = \frac{\text{Max Temp} - \text{Min Temp}}{\text{Max Volts} - \text{Min Volts}} = \frac{60 - (-40)}{5 - 0} = \frac{100}{5} = 20$$

The Offset value would be calculated using the calculated slope value, a known temperature value in the measurement range, and the known sensor output voltage for that temperature.

$$\text{Offset} = \text{Temp} - (\text{Voltage} * \text{Slope}) = 60 - (5 * 20) = -40.0$$

The Offset value was calculated using known values. At a temperature of 60° Celsius, the temperature probe output will be 5 Volts. Also at a temperature of -40° Celsius, the temperature probe output will be 0 Volts. Notice here that the offset is the same as the minimum temperature value. The offset is always equal to the minimum sensor value when the corresponding sensor output is 0.00 volts.

Example #2: Now look at an example where the minimum voltage does not go to 0.00 volts.

A temperature probe with a 1 to 5 Volt output for a temperature range of -50° to $+50^{\circ}$ Celsius would have the following setup. The slope would be calculated as follows:

$$\text{Slope} = \frac{\text{Max Temp} - \text{Min Temp}}{\text{Max Volts} - \text{Min Volts}} = \frac{50 - (-50)}{5 - 1} = \frac{100}{4} = 25$$

The Offset value would be calculated using the calculated slope value, a known temperature value in the measurement range, and the known sensor output voltage for that temperature.

$$\text{Offset} = \text{Temp} - (\text{Voltage} * \text{Slope}) = 50 - (5 * 25) = -75.0$$

The Offset value was calculated using known values. At a temperature of 60° Celsius, the temperature probe output will be 5 Volts. Also at a temperature of -40° Celsius, the temperature probe output will be 0 Volts.

Notice here the minimum voltage is no longer 0.00 and the offset does not equal the minimum sensor value as in the first example.

In both examples there were two temperature values that we also knew the corresponding voltages. Knowing these values allows us to calculate the slope and offset based on what is often called a two point calibration. The next section describes more in theory the two point calibration process.

11.6 Two Point Calibration Basics

In general math terms a linear equation or straight line equation has the basic form as shown below.

$$Y=MX+B.$$

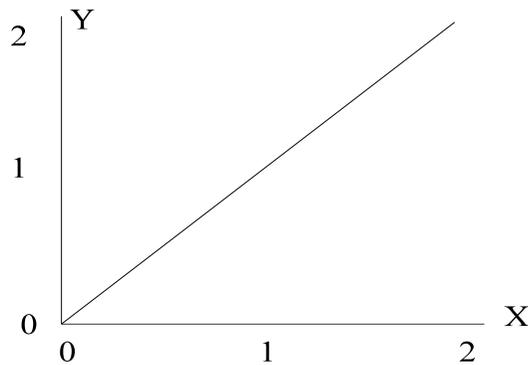
Where Y = the calculated results.

M = the slope of the equation.

X = the input variable.

B = the offset of the equation.

Sometimes it is easier to see the relationship of the input variable and the calculated output in graphical form. When this equation is graphed it will always produce a straight line. The angle or steepness of the line is determined by the slope value. On a graph that uses the same scale for the X and Y axis and a slope of 1.00 the line will have a 45 degree angle.



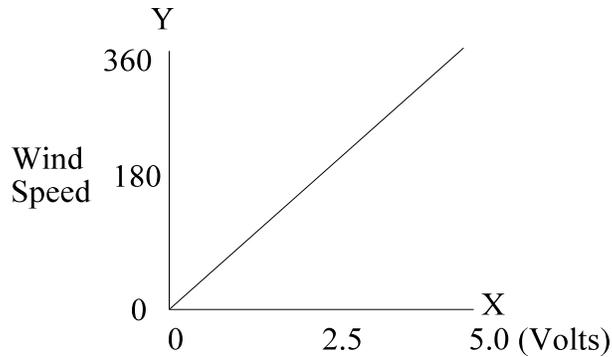
Slope = 1, Line = 45 degrees for the same scale for X and Y.

The slope is calculated by dividing the rise by the run. The rise is the difference between two points on the Y axis, $Y_2 - Y_1$. The run is the difference between two points on the X axis that correlate to the same points on the Y axis, or $X_2 - X_1$.

$$\text{Slope} = M = (Y_2 - Y_1) / (X_2 - X_1)$$

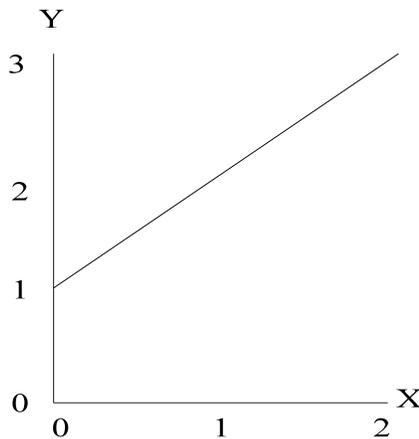
When the values for the two points are manually obtained or manually measured, use two points with as big a difference as possible. This will help limit errors based on errors in the measurements. For example if a sensor has a 0.0 to 5.0 output and the values for the two points was obtained at 0.0 volts and 1.0 volt, any error would be multiplied five times when the output was at 5.0 volts.

Slope values less than 1.00 will be less than the 45 degree angle and slopes greater than 1.00 will have an angle greater than 45 degrees when the X and Y scales are the same. Often the scales for the X and Y axes are changed to produce a better looking graph.



Wind Speed Vs Sensor Voltage
X and Y scales adjusted for appearance

The offset is calculated by rearranging the original equation to solve for the offset and then using known values for the other variables to solve for the offset. The known values can come from any single point on the graph, for example Y2 and X2, but not Y2 and X1 as they are from different point on the graph. The offset will not change the angle or slope of the line but vertically shifts the line based on the value of the offset.



Line shifted vertically based on value of the offset.

12.1 Digital I/O Overview

The digital I/O options are very flexible, allowing them to be used for a wide range of applications. The digital I/O can be used when a status input or a control output is required. These two pins can be configured totally independently of each other and can also be used together for applications using a quadrature input or to simulate a quadrature output.

12.2 Digital I/O Menus

Built in menu structure: Digital I/O Options Menu. The menu for digital I/O 2 is the same as below.

Sensor Input Setup->	Dig I/O 1 Setup ->	Digital I/O 1 = 1
		Mode [Digital Input]
		Trg Fnt[0]
		Pulse Length [1000]
		WarmUp Delay [250]
		Test Quad Out?

Built in menu structure: Encoder Input and Output Options Menu.

Sensor Input Setup->	Encodr Input Setup->	Enc Out Src [None]
		Encodr Val[X.XXX]
		Encodr Slp[0.01000]

The XL™ can use the two digital I/O pins to connect to a quadrature shaft encoder such as the Handar 436A, or to simulate a quadrature shaft encoder. For proper operation with a shaft encoder that increments clockwise, the phase A signal should be input into pin 1 and the phase B signal should be input into pin 2.

PC Menu screen: Digital I/O Options.

```
Digital I/O Setup      (Esc to Return)

    Digital I/O #1 = 1
A - I/O Mode          = Digital Input
B - Trigger When     = 0
C - Pulse Length     = 1000 ms
D - Warm Up Delay    = 250 ms
1 - Test Output 1

    Digital I/O #2 = 1
E - I/O Mode          = Digital Input
F - Trigger When     = 0
G - Pulse Length     = 1000 ms
H - Warm Up Delay    = 250 ms
2 - Test Output 2

O - Encoder Out Source: None
V - Encoder Value    = 0.000
S - Encoder Slope    = 0.010

Enter Option >
```

12.3 Digital I/O Options

PC Interface View

Digital I/O #1 = 1

Built In Display Screen

Digital I/O 1 = 1

This screen gives the current state of the digital I/O pin. If the pin is configured as an input, the value will be a 1 or a 0 meaning “On” or “Off” respectively. If the pin value is a 1, the input voltage will be approximately 3.5 volts or higher, (normally 5.0 volts). If the pin value is a 0, the input voltage will be approximately 0.8 volts or less, (normally 0.0 volts). The range between 0.8 and 3.5 is not defined and may be either a 1 or a 0.

If the pin is configured as an output, the value will be a 1 or a 0 based on whether the output is set to a 1 or a 0, “On” or “Off” respectively. However, the output may be set to a 1 or a 0, but the connected equipment may prevent the output from going to the desired state if it is causing too great a load on the output. In this case the reported value matches the desired state and **not** the actual state. Other functions for this screen are available based on the mode of the I/O pin as listed below.

NOTE: The following statements relate only to the built in keypad / display.

When Configured As An Input

Pressing the ENTER key will display “Digital Input Mode”, indicating the current pin configuration is an input.

When Configured For Triggered Continuous Output

Pressing the ENTER key will toggle the output from a 1 to a 0 or from a 0 to a 1 based on the current state of the output.

When Configured For Triggered Pulsed Output

Pressing the ENTER key will cause the output to pulse on and then turn off. The duration of the pulse is set using the “Pulse Length” option. This value is in milliseconds so the pulse length will be between 1 mS and 9.999 seconds.

When Configured For On For Scan

Pressing the ENTER key will toggle the output as in the triggered continuous output mode.

When Configured For Auto Continuous

Pressing the ENTER key will toggle the output as in the triggered continuous output mode.

When Configured For Encoder Out

Pressing the ENTER key has no affect in this mode.

PC Interface View

Built In Display Screen

A - I/O Mode = Digital Input

Mode [Digital Input]

There are five main modes for the digital I/O pins. Each I/O pin can be individually configured as an input or an output. The exceptions are the simulated quadrature shaft encoder output mode and the quadrature shaft encoder input mode. When using the encoder output mode, both I/O pins must be set to the “Encoder Out” mode. When using the quadrature input mode, both pins must be set to the “Digital Input” mode.

“Digital Input” Input Mode

The selected pin is used as a digital input. This could be used to test the status of an external device, such as a motor. The digital I/O pin would be used as the source for data in the logging report options; a 1 would be stored if the motor was on, or a 0 would be stored if the motor was off.

This is also the mode used if the digital I/Os are to be used with an external quadrature shaft encoder.

“Trigger Cont.” Triggered Continuous Output Mode

The selected pin is configured as an output that will turn on and off based on a user defined trigger condition. The output will stay on until the condition goes away. For example, if a pump is to be turned on when the water level is greater than 10.0 feet, the user would set the trigger

condition to “stage>10.0.” The digital I/O must be selected as a source in the logging report options in order to tell the system when to evaluate the trigger condition. The logging report options could be set to log Date, Time, Stage, and Dig I/O 1. As the unit turned on to scan the sensors, it would log the date and time, measure and log the stage, and then evaluate the trigger function. If the trigger condition was true, the output would turn on and a ‘1.0’ would be logged in the data file. The output would stay on until the next scan, at which time it would be reevaluated to see if it should stay on or be turned off. If on the next scan the water level was below 10.0, the digital I/O would be turned off and a ‘0.0’ would be logged to the file.

“Trigger Pulse” Pulsed Output Mode

The selected pin is configured as an output that will pulse on and off based on a user defined trigger condition. Continuing with the last example, if a warning horn is to sound at each scan the water is above 9.0 feet, the user would set the trigger condition to “stage>9.0.” The digital I/O must be used as a data source in the logging options in order to tell the system when to evaluate the trigger condition. The logging options would be set to log Date, Time, Stage, Dig I/O 1, and Dig I/O 2. As the unit turned to scan the sensors it would log the date and time, measure the stage, test Digital I/O 1, and evaluate the trigger condition to see if the stage was greater than 9.0 feet. If the trigger condition was true, the output would pulse for the time set in the “Pulse Length” option. The output would pulse after each scan when the water level was greater than 9.0 feet.

“On For Scan” On At Scan Time Mode

The selected output will turn on at the beginning of each scan and delay the scanning process for a time specified by setting the “WarmUp Delay” option. After the warm up delay, the normal scan process will continue. This would be used for applications that require an external device to be turned on for every scan such as a motor or a pump. At the end of the scan the output will be turned off. This Digital I/O does not have to be used as a data source in the logging options in order to turn on and off when in this mode.

“Auto Continue.” Auto Continuous Output Mode

The auto continuous mode is very similar to the triggered continuous mode. The selected pin is configured as an output that will turn on and off based on a user defined trigger condition. The output will stay on until the condition goes away. However, when the auto continuous mode is selected, the digital I/O does **not** need to be used a source in the logging options in order to tell the system when to evaluate the trigger condition. When the auto continuous mode is selected, the digital I/O will be evaluated every time the unit scans. The output will be automatically triggered during the scan process if the condition is true, and the output will remain triggered until the condition is no longer true.

“Encoder Out” Simulated Shaft Encoder Output Mode

When the XL™ is used to simulate a shaft encoder output, both I/O pins must be set to the “Encoder Out” mode. When using this mode, the Dig I/O 1 pin will simulate the Phase A signal and the Dig I/O 2 pin will simulate the Phase B signal of a quadrature shaft encoder. Any of the normal input options such as stage, analog input, SDI-12 value, or even a function can be used as

the data source for the encoder output. For example the stage value from the built-in pressure transducer of the H-350CL could be used as the data source to calculate the quadrature output on the two I/O pins. If this mode is selected, a stage measurement would be made as a reference point immediately after scanning is enabled. At each scan, the new stage measurements will be compared to this reference point and the difference will be used to determine how many counts should be made on the I/O pins. The new stage measurement will be saved as the reference point for the next scan. The quadrature output is increased 1 count for every 0.01 unit increase in the stage measurement.

PC Interface View

Built In Display Screen

B - Trigger When = 0

Trg Fnt[0]
-----------	---

This option screen allows the user to view and edit the conditional statement used to determine if the digital I/O pin should be set high when the selected digital I/O is configured as a triggered output. By pressing enter, the user begins the editing process. The flashing cursor will indicate the character position that may be edited. The user can use the RIGHT and LEFT arrow keys to change to cursor position, and the UP and DOWN arrow keys to change the blinking character.

This statement is normally a logical expression that is true or false . For example, “ana1>10.0” would equate to true if the value for analog channel 1 was greater than 10.0 and would equate to false if it was less than or equal to 10.0. Logical expressions return a value of 1.0 if true and 0.0 if false. If the conditional statement is true the output will be triggered, (set or pulsed high).

The trigger condition is actually true for any value that is greater than 0.0 and is false for any value that is 0.0 or less. This allows for standard math expressions to also be used for the trigger condition. For example, if a temperature probe was connected to analog channel 1 that measured temperature in degrees Fahrenheit, a math equation like “(ana1-32)*-1” could be used to turn on a heater any time the temperature was below 32 degrees F. Any time the temperature was at or above freezing (32 degrees) the result of the equation would be zero or negative and the condition would be considered false, however, if the temperature was below freezing, the result would be positive and the condition would be considered true.

The conditional statement can be up to 48 characters long and can be based on multiple conditions as shown in the next example: “(ana1>10.0)&(counts>0.05)”. In this example the value for analog channel 1 must be greater than 10.0 **AND** the count input (normally rain fall) must be greater than 0.05 for the condition to be considered true. The conditional statements here use the same format and operators as the general purpose functions found in chapter 22. Refer to chapter 21 for detailed instructions for editing the conditional statements, mathematical and logical operators, variable names, etc. The functions and conditional statements are much easier to edit and test using the PC menu mode interface.

If the conditional statement needs to be greater than 48 characters, the user may enter one of the 40 user definable functions as the conditional statement and enter the real conditional statement in the selected user defined function.

The default conditional statement for this option is the number '0' which basically disables the trigger condition as 0.0 by itself equates to 0.0 or false.

PC Interface View

Built In Display Screen

C - Pulse Length = 1000 mS

Pulse Length [1000]

This option sets the pulse duration of the output when the mode is set to “Trigger Pulse.” This value is in milliseconds, and the value can range from 1 millisecond to 9.999 seconds. The default value is 1000 milliseconds (1 second).

PC Interface View

Built In Display Screen

D - Warm Up Delay = 250 mS

WarmUp Delay [250]

When the mode is “On For Scan,” the warm up delay sets a time delay between when the output goes high and when the scan process continues on. This pauses the scanning process to allow for sensors to warm up or stabilize for proper operation with the XL™. This value is in milliseconds, and the value can range from 1 millisecond to 9.999 seconds. The default value is 250 milliseconds.

An example application where this option could be used is for a motor that needs to be turned on at each scan but requires a delay of 2 seconds before the sensors are scanned. For this application, the warm up delay would be set to 2000.

PC Interface View

Built In Display Screen

1 - Test Output 1

**Not Available In This Area Of
The Built In Menu**

This section only describes how to test the output using the PC interface. To test the I/O using the built in menu see the section above. When the digital I/O pin is configured as an output, pressing the 1 key will activate the pin for testing purposes. If the pin is configured for pulsed output, the output will turn on for the defined pulse length and then turn off again. If the pin is configured for continuous operation, pressing the 1 key will cause the output to toggle between high and low.

12.4 Quadrature Shaft Encoder Options

The XL™ uses the two digital I/O pins to connect to a quadrature shaft encoder or to simulate a quadrature shaft encoder. For proper operation with a shaft encoder that increments clockwise, the phase A signal should be input into pin 1 and the phase B signal should be input into pin 2.

NOTE: When the digital I/O are used for shaft encoder input they cannot be used as outputs.

PC Interface View

Built In Display Screen

O - Encoder Out Source: None

Enc Out Src [None]

The two digital I/O pins can be used together to output a quadrature signal. The source for this output mode would be any of the standard input variables such as stage or analog channel 1. The most common is the stage variable on the H-350 XL or another input source like an SDI-12 input that is used to read the stage. However any data source could be used. If this option is set to NONE then the encoder output options is disabled. With this set to none the digital I/Os can be used for normal digital I/O operations or as a shaft encoder input.

Scanning should be turned off when enabling this option. When this mode is enabled and scanning is turned on the system will measure a reference or starting point. Each time the unit scans it will measure the selected source and compare the new value with the older reference value and toggle the digital I/O's based on the difference. Then the new value is saved as the reference point to be used with the next scan.

PC Interface View

Built In Display Screen

V - Encoder Value

Encodr val [X.XXX]

When both of the digital I/O pins are configured as inputs, they may be used to read a quadrature shaft encoder. The current value of the shaft encoder will be displayed here. This value may also be edited by the user in order to set the value to some reference point. The internal counter can count ± 32767 counts. When a new value is entered, the internal counter is reset allowing the counter to count ± 32767 counts from the new value, not from zero.

PC Interface View

Built In Display Screen

S - Encoder Slope = 0.010

Encodr Slp[0.01000]

This option screen allows the user to enter a slope (or multiplier) value that is applied to each count in order to calculate the final quadrature input value. The default slope is 0.01. Most shaft encoder's produce 100 counts per revolution, so a slope of 0.01 will equate to 1.00 for one revolution. When using a pulley with a 1 foot circumference, each count is 0.01 foot of change and one revolution is one foot of change.

PC Interface View

Built In Display Screen

Not Available Using PC Menu

Test Quad Out?

This option allows the user to test the simulated encoder output mode. Pressing the Enter key on this screen will prompt the user to **Press Up or Down**. Pressing the up key will cause the XL™ to simulate 100 counts up, whereas pressing the down key will simulate 100 counts down. Normally the user will first count up 100 counts and then do the test again by counting down 100 counts so the net change is 0.0 but looking on a chart drive a short vertical line would be visible.

Chapter 13

Counter And Frequency Inputs

13.1 Introduction

This chapter will cover both the counter input and the frequency input. The counter input is normally used with rain gages and the default settings are ready for the most common type of tipping bucket rain gage. The counter can also be used with any sensor that acts as a switch closure or produces a 0 to 5 volt pulse. Two counter values are derived from the single counter input, a total count value (TotCnt) and an interval count value (Counts) that will be reset automatically based on some time interval such as hourly or daily. The counters WILL NOT be reset to 0 when scanning is enabled, but will maintain any preset value.

The frequency input is normally used for wind speed sensors but can be used with any sensor that produces a low level AC frequency output. The AC signal is normally in the range of 0.15 volts peak to peak centered at 0.00 volts.

13.2 Counter and Frequency Menus

Built in menu structure: Counter Input Options Menu

Sensor Input Setup->	Counter Setup ->	Counts [X.XXX]
		Total Cnt [X.XX]
		Reset Counters ?
		Ctr Slp [0.0100]
		Cnt Interval [Daily]
		Ctr Mode [Count Only]
		Rate Win Size [15]
		Ctr Debounce [250]mS

Built in menu structure: Frequency Input Options Menu

Sensor Input Setup->	Frequency Setup ->	Frequency = X.XXX
		Freq Slp[1.0000]
		Freq Ofst[0.0000]

PC Menu Screen: Counter and Frequency Input Options.

Notice that both the counter and frequency options are on the same menu on the PC interface.

```
Counter, Frequency Setup (Esc to Return)

C - Counts (Int): 0.00
T - Total Counts: 0.00
S - Slope: 0.01
I - Cnt Interval: Daily
M - Counter Mode: Count Only
W - Rate Win Size: 15
D - Debounce Time: 5 mS
R - Reset Counters

Frequency: 0.00
F - Freq Slope: 1.0000
O - Freq Offset: 0.0000

Enter Option >
```

13.3 Counter Options

PC Interface View

Built In Display Screen

C - Counts (Int): 0.00

Counts [0.00]

This screen displays the count value for the current interval (Daily, Hourly, Scan). The default interval is 'Daily,' but the interval can be set to Hourly or Scan. When set to Daily, this counter will get reset to 0.00 at the beginning of each day, or if the interval is set to Hourly, it will get reset to 0.00 at the top of each hour, or if the interval set to Scan, the value will be reset after each scan.

This option is also used to enter an initial or offset value. This value is not reset automatically when scanning is enabled, and should be set by the user to an initial value if needed.

PC Interface View

Built In Display Screen

T - Total Counts: 0.00

Total Cnt [0.00]

This screen displays the total count value since the counter was last reset. This option is also used to enter an initial or offset value. This value is not reset automatically when scanning is enabled, and should be set by the user to an initial value if needed. For example, if the unit was installed in the middle of a water year, the total count value could be set to the total amount of rain received to that point in time for the current water year.

PC Interface View

Built In Display Screen

S - Slope: 0.01

Ctr Slp [0.01]

This option allows the user to define a slope value that will be applied to each count (switch closure) in order to calculate the values of both counters. The default value is 0.01 so that when connected to a tipping bucket rain gauge each tip or count (switch closure) is equal to 0.01 inches of rain.

PC Interface View

Built In Display Screen

I - Count Interval: Daily

Cnt Interval [Daily]

This option allows the user to select the count interval which will determine how often and when the interval counter will be reset 0.00. The default interval is “Daily.” Valid options are:

Daily When the count interval is set to “Daily,” the Counts value will report the number of counts since midnight. The Counts value will be reset to 0.00 every midnight after all scanning and report processes have completed.

Hourly When set to “Hourly,” the Counts value will report the number of counts since the top of the last hour.

Scan If set to “Scan,” the Counts value will report the number of counts since the last scan.

01 Jan Resets the ‘Counts’ value to 0.00 on the first scan of January 1st of each year.

01 Oct Resets the ‘Counts’ value to 0.00 on the first scan of October 1st of each year. Several agencies use October 1st as the start of the ‘water year’.

PC Interface View

Built In Display Screen

M - Counter Mode: Off

Ctr Mode [Off]

This option allows the user to select the counter mode of operation. The default mode is “Count Only”. If enabled, the counters will be active, even if scanning is turned off. Valid options are:

Off Counters are disabled.

Count Only Both counters are enabled.

Cnt & Txd Both counters are enabled, and if the ALERT radio option is enabled, the system checks to see if an ALERT transmission should be sent.

Cnt & Log This mode could be called “Count, Scan and Log”. The counters are enabled, and the XL™ will execute a scan at the time of each event (count). All sensor inputs defined in the logging report options will be serviced and logged to the data file at the time of the event. Options such as log rates and column functions are ignored for this log entry. The Tscans variable is not incremented by this scan.

Cnt & BAS1 In this mode a pulse on the counter input will cause the counters to increment and will also execute the BASIC1 program if loaded.

PC Interface View

Built In Display Screen

W - Rate Win Size: 15

Rate Win Size [15]

There is a variable called CtRate. This variable is the rate at which the counter is activated during the rate window. The range of the rate window size is 1 to 1440 minutes which is one minute to one day. The count rate is calculated by taking the total rain for the time period and dividing it by that time in minutes. Now the rate of rain fall is not based on a set starting time like midnight or the top of each hour, but starts at the current scan and goes back in time to the start of the window, or in other words this is a sliding window.

An example of using this option and the CtRate variable follows. The user wants to record rain fall and the rate of rain fall. The logger is set to log date, time, totcnt for rain fall, and CtRate for the rate of rain fall. The scanning is set to 15 minutes and the rate window size is set to 1440 for a one day rate window. Now as the data logger scans and logs data it will log the rain fall in the third column and the rate of rain fall in the fourth column. If in a 24 hour time period it rains only 0.01 inch (one tip) it would report 0.000006944 which is 0.01 divided by 1440, or 0.000006944 inches of rain per day. If it rained for half a day at .5 inches and then 0.25 inches for half a day, at the end of the 24 hour period it would report 0.375 inches of rain for that 24 hour period.

PC Interface View

Built In Display Screen

D - Debounce Time: 250 mS

Ctr Debounce [250] mS

This option sets the debounce time in milliseconds. The range is 0 to 255 milliseconds. The debounce time is the duration of time after a count is received before another count will be recognized. Most electrical switches have a characteristic known as bounce so when the switch is turned on or off it will fluctuate between the on and off condition for a some time period, normally milliseconds, and then stabilize to the desired position. These fluctuations can cause added unwanted counts.

Another condition that is common in this industry is when using tipping bucket rain gages there are times when the bucket will physically bounce back up when it tips from one side to the other. This mechanical bounce can cause extra counts if the travel of the bucket is far enough to trip the relay, and normally happens within one or two hundredths of a second. In a standard tipping bucket rain gage using an 8 inch opening and counting 0.01 inches of rain per tip, the fastest the bucket will be tipping at 26 inches of rain per hour will be approximately one tip every 0.4 seconds. In this case the debounce setting could be set to 200 to 255 milliseconds and it would prevent these unwanted tips.

<i>PC Interface View</i>	<i>Built In Display Screen</i>
R - Reset Countes	Reset Counters?

This option resets both counters to 0.00 and resets the count rate counter.

13.4 Frequency Options

<i>PC Interface View</i>	<i>Built In Display Screen</i>
Frequency: 0.00	Frequency = 0.00

This screen reports the real time converted value for the frequency input channel. If a wind speed sensor is connected and the coefficients are set to convert frequency to wind speed, the value displayed will be the wind speed.

$$\text{Value} = \text{Frequency} * \text{Slope} + \text{Offset}$$

<i>PC Interface View</i>	<i>Built In Display Screen</i>
F - Freq Slope: 1.0000	Freq Slp [1.0000]

This option allows the user to enter the slope (multiplier) value that will be applied to the raw measured frequency in order to convert the frequency into meaningful wind speed units.

<i>PC Interface View</i>	<i>Built In Display Screen</i>
O - Frequency Offset: 0.0000	Freq Ofst [0.0000]

This option allows the user to enter an offset into the frequency calculation.

NOTE: The offset is only applied if the input frequency is not 0.0. The frequency input is normally used for wind speed sensors, and the offset value is a low number that represents the drag of the sensor. If there is no wind, meaning the raw frequency input is 0.0, the reported value should be 0.0 and not the offset. Therefore the offset is not applied when the wind is not blowing.

Chapter 14

SDI-12 Operations

14.1 SDI-12 Overview

The XL™ can operate as an SDI-12 sensor, as an SDI-12 data logger, or as both, an SDI-12 sensor and data logger simultaneously. This chapter is split into four sub sections based on the major options the SDI-12 section supports.

- 1 - SDI-12 test mode including the transparent options and the full screen mode.
- 2 - SDI-12 Logger mode setup options.
- 3 - SDI-12 Sensor mode setup options.
- 4 - Built in support for the H-310 and the H-330 / H-331
- 5 - SDI-12 Supported commands, (sensor mode).

14.2 SDI-12 Transparent Mode and Full Screen Mode

The SDI-12 Transparent options allow the user to talk directly with SDI-12 sensors. This mode allows the user to setup, test, and control SDI-12 sensors. All SDI-12 sensors must implement a set of standard commands. When using the XL™ these standard commands can be sent to a sensor using a single key press. Extended commands specific to each sensor may also be sent to a sensor, but the user must enter these commands based on the sensor manufactures requirements.

Built in Menu Structure: SDI-12 Transparent Options.

Sensor Input Setup->	SDI Transparent ->	SDI-12 Test Adrs [0]
		Send Ack Cmd?
		Send ID Cmd?
		Send Verify Cmd?
		Send Measure Cmd?
		Send Data 0 Cmd?
		Send Extended Cmd?
		Ext Cmd[0]
		Set SDI12 Line High?

PC Menu Screen: SDI-12 Transparent Options.

```
Generic SDI-12 Options  (Esc to Return)

T - Test Address: 0
A - Acknowledge
I - Identify
V - Verify
M - Measure
D - Data Retrieval
S - Send Extended
E - Edit Extended: 0
F - Full Screen Transparent / Monitor Mode
L - Look For Sensors

Enter Option >
```

PC Interface View

Built In Display Screen

T - Test Address: 0

SDI-12 Test Adrs [0]

This option sets the SDI-12 address that the XL™ will use to communicate with each SDI-12 sensors. This allows for the standard SDI-12 commands to be sent as single key press. This is not to be confused with the option that sets the SDI-12 address of the XL™ when it is used as a sensor.

PC Interface View

Built In Display Screen

A - Acknowledge

Send Ack Cmd?

This command sends the address followed by the “!” terminator. The normal response is the sensor address followed by a Carriage Return and Line Feed. If the sensor is not connected or does not respond, the XL™ will respond with, “Communication Timed Out.” Refer to the sensor manufacturer for proper response to the Acknowledge Command.

Pressing the ‘A’ key from the PC menu or the ENTER key in the built in menu causes the SDI-12 Acknowledge command “a!” to be sent to the sensor using the address defined above. The sensor’s response is displayed on the screen. If there are any errors, a no response message is displayed. A detailed description of the SDI-12 commands is given in Appendix B.

PC Interface View

Built In Display Screen

I - Identify

Send Id Cmd?

This command sends the address followed by “I!” which is the standard SDI-12 identify command. The normal response is the sensor address followed by general information about the sensor, such as version number, manufacture, etc. The response is generally longer than what will fit on the built in display so it may scroll across the screen. If an error occurs, an error message will be displayed. Refer to the sensor manufacturer for proper response to the Identify Command.

PC Interface View

Built In Display Screen

V - Verify

Send Verify Cmd?

This command sends the address followed by “V!” which is the standard SDI-12 verify command. The normal response is sensor specific information such as a memory test result. If an error occurs, the XL™ will respond with an error message. Refer to the sensor manufacturer for proper response to the Verify Command.

PC Interface View

Built In Display Screen

M - Measure

Send Measure Cmd?

This command sends the address followed by “M!” which is the standard SDI-12 measure command. If an error occurs, the XL™ will respond with an error message. The response to this command is the time required to make the measurement and the number of values that will be returned by the sensor. See the sensor manufacturer's documentation for a description of the actual response for each sensor.

PC Interface View

Built In Display Screen

D - Retrieve Data

Send Data 0 Cmd?

This command sends the address followed by “D0!” which is the standard SDI-12 data retrieval command. The command is used to retrieve data from the sensor following a measurement command or other command that may take longer than a second to complete. Executing this command prior to a completed sensor measurement will abort the measurement. If an error occurs, the XL™ will respond with an error message. Refer to the sensor manufacturer for proper response to the Data 0 Command.

On the built in display the response may scroll across the screen. If the “D0” command did not retrieve all the available data, then the screen will indicate “Send Data 1 Cmd?” and will continue to bump the “Dx” command until all the data has been retrieved.

On the PC menu if more ‘D’ commands are needed, they will be sent automatically and the response for each ‘D’ command will be listed on a separate line of the screen.

PC Interface View

Built In Display Screen

S - Send Extended Cmd

Send Extended Cmd?

This option is used to send commands that are specific to a single sensor and are not part of the standard SDI-12 command set. The command sends the address, then the user entered text using the “Edit Extended Command” option, followed by the ‘!’ terminator. If an error occurs, the XL™ will respond with an error message. Refer to the sensor manufacturer documentation for proper response to the corresponding Extended Command.

PC Interface View

Built In Display Screen

E - Edit Extended:

Ext Cmd[0]

This screen is used to enter or edit an extended command. It is not necessary to include the sensor address or the “!” terminator, they are added automatically. Refer to the sensor manufacturer documentation for command options.

PC Interface View

Built In Display Screen

F - Full Screen Transparent / Monitor Mode

Not Available In Built In Menu

This option opens a window allowing the user to type commands directly from the keyboard and see responses from the connected sensors. This is a very easy way to enter non standard SDI-12 commands to setup and verify sensor configurations. When entering commands do so as explained in the sensor manufactures documentation and the ENTER key can be used in place of the ‘!’ character.

This mode is also very useful for monitoring the communication between another data logger and sensor to see that the communications look normal. For example an application may be using the SDI-12 radio link to communicate with a sensor that is remotely located. Connecting an XL series logger to the remote SDI-12 network will allow the commands and responses at this point

to be monitored. If the system does not work as expected this is useful to see if the commands are being received and if the sensor is responding to the commands. The XL can also send commands to the sensor to see that it is working properly without having to go through the radio network.

When using this option the ESC key is used to move back to the previous menu.

PC Interface View

Built In Display Screen

L - Look For Sensors:

Not Available In Built In Menu

This option is used to automatically search for SDI-12 sensors connected to the unit. This only looks for sensors connected to the SDI-12 port, not those connected to an RS232 port using the H-4191 SDI-12 to RS232 interface. This will first search the addresses 0 to 9 and then pauses to see if the user wants to look for sensors using the upper and lower case letters as addresses. If a sensor is found it will list its response to the ID command which should include the manufactures name, model number of the sensor, and version information.

If two or more sensors use the same address they will not be recognized and the conflict must be detected and resolved by the user. Using the full screen SDI-12 mode may help find sensor conflicts.

PC Interface View

Built In Display Screen

Not Available On The PC Menu

Set SDI12 Line High?

This option is for testing the SDI-12 data line. Pressing enter will cause the SDI-12 data line to go high (approximately +5.0 V). Using a volt meter the user can test the SDI-12 data line at different points in the the network to see that nothing is overloading the data line and that it is connected correctly.

14.3 SDI-12 Data Logger Mode

The XL can log data from any of its normal inputs including SDI-12 sensors. This section describes how to configure the logger to work with the different SDI-12 sensors.

The submenu options here allow the user to select the type of measurement command that will be sent for each address. For example, if the user is using an SDI-12 sensor with address 1 and wants to send the M1 command when the sensor is logged rather than the M command, the user would select M1 for address 1 measurement type. Also, if user was monitoring an SDI-12 sensor with two data loggers and wanted to record the same measurement data on both loggers, the user would want to issue the M command (and subsequent D0 command) with one data logger and then issue only the D0 command with the other data logger. Selecting D0 for the address measurement type in this menu would cause the XL™ to only send the D0 command when the sensor was logged by the XL™.

These menu options allow the user to select the type of measurement command that will be sent for each address. For example, if the user is using an SDI-12 sensor with address 1 and wants to send the M1 command when the sensor is logged rather than the M command, the user would select the address 1 desired by pressing the 1 key then use the UP/DOWN keys to locate the M1 option and then press ENTER to execute. Also, if user was monitoring an SDI-12 sensor with two data loggers and wanted to record the same measurement data on both loggers, the user would want to issue the M command (and subsequent D0 command) with one data logger and then issue only the D0 command with the other data logger. Selecting D0 for the address measurement type in this menu would cause the XL™ to only send the D0 command when the sensor was logged by the XL™.

Built in Menu Structure: SDI-12 Logger Mode Options.

System Setup	->	SDI12 Logger Setup->	Timeout Val[0.00]
			Adrs 0 M Type[M] ->
			Adrs0 Port[SDI-12]->
			Adrs0 Redirect [0]->

PC Menu Screen: SDI-12 Logger Mode Options.

```

SDI-12 Logger Mode Setup      (Esc to Return / ? For Help)

T - No Response Timeout Value:  0.000
R - Reset to SDI-12 Logger Mode Defaults
V - View Current SDI-12 Values
a M - Adrs (a) Measurement Type
a P - Adrs (a) Serial Port
a A - Adrs (a) Redirect Option

SDI-12   Measure   Port   Address
Address  Type      Address Redirected
-----
0 -      M         SDI-12  0 Ok
1 -      M         SDI-12  1 Ok
2 -      M         SDI-12  2 Ok
3 -      M         SDI-12  3 Ok
4 -      M         SDI-12  4 Ok
5 -      M         SDI-12  5 Ok
6 -      M         SDI-12  6 Ok
7 -      M         SDI-12  7 Ok
8 -      M         SDI-12  8 Ok
9 -      M         SDI-12  9 Ok

Enter Option >
    
```

PC Interface View

Built In Display Screen

T - No Response Timeout Value: 0.000

```

Timeout Val [0.000]
    
```

This will be the value used by the XL™ if an SDI-12 sensor does not respond. The default value is 0.00 but this is sometimes valid data and makes it hard to see if the sensor is operating or not. The user may select a number that is outside the normal range like -999 for a temperature sensor, and now if the recorded value is -999 it is obvious the sensor did not respond.

PC Interface View

Built In Display Screen

R - Reset to SDI-12 Logger Mode Defaults

Not Available In Built In Menu

This option resets all the settings on this screen to the factory default value.

PC Interface View

Built In Display Screen

V - View Current SDI-12 Values

Not Available In Built In Menu

View the values for each address and parameter.

PC Interface View

Built In Display Screen

a M - Adrs (a) Measurement Type

Adrs 0 M Type [M]->

Set the measurement type for the selected address

PC Interface View

Built In Display Screen

a P - Adrs (a) Serial Port

Adrs 0 Port[SDI-12]->

Select which port to use for the selected address. SDI-12 commands may be directed out one of the serial ports instead of the standard SDI-12 port.

PC Interface View

Built In Display Screen

a A - Adrs (a) Redirect Option

Adrs 0 Redirect [0]->

Select if the primary address will be redirected to a secondary address. This is used when multiple measurement types are required for a single sensor.

14.4 SDI-12 Sensor Mode

The XL™ can be configured as an SDI-12 sensor when used with other data loggers. SDI-12 sensors will have a unique address and will measure between 1 to 9 data values. The options under this menu allow the user to select what address the XL™ will respond to and what data will be returned to the external data logger.

Built in Menu Structure: SDI-12 Sensor Mode Options.

System Setup	->	Sensor Mode Setup	->	Sensor Mode Enabled
				Sensor Mode Adrs [X]
				SDI Meas. Time = XXX
				Par 1 Source [XXXXXX]
				:
				Par 9 Source [XXXXXX]
				Par 1 Digits [2]
				:
				Par 9 Digits [2]

PC Menu Screen: SDI-12 Sensor Mode Options.

```

Sensor Mode Setup (Esc to Return)

SDI-12 Sensor Mode Status: Enabled
A - SDI-12 Address: 0
T - Total Measurement Time: 7
1 - Parameter 1: Stage B - Digits: 2
2 - Parameter 2: PSI C - Digits: 2
3 - Parameter 3: PtTemp D - Digits: 2
4 - Parameter 4: None E - Digits: 2
5 - Parameter 5: None F - Digits: 2
6 - Parameter 6: None G - Digits: 2
7 - Parameter 7: None H - Digits: 2
8 - Parameter 8: None I - Digits: 2
9 - Parameter 9: None J - Digits: 2

Enter Option >
  
```

SDI-12 Sensor Mode Status: Enabled

Sensor Mode Enabled

The first message displayed here is a status message indicating if the SDI-12 sensor mode is enabled or disabled. If the first parameter is set to 'None' then the unit is disabled as an SDI-12 sensor. Breaks and commands from other equipment will not be responded to by the system if it is disabled.

A few of the newer SDI-12 sensors from some manufactures can be set up in different modes and may cause the SDI-12 data line to go active when the sensor is not really using the SDI-12 mode. This may cause the XL series logger to look for commands on the SDI-12 dat bus which causes it to stop responding to other tasks. If the XL sensor mode is disabled it will ignore activity on the SDI-12 data line.

PC Interface View

Built In Display Screen

A - SDI-12 Address: 0

Sensor Mode Adrs [0]

Each SDI-12 sensor used within a network must have a unique address. Addresses are a single character normally in the range of 0 to 9 but may include other characters like A to Z or a to z. The default address for the H-350XL™ is '0', and the other XL series loggers uses the letter 'Z' as the default address.

NOTE: If the XL™ is used as the only data logger in the network, this address will have no effect on the system and another SDI-12 sensor may have this same address.

PC Interface View

Built In Display Screen

T - Total Measurement Time: 5

SDI Meas Time [005]

The measurement time is calculated by the system and is the time required to make all the measurements requested. This time is dependant on how many parameters are used, what they are, and the measurement time for each. The SDI-12 specification indicates the time may be from 0 to 999 seconds, and this time is reported to the data logger when the data logger requests the sensor to take a measurement. When the unit calculates a measurement time this is a minimum time and the user can increase it from that point. The system cannot calculate the measurement time for all situations. For example, if basic programs are used or if long sampling times are used for an analog input, then the user must adjust this time to account for the added time required by these options.

1 - Parameter 1: None

Par 1 Source [None]

Up to nine values may be defined to be measured and sent to the data logger. The default is to send back the stage, PSI and temperature in that order for the H-350XL. The standard input source options are available except the SDI-12 sources, time and date, see the list below.

Available Source Options

None	This parameter is not used, and all following parameters are ignored.
Stage	Use the Stage reading for this parameter. (H-350XL™ Model only)
PSI	Use the PSI reading for this parameter. (H-350XL™ Model only)
PtTemp	Use the Temperature reading for this parameter. (H-350XL™ Model only)
RemStg	Use Remote Stage reading for this parameter. (H-350XL™ Model only)
Counts	Use the Counts for this parameter.
TotCnt	Use the Total Counts for this parameter.
CtRate	Use the Count Rate for this parameter.
AnaX	Use analog channel X for this parameter.
DigI/OX	Use digital I/O X for this parameter.
Freq	Use the frequency reading for this parameter.
Encoder	Use the encoder input value for this parameter.
Batt	Use the Battery reading for this parameter.
Tscans	Use the Tscans reading for this parameter.
BasicX	Use the BasicX reading for this parameter.
FNT01 to FNT40	Use the selected user defined math function result for this parameter.

NOTE: When the XL™ is used as a sensor connected to another data logger using the SDI-12 interface, the aD0 command will return data values for parameters 1, 2, and 3, the aD1 command will return data values for parameters 4, 5, and 6, and the aD2 command will return data for parameters 7, 8, and 9.

B - Digits: 2

Par 1 Digits [2]

These options allow the user to define how many digits to the right of the decimal will be returned for each SDI-12 parameter. The default is two, but it may be set between 0 and 6.

14.5 H-310 Setup

The following menus allow the user an easy way to setup the Design Analysis H-310 sensor without having to know the SDI-12 commands used to set the slope and offset coefficients in the H-310. These same setups can be done in the standard transparent mode using extended commands but it is easier here as the XL™ sends all the commands automatically. If the address for the H-310 is not correct then a H-310 not responding message will be displayed. Press the cancel to continue.

Sensor Input Setup->	H-310 Setup	->	SDI-12 Test Adrs [0]
			H310 Stage [X.XX]
			H-310 Units [PSI]

PC Interface View

Not Available On The PC Menu

Built In Display Screen

SDI-12 Test Adrs [0]

This option sets the SDI-12 address the XL™ will use to communicate with an H-310 sensor. This is not related to the option that is used to set the address of the XL™ when it is used as a sensor.

PC Interface View

Not Available On The PC Menu

Built In Display Screen

H310 Stage [X.XX]

This option screen is used to view the current stage reading of the H-310. It may also be used to enter an initial stage value and have the XL™ automatically calculate the necessary offset. The XL™ will then issue the appropriate SDI-12 commands to program the offset value of the H-310. The default offset value of the H-310 is 0.0.

PC Interface View

Not Available On The PC Menu

Built In Display Screen

H310 Units [PSI]

This option is used to set the units that the stage value will be reported in. The default is set to report the PSI reading of the H-310 pressure transducer. The user can change the units to report the stage in feet or enter a user defined slope to convert the value to some other unit. The available options are listed here.

- Feet:** This uses a slope of 2.3067 and reports water level in feet. A pressure sensor that reports PSI based on a water level can be converted to water level in feet by multiplying the PSI value by 2.3067.
- Feet Dn:** This uses a slope of -2.3067 and reports water level in feet normally referenced to the ground surface of a well. As the water level rises towards the ground level the value reported becomes smaller.
- PSI:** This uses a slope of 1.00 and reports the PSI based on the water level. Multiplying by 1.00 will not change the base value, which in this case is PSI.
- User Def:** This will open a new menu screen allowing the user to enter in any slope value desired. This could be used to report the stage in meters, inches, etc.

Remember these settings are programmed into the H-310, not the XL™.

14.6 H-330 / H331 Setup

The following menus allow the user an easy way to setup the Design Analysis H-330 and H-331 shaft encoders without having to know the SDI-12 commands used to set the slope and offset of the encoder. These same setups can be done in the standard transparent mode using extended commands, but it is easier here as the XL™ sends all the commands automatically. If the address for the H-330 is not correct then a H-330 not responding message will be displayed. Press the Cancel key to continue.

Sensor Input Setup->	H-330 Setup	->	SDI-12 Test Adrs [0]
			H330 Stage [X.XX]
			H-330 Units [Ft CW]

PC Interface View

Not Available On The PC Menu

Built In Display Screen

SDI-12 Test Adrs [0]

This option sets the SDI-12 address the XL™ will use to communicate with the H-330 or the H-331 encoder. This is not related to the option that is used to set the sensor address of the XL™ when it is used as an SDI-12 sensor.

PC Interface View

Not Available On The PC Menu

Built In Display Screen

H330 Stage [X.XX]

This option screen is used to view the current stage reading of the H-330. It may also be used to enter an initial stage value and have the XL™ automatically calculate the necessary offset. The XL™ will then issue the appropriate SDI-12 commands to program the offset as needed in the H-330 or the H-331.

Not Available On The PC Menu

H330 Units [Ft CW]

This option is used to set the units the stage value will be reported in. The H-330/H-331 has a resolution of 200 counts per revolution. Using a 1.0 foot circumference pulley equates to 200 counts per foot. The default slope value of 0.005 per count will report each complete turn as one foot of water level change. The user can change the units to one of two predefined options or select a user defined value. The available options are listed below.

Ft CW: This uses a slope of 0.005 and will report water level in feet based on the pulley turning clock wise for an increase in water level.

Ft CCW: This uses a slope of -0.005 and reports water level in feet based on the pulley turning counter clock wise for an increase in water level.

User Def: This will open a new menu screen allowing the user to enter in any slope value desired. This could be used to report the stage in meters, inches, etc.

Remember these settings are programmed into the H-330 or H-331, not the XL™.

14.7 SDI-12 Sensor Mode Supported Commands

Standard Commands			
Command	Format	Response	Notes
Acknowledge	a!	a←	
Identify	aI!	aID String ←	
Measure	aM!	atttn←	Must use Data Retrieval command to get the data
Verify	aV!	atttn←	
Data Retrieval	aDx!	a±X.XX±X.XX...←	
Change Address	aAb!	b←	
Extended Commands			
Read Offset	aXRO!	atttn ←	0.00 = Default
Write Offset	aXWOvalue!	atttn ←	
Read Slope	aXRS!	atttn ←	1.000 = PSI 2.3067 = Feet
Write Slope	aXWSvalue!	atttn ←	

14.7.1 SDI-12 Command and Response Protocol

This is a brief description of the Serial Digital Interface (SDI-12) Command and Response protocol used by the *WATERLOG*[®] Series Model H-350XL™ when used as a sensor. Included is a description of the commands and data format supported by the H-350XL™.

Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR HYDROLOGIC AND ENVIRONMENTAL SENSORS." Version 1.1 November, 1993 Coordinated by Campbell Scientific, Inc., Logan, Utah.

During normal communication, the data recorder sends an address together with a command to the H-350XL™. The H-350XL™ then replies with a "response". In the following descriptions, SDI-12 commands and responses are enclosed in quotes. The SDI-12 address and the command/response block terminators are defined as follows:

- "a" Is the sensor address. The following ASCII Characters are valid addresses: "0" to "9", "A" to "Z", and "*". The H-350XL™ can be configured to respond to any of the 36 addresses. Sensors will be initially programmed at the factory with the address of "0" for use in single sensors systems. Addresses "1" to "9" and "A" to "Z", can be used for additional sensors connected to the same SDI-12 bus. Address "*" is a "wildcard" address which selects any sensor, regardless of its actual address.
- "!" Is the last character of a command block.
- "<cr><lf>" Are carriage return (0D) hex and line feed (0A) hex characters. They are the last two characters of a response block.

Notes:

- All commands/responds are upper-case printable ASCII characters.
- Commands must be terminated with a "!" character.
- Responses are terminated with <cr><lf> characters.
- The command string must be transmitted in a contiguous block with no gaps of more than 1.66 milliseconds between characters.
- All ASCII-Hex commands, arguments and data values are transmitted most significant digit first.

14.7.2 Standard SDI-12 Command Set

All SDI-12 sensors should incorporate a set of standard commands. These commands are used for making measurements, collecting data, identifying the sensor and verifying the sensor is working properly. Since all sensors use the same basic commands it is easy to memorize and use these commands on any sensor.

14.7.3 Send Acknowledge Command

The Send Acknowledge command returns a simple status response which includes the address of the sensor. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
----- "a!"	----- "a<cr><lf>"

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").

14.7.4 Send Identification Command

The Send Identification command responds with sensor vendor, model, and version data. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
----- "aI!"	----- "allcccccccmmmmmmvvxx...xx<cr><lf>"

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- I Is an upper-case ASCII character.
- ll Is the SDI-12 version compatibility level, e.g. version 1.0 is represented as "10".
- ccccccc Is an 8 character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.
- mmmmmm Is a 6 character field specifying the sensor model number.
- vvv Is a 3 character field specifying the sensor version number.
- xx...xx Is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder.

Response to a "aI!" command:

```
"a10      DAAH350XLvvS#nnnnnnVkkk<cr><lf>"
```

H-350-XL implementation of optional field:

```
S#nnnnnnVkkk (12 bytes total)
```

Where:

- "nnnnnn" is a six character sensor serial number
- "kkk" is a three digit sensor firmware revision level

14.7.5 Measure Command

The Measure Command causes a measurement sequence to be performed. Data values generated in response to this command are stored in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M" or "V" command is executed.

Command	Response	Description
"aM!"	"atttn<cr><lf>"	Initiate measurement
"aM1!"	"atttn<cr><lf>"	Additional measurement commands

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- M (or M1) are upper-case ASCII characters.
- ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have measurement data available in its buffer.
- n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

Upon completion of the measurement, a service request "a<cr><lf>" is sent to the data recorder indicating the sensor data is ready. The data recorder may wake the sensor with a break and collect the data any time after the service request is received or the specified processing time has elapsed.

The following table lists the measure commands supported by the *WATERLOG*[®] H-350XL[™] and the responses from the sensor.

H-350XL™ Supported Measurement Commands:

Response to a "aM!" command: (when the system is set to factory defaults)

Command	Response	Time	Values	Description
"aM!"	"a0063<cr><lf>"	6 sec	3	Initiate pressure and temperature measurement

Subsequent Command	Response
"aD0!"	a+xxx.xxx+yyy.yyy+zz.z<cr><lf>

Key	Description	Units
xxx.xxx	Current Stage	Feet (Default)
yyy.yyy	Current Pressure	Pounds-per-Square Inch (PSI)
zz.z	Current Temperature	Centigrade (°C)

Note: The number of parameters returned and their order, can be modified by the user.

Response to a "aM1!" command:

Command	Response	Time	Values	Description
"aM1!"	"a0084<cr><lf>"	8 sec	4	Initiate diagnostic pressure and temperature measurement

Subsequent Command	Response
"aD0!"	a+xxx.xxx+yy.y+XXXXXX+YYYYYY<cr><lf>

Key	Description	Units
xxx.xxx	Current Pressure	Pounds-per-Square Inch (PSI)
yy.y	Current Temperature	Centigrade (°C)
XXXXXX	Current Pressure	Raw Reading
YYYYYY	Current Temperature	Raw Reading

14.7.6 Initiate Verify Command

The Verify Command causes a verify sequence to be performed. The result of this command is

similar to the "aM!" command except that the values generated are fixed test data and the results of diagnostic checksum tests. The data generated in response to this command is placed in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another command is executed.

Command	Response	Description
"aV!"	"atttn<cr><lf>"	Initiate verify sequence

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- V Is an upper-case ASCII character.
- ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
- n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

Response to a "aV!" command:				
Command	Response	Time	Values	Description
"aV!"	"@0104<cr><lf>"	10 sec	4	Return fixed data and diagnostic data for testing purposes.
Subsequent Command		Response		
"aD0!"		a+123.456+78.9+y+z<cr><lf>		
Key	Description	Units		
+123.456	Fixed test data			
+78.9	Fixed test data			
y	ROM checksum test	0 = Failed, 1 = Passed		
z	Watchdog timer status	0 = Off, 1 = On		

14.7.7 Send Data Command

This command returns sensor data generated by a previous "aM!" or "aV!" command, or other commands that return data and take longer than 1 second to complete. Values returned will be sent in 33 characters or less. The sensor's data buffer will not be altered by this command. On the XL series of loggers, only the D0, D1 and D2 commands are supported or needed.

Command	Response
"aD0!" through "aD9!"	"apd.d ... pd.d<cr><lf>"

Where: a Is the sensor address ("0" to "9", "A" to "Z", or "*").

D0..D9 Are upper-case ASCII characters.

p Is a polarity sign (+ or -), and is used to separate values.

d.d Represents a numeric data value. If a decimal is not used, it is assumed to be after the last digit. For example: +3.29 +23.5 -25.45 +300

If the number of values returned by a "aD0!" command is less than the number specified by the result of the previous "M" or "V" command, the rest of the data must be collected using "aD1," "aD2!" "aD9!" until all values specified have been collected.

If one or more values were specified and a "aD0!" returns no data (a<CR><LF> only), it means that the measurement was aborted and a new "M" command must be sent. The following is an example of a normal measure command followed by the "aD0!" command.

Response to a "aD0!" command:		
Previous command	Response format	
-----	-----	
"aM!"	"a0163<cr><lf>"	
Subsequent D0 Command	Response format	
-----	-----	
"aD0!"	a+xxx.xxx+yyy.yyy+zz.z<cr><lf>	
Key	Description	Units
-----	-----	-----
xxx.xxx	Current Stage	Feet (Default)
yyy.yyy	Current Pressure	Pounds-Per-Square Inch (PSI)
zz.z	Current Temperature	Centigrade (°C)

14.7.8 Change Sensor Address

The Change Sensor Address command allows the sensor address to be changed. The address is stored in non-volatile EEPROM within the sensor. The H-350XL™ will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

Command	Response	Description
"aAn!"	"n<cr><lf>"	Change sensor address

Where:

- a Is the current (old) sensor address ("0" to "9", "A" to "Z", or "*"). An ASCII "*" may be used as a "wild card" address if the current address is unknown and only one sensor is connected to the bus.
- A Upper-case ASCII character.
- n Is the new sensor address to be programmed ("0" to "9", "A" to "Z", or "*").

NOTE: To verify the new address use the "Identify Command."

Example of a "Change Sensor Address" command:

Command	Response	Description
"aA2!"	"2<cr><lf>"	Change sensor address to "2"

14.7.9 Extended SDI-12 Command Set

Since not all SDI-12 sensors are the same, and may need to be configured differently, each sensor may have additional commands for programming configuration options. Any command used to setup or program an SDI-12 sensor outside the standard command set would be an extended command. The user must realize the extended commands can be implemented several different ways and is up to the manufacture on this implementation. As such it is very important to have operating manuals close at hand when working with SDI-12 sensors.

14.7.10 Write "User Units Slope" Command

The Write User Units Slope command loads the "User Units Slope" coefficient term. The new value is stored in non-volatile EEPROM within the sensor. Once the new slope term is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using the "D" command. To verify the current "User Units Slope" any other time, use the "Read User Units Slope" command.

Command	Response	Description
"aXWSddd!"	"atttn<cr><lf>"	Write User Units Slope coefficient

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- XWS Are upper-case ASCII characters.
- ddd Is the new User Units Slope value. The input format is very flexible. Some examples are shown below.
 - 20.095
 - 0.195
 - 7.984E+10
 - 167.824E5
 - 005.9357E-7
 - 500
- ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
- n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer.

Example of a "Write User Units Slope" command:

Command	Response	Time	Values	Description
"aXWS1.234!"	"a0021<cr><lf>"	2 sec	1	Write user units slope coefficient

14.7.11 Write "User Units Offset" Command

The Write User Units Offset command loads the "User Units Offset" coefficient term. The new value is stored in non-volatile EEPROM within the sensor. A copy of this value is placed in the sensor data buffer for verification. It can be viewed by using the "D" command. To verify the "User Units Offset" at any other time, use the "Read User Units Offset" command.

Command	Response	Description
----- "aXWOddd!"	----- "atttn<cr><lf>"	----- Write User Units Offset coefficient

Where:

a Is the sensor address ("0" to "9", "A" to "Z", or "*").

XWO Are upper-case ASCII characters.

ddd Is the new User Units Offset value. The input format is very flexible. Some examples are shown below.

20.095
0.195
7.984E+10
167.824E5
005.9357E-7
500

ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.

n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer.

Example of a "Write User Units Offset" command:

Command	Response	Time	Values	Description
----- "aXW012.34!"	----- "a0021<cr><lf>"	----- 2 sec	----- 1	----- Write user units offset coefficient

14.7.12 Read "User Units Slope" Command

The Read User Units Slope command reads the "User Units Slope" coefficient term. The value is read from non-volatile EEPROM within the sensor and loaded into the sensor data buffer. It can be viewed by issuing a "D" command.

Command	Response	Description
"aXRS!"	"atttn<cr><lf>"	Load sensor buffer with User Units Slope

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- XRS Are upper-case ASCII characters.
- ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
- n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer.

Example of a "User Units Slope" command:

Command	Response	Time	Values	Description
"aXRS!"	"a0021<cr><lf>"	2 sec	1	Load sensor buffer with the User Units Slope coefficient

Subsequent Command	Response
"aD0"	a+xxx.xxx<cr><lf>

Key	Description
xxx.xxx	User Units Slope

14.7.13 Read "User Units Offset" Command

The Read User Units Offset command reads the "User Units Offset" coefficient term. The value is read from non-volatile EEPROM within the sensor and loaded into the sensor data buffer. It can be viewed by issuing a "D" command.

Command	Response	Description
"aXRO!"	"atttn<cr><lf>"	Load sensor buffer with User Units Offset

Where:

- a Is the sensor address ("0" to "9", "A" to "Z", or "*").
- XRO Are upper-case ASCII characters.
- ttt Is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.
- n Is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer.

Example of a "User Units Offset" command:

Command	Response	Time	Values	Description
"aXRO!"	"a0021<cr><lf>"	2 sec	1	Load sensor buffer with the User Units Offset coefficient

Subsequent Command	Response
"aD0"	a+xxx.xxx<cr><lf>

Key	Description
xxx.xxx	User Units Offset

Chapter 15

Logging Options

15.1 Logging Overview

The logging options are used to determine if and how the data will be stored to the internal memory of the XL™. The following shows the “Logging Options” screen.

15.2 Logging Options Menus

The following menu structures represent the sub menus under the “Logging Options” header. This is where the user defines which data will be stored in the data memory and other logging functions.

Built in Menu Structure: Logging Options Menu.

Output Options ->	Logging Options ->	Logging [On]
		.NEW File [None]
		Data Fmt [Normal]
		Wrap Mode [Disabled]
	Report Options ->	Source 1 [Date]->
		Header 1[]->
		Log Rate[HH:MM:SS]->
		Digits 1 [2] ->
		Col 1 Fn() [NOW]->
		Stat Scrn 1 [No] ->

Notice the options in the far right column have arrows ‘->’ indicating there are more options to the right. In this case this is the first column of a table and it will extend to the right for a total of 25 columns. As described in chapter 3, use the arrow keys to move around the table and other editing techniques to make any desired changes in the table.

PC Menu Screen: Logging Options.

```

Logging Options          (Esc to Return)

N - .NEW File:  None
T - Data Format: Normal
W - Wrap Mode:  Disabled
A - All Log Rates To Scan Rate

Scan Rate = 00:15:00      Est. Days To Fill Memory: 793

Column      | [01]          02          03          04          05
-----|-----
S - Source  | Date         Time         Stage         PtTemp        Batt
H - Header  | MM/DD/YY     HH:MM:SS     Stage         PtTemp        Battery
R - Log Rate| 00:15:00     00:15:00     00:15:00     00:15:00     00:15:00
D - Digits  | 2            2            2            2            2
F - Function| NOW          NOW          NOW          NOW          NOW
U - Stat Scrn| No          No          Yes          Yes          Yes

-> - Next
<- - Previous

Enter Option >

```

Notice the brackets around the 01 for column one indicating any changes will apply to that column only. This table has 25 columns. The brackets may be moved to the desired column using the Right and Left arrow keys as indicated on the screen..

- > - **Next** Advance to the next column. This option has no effect on the last column.
- <- - **Previous** Move left to the previous column. This option has no effect on the first column.

15.3 Logging Options

The options below describe how to setup the logging features of the system. The order of the options follow that of the PC menu listed above.

PC Interface View

N - .NEW File: None

Built In Display Screen

.New File [None]

There are some special applications that can be used to automatically download data from the XL™ over the serial port via modem or some other type of communication equipment. The XL™ can be setup to log data to a special file called a .NEW file. The data will be stored in both the main file and in the .NEW file. A PC or other device can easily be programmed to collect data from the XL™ by issuing the “DUMPNEWDATA” command. The data in the .NEW file will be transmitted to the system issuing the command. The .NEW file will be terminated with 3 NULL characters making it easy for the other system to know the end of file has been received. At this point the system issuing the commands could send the “ERASENEWDATA” command

in order to delete the .NEW file. On the next scan the .NEW file would be created again, and the new data would be placed in it. The system issuing the commands could be setup to automatically collect the data as often as needed, from every few minutes to once every few months. The new data could also be retrieved manually by the user.

The XL™ will continue to place data in the .NEW file until told to erase it. If during the data transfer a break in the communications happens, most likely the data would not all get to the receiving system, and the XL™ would not receive the erase command, so the new data would still be available for retrieval. This two command approach protects the user from losing data. The main data file will always be available for retrieval and will include all data from the time scanning was enabled.

If multiple users are looking at the .NEW file it will take some coordination on their part on who will be erasing the .NEW data file.

Without the use of the .NEW file the user would have to retrieve the main data file which would become larger as time passed causing the transmission to become exceedingly long and the user would have to deal with data that has already been transmitted before.

PC Interface View

Built In Display Screen

T - Data Format: Normal

Data Fmt [Normal]

The data stored to internal memory is done so as an ASCII data file. There are a few different formats for this file as described below.

Normal: This mode uses 8 characters for each data value. If a data value is less than 8 characters then leading spaces are used thus keeping the columns of data aligned. A space is used to separate the data values. This mode produces an easily readable file. Here is a sample of the format.

```
08/27/05 15:30:00    98.73    9.45    12.34
08/27/05 15:45:00   105.76   10.73   12.33
```

Normal CSV: This mode is just like the normal mode except that a comma is used to separate the data values. This mode still uses 8 characters for each data value. If a data value is less than 8 characters then leading spaces are used. Again a comma is used to separate the data values. This mode produces an easily readable file and may be easier to import to other programs like a spreadsheet. Below is a sample of this format.

```
08/27/05,15:30:00, 98.73, 9.45, 12.34
08/27/05,15:45:00, 105.76, 10.73, 12.33
```

No Padding: This mode is just like the normal mode except that if a data value is less than 8 characters then leading spaces are not used. Again a space is used to separate the data values. This mode produces a smaller file but may be harder to read as columns may not line up. See the sample of this format below

```
08/27/05 15:30:00 98.73 9.45 12.34
08/27/05 15:45:00 105.76 10.73 12.33
```

No Pad CSV: This mode is just like the no padding mode except that data values are separated by commas. This mode produces a smaller file but may be harder to read as columns may not line up. This may also import better into other programs. See the format below.

```
08/27/05,15:30:00,98.73,9.45,12.34
08/27/05,15:45:00,105.76,10.73,12.33
```

PC Interface View

Built In Display Screen

W - Wrap Mode: Disabled

Wrap Mode [Disabled]

This option is used to allow the unit to continue logging once the data memory fills up by erasing some of the oldest data. The wrap process of deleting old data actually happens when the data memory is about half full. In most cases this mode is not needed as the data memory will hold several years of data under normal logging conditions and the unit should be cleared out every once in a while anyway. The process to erase old data and continue logging may take a few minutes so if the scan rate is fast some data may be lost while the unit is deleting old data.

PC Interface View

Built In Display Screen

A - All Log Rates To Scan Rate

Not Available in Built In Menu

It may be a desire to change the log rates to the scan rate and this option may be used to adjust all of them using one simple command instead of having to adjust all of them individually.

PC Interface View

Built In Display Screen

Scan Rate = HH:MM:SS

Not Available in Built In Menu

This is just a status screen showing the current scan rate. This may help in setting the log rates.

Ext. Days To Fill Memory: XXX

Not Available in Built In Menu

This is a status screen that shows the number of days it would take to fill the internal data memory card with data based on the current system configuration.

S - Source

Source 1 [Date]->

This selects what input will be used to provide data for the selected column. The selected column is indicated by the brackets '[xx]' around the column number when using the PC menu. Source options included are Date, Time, Stage, Temp, Batt, SDI-12 inputs, etc. If "None" is selected as the source, the selected column and all subsequent columns will be disabled. When changing this option use the Up and Down arrow keys to move through the valid options.

Available options are listed below.

- None The column is turned off, and all following columns are ignored.
- Date Place the current Date in the column.
- Time Place the current Time in the column.
- Stage Place the Stage reading in the column. (H-350XL™ Model only)
- PSI Place the PSI reading in the column. (H-350XL™ Model only)
- PtTemp Place the Temperature reading in the column. (H-350XL™ Model only)
- RemStg Place the Remote Stage reading in the column.
- Counts Place the summation count value in the column.
- TotCnt Place the total counts value in the column.
- CtRate Place the counter rate value in the column.
- AnaX Place analog X value in the column (there are 4 analog channels).
- DigI/OX Place digital I/O X value in the column (there are 2 digital I/O ports).
- Freq Place the Frequency value in the column.
- Encodr Place the encoder value in the column.
- Batt Place the Battery reading in the column.
- TScans Place the total number of scans in the column.
- BasicX Place the XL-Basic reading in the column (valid X is 1 - 5).
- SDIAP Place the selected SDI-12 reading in the column (valid AP is 01 - 99).
Note the SDI-12 entries go from address 0 to 9. The parameter is always 1 to 9.
The entry SDI62 would indicate the sensor at address 6 and use the 2nd parameter.

- FNTXX Place the selected user defined math function result in the column (01 - 40).
Note there are 40 user definable math functions that can be used for advanced operations. Selecting a math function as a report column source will cause that

function to be analyzed and the results logged to that column. See a later section for a detailed description of the math operations.

SITE_ID The 8 character site id is placed in the data file.

When the XL™ turns on to scan the connected sensors and log data, it looks at the selections in these columns to see exactly which sensors to scan and log. As soon as it comes to a column source defined as “None” it stops the logging process and moves to the next task.

The default source values for the different XL series products is listed in the table below. In many cases the default values will be what is needed for the user application and no changes will be needed.

Column	H-350XL	H-500XL / H-522 / H-522P	H-510XL
1	Date	Date	Date
2	Time	Time	Time
3	Stage	Batt	Stage
4	PtTemp	None	Batt
5	Batt	None	None
6 to 25	None	None	None

PC Interface View

Built In Display Screen

H - Header

Header 1 [MM/DD/YY] ->

This option is used to enter a text header for each column of data. For example if the source is set to “Stage,” the column header could also be set to stage, or it could be set to read “Water Ft” or “Wtr Lvl,” or anything the user decided. This is especially useful when the source is one of the SDI-12 channels or a function as they are not intuitive on what the input is.

The header is not only used in the data file but is also used for the status screens and for the side button displays. On the status screens and side button screens if the header is defined, then it will be used to identify the data but if the header is left blank (first character is a space) then the source text will be used to identify the data value.

PC Interface View

Built In Display Screen

R - Log Rate: HH:MM:SS

Log Rate [HH:MM:SS] ->

This displays the current log rate for the selected column. This option is used to allow the XL™ to log data to the different columns at different rates. The default value is 00:15:00 or 15 minutes which is equal to the default scan rate. Setting the log rate should be done with the scan rate in mind. In most cases the log rate and scan rate are the same, but it is possible to scan faster than the log rate and then log a data value based on several scans such as an average, a max or a min value. Lets say scanning is set to once a minute and the log rate is set to 15 minutes. In this case there will be 15 scans for every log value and the average of the 15 values could be logged. Now if the log rate is faster than the scan rate then it will log based on the scan rate. For example if the log rate is set to 1 minute and the scan rate is at 15 minutes then data will be scanned and logged once every 15 minutes regardless of the 1 minute log rate. Setting the log rate to once a second will cause the logging to follow the scan rate. Try to avoid odd settings like a 3 minute scan rate and log rate for one column of 5 minutes and another column of 15 minutes. This will work but may be confusing to other users as the 3 minute scan does not divide easily into the 5 minute log rate.

PC Interface View

Built In Display Screen

D - Digits

Digits 1 [2] ->

This sets the number of digits to the right of the decimal that will be logged with the data value. This allows values like the battery voltage to be displayed without showing too much precision, and other values like the stage to be logged with the precision needed. This has no affect on the Date and Time sources. Each column is set for 8 characters so if the digits is set to 2, then that leaves 1 character for the decimal point and 5 for digits to the left of the decimal point. If the value is less the 5 digits on the left of the decimal point then the value may be padded with

leading spaces.

PC Interface View

Built In Display Screen

F - Function

Col 1 Fn () [Now] ->

Column functions are used to perform mathematical operations on the data logged in the data file. These operations are based on all the data scanned for that column since scanning was turned on, or they are based on a subset of the data for that column. Column functions that end in “_T” are based on the total data set for a column, and functions that end in “_S” are based on a subset of the data scanned from the present time back to the last log interval for the selected column. In some cases the user definable functions may need to be used to generate specialized functions for specific applications. Below is a list of the available built in functions for manipulating the column data.

Now:

This is the default setting. This will take the last scanned value for this column and log it into the data file based on the log rate.

Avg_S:

This will average a number of scanned values for this column and log the results. The number of values to average together is based on how many scans will happen during the log rate period. For example lets say the scan rate is every 15 minutes and one column is set up to log the temperature from a sensor connected to analog channel 1 with a log rate of 15 minutes, and a column function of NOW. And a second column is setup to log data from the same sensor but the log rate is set to 1 hour, and the column function is set to AVG_S. The first column will log the current temperature every 15 minutes. The second column would average 4 readings and log the results once an hour since there are 4 scans in the hour scanning at a rate of 15 minutes. Think of the ‘S’ as standing for a subset of the total data column.

Max_S:

This will find the maximum value scanned out of the last few scans based on the scan rate and log rate for this column and log the results. Continuing on with the example for the Avg_S function, lets say another column is set up to log the temperature from the same sensor connected to analog channel 1 with a log rate of 1 hour, and a column function of MAX_S. This column will log the maximum temperature for the hour.

Min_S:

This will find the minimum value scanned out of the last few scans based on the scan rate and the log rate for this column and log the results. Continuing on with the example for the Avg_S function, lets say another column is set up to log the temperature from the same sensor connected to analog channel 1 with a log rate of 1 hour, and a column function of MIN_S. This column will log the minimum temperature for the hour.

TmMax:

This will log the time that a max value was found based on the samples between two log intervals or based on a subset of the data values. For example lets say a column is set to log stage every 15 minutes using a function of Max_S and a second column is set to log stage every 15 minutes using a function of TmMax and the scan rate is set to 1 minute. That means there will be 15 scans for each log and the first column will log the maximum stage value out of the 15 readings. The second column will not log the stage value but will log the time that the maximum stage value occurred.

TmMin:

This will log the time that a min value was found based on the samples between two log intervals or based on a subset of the data values. For example lets say a column is set to log stage every 15 minutes using a function of Min_S and a second column is set to log stage every 15 minutes using a function of TmMin and the scan rate is set to 1 minute. That means there will be 15 scans for each log and the first column will log the minimum stage value out of the 15 readings. The second column will not log the stage value but will log the time that the minimum stage value occurred.

Sum_S:

This will add up the scanned values for the column for the log rate period and log one value at the end of the log rate. For example, lets say there are two columns set up to report counts. The first is set up to report counts on every scan and the second is set with a log rate of 1 hour so it will report only once an hour with a total count for that hour.

Avg_T:

This will average every scan regardless of the log rate. If the scan rate is 15 minutes and one column is set up to log the water level of a lake with a log rate of 15 minutes and a column function of NOW, and a second column is set up to log the same data with a log rate of 1 hour and the column function set to AVG_T, the first column will log the current lake level every 15 minutes. The second column would log a value once an hour because the log rate is set to 1 hour, but the value would be the average water level since scanning was turned on. All values scanned since scanning was enabled would be included in the average.

Max_T:

This would log the maximum data value scanned since scanning was enabled. The value would be logged based on the log rate. This data value would be like a crest stage gage showing the highest water level since scanning started.

Min_T:

This would log the minimum data value scanned since scanning was enabled. The value would be logged based on the log rate. This could be used to see what the minimum battery has been since scanning was turned on.

Sum_T:

This will add up all the values scanned for this column since scanning was enabled and log a the value at each log interval.

Alwys:

There are a few reasons to use this option. First lets assume the scan rate is set to a rate faster than the log rate for a specific log column. If the log column is also used as a status screen then it may be desirable to update more often so the value originally displayed on the status screen is more recent. Pressing the Enter key will also cause the status screen to update so this may not be as important.

The second reason to measure every scan even if the value will not be logged every scan is to provide an updated value for other processes that happen more often. The following Logging Options segment shows column 3 to be logged every hour but the function Alwys is used so it is measured each scan. Now look at column 4 that uses a function as a source and is logged every 15 minutes, equal to the scan rate. If the function uses the stage value as part of its calculation then it will be using a fresh stage value each scan. If column 3 function was set to Now, meaning scan and log only as needed and in this case once an hour, then the function in column 4 would use the same stage value measured at the top of the hour for its 15 minute, 30 minute and 45 minute scan.

Logging Options		(Esc to Return)			
Scan Rate = 00:15:00		Est. Days To Fill Memory: 213			
Column	[01]	02	03	04	05
S - Source	Date	Time	Stage	Fnt01	Batt
H - Header					
R - Log Rate	00:15:00	00:15:00	01:00:00	00:15:00	00:15:00
D - Digits	2	2	2	2	2
F - Function	NOW	NOW	Alwys	NOW	NOW
U - Stat Scrn	No	No	Yes	Yes	Yes

NoLog:

This option is used to start or run a process without having to place any data in the data file. For example it may be required to execute an XL Basic program at the beginning of the scan process and not have unwanted data in the data file. The following Logging Options segment shows column 1 set to execute an XL Basic program but not to log anything based on the basic program.

Also look at column 5, the function is also set to NoLog and the StatScrn option is set to Yes. This allows a status screen to be defined but not logged.

Logging Options		(Esc to Return)			
Scan Rate = 00:15:00		Est. Days To Fill Memory: 213			
Column	[01]	02	03	04	05
S - Source	Basic1	Date	Time	Stage	PSI
H - Header					
R - Log Rate	00:15:00	00:15:00	00:15:00	00:15:00	00:15:00
D - Digits	2	2	2	2	2
F - Function	NoLog	NOW	Alwys	NOW	NoLog
U - Stat Scrn	No	No	No	Yes	Yes

PC Interface View***Built In Display Screen*****U - Stat Scrn**

Stat Scrn 1 [No]->

This option is used to enable or disable this column to be used as a status screen. When the unit is turned on from the front panel it will display a sign on message then data for each column that has been set to be used as a status screen. On an H-350XL the defaults for the first two columns are date and time and the option to use these two columns as status screens is disabled. The next three columns are Stage PtTemp and battery all of which are used as status screens. Now when the unit is turned on using these default settings the stage value will be displayed after the sign on messages. Pressing the Down arrow will display the pressure transducer temperature value, and pressing the Down arrow again will display the battery voltage. In most cases the value displayed is the not a new reading but the last measured value. While a status screen is displayed the ENTER key can be pressed to cause the input to be measured again and the displayed value would be current. Up to 25 status screens could be used.

Chapter 16

Operation with the GOES Radio

16.1 Introduction

The GOES Radio is capable of sending data at regular timed intervals called the Timed Transmissions or Self Timed Mode, and at random intervals called the Random Transmissions or random mode. Both types of transmissions can be in operation at the same time. The XL™ will check if data is to be sent to the GOES Radio data buffer after each scan interval. If data is in the GOES radio timed data buffer it will be transmitted at its normal interval. Data in the random buffer will be transmitted at a random time based on the random rate setting.

16.1.1 GOES Radio Data Connection

The XL™ is used to program the GOES Radio setup options and to send data to the Radio to be transmitted. The communication link between the XL™ and the GOES Radio is normally through the RS-232 Com Port 2. This is always the case when using the H-350XL, H-500XL and H-510XL. On the H-522 and H-522+ it depends on the board revision on which port is used. On board revisions 3.1 and older, com port 2 is disconnected from the I/O panel and connects internally to the built in GOES radio. The connector on the I/O panel for com port 2 is only there for mechanical reasons. On board revision 3.3 and newer there is a new internal com port used specifically for the GOES radio (com 5) that is not available on the outside of the unit. In this case com port 2 can still be used by the user for other applications. The software can detect the hardware version and automatically adjusts to use the correct com port.

16.1.2 GOES Radio Types

The XL series data logger is compatible with several different GOES radios from three different manufactures. The menus used to set up and program the GOES radio is basically the same for all of the different radios. The radio may be the original GOES radio from Telonics that supported only 100 baud transmissions or the newer units from Signal Engineering and Microcom offering 100, 300 or 1200 baud operation. Although all attempts have been made to make the interface the same for all radios, there are still a few differences between the radios. The table below shows the different radios used with the XL series data logger and some of the basic differences. Other differences will be explained under each section as needed.

Note: There are several options in the GOES Radio setup, some of these options are stored in the Radio memory, and some in the XL™ memory. The options stored in the XL™ are protected from power failures, but those stored in the radio are not. To protect the options stored in the radio, make sure power connections are secure and heavy gauge wire is used.

GOES Radio Types / Basic Differences		
Manufacture / Model Number	Design Analysis Model Number	Notes
Telonics TGT-1	H-222	This was the original GOES radio sold and supported by Design Analysis. This was only a 100 baud rate radio. Soon after the high data rate specification was released, Telonics stopped selling GOES radios. Shortly after that they no longer would repair them also. Design Analysis still supports this radio as much as possible but realizes most users have moved on to the high data rate radios.
Signal Engineering SE-100	H-222	This was the first radio used after the Telonics radio became obsolete. This was also only a 100 baud radio.
Signal Engineering SE-300	H-222-SE	This radio was built and shipped during the time most manufactures stopped building low data rate radios and were waiting for the high data rate specification to be completed. The delay in the specification created a problem for users as they could not order equipment during this time. This radio allowed for 100 and 300 baud transmissions but not 1200 baud rates. It also did not utilize GPS time keeping circuitry. The accuracy of the built in clock was good enough for the original 100 baud applications and for most of the 300 baud applications. Most often this radio was shipped with a secondary GPS time keeping system utilizing a Garmin antenna and receiver.
Signal Engineering SE-1200	H-222-DASE	This is a 100, 300 or 1200 baud radio with built in GPS for time keeping.
Signal Engineering Omnisat	H-222-DASE	This is the newer version of the SD-1200. This radio has the ability to be used for both normal domestic and international use with the MSAT system, Middle Eastern Satellite system. Notice the DAA part number is the same as for the SE-1200 model.
Microcom GTX 1.0DA	H-222-DA	This radio was used when we could not buy the Signal Engineering radios directly from the manufacture. This is a 100, 300, 1200 baud radio.
Signal Engineering INSAT	H-222-INSAT	This is a special radio used in the India Satellite Radio Network. The options and setup instructions for this radio are described in a separate application note. Only users in India need to be concerned with these options.

16.2 Configuring the GOES Radio, General Options

The following sections describe the submenus used for configuring the GOES radio. The following menu shows the submenu structure for the GOES radio setup options. The menu displayed will first be those from the built in interface and then the same options using the PC menu interface. Each of the options can be changed using the standard editing methods of the XL™ using the built in keypad / display interface or from the PC interface.

The GOES radio must be connected to the correct comm port in order for the XL to recognize the GOES radio and allow access to the menus for the radio. If the radio is not connected to the right port, an error message will be displayed. Basically, on the H-350XL, the H-500XL and the H-510XL, com port 2 must be used for the GOES. On the H-522 and the H-522+ the com port is connected internally. Refer to section 16.1.1 on using the correct com port and the different options based on the hardware revision. The last section of chapter two also discusses the different hardware revisions.

Several of the GOES options are assigned by NOAA / NESDIS, (United States Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Services). Other options are user dependant. It is the responsibility of the user to apply for and receive approval from NOAA for operating on the GOES system. This chapter assumes the user has a basic understanding of the GOES system and it capabilities.

Once the radio is enabled and scanning is turned on, several of the GOES options cannot be changed. The message “**Turn Scanning and GOES Off First**” will be displayed indicating that scanning must be turned off and the GOES Mode must be turned off before the change can be made. If some of the options are changed without disabling the radio first, those changes may not be acknowledged by the radio. Be sure to turn off the radio before changing the GOES Radio options.

The GOES menus are broken down into 4 groups. First is the basic GOES options. Second is the options for the self timed transmissions. Third is the options for the random transmissions. Last is the GOES status and diagnostic screens.

Below is the menu structure for the basic GOES options when using the built in display.

Built in Menu Structure: GOES Main Menu Options.

GOES Options	->	Radio Type[SE-1200]
		GOES Mode: [Off]
		GOES Time [00:00:00]
		GOES Adrs [00000002]
		GOES Preamble[Short]
		Self Timed Options->
		Random Options ->
		Next Txd: N/A
		Next Txd At: N/A
		Reset GOES Options?

The following shows the basic GOES options screen when using the PC interface. These options are used to set up both self timed and random transmissions.

PC Menu Screen: GOES Main Menu Options.

```
GOES Radio Options      (Esc to Return)

GOES Radio Type: SE-1200
Time To ST Txd:
Next ST Txd At:

M - Mode:      Off
A - Address:   00000002
T - Time:      00:00:00
P - Preamble:  Short
S - Self Timed Options
R - Random Options
D - Diagnostic Menu
G - Reset GOES Options To Default Values

Enter Option >
```

GOES Radio Type:

Radio Type: [SE1200]

From the PC menu shown above this is a status screen only listing the current radio type selected. The radio type could be changed using a previous menu. Using the built in menu the user can change the radio type as needed. If the wrong type of radio is selected the GOES menus will not be shown and a message indicating the radio is not responding will be displayed.

NOTE: This option is not saved as part of the configuration file. This prevents the radio type from inadvertently being changed.

NOTE: When using the H-522 and the H-522 +, the GOES radio is built into the data logger and therefore will not be changing. On these two model numbers the radio type cannot or should not be changed as the radio is built into the data logger and will not be changing.

Available options are listed below. Also refer to the table on page 16.2 that describes the different radios. The GOES radio type should not need to be changed in most cases. Normally this is only used if upgrading from an older style radio to a new unit, or one manufacture to a different manufacture.

- SE-100:** This is a 100 baud radio from Signal Engineering. This did not have GPS capability.
- SE-300:** This is a 100, 300 baud radio from Signal Engineering. This radio did not have the built in GPS receiver, but may be equipped with an SDI-12 based GPS receiver. The SDI-12 based GPS uses an interface board that was packaged inside the gray case with the GOES radio but was actually functioned separately from the radio.
- SE1200:** This is a 100, 300, 1200 baud radio from Signal Engineering. This radio also has an integrated GPS receiver for time keeping. Signal Engineering's first 1200 baud radio was labeled SE-1200. Later they came out with a radio labeled the 'Omnisat' radio. In either case use this selection for the radio type.
- Telonics:** This is the older 100 baud radio from Telonics. This radio is no longer available for purchase, but several still in use. Telonics no longer supports this radio but Design Analysis can do some testing with this radio.
- DA-1200:** This is a 100, 300, 1200 baud radio from Microcom. This radio also has an integrated GPS receiver for time keeping. This radio is identified by its LED's as it utilizes four different LEDs to aid in its use.

PC Interface View

Built In Display Screen

Time To ST Txd: HH:MM:SS

Next Txd: HH:MM:SS

This is a status screen that counts down the time to the next timed transmission. If the scanning is turned off and the GOES mode is off then this displays “N/A” on the built in display and is left blank on the PC menu. This option is only available when using the Signal Engineering radio H-222-DASE. This option is not available using the built in menu.

PC Interface View

Built In Display Screen

Next ST Txd At: HH:MM:SS

Next Txd At: HH:MM:SS

This is a status screen that displays the time of the next scheduled timed transmission. If the scanning is turned off and the GOES mode is off then this displays “N/A” on the built in display and is left blank on the PC menu. This option is only available when using the Signal Engineering radio H-222-DASE. This option is not available using the built in menu.

PC Interface View

Built In Display Screen

M - Mode:

GOES Mode: [Off]

This option allows the user to define the GOES Radio mode of operation. This option should only be turned on after all other GOES options are set as desired. The system may not allow the radio to be turned on if the other options are not set properly. For example, if the Self-Timed settings are such that the time required to send the data is greater than the defined transmit window, then an error message is displayed. The options for the GOES mode are as follows:

- Off:** The radio is disabled, changes to the radio options may be made while in this mode.
- Timed:** The radio is set for Self-Timed transmissions only. Few if any changes can be made to the radio options while in this mode.
- Random:** The radio is set for Random Transmissions. Few if any changes can be made to the radio options while in this mode.
- Both:** Both Self-Timed and Random Transmissions are enabled. Few if any changes can be made to the radio options while in this mode.

PC Interface View

Built In Display Screen

T - Time:

GOES Time [HH:MM:SS]

This option may act differently based on the different radio types as explained below. This option allows the user to set or check the time clock in the GOES Radio. This is a different clock than the one in the data logger section of the XL™. This clock must be set to universal standard time, while the time clock in the data logger section may be set to the local time or any other time desired.

NOTE: When using the H-222DASE radio, the clock in the radio is set using a built in GPS system. At initial power up the radio will continuously try to acquire time from the GPS system in order to set the time. Once time is set the radio will try once a day for ½ hour to re-sync the time clock. If 7 days have elapsed without a time sync, then the GPS receiver will stay powered up continuously trying to re-sync again. The user can look at the time but cannot change it. If the clock is not incrementing every second as expected, then the radio has not acquired time from the GPS system, this is common at initial power up. The radio will not transmit if the time has not been acquired initially or if it has been more than 7 days since the last GPS time sync.

When using the H-222DA radio the radio will allow the time to be manually set, but is best to allow it to sync from the GPS receiver before turning on the GOES mode.

When using the H-222SE-100 or the H-222SE-300 the system may include a GPS time keeping option. In this case the GOES time can still be set by the user. The GPS time keeper may be physically packaged with the GOES radio but is not directly part of the radio functionally.

The Telonics radio will not allow its clock to be set when the radio is enabled. Therefore the GPS options are invalid in this case.

PC Interface View

Built In Display Screen

A - Address:

GOES Adrs [xxxxxxxx]

This is the 8 character DCP (Data Collection Platform) address or ID assigned by NESDIS. This is automatically transmitted with the data to the GOES satellite. The address must be in capital letters. If entered in lower case they will be changed automatically to upper case.

PC Interface View

Built In Display Screen

P - Preamble:

GOES Preamble [Short]

At the beginning of each transmission, a preamble signal is sent to the satellite. The preamble is a carrier signal with no data modulation. This allows the satellite to lock on the signal easier. A short preamble is the default. A long preamble is the other option. This option is only valid for 100 baud transmissions. On 300 and 1200 baud transmissions the preamble is always short. The table below shows the time difference between using a short and long preamble.

Preamble Type	Short	Long
Total Preamble Time	0.98 seconds	7.3 seconds

PC Interface View

Built In Display Screen

S - Self Timed Options

Self Timed Options ->

This option opens up the menu structure for configuring all the self timed transmission options. This will be described in detail in a following sections titled “Self Timed Options”.

PC Interface View

Built In Display Screen

R - Random Options

Random Options ->

This option opens up the menu structure for configuring all the random transmission options. This will be described in detail in a following sections titled “Random Options”.

PC Interface View

Built In Display Screen

D - Diagnostic Menu

Not Available In Built In Menu

The GOES diagnostic menu is only available using the PC menu interface. Using this option opens up the menu structure for viewing general radio information and running some tests on the radio. This is also dependant on the radio type. This will be described in detail in following sections titled “GOES Radio Diagnostics”.

G - Reset GOES Options to Default Values

Reset GOES Options?

This option is used to reset just the GOES options to the default values. The GOES options are complex and this allows an easy way to start fresh with this section of the XL without affecting any other sections or options of the XL.

16.3 GOES Self-Timed Options

Below is the menu structure for the Self Timed GOES options when using the built in display and keypad. Several of these screens use the abbreviation ST to indicate one of the Self-Timed options.

Built in Menu Structure: GOES Self Timed Options.

GOES Options	->	Self Timed Options ->	ST Channel [000]
			ST Rate [00:00:00]
			ST Offset [00:00:00]
			ST Baud Rate = 100
			ST Window [15 Sec]
			Center Data [Yes]
			ST Data Fmt [SHEF]
			Data Order [SCAN]
			Data First [Newest]
			Send SHEF Codes[No]
			Append Bat Valu[No]
			Extra Data Sets [01]
		ST Data Options ->	Source 1 [None]->
			SHEF Code 1 []->
			MeasRate 01[00:15:00]
			Format 1 [XX.XX]->
			ST Buffer Cnt = 0
			Txd Test Carrier?

PC Menu Screen: GOES Self Timed Options.

```
Self Timed Options      (Esc to Return)

C - Channel Number:      000
R - Transmit Rate:       01:00:00
O - Tx Offset Time:      00:00:00
W - Self Timed Window:   15 Sec
I - Center Data In Window: Yes
B - Self Timed BaudRate: 100
F - Data Format:          SHEF
D - Data Order:          SCAN
N - Data Sent First:     Newest
H - Send SHEF Headers:   No
A - Append 1 Battery Scan: No
S - Redundant Data Sets: 1
T - Transmit Options
V - View XL Buffer Data

Radio Buffer Byte Count: 0
XL Buffer Byte Count:    XXX of XXX Bytes Max
Actual Transmit time:   XX Seconds

Enter Option >
```

PC Interface View

Built In Display Screen

C - Channel [000]

ST Channel [000]

This option allows the user to enter the Self-Timed Transmission channel number assigned by NESDIS. The range for use with the domestic satellites is 001 to 199 and represents a specific frequency for communicating with the satellites. If the channel is an even number then it is communicating with the western satellite. If the channel number is odd it is communicating with the eastern satellite. Channels from 200 and above are for international use.

PC Interface View

Built In Display Screen

R - Transmit Rate: 01:00:00

ST Rate [HH:MM:SS]

This option allows the user to set the rate at which data will be transmitted over the Self-Timed channel. The default is a 1 hour rate, for example 01:00:00. This along with the setting for the “ST Offset” determine the true time that data will be transmitted. See the ‘Tx Offset Time’ option below for an example. This option also indirectly determines how much data will be sent each transmission. Use 00:00:00 for a 24 hour transmit rate. The transmit rate is assigned by NESDIS.

PC Interface View

Built In Display Screen

O - Tx Offset Time

ST Offset [HH:MM:SS]

This is a time offset for all timed transmissions based on the transmit rate. This will also be the time of the first transmission of the day relative to midnight. This offset time is also assigned by NESDIS. The offset time must be less than the transmit rate. This setting and the setting for the ‘ST Rate’ determine the start of the transmit window. As an example, assume the offset time is set to 00:30:15. The Transmission rate is set to 04:00:00. With this information, the XL™ can calculate the start time of each transmission window for a single day. This would be at 00:30:15, 04:30:15, 08:30:15, 12:30:15, 16:30:15, and 20:30:15. The actual duration of the transmission is determined by the amount of data to be transmitted. The transmission must fit in the transmit window assigned by NESDIS.

Do not add time to the offset in order to center the data as this can be done automatically using the option described below, ‘Center Data In window’.

PC Interface View

Built In Display Screen

W - Self Timed Window

ST Window [15] Sec

NOAA will assign a window length indicating how much time is allowed to transmit data. The default is a 15 second window. The options range from 1 minute to a 5 second window. The transmission may be set to start the transmission at the beginning of the window (default) or to center the data transmission in the window as described below in the ‘Center Data In Window’ option..

PC Interface View

Built In Display Screen

I - Center Data In Window

Center Data [No]

This option is used to center the transmitted data in the transmission window. The default is to not center the data which means the transmission will start at the beginning of the window. If set to center the data in the window, the XL™ will calculate how long it would take to transmit the selected data and delay the start of the transmission to center the data in the middle of the window. If enabled, the centering process is done automatically, and the user should not add any time to the offset option in an attempt to center the data.

Note: This option is not valid on the Telonics radio. The Telonics radio will automatically center the data no matter of the user’s desire.

PC Interface View

Built In Display Screen

B - Self Timed BaudRate

ST Baud Rate [300]

This option is used to set the baud rate for the Self-Timed transmissions. This may be different than the random transmission baud rate. This option is dependent on the radio type with valid options of 100, 300 or 1200 baud. This will also be assigned by NOAA.

PC Interface View

Built In Display Screen

F - Data Format

ST Data Fmt [SHEF]

Self-Timed transmissions can be either a SHEF (ASCII) or a Binary format. The SHEF format uses plain ASCII text and are easily readable, but they take longer to transmit. On the other hand, Binary data is transmitted quicker, but the file will need to be decoded before it can be read. If more data is needed, then a Binary format may have to be used. Refer to the GOES Data Format section below for more details on the SHEF format and the GOES Binary format.

SHEF: Send data in a readable ASCII format. For example, 15.26 means just that, 15.26.

BINARY: Send data using a three character coded sequence for each value. For example, 15.26 would be represented as @Wv. See the GOES Pseudo-Binary Look Up Table later in this chapter for instructions on decoding these values. Binary data will be preceded with the characters “BST” for binary scan ordered data transmissions or with “BCT” for binary channel ordered data transmissions.

PC Interface View

Built In Display Screen

D - Data Order

Data Order [Scan]

This option defines if data will be sent based on each transmitted line representing a single scan or each transmitted line representing a single channel or sensor.

Scan Order: Each line of data represents one scan and one value from each defined input.

HG TA VB	SHEF headers turned on. Stage, Temp, and Battery values in each line. Each line is a different scan at some defined time interval.
18.34 22.78 12.45	
18.76 22.45 12.44	
18.97 22.15 12.45	
19.43 22.02 12.45	

Channel Order: Each line represents all the data from a single sensor.

HG 18.34 18.76 18.97 19.43	Each line has all data from a single sensor. Each value in the line is scanned at different times based on scan rate.
TA 22.78 22.45 22.15 22.02	
VB 12.45 12.44 12.45 12.45	

PC Interface View

Built In Display Screen

N - Data Sent First

Data First [Newest]

This option defines if the ‘Newest’ or ‘Oldest’ data should be sent first. Some decode programs only accept the data in one format and not the other.

PC Interface View

Built In Display Screen

H - Send SHEF Headers

Send SHEF Codes [No]

The system uses this option to see if SHEF codes are to be included in the data transmission. The SHEF code is a two character code that represents the data. For example the standard SHEF code for the stage data is HG for height of the gauge or TA for ambient temperature. The SHEF codes may be useful in decoding and although SHEF codes can be defined and transmitted, no attempt was made to hold to the SHEF code format. Sending the SHEF code will add time to the transmission so it may cut down on the amount of data transmitted.

SHEF stands for ‘Standard Hydrometeorological Exchange Format’ (SHEF). This is a documented set of rules for coding of data in a form for both visual and computer recognition. It

is designed specifically for real-time use and is not designed for historical or archival data transfer. All the critical elements for identification of data are covered. Station identifiers, parameter descriptors, time encoding conventions, unit and scale conventions, and comment fields are all part of the code. The true SHEF implementation does not lend itself well to GOES transmissions but using portions of it can be helpful.

PC Interface View

Built In Display Screen

A - Append 1 Battery Scan

Append Bat Valu[No]

This option allows one battery reading to be appended to the data being transmitted. Normal applications transmit 15 minute data yet battery values are not required that often. Fifteen minute battery readings also take up transmit time that could be used for other data. Selecting 'Yes' to this option allows the user to still get a battery value for each transmission, while shortening the transmit time and allowing other data to be transmitted instead.

PC Interface View

Built In Display Screen

S - Redundant Data Sets

Extra Data Sets [01]

This option is used to set the number of extra data sets to send with each transmission. A data set is defined as the data collected for between transmissions. Setting this option to 00 would mean do not send any extra or redundant data sets. The only data that would be transmitted is the data collected since the last transmission. The default value is 01 indicating to the system to send one set of extra or redundant data along with the new data. The new data would be the data collected since the last transmission and the extra data set(s) would be the data collected between the older transmissions in logical order. Sending redundant data is a common practice with the GOES system, and allows the data to be transmitted more than once, protecting against lost transmissions.

PC Interface View

Built In Display Screen

T - Transmit Options

ST Data Options ->

One of two menus will be displayed here based on the setting of the 'Data Format' option. The submenu allows the user to select the data that is to be transmitted, and in which order. Measurement rates and formatting options are also available. If the data format is SHEF then the user can also define SHEF codes if desired. Defining the options here is similar to defining columns in a spreadsheet.

Menus for Data Format set to SHEF:

Built in Menu Structure: GOES Self Timed Data Options, (SHEF Format).

(The menu shows some options set based on using an H-350XL™ with the built in stage sensor)

ST Data Options->	Source 1 [Stage]->	Source 2 [Temp]->	...	Source 20 [None]->
	SHEF Code 1 [HG]->	SHEF Code 2 [TA]->	...	SHEF Code 20 []->
	MeasRate 1 [HH:MM:SS]	MeasRate 2 [HH:MM:SS]	...	MeasRate 20 [HH:MM:SS]
	Format 1 [XX.XX]	Format 2 [XX.XX]	...	Format 20 [XX.XX]

PC Menu Screen: GOES Self Timed Transmit Options, (SHEF Format).

(The menu shows some options set based on using an H-350XL™ with the built in stage sensor)

```

ST Transmit Options      (SHEF or ASCII Mode)      (Esc to Return)

A - All Meas. Rates Set To Scan Rate

Scan Rate = 00:05:00

Column      | [01]      02      03      04      05
-----|-----|-----|-----|-----|-----
S - Source: | Stage     Temp     None     None     None
C - SHEF Code: | HG        TA
R - Meas Rate: | 00:15:00  00:15:00  00:15:00  00:15:00  00:15:00
F - Format:   | XX.XX     XX.XX     XX.XX     XX.XX     XX.XX

-> - Next
<- - Previous

Enter Option >
    
```

PC Interface View

Built In Display Screen

S - Source

Source 1 [None]

The source option is used to select what data value will be transmitted and in what order. Each column normally has a different data source based on the standard input options. If the column source option is set to “None” then that column and all following columns are disabled. When this option is selected use the UP and DOWN arrow keys to view the valid options as listed below.

None	The column is turned off, and all following columns are ignored.
Date	Place the date in the column (Normally the date is not sent as GOES data).
Time	Place time in the column, (Normally the time is not sent as GOES data).
PSI	Place the PSI reading in the column. (H-350XL™ model only)

Stage	Place the stage reading in the column. (H-350XL™ model only)
PtTemp	Place pressure transducer temperature reading in the column. (H-350XL™ only)
StgStd	Place Standard Deviation value in the column. (H-350XL™ NOAA mode only)
StgOlr	Place the number of outliers in the column. (H-350XL™ NOAA mode only)
RemStg	Place the remote stage measurement reading in the column.
Counts	Place the counts reading in the column.
TotCnt	Place the total count reading in the column.
CtRate	Place the count rate reading in the column.
Batt	Place the battery reading in the column.
Ana1 to Ana4	Place analog X reading in the column.
Dig1 to Dig2	Evaluate digital I/O x and place a 0 or 1 in the column based to the results.
Freq	Place the converted frequency reading in the column.
Encodr	Place the quadrature encoder count in the column.
Tscans	Place the number of scans reading in the column.
Basic1 to Basic5	Place the value returned to the BasicX variable in the column.
SDI01 to SDI99	Place the selected SDI-12 reading in the column.
Fnt01 to Fnt40	Place the results of function xx in the column.

Note: The SDI-12 entries go from address 0 to 9. The parameter is always 1 to 9. The entry SDI 62 would indicate the sensor at address 6 and use the 2nd parameter.

PC Interface View

Built In Display Screen

C - SHEF Code

SHEF Code 1 [XX]

The SHEF code for each data value may be defined by the user. This is normally a two character entry that represents the data value. For example “HG” equals height gage, and “TA” equals temperature ambient.

SHEF stands for ‘Standard Hydrometeorological Exchange Format’ (SHEF). This is a documented set of rules for coding of data in a form for both visual and computer recognition. It is designed specifically for real-time use and is not designed for historical or archival data transfer. All the critical elements for identification of data are covered. Station identifiers, parameter descriptors, time encoding conventions, unit and scale conventions, and comment fields are all part of the code. The true SHEF implementation does not lend itself well to GOES transmissions but using portions of it can be helpful.

PC Interface View

Built In Display Screen

R - Meas Rate

MeasRate [00:15:00]

This option is used to indicate how often the sensor for this column should be measured. Fifteen

minute data is the default, [00:15:00]. This allows data for the different columns to be collected at different rates. This value is normally a multiple of the scan rate. The scan rate may be faster so other devices may be updated quicker. For example if a display is needed to be updated at least once every 6 minutes, the scan rate could be set to a 5 minute rate which means every third scan will happen at the same time the GOES needs to be measured based on the default value of a fifteen minute GOES measurement rate. The display would be updated every five minutes.

If the scan rate gets set slower than the GOES measurement rate then the actual measurement rate will be the same as the scan rate. It is possible to set the GOES measurement rate to a very fast rate such as one second, then it will basically just follow the scan rate.

PC Interface View

Built In Display Screen

F - Format

Fmt 01 [XX.XX]

The user can choose a data display format for each GOES data value transmitted. This option is only valid for the SHEF data, not for binary data. The format indicates how many digits should be displayed on each side of the decimal point. The default is XX.XX which is 2 digits on each side of the decimal point. This gives a range of -9.99 to 99.99. If the value is outside the range, then the most significant digits are displayed and the decimal point is shifted as needed. For example a value of 123.45 would be displayed as 123.4 if the XX.XX format was used. Some GOES decoding programs must have data in a fixed format so it is important to choose a format that fits the range of data expected for that column. Also choosing a format that displays several digits like XXXX.XX will waste space and transmission time if the data for the column never uses that many characters.

Menus for Data Format set to BINARY:

Built in Menu Structure: GOES Self Timed Data Options, (Binary Format).

(The menu shows some options set based on using an H-350XL™ with the built in stage sensor)

ST Data Options->	Source 1 [Stage]->	Source 2 [Temp]->	...	Source 20 [None]
	MeasRate 1 [HH:MM:SS]	MeasRate 2 [HH:MM:SS]	...	MeasRate 20 [HH:MM:SS]
	No. Bytes 1 [3] ->	No. Bytes 2 [3] ->	...	No. Bytes 20 [3]
	No. Digits 1 [2] ->	No. Digits 2 [2] ->	...	No. Digits 20 [2]
	Sign [Signed Mag.]->	Sign [Signed Mag.]->	...	Sign [Signed Mag.]->
	Column 1 Range: xxx	Column 1 Range: xxx	...	Column 1 Range: xxx

PC Menu Screen: GOES Self Timed Transmit Options, (Binary Format).

(The menu shows some options set based on using an H-350XL™ with the built in stage sensor)

```

ST Transmit Options      (SHEF or ASCII Mode)      (Esc to Return)
A - All Meas. Rates Set To Scan Rate
Scan Rate = 00:05:00

Column      | [01]      02      03      04      05
-----|-----
S - Source: | Stage     Temp     None     None     None
R - Meas Rate: | 00:15:00  00:15:00  00:15:00  00:15:00  00:15:00
B - Bytes   | 3         3         3         3         3
D - Digits  | 2         2         2         2         2
P - Sign Mode | Signed Mag. Signed Mag. Signed Mag. Signed Mag. Signed Mag.
  Min Range | -1310.72 -1310.72 -1310.72 -1310.72 -1310.72
  Max Range | 1310.72  1310.72  1310.72  1310.72  1310.72

-> - Next
<- - Previous

Enter Option >
    
```

PC Interface View

Built In Display Screen

S - Source

Source 1 [None]

The source option is used to select what data value will be transmitted and in what order. Each column normally has a different data source based on the standard input options. If the column source option is set to “None” then that column and all following columns are disabled. When this option is selected use the UP and DOWN arrow keys to view the valid options. See the corresponding option under the ‘SHEF Mode’ transmit options above for more details

PC Interface View

Built In Display Screen

R - Meas Rate

MeasRate [00:15:00]

This option is used to indicate how often the sensor for this column should be measured. Fifteen minute data is the default, [00:15:00]. This allows data for the different columns to be collected at different rates. This value is normally a multiple of the scan rate. The scan rate may be faster so other devices may be updated quicker. For example if a display is needed to be updated at least once every 6 minutes, the scan rate could be set to a 5 minute rate which means every third scan will happen at the same time the GOES needs to be measured based on the default value of a fifteen minute GOES measurement rate. The display would be updated every five minutes.

If the scan rate gets set slower than the GOES measurement rate then the actual measurement rate will be the same as the scan rate. It is possible to set the GOES measurement rate to a very fast rate such as one second, then it will basically just follow the scan rate.

PC Interface View

Built In Display Screen

B - Bytes

No. Bytes 1 [3] ->

Each data value is converted into a Pseudo Binary format consisting of 1 to 4 bytes. The more bytes used to represent a value means more precision and range can be preserved, at the expense of sending fewer values. Each byte in this format uses 6 bits for data, one bit always set to a 1, and one bit for parity. Now 1 byte with 6 bits used for data gives a range of 0 to 63 so a one byte value in many cases is not too useful. On the other hand a 4 byte value can have a range of 0 to 16777215 which is a large range.

This option along with the digits and signed value options determine how the data will be stored. The section below discussing the minimum and maximum range discuss this in more detail.

PC Interface View

Built In Display Screen

D - Digits

No. Digits 1 [2] ->

This option is used to define the number of digits to the right of the decimal point that should be preserved. For example a water level value in meters will still need to have millimeter resolution so this option would be set to 3. On the other hand a wind direction may be set to use whole numbers only so the digits is set to 0. The range is from 0 to 4.

This option along with the bytes and signed value options determine how the data will be stored. The section below discussing the minimum and maximum range discuss this in more detail.

PC Interface View

Built In Display Screen

P - Sign Mode

Sign [Signed Mag.]

This option indicates if the values will be just positive values like a wind direction, 0 to 360 degrees, always positive; or may include negative values also like an air temperature value. Signed numbers can be in a Twos compliment format or can be in a signed magnitude format.

PC Interface View

Built In Display Screen

Min Range

Column 1 Range: +13..

Note that the built in display only shows 20 characters at a single time so when this message is displayed, the range will scroll across the screen to show the complete message.

These two values show the actual range of values that can be properly represented in the GOES pseudo binary format based on the number of bytes selected, the digits selected and if the value is positive only or signed. The table below shows all the possible combinations. To determine which settings to use first determine the range of values the sensor will have and then what precision is needed as far as digits to the right of the decimal. For example, if wind direction was to be converted into this format look at its range which is 0 to 360 degrees and does not go negative. A byte count of 2 and a decimal value of 1 and positive only will give a range of 0.0 to 409.5 which easily covers the range of 0 to 360. Look at a temperature probe that will go from -50 to +50 and needs to have 0.01 degree resolution. In this case the bytes would have to be 3, the digits 2, and use signed values.

DATA FORMAT / RANGE TABLE						
Bytes	Digits	Signed Values = N		Signed Values = Y		Resolution
		Min	Max	Min	Max	
1	0	0	63	-32	31	1
2	0	0	4095	-2048	2047	1
3	0	0	262143	-131072	131071	1
4	0	0	16777215	-8388608	8388607	1
1	1	0.0	6.3	-3.2	3.1	0.1
2	1	0.0	409.5	-204.8	204.7	0.1
3	1	0.0	26214.3	-13107.2	13107.1	0.1
4	1	0.0	1677721.5	-838860.8	838860.7	0.1
1	2	0.00	0.63	-0.32	0.31	0.01
2	2	0.00	40.95	-20.48	20.47	0.01
3	2	0.00	2621.43	-1310.72	1310.71	0.01
4	2	0.00	167772.15	-83886.08	83886.07	0.01
1	3	0.000	0.063	-0.032	0.031	0.001
2	3	0.000	4.095	-2.048	2.047	0.001
3	3	0.000	262.143	-131.072	131.071	0.001
4	3	0.000	16777.215	-8388.608	8388.607	0.001
1	4	0.0000	0.0063	-0.0032	0.0031	0.0001
2	4	0.0000	0.4095	-0.2048	0.2047	0.0001
3	4	0.0000	26.2143	-13.1072	13.1071	0.0001
4	4	0.0000	1677.7215	-838.8608	838.8607	0.0001

NOTE: The bold values show the default settings and range. If in question on how to set this just use the default values. Changing these options can greatly affect how the data must be decoded.

PC Interface View

Built In Display Screen

Radio Buffer Byte Count

ST Buffer Cnt = 0

This is a status screen that shows how many bytes are in the Self-Timed buffer of the Radio ready to be transmitted. This option acts differently based on the radio manufacture.

Note: When the Telonics radio is used, data is sent to the radio on every scan. The ST buffer byte count will normally show the number of bytes ready for transmission at all times except during the time just after a transmission and before the next scan at which time it will report zero bytes.

When using the Microcom radio or one of the Signal Engineering radios, data is loaded into the radio buffer only on the scan just before the transmission. In this case the ST buffer Byte count value will normally show a value of 00 except between the time of the scan just before the transmission and the transmission itself.

PC Interface View

Built In Display Screen

XL Buffer Byte Count: xxx of xxx Bytes Max

Not Available In Built In Menu

There is a buffer in the data logger section of the system that is used to collect, format and manage the data to be sent to the GOES radio buffer for transmission. This status screen indicates how many bytes are in the buffer of the data logger and how many bytes it would hold based on the current menu options such as baud rate, window size, redundant data, etc. This is used to see that the data logger section is set up properly.

NOTE: If the amount of data to be transmitted is greater than the indicated max bytes, the system will not allow the GOES mode to be turned on. The user must reduce the amount of data to transmit.

PC Interface View

Built In Display Screen

V - View XL Buffer Data

Not Available In Built In Menu

There is a data buffer in the XL™ that holds the data that will be sent to the GOES Radio. This buffer can be viewed at any time to see the data that will be transmitted by the GOES radio. If the radio is not enabled, the viewed data will be a series of slashes “/” or “@” characters representing the selected data format. When the radio is turned on and scanning is started the slashes will be replaced with real data. This is an easy way to see if the data format and setup information is correct.

16.4 GOES Random Options

Random transmissions are sent based on some condition such as high water or heavy rain fall. Several of the option screens use the abbreviation RR to indicate this is a Random mode option. Random data will always use the pseudo-binary format and the data will be preceded with the characters "BRT".

Built in Menu Structure: GOES Random Transmit Options.

GOES Options	->	Random Options	->	RR Channel:	[000]
				RR Rate:	[00:00:00]
				RR Baud Rate =	100
				Tx Fnt [0]
				RR Data Opts	->
				Source	1 [XXXXXX]
					:
					Source
				5 [XXXXXX]	
				RR Buffer Cnt =	0
				Transmit RR Data?	

PC Menu Screen: GOES Random Transmit Options.

```

Random Options          (Esc to Return)

C - Channel Number:   000
R - Transmit Rate:    00:00:00
B - Random BaudRate:  100
A - Alarm Condition:  0
T - Transmit Options
F - Force Random Transmission

Buffer Byte Count:    0

Enter Option >
  
```

PC Interface View

C - Channel Number

Built In Display Screen

RR Channel [000]

This option allows the user to enter the Random transmission channel number. The range is 1 to 199 and represents a specific frequency for communicating with the satellite. The channel number will be assigned by NESDIS.

PC Interface View

Built In Display Screen

R - Transmit Rate

RR Rate [HH:MM:SS]

This option allows the user to set a window length used by the radio to generate a random time to transmit the data. When data is placed in the random transmit buffer of the radio, that data will be transmitted at some random time in the time window set by the “RR Rate” option. For example, let's assume a random rate of 30 minutes. When data is sent to the random buffer, the transmission is randomly scheduled at some time within the next 30 minutes.

PC Interface View

Built In Display Screen

B - Random BaudRate

RR Baud Rate [100]

This option is used to set the baud rate for the random transmissions. At this time the only baud rate used by NOAA is 100 baud. If NOAA ever uses higher baud rates in the future then this option will allow the user to change it as needed. Keep in mind this baud rate may be different than the Self-Timed transmission baud rate.

PC Interface View

Built In Display Screen

A - Alarm Condition

Tx Fnt [xxxxxxxxxxxxxxxxxxxx]

This screen displays the conditional statement used to see if a random transmission should be sent. This statement is normally a logical expression that evaluates to being true or false . For example, “ana1 > 10.0” would equate to true if the value for analog channel 1 is greater than 10.0 and would equate to false if it was less than 10.0. Logical expressions return a value of 1.0 if true and 0.0 if false. If the conditional statement is true then a random transmission will be scheduled.

The transmit trigger condition is actually true for any value that is greater than 0.0 and is false for any value that is 0.0 or less. This allows for standard math expressions also to be used for the transmit trigger condition. For example, if a temperature probe was connected to analog channel 1 that read in degrees F, a math equation like “(ana1 - 32) * -1” could be used to trigger a transmission any time the temperature was below 32 degrees F. If the temperature is at or above freezing (32 degrees) the results of the equation would be zero or negative and would be considered false, otherwise it would be positive and would be true.

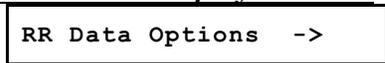
The conditional statement can be up to 48 characters and can be based on multiple conditions as shown in the next two examples; “(ana1>10.0) & (counts > 0.05)”. In this example the value for analog channel 1 must be greater than 10.0 **AND** the counts input (normally rain fall) must be

greater than 0.05. Another example would be; “(ana1>10.0) | (counts > 0.05)”. In this example the value for analog channel 1 must be greater than 10.0 **OR** the counts input (normally rain fall) must be greater than 0.05 in order for the function to be true, which would cause a random transmission. The conditional statement can be edited using the local display / keypad or by using the PC menu interface. See chapter 22 ‘Functions’ for a complete understanding on how to enter, edit and evaluate the math and logic functions.

PC Interface View

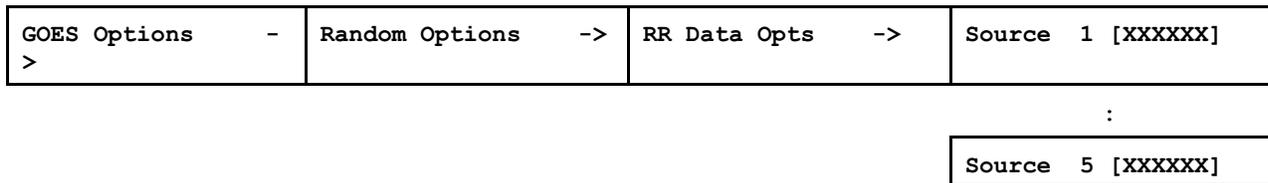
Built In Display Screen

T - Transmit Options

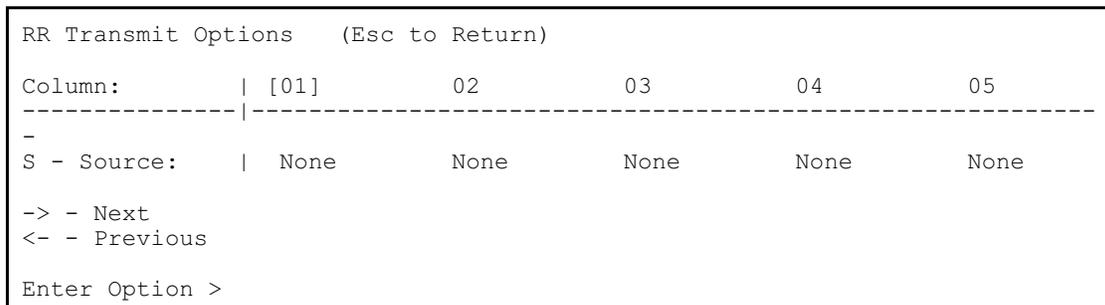


The submenus under this option allow the user to select the data to be sent to the radio and the order. Defining the options here is like defining columns in a spreadsheet. Source #1 will be the first data value sent to the GOES Radio, Source #2 the next and so on. Options include Date, Time, Stage, PSI, Temp Battery Voltage, or any other input option. There are a total of five screens for entering different sources under this option allowing up to five data values to be transmitted randomly.

Built in Menu Structure: GOES Random Transmit Options.



PC Menu Screen: GOES Random Transmit Options.



PC Interface View

Built In Display Screen

S - Source

Source 1 [None]

The source option is used to select what data value will be transmitted and in what order. Each column normally has a different data source based on the standard input options. If the column source option is set to “None” then that column and all following columns are disabled. When this option is selected use the UP and DOWN arrow keys to view the valid options. This is just like setting up the data sources for the timed transmissions.

PC Interface View

Built In Display Screen

Buffer Byte Count

RR Buffer Cnt = 0

This is a status screen that shows how many bytes are in the random transmit buffer of the radio.

PC Interface View

Built In Display Screen

F - Force Random transmission

Transmit RR Data?

This option causes the system to immediately send the data defined in the Random Data Options menu. This may be useful for testing the system. The radio will not send data if a transmission has happened within the last minute as there must be a 1 minute delay between transmissions.

16.5 GOES Diagnostics

The newer Signal Engineering radios and the Microcom radio have some diagnostic menus. These menus are used to check the condition of the radio and other functions. There is no diagnostics for the Telonics radio or the original Signal Engineering radios.

The diagnostic menu options are only available when using the PC menu interface. Below is the options for the Signal Engineering Omnisat radio.

```
SE-100, 300, 1200 GOES Radio Diagnostics      (Esc to Return)

C - Transmit Carrier Only Using Self Timed Channel; (Use Dummy Load)
S - View General Radio Status
T - Run / View Self Test Info.
G - GPS Receiver Status: Disabled
M - send Message On Random Channel

Enter Option >
```

PC Interface View

Built In Display Screen

C - Transmit Carrier Only Using Self Time Channel; Not Available In Built In Menu

This option is used to test the RF power output when the signal is not being modulated. This test allows for the true power of the transmitter to be measured. This will run for 90 seconds or until the user presses a key to stop the transmission.

Since this is on the self timed channel and is normally used as a local power test it should only be used when the unit is connected to a dummy load. Transmitting on this channel while connected to an antenna will interfere with other users and other sites.

A couple of things to watch for is the power reading on the watt meter to see that it holds steady and does not drop off in time as the test is used for a minute or more. The other thing to watch is the battery voltage level at the radio to see that it does not drop off significantly also.

To use this option the scanning must be turned off and the GOES mode must be off also.

S - View General Radio Status;

Not Available In Built In Menu

This option just displays general information about the radio, information about the last transmission, the last time sync etc.

```
General Radio Status

Battery Voltage (Current)           = 12.7
Battery Voltage (Before Last Tx)   = 12.7
Battery Voltage (During Last Tx)   = 12.4

Current Temperature (Degrees C)    = 25

Latitude   = 00000000
Longitude  = 00000000

Day of Last GPS Time Sync (Jday)   = 74
Time of Last GPS Time Sync: 22:46:34

Number of Missed GPS Time Sync's  = 0
Day of Last Missed GPS Time Sync (Jday) = 0
Time of Last Missed GPS Time Sync: 00:00:00

Last Transmission Duration = 0.219 Seconds

Fail Safe Status: Ok
```

The battery voltage readings give a good indication of how the battery is holding up. Mainly look at the difference between the voltage during the last transmission and one of the other readings to see if there is a large difference.

The current temperature reading should be close to ambient but may be off by a few degrees.

The latitude and longitude at the site are listed if the GPS receiver is working and has acquired the time and other GPS information.

There is general GPS information listing if the time has synced, when it synced, how many missed syncs have occurred , etc.

The fail safe status is also listed on this screen and should always indicate it is ok. If it shows the fail safe has tripped then reset it by pressing the reset button on the radio.

PC Interface View

Built In Display Screen

T - Run / View Self Test Info.

Not Available In Built In Menu

This option causes the radio to execute a series of self tests and may take about 15 seconds to complete. There are several checksum or CRC tests here that return OK or an Error. If a CRC test fails it may be best to call technical support to discuss the problems. There are also some battery and temperature tests. The temperature test often fails and it is normal if the temperature is not at room temperature. The temperature reading should be close to ambient temperature.

PC Interface View

Built In Display Screen

G - GPS Receiver Status

Not Available In Built In Menu

This option is used to enable or disable the GPS receiver. Normally it is only disable to test the transmitter when it is taking a long time to sync. If the GPS receiver is disabled the user can manually set the GOES time clock.

PC Interface View

Built In Display Screen

M - Send Message on Random Channel

Not Available In Built In Menu

This option allow the user to type in a message and transmit it on the random channel. The message must be 40 characters or less.

16.6 GOES Radio Setup Example

The following example assumes that NOAA assigned the following settings for the application.

DCP Address = ABCD1234
ST Channel # = 56
ST Rate = 1 hour
ST Offset = 00:37:40
ST Baud Rate = 300
ST Window = 10 seconds
RR Channel # = 100

The options would be setup as follows:

GOES Mode: [Timed]
GOES Time: [00:11:22] (set as needed)
DCP Adrs: [ABCD1234]
GOES ST CHNL: [056]
ST Rate: [01:00:00]
ST Offset: [00:37:40]
ST Baud Rate [300]
ST Window [10]
Center Data [No]
ST Data Fmt [SHEF]
Data Order [Scan]
Data First [Newest]
Send SHEF Codes [No]
Append Batt Valu [Yes]
Extra Data Sets [01]

Source 1 [Stage]	Source 2 [Temp]	Source 3 [SDI01]	Source 4 [None]
SHEF Code 1 [HG]	SHEF Code 2 [TA]	SHEF Code 3 [PR]	SHEF Code 4 []
MeasRate 1 [00:15:00]	MeasRate 2 [00:15:00]	MeasRate 3 [00:15:00]	MeasRate 4 [00:15:00]
Format 1 [XX.XX]	Format 2 [XX.XX]	Format 3 [XX.XX]	Format 4 [XX.XX]

Also assume that the logging interval is set to 15 minutes.

Note that with a 15-minute scan interval and a 1 hour transmission rate, there will be 4 scans for every GOES transmission. Since the “Extra Data Sets” option is set to 01, then there will be 4 new scans plus 4 old scans transmitted. The latter 4 are redundant and should have been transmitted as the 4 new scans in the previous transmission.

There are three values being sent in a SHEF (ASCII) format and each value is formatted for 5 bytes. There is also a space between data values and a carriage return and line feed for every line. In this case 4 more bytes per line, two spaces, the carriage return and the line feed, for a

total of 19 bytes per line or 19 bytes per scan. This multiplied by the number of total lines transmitted (8) give the number of bytes per transmission, $19 * 8 = 152$. At 300 baud the 152 bytes would be approximately 6 seconds. This is ok for the 10 second window but would be too long to fit in a 5 second window. If the data does exceed the window, several things could be changed; the data could be sent in a binary format, less values could be sent to the Radio, or the 'Extra Data Sets' could be set to 0 allowing only new data to be sent.

For this example, assume the "Extra Data Sets" option is set to 02. This increases the amount of data to 228 bytes. At 300 baud the 228 bytes would take about 7.5 seconds. At 7.5 seconds a margin of 2.5 seconds is available for preamble, non-data information, and guard time . This would fit in a 10 second window allowing very little room for drift in the real time clock.

16.7 GOES Binary Data

The self-timed binary transmission and all random transmission formats use a 6-bit per byte pseudo binary format. The GOES system supports 1, 2, 3, and 4 byte values with 6, 12, 18, and 24-bit precision respectfully. The XL™ will use 3 bytes (18 bits) for the main input data values. The appended battery voltage will use a single byte (6 bits). The time and date will also use only one byte each for seconds, minutes, hours, day, and month. However date and time are very seldom transmitted through the GOES system, and if so, mainly for testing purposes. The following shows the byte format:

1 Byte Value:

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Parity	Always 1	DATA 5	DATA 4	DATA 3	DATA 2	DATA 1	DATA 0

3 Byte Value:

BYTE 3								BYTE 2								BYTE 1							
23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
P	1	D 17	D 16	D 15	D 14	D 13	D 12	P	1	D 11	D 10	D 9	D 8	D 7	D 6	P	1	D 5	D 4	D 3	D 2	D 1	D 0

Bit 7 is used for parity and will be stripped off by the time the data sent to the decoding software. Bit 6 always set to '1', forcing the data byte to always be a printable character in the ASCII table. Valid characters along with there weighted values are listed in the GOES PSEUDO-BINARY LOOK-UP TABLE on a following page.

Instructions for using the GOES PSEUDO-BINARY LOOK-UP TABLE:

A GOES pseudo binary byte is represented by a single ASCII printable character. All data values (except battery voltage, time and date) will be made up using three pseudo-binary bytes. To use the table, look up the weight of each pseudo-binary character using the column according to the

relative position of the character in the three byte pseudo-binary value as transmitted by the XL™. To obtain the original value, add the weights of all three characters. If the value is greater than 131071, then subtract 131072 from the value and change the sign to negative. Finally, divide the number by 100. The following is an example:

$$H^g = (32768 + 1920 + 39) = 34727$$

H	in the left position	=	32768
^	in the middle position	=	1920
g	in the right position	=	39

			Total = 34727

This is less than 131071 so just divide by 100.
Divide by 100. $34727 / 100 = 347.27 = \text{final value.}$

Example of a negative number, negative numbers are represented as signed values, in other words values bigger than 131071 are actually negative and

$$rSx = (204800 + 1216 + 56) = 206072$$

r	in the left position	=	204800
S	in the middle position	=	1216
x	in the right position	=	56

			Total = 206072

This is greater than 131071 so subtract it from 131072.
 $206072 - 131072 = 75000$
Then divide by 100 and change the sign. $(-1) * 75000 / 100 = -750.00 = \text{final value.}$

Appended battery values are encoded using a single byte. To decode the appended battery voltage use the weighted value for the character from the right hand column and multiply it by 0.3124, and then add 0.311.

Example the single character for the appended battery voltage is 'h'. This is a weighted value of 40. Now $40 * 0.3124 + 0.311 = 12.81 \text{ volts.}$

Date and time are transmitted as 3 bytes each, a byte for date, one for month, one for year and so on. An example of date and time values in binary follows, again use the right hand column of the look up table..

CLHWxs	C = 3 = month, March; W = 23 = Hours;	L = 12 = Date, the 12 th ; x = 56 = minutes,	H = 8 = Year, 2008. s = 51 = seconds.
--------	--	--	--

16.8 GOES FOUR BYTE PSEUDO-BINARY LOOK-UP TABLE

PSEUDO BINARY CHAR.	4 th CHAR FROM RIGHT	3 rd CHAR FROM RIGHT	2 ND CHAR FROM RIGHT	RIGHT MOST CHART	PSEUDO BINARY CHAR.	4 th CHAR FROM RIGHT	3 rd CHAR FROM RIGHT	2 ND CHAR FROM RIGHT	RIGHT MOST CHAR.
@	0	0	0	0	`	8388608	131072	2048	32
A	262144	4096	64	1	a	8650752	135168	2112	33
B	524288	8192	128	2	b	8912896	139264	2176	34
C	786432	12288	192	3	c	9175040	143360	2240	35
D	1048576	16384	256	4	d	9437184	147456	2304	36
E	1310720	20480	320	5	e	9699328	151552	2368	37
F	1572864	24576	384	6	f	9961472	155648	2432	38
G	1835008	28672	448	7	g	10223616	159744	2496	39
H	2097152	32768	512	8	h	10485760	163840	2560	40
I	2359296	36864	576	9	i	10747904	167936	2624	41
J	2621440	40960	640	10	j	11010048	172032	2688	42
K	2883584	45056	704	11	k	11272192	176128	2752	43
L	3145728	49152	768	12	l	11534336	180224	2816	44
M	3407872	53248	832	13	m	11796480	184320	2880	45
N	3670016	57344	896	14	n	12058624	188416	2944	46
O	3932160	61440	960	15	o	12320768	192512	3008	47
P	4194304	65536	1024	16	p	12582912	196608	3072	48
Q	4456448	69632	1088	17	q	12845056	200704	3136	49
R	4718592	73728	1152	18	r	13107200	204800	3200	50
S	4980736	77824	1216	19	s	13369344	208896	3264	51
T	5242880	81920	1280	20	t	13631488	212992	3328	52
U	5505024	86016	1344	21	u	13893632	217088	3392	53
V	5767168	90112	1408	22	v	14155776	221184	3456	54
W	6029312	94208	1472	23	w	14417920	225280	3520	55
X	6291456	98304	1536	24	x	14680064	229376	3584	56
Y	6553600	102400	1600	25	y	14942208	233472	3648	57
Z	6815744	106496	1664	26	z	15204352	237568	3712	58
[7077888	110592	1728	27	{	15466496	241664	3776	59
\	7340032	114688	1792	28		15728640	245760	3840	60
]	7602176	118784	1856	29	}	15990784	249856	3904	61
^	7864320	122880	1920	30	~	16252928	253952	3968	62
	8126464	126976	1984	31	?	16515072	258048	4032	63

16.9 Common GOES Terms

Baud Rate: GOES data is transmitted from the DCP to the GOES satellite at a baud rate of 100, 300, or 1200 bits per second.

DAMS: **D**ata **A**cquisition and **M**onitoring **S**ystem.

DAPS: **D**ata **C**ollection **S**ystem **A**utomated **P**rocessing **S**ubsystem.

DCP: **D**ata **C**ollection **P**latform.
A data logger or data recorder system capable of gathering data from different sensors and transmitting the data to the GOES satellite.

DCS: **D**ata **C**ollection **S**ystem.
See DCP.

DOMSAT: **D**omestic **C**ommunication **S**atellite.
A commercial satellite used to rebroadcast GOES data.

DRGS: **D**irect **R**eadout **G**round **S**tation
A receiver capable of receiving data directly from the GOES satellite.

DPS: **D**ata **P**rocessing **S**ystem.

GMT: **G**reenwich **M**ean **T**ime.
All DCPs are assigned a time slot in which they are allowed to transmit. All DCPs must have an accurate time clock set to GMT in order to make sure they transmit only during the assigned time slot.

GOES: **G**eostationary **O**perational **E**nvironmental **S**atellite.
DCP or DCS systems transmit data to the GOES satellite. There are two functional satellites used for DCP operations, both are at a fixed position above the earth. One in the eastern sky and one in the western sky. This allows DCP antennas to be aimed at a fixed point for optimal operation.

LRGS: **L**ocal **R**eadout **G**round **S**tation
A receiver capable of receiving data from the DOMSAT satellite.

NESDIS: **N**ational **E**nvironmental **S**atellite, **D**ata, and **I**nformation **S**ervice.

NIST: **N**ational **I**nstitute for **S**tandards and **T**echnology.

NOAA: **N**ational **O**ceanic and **A**tmospheric **A**dministration.

NWS: National Weather Service.

PDT: Platform Description Table.

Note: Each DCP will have a PDT defined on a computer system at NESDIS. If the table is not completely defined, then when data is retrieved the error message "PDT RECORD IS NOT COMPLETE," will appear. Part of this table describes the Radio manufacture and model number. For the Telonics radio, the items must be entered into the PDT table as shown below.

Manufacture: "Telonics, INC."

Model Number: "TGT-1"

Preamble: This is a carrier signal sent to the satellite before any data is sent.

Preamble Type	Short Preamble	Long Preamble
Total Preamble Time	0.98 seconds	7.3 seconds

SHEF Codes: A two character code that describes the DCP message data type. Common Shef codes are shown below.

HG = Stage

TA = Temperature Air

VB = Battery Voltage

Transmission Window:

The scheduled time interval which a DCP can transmit data in the self-timed mode. This is normally a one-minute window. GOES Radios using the higher baud rates may be assigned a shorter window.

UDT: User Description Table.

16.10 Julian Day Tables

Julian Day Table (Non Leap Year)

DAY	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

Julian Day Table (Leap Year)

DAY	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1	1	32	61	92	122	153	183	214	245	275	306	336
2	2	33	62	93	123	154	184	215	246	276	307	337
3	3	34	63	94	124	155	185	216	247	277	308	338
4	4	35	64	95	125	156	186	217	248	278	309	339
5	5	36	65	96	126	157	187	218	249	279	310	340
6	6	37	66	97	127	158	188	219	250	280	311	341
7	7	38	67	98	128	159	189	220	251	281	312	342
8	8	39	68	99	129	160	190	221	252	282	313	343
9	9	40	69	100	130	161	191	222	253	283	314	344
10	10	41	70	101	131	162	192	223	254	284	315	345
11	11	42	71	102	132	163	193	224	255	285	316	346
12	12	43	72	103	133	164	194	225	256	286	317	347
13	13	44	73	104	134	165	195	226	257	287	318	348
14	14	45	74	105	135	166	196	227	258	288	319	349
15	15	46	75	106	136	167	197	228	259	289	320	350
16	16	47	76	107	137	168	198	229	260	290	321	351
17	17	48	77	108	138	169	199	230	261	291	322	352
18	18	49	78	109	139	170	200	231	262	292	323	353
19	19	50	79	110	140	171	201	232	263	293	324	354
20	20	51	80	111	141	172	202	233	264	294	325	355
21	21	52	81	112	142	173	203	234	265	295	326	356
22	22	53	82	113	143	174	204	235	266	296	327	357
23	23	54	83	114	144	175	205	236	267	297	328	358
24	24	55	84	115	145	176	206	237	268	298	329	359
25	25	56	85	116	146	177	207	238	269	299	330	360
26	26	57	86	117	147	178	208	239	270	300	331	361
27	27	58	87	118	148	179	209	240	271	301	332	362
28	28	59	88	119	149	180	210	241	272	302	333	363
29	29	60	89	120	150	181	211	242	273	303	334	364
30	30		90	121	151	182	212	243	274	304	335	365
31	31		91		152		213	244		305		366

16.11 GOES Downlink Message Header Basics

At times a user must look at the raw data sent from the satellite to see if things are working properly. The first part of the message is very important to understand as it may help identify problems at a site. Below is an actual message sent from a site.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

Now lets break this down to understand it better.

The first 8 characters are the site ID or DPC address. They are shown in bold below.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next two bytes are the year. In this case the 08 is for 2008.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next 3 bytes are the julian day. In this case 078 and is March 18th, on a leap year..

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next 6 bytes is the time the transmission was received. This should be within the assigned time window. In this transmission it was at 18 hours, 49 minutes and 03 seconds.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next byte indicates if the transmission was received properly, the “G” indicates ‘Good’. Other possibilities are ‘P’ for parity errors and ‘?’ for unknown errors.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

the next two bytes show the signal strength of the signal received at the satellite. In this case it is 51 which is real good. Numbers in the high forties is good, lower forties is fair and if at 35 or less, it is surprising the transmission is making it to the satellite.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next two bytes indicate if there is any frequency drift. A plus 0 is ideal indicating no drift. In this case the +1 indicates a positive drift of 50 Hz from the center frequency. For each count, 1, 2, 3 etc it refers to 50 Hz per count of drift. A drift of 1 or 2 positive or negative is common.

```
163708DE08078184903G51+1NN021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj
```

The next two bytes indicate modulation status. The NN indicates normal modulation index, and normal modulation quality. The index may also report an 'H' or 'L' for high or low modulation index. The quality may also report 'F' or 'P' for fair or poor quality.

163708DE08078184903G51+1**NN**021EUB00023BCT@DZ@DY@Dc@Db@Dm@Dxj

The next three bytes are the channel number. In this case 021 is channel 21. This is an odd number which normally indicates it is transmitting to the eastern satellite, (75 Degrees W). Even channel numbers normally transmit to the western satellite, (135 Degrees W).

163708DE08078184903G51+1**NN021E**UB00023BCT@DZ@DY@Dc@Db@Dm@Dxj

The next byte is a letter 'E' or 'W' indicating the eastern or western satellite. In this case the eastern satellite.

163708DE08078184903G51+1**NN021E**UB00023BCT@DZ@DY@Dc@Db@Dm@Dxj

The next two bytes are TBD.

163708DE08078184903G51+1**NN021EUB**00023BCT@DZ@DY@Dc@Db@Dm@Dxj

The next few bytes indicate how many data bytes are going to be transmitted. In this case 00023 data bytes.

163708DE08078184903G51+1**NN021EUB00023**BCT@DZ@DY@Dc@Db@Dm@Dxj

This is the end of the header information added by the GOES system. Everything from this point on is from the data logger and is normally data. The data could be decoded using the discussion in section 16.7 above.

Also in this case it is easy to see this is a 100 baud transmission. This is possible to see because the data starts immediately after the data byte count. A 300 or 1200 baud transmission will have one extra byte in the header information. This extra byte is after the byte count and the start of data. This extra byte will always be one of four possibilities and indicates the type of data and if the unit successfully updated its time from a GPS system since the last transmission. The possibilities are listed below.

Character	Comment
Space	ASCII Data, No time sync since the last transmission
Double quote “	ASCII Data, Time did sync since the last transmission
Single Quote ‘	Binary Data, No time sync since the last transmission
Lower Case b	Binary Data, Time did sync since the last transmission

The following is a 300 baud transmission that shows binary data and that the unit did sync since the last transmission, notice the lower case ‘b’ after the byte count..

```
DD9F27E808078225854G38+0NN154WFF00051bBCTB1M@EM@EL@EL@EL@EL@EL@
EL@EL@T^@T^@T^@T^@EK@D~M
```


Chapter 17

ALERT Radio Operation

17.1 Introduction

The ALERT standard has been used for monitoring and transmitting data in the environmental industry for several years. ALERT stands for Automated Localized EEE Real Time. This format was initially intended as a means to transmit data based on some change of that data. More users are using this as means to transmit data at timed intervals as a primary means of data collection.

17.2 ALERT Menus

The following menus are used to enable and define what data will be transmitted using the ALERT/IFLOWS radio system. Up to twenty data values can be monitored and transmitted based on user entered alarm conditions and / or on a timed bases.

Built in Menu Structure: ALERT Menus.

Alert Radio	->	ALERT Radio [Off]		
		Tx Offset [00:00:00]		
		ALERT Sensor Setup->	Source 1 [None]->	... Source 20 [None]->
			ALERT ID 1 [0000]->	... ALERT ID 20 [0000]->
			Range [20.470] ->	... Range [20.470] ->
			Divisor = 100.0 ->	... Divisor = 100.0 ->
			Base = 0.00 ->	... Base = 0.00 ->
			Data Fnt 1[NOW]->	... Data Fnt 20[NOW]->
			Txd Rate [8 Hours]->	... Txd Rate [8 HOURS]->
			Trg 1 [Off]->	... Trg 20 [Off]->
			Trig Pnt[1.000]->	... Trig Pnt[1.000]->
			HoldOff 1 [015]->	... HoldOff 20 [15]->
			Override[2.000]->	... Override[2.000]->
			Force ALERT 1 Txd?	... Force ALERT 20 Txd?

PC Menu Screen: ALERT Menu Options.

```

ALERT Radio Options      (Esc to Return)

A - ALERT Radio: Off
O - Timed Tx Offset: 00:00:00

Column      | [1]      2      3      4      5
-----|-----|-----|-----|-----|-----
S - Source  | None     None   None   None   None
I - ALERT ID| 0000     0000   0000   0000   0000
R - Range   | 20.470   20.470 20.470 20.470 20.470
  Divisor   | 100.00   100.00 100.00 100.00 100.00
  Base      | 0.000    0.000   0.000   0.000   0.000
D - Data Function | NOW     NOW    NOW    NOW    NOW
T - Timed Txd Rate | 8 Hours 8 Hours 8 Hours 8 Hours 8 Hours
M - Trigger Mode | Off     Off    Off    Off    Off
P - Trigger Point | 1.00    1.00   1.00   1.00   1.00
H - HoldOff Minutes | 15     15     15     15     15
Q - HoldOff Trg Pt | 2.00    2.00   2.00   2.00   2.00
F - Force Transmission
-> - Next
<- - Previous

Enter Option >
    
```

17.3 ALERT Options

The options below describe how to setup and use the ALERT system. The order of the options follow that of the PC menu listed above.

PC Interface View

Built In Display Screen

A - ALERT Radio: Off

ALERT Radio [Off]

This option is used to enable or disable ALERT radio operations. The default is “Off”. Valid options are Off, Comm-1, Comm-2, and Comm-3. Enabling the ALERT radio also selects which com port it will be used on.

PC Interface View

Built In Display Screen

O - Timed Tx Offset: 00:00:00

Tx Offset [00:00:00]

This option is the timed transmit offset. The timed transmit rate is added to this offset value from midnight. For example, if the transmit offset was set to 00:15:00 and the transmit rate was set to 4 hours then the transmission would happen at 00:15:00, 04:15:00, 08:15:00, etc. The offset must be less than the fastest timed transmit rate. This has no affect on the conditional transmissions.

PC Interface View

Built In Display Screen

S - Source: None

Source xx [None]->

This option is used to define what data will be transmitted for the timed transmissions and for the conditional transmissions. The data value for this source is also used to test against the trigger point based on the trigger mode to see if a conditional transmission should be made.

PC Interface View

Built In Display Screen

I - ALERT ID: 0000

ALERT ID xx [0000]->

Each sensor transmitting on an ALERT network must have a unique ID. The ID will be a number between 0000 and 8191. This number will be assigned by the ALERT network administrator.

A typical use of this is to use the first two digits, (00 to 81) to identify a site and to use the last two digits to identify the sensor type. This approach makes it very easy to identify a data value.

PC Interface View

Built In Display Screen

R - Range 20.47

Range [20.470] ->

This option actually set the resolution that will be used for the ALERT transmission. The value sent by the ALERT radio will always be an integer or a whole number in the range of 0000 to 2047. Now for this option the default range is 20.47 that calculates to a resolution of 0.01 for each count of the ALERT format.

For example, a 15 PSI pressure transducer will cover a range of about 35 feet of water. In this case as long as the water level is between 0.00 and 20.47 the value transmitted will be the stage multiplied by 100 to get a number of 0000 to 2047. As the water level increases past the 20.47 mark, the ALERT value transmitted rolls over to 0000 and increments up again for a water level of 20.48 to the 35 foot mark. If the water level is greater than 20.47 the data logger recognizes this and adjusts the base value accordingly. Base station software allows the user to enter in a multiplier and a base. The base can be thought of as an offset that automatically adjusts as the ALERT value increases past the 2047 point or decreases lower than 0000 and rolls back to 2047. Notice on the data logger the base value is displayed only as a status screen, the user cannot directly change it. On a new installation the technician can see what the data logger is using for a base and make sure that value is set in the base station. Once entered in the base station it should adjust automatically as the value goes up and down. The following table shows the relationship between the real data value, the base value and the ALERT value.

Relationship of the Data Value, Base and the ALERT Value Based On Data Values Of 0.00 to 35.00		
Data Value	Base Value	ALERT Value
0.00	0.00	0000
0.01	0.00	0001
0.02	0.00	0002
10.00	0.00	1000
20.00	0.00	20.00
20.46	0.00	2046
20.47	0.00	2047
20.48	20.48	0000
20.49	20.48	0001
34.99	20.48	1451
35.00	20.48	1452

Relationship of the Data Value, Base and the ALERT Value Based On Data Values Of 0.00 to 35.00

As stated above the range value defaults to 20.47 and other options are a multiple of that value.

The range option also set the resolution as shown in the following table.

Range	Resolution	Range	Resolution
20.47	0.01	818.80	0.40
40.94	0.02	1023.50	0.5
81.88	0.04	1637.60	0.80
102.35	0.05	2047.00	1.00
163.75	0.08	2558.75	1.25
204.70	0.10	4094	2.00
409.40	0.20	5117.50	2.50
511.75	0.25		

Now it may be better if the ALERT value does not roll over based on the data value and the needed resolution is not as important. Look at wind direction as an example. Wind direction is limited to 0.0 to 360.0 degrees. The range option could be changed from 20.47 to 409.40. Now this number may sound abnormal but it is a multiple of the default value of 20.47. Using a range value of 409.4 will allow the wind direction to be transmitted without the roll over occurring and the base will always be at 0.00. But now the resolution is 0.2 which is normally fine for wind direction.

PC Interface View

Built In Display Screen

Divisor

Divisor = xx.xx ->

The divisor is the value the ALERT value must be divided by to convert the ALERT transmitted value back to the original data value. The divisor is based on the range value and is listed as a status screen as the user cannot directly change it. It is calculated as 2047 / Range Value. The divisor or the inverse of the divisor is used by the base station to convert the ALERT value back to the original data value.

PC Interface View

Built In Display Screen

Base = XX.XX

Base = xx.xx ->

The base is used like an offset that shifts automatically based on the range selected above and on the actual data value. Notice this is a status screen and cannot be directly changed by the user. The base is used by the base station to convert the ALERT value back to the original value.

D - Data Function: Now

Data Fnt xx [Now]->

Column functions are used to perform mathematical operations on the data being transmitted. These operations are based on all the data scanned for that column since scanning was turned on. Column functions that end in “_T” are based on the total data set, and functions that end in “_S” are based on a subset of the data for the selected column.

Now: This is the default setting and causes the current value for the column to be transmitted at a time based on the transmit rate.

Avg_S: This will average X number of scanned values for this column and log the results. The value of X is the number of scans that happen during the transmit rate interval. Lets say the scan rate is every 15 minutes and the transmit rate is set to one hour, then there will be four scans in the hour and the four values will be averaged and the results will be transmitted based on the transmit rate.

Max_S: This will find the maximum value scanned out of the last X number of scanned values for this column and transmit the results. The value of X is the number of scans that happen during the transmit rate interval.

Min_S: This will find the minimum value scanned out of the last X number of scanned values for this column and transmit the results. The value of X is the number of scans that happen during the transmit rate interval.

Sum_S: This will add up the last X values scanned for this column where X is the number of scans that happen during the transmit rate interval..

Avg_T: This will average every scan since scanning was started and transmit the result based on the transmit rate.

Max_T: This will transmit the maximum data value scanned for this column since scanning was enabled. The transmission will be based on the transmit rate.

Min_T: This will transmit the minimum data value scanned for this column since scanning was enabled. The transmission will be based on the transmit rate.

Sum_T: This will add up all the values scanned for this column since scanning was enabled, regardless of the skip rate. The skip rate only sets how often data is logged.

PC Interface View

Built In Display Screen

T - Timed Tx Rate: 8 Hours

Txd Rate [8 Hours]->

This option sets the timed transmit rate. This option can be used as a primary method to transmit data or used to transmit just a few times a day to verify the radio is still functional. The timed interval range is from every 15 minutes to once a day or may be set to 'Off'.

PC Interface View

Built In Display Screen

M - Trigger Mode: Off

Trig xx [Off]->

The trigger mode option allows the user to decide what condition should be met before sending an ALERT type of transmission. The following shows the options. All conditional tests are based on the current value of the source, not an average, max, min etc, that may be used for the timed transmissions.

> **Set Pt:** Greater than the set point. Transmit IF the data is greater than the defined Set Point. This could be used to schedule a transmission due to high water.

< **Set Pt:** Less than the set point. Transmit IF the data is less than the defined Set Point. This could be used to schedule a transmission based on the battery level starting to drop.

Delta: Transmit based on a change in data. A transmission is scheduled IF the data changes more than the defined set point value. The change can be either an increase or a decrease. This could be used to track a changing stream or rainfall.

Always: Always transmit. No condition has to be met, a transmission is automatically sent on each scan. Keep in mind the ALERT specification limits the time between transmissions to about 30 seconds.

PC Interface View

Built In Display Screen

P - Trigger Point: 1.00

Trig Pnt [1.00]->

The "Trigger Point" option is used to enter the value used to compare with the actual data to see if an ALERT type of transmission should be sent. The 'Trigger Mode' section above described the types of conditions that can be used to trigger a transmission. For example, if the user wanted to transmit based on the stage exceeding 10 feet, then the trigger mode would be set to "> Set Pt" and the trigger point would be set to 10.0. Now at each scan interval that the stage was at 10 feet or greater, the trigger condition would be true and the data would be transmitted. When the stage dropped below the 10 foot level the ALERT type of transmissions would stop.

PC Interface View

Built In Display Screen

H - HoldOff Minutes: 15

Hold Off xx [15]->

Once a transmission has been sent it may be desirable to stop future transmissions for a period of time in order to prevent a high number of transmissions from the same sensor. The system uses a “Hold Off” variable to indicate how long this time period should last in minutes. The default value is 15 minutes.

PC Interface View

Built In Display Screen

O - Override: 2.00

Override [2.00]->

During the hold off time it still may be desirable to transmit if the data value has drastically changed. This override value is a secondary trigger level used like the normal trigger level described above but is only used during the hold off time.

PC Interface View

Built In Display Screen

F - Force Transmission

Force ALERT x Txd?

During the installation it may be desirable to force a transmission in order to test the system. Pressing the ENTER key here will cause a transmission to be sent using the ID and data value as described above for the selected column.

17.4 Special Cases For ALERT Transmissions

An ALERT type (non timed) transmission can be made at times other than just at the time of a scan. The most common is when the counter input is enabled and set to ‘Count and Transmit’ or to ‘Count and Log’. In this case an ALERT transmission may be made at the time the counter input detected a new count or pulse input. In this case only the data for the counter input will be sent.

If a manual measurement request is made by the user, this can also cause the system to evaluate the conditional transmit operations and then transmit any data that meets the conditional requirements.

Chapter 18

4 To 20 Milliamp Output

18.1 Introduction

These options allow the XL™ to use any of its input signals as a data source to generate a current output simulating a 4 to 20 mA sensor. The XL does not actually generate the current in the loop but controls the current in a loop that is externally powered. The 4 to 20 milliamp connection points are optically isolated from the rest of the XL circuitry.

18.2 4 To 20 Milliamp Menus

Built in Menu Structure: 4 to 20 Milliamp Options Menu.

Output Options ->	4-20 mA Options ->	mA Output = X.XXX
		4-20 Source [None]
		Max Value [20.00]
		Min Value [0.00]

PC Menu Screen: 4 To 20 Milliamp Options.

```
4 to 20 MilliAmp Output Options      (Esc to Return)
Current Milliamp Output: Not Enabled
S - Data Source:      None
H - Maximum Level: 20.000
L - Minimum Level:  4.000
Enter Option >
```

18.3 4 To 20 Milliamp Options

PC Interface View

Current Milliamp Output: xx.xx

Built In Display Screen

mA Output = xx.xx

This screen shows what the output current should be if it were measured with a current meter. It should be in the range of 4 to 20 milliamps. This is based on the value of the data source, the Max value and the Min value.

If a current meter is used to verify the output and it does not match this value then check the

wiring and voltage levels to verify they are ok. If the current meter reads zero milliamps then the wires could be connected backwards or there is no power source for the loop. Remember that this output controls the current in the loop but does not provide the power for the loop. An external power source is required.

If the current displayed on a meter is in the range of 4 to 20 milliamps but is less than what is displayed by this option, then it may be the external power source is not big enough. In most cases a 12 volt battery will not be sufficient to power the loop. In most cases a 24 volt battery is required. This reading and the actual current value may track at lower values but as the current approaches the 20.0 milliamp level the actual current as displayed on an external meter will start to drop off indicating the battery voltage is too low.

PC Interface View

Built In Display Screen

S - Data Source: None

4-20 Source [None]

This selects what sensor is to be simulated as a 4 to 20 milliamp sensor. For example, if a temperature sensor was connected to analog channel 1, then analog channel 1 would be set as the data source.

PC Interface View

Built In Display Screen

H - Maximum Level: 20.00

Max Value [20.00]

This is the maximum value to look for from the data source. Continuing on from the example above, if the temperature probe had a range of -50 to +50 degrees, then the max level would be set to +50, and the min level set to -50. Now a temperature of -50 would cause a milliamp output of 4.00 milliamps and +50 degrees would produce a 20.0 milliamp output.

PC Interface View

Built In Display Screen

M - Minimum Level: 4.00

Min Value [4.00]

This option is used to set the minimum value to look for from the data source. Use the example from above for details on how the minimum level is used in determining the current in the loop.

Note that as the range is enlarged the resolution of the output current is decreased, and the opposite if the range is reduced. The resolution is calculated as:

$$(\text{mA Output Range}) / (\text{Input Range}) = \text{mA per Input Unit Change.}$$

In this example:

$$(20 - 4) / (50 - (-50)) = 16/100 = 0.16\text{mA per degree change.}$$

The resolution of the output signal can also be calculated based on the resolution of the DAC (digital to analog converter). If the DAC has a resolution of 12 bits which is 1 part in 4096 we can calculate the resolution of the source based on the following equation:

$$\text{Input Range} / 4096 = \text{resolution}$$

$$\text{In this example: } 100 / 4096 = 0.02441 \text{ degree.}$$

If the DAC has a resolution of 16 bits then it is 1 part in 65536. In this case the resolution is much greater.

$$\text{Input Range} / 65536 = \text{Resolution}$$

$$\text{In this example: } 100 / 65536 = 0.001526 \text{ degrees.}$$

If the hardware revision is 3.3 or newer a 16 bit DAC is used and hardware revisions 3.1 and older use a 12 bit DAC.

18.4 4 to 20 Hardware Connections / Wiring

Pins 12 and 13 of the terminal block provide connection points for the 4 to 20 milliamp output signal.

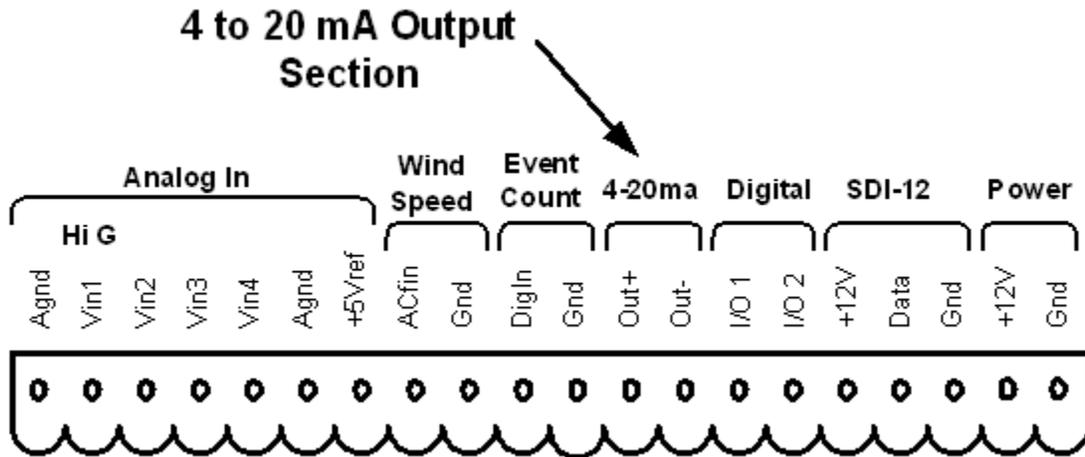


Figure 18-1 4 to 20mA Output Section

Several instrumentation applications use sensors that provide an industry standard 4 to 20 milliamp output signal. The XL™ Series data logger / DCP can output a 4 to 20 milliamp signal based on any of its inputs. For example, a user may want to connect a temperature probe to the XL™ and convert the temperature value into a 4 to 20 milliamp output. A temperature probe on Analog Channel 1 that produces a 0 to 5 volt output representing 0 to 100 degrees Celsius could easily be setup to produce a 4 to 20 milliamp output that represents the 0 to 100 degrees. The XL™ does not actually output a 4 to 20 milliamp signal, but rather controls the current in a loop that is powered externally. Figure 2-11 shows a basic connection diagram.

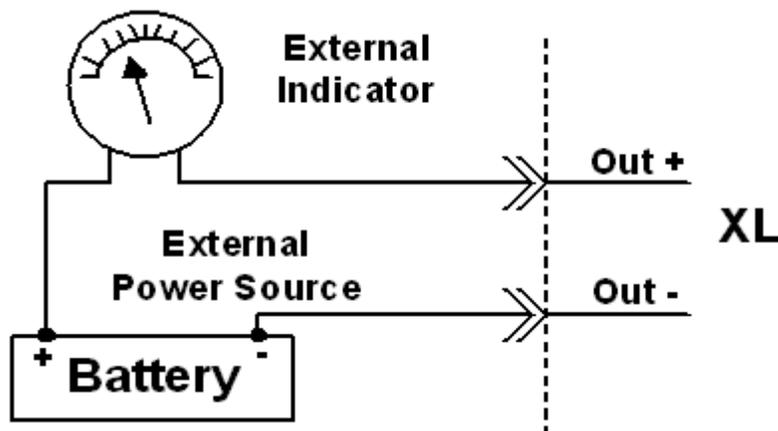


Figure 18-2 Basic 4-20 mA Wiring Configuration

Chapter 19

Alarm Call Out

19.1 Overview

The alarm call out options were added for NIWA in New Zealand but may be useful to other users also. The overall intent was to allow a method for the unit to call out to another computer system using a few different modes such as modems and radios.

The following menus are used to enable and define what data will be sent based on alarm conditions. The data is sent via a modem or RF radios using a very specific format. Up to ten data values can be monitored and sent based on user entered alarm conditions.

19.2 Alarm Call Out Menus

Built in Menu Structure: Alarm Call Out Screens.

Alarm Setup	->	Alarms Enabled [No]		
		Alarm Retries [0]		
		Individual Setup	->	
		Source 1 [None]	->	... Source 10 [None]
		Trg 1 [Always]	->	... Trg 10 [Always]
		Set Pnt 1[1.00]	->	... Set Pnt10[1.00]
		Rst Pnt 1[1.00]	->	... Rst Pnt10[1.00]
		Tx Tag 1 [Alarm1]->		... Tx Tag 10 [AlarmX]
		S# 1[0]	->	S#10[0]
		Comm 1 [Direct]	->	... Comm 10 [Direct]
		Ph# 1[N/A]	->	... Ph#10[N/A]
		Force Alarm 1?		... Force Alarm 10?

PC Menu Screens: Alarm Call Out Options.

Alarm Call Out Options (Esc to Return)					
A - Alarms Enabled: No					
N - Number of Retries:0					
Column	[1]	2	3	4	5
S - Source:	None	None	None	None	None
M - Trigger Mode:	> Set Pt				
T - Trigger Point:	1.000	1.000	1.000	1.000	1.000
R - Reset Point:	0.000	0.000	0.000	0.000	0.000
I - ID Tag:	All	Al2	Al3	Al4	Al5
B - Site Number:	0	0	0	0	0
C - Connection:	Direct	Direct	Direct	Direct	Direct
P - Phone#/Address:	N/A	N/A	N/A	N/A	N/A
Active / Tries:	No / 0				
F - Force Transmission					
-> - Next					
<- - Previous					
Enter Option >					

PC Interface View

Built In Display Screen

A - Alarms Enabled: No

Alarms Enabled [No]

This option is used to enable or disable Alarm operations. The default is “No”.

PC Interface View

Built In Display Screen

N - Number of Retries: 0

Alarm Retries [0]

In some cases there may be problems in sending the data. For example, if the user is using a radio option which may have problems communicating based on a crowded network or environmental conditions, etc then the user may desire to send the data a few times.

PC Interface View

Built In Display Screen

S - Source

Source 1 [None]->

This option is used to define what data will be sent. The data value for this source is also used to test against the set point based on the trigger mode to see if the data should be sent.

PC Interface View

Built In Display Screen

M - Trigger Mode

Trg 1 [Always] ->

The trigger mode option allows the user to decide what condition should be met before sending the data. The following shows the options.

Off: Conditional transmissions are disabled. Data will only be sent when forced.

> **Set Pt:** Greater than the set point. Send data IF the data is greater than the Set Point. This could be used to send data due to high water.

< **Set Pt:** Less than the set point. Send data IF the data is less than the Set Point. This could be used to send data based on the battery level starting to drop.

Delta: Send data based on a change in data. Data is sent IF the data changes more than the set point value. The change can be either an increase or a decrease. This could be used to track a changing stream or rainfall.

Always: Always send data. No conditions have to be met, data is sent automatically on each scan.

PC Interface View

Built In Display Screen

T - Trigger Point

Set Pnt 1 [0.0000]->

The “Trigger” or “Set Point” option is used to enter the value used to compare with the actual data to see if data should be sent. The section above describes the type of conditions that can be used to trigger a transmission. For example, if the user wanted to send data based on the stage exceeding 10 feet, then the trigger mode would be set to " > Set Pt " and the trigger point would be set to 10.0. Now at each scan interval that the stage was at 10 feet or greater, the trigger condition would be true and data would be sent.

PC Interface View

Built In Display Screen

R - Reset Point: 0.00

Rst Pnt 1 [0.0000]->

The Reset Point is a point that the user defines to reset the trigger mode to prepare for another trigger. From the example above, the trigger was set when the stage went greater than 10 feet, if the reset point was set to 5 feet, the trigger would not be reset and ready for another trigger until the stage goes to or below 5 feet.

PC Interface View

Built In Display Screen

T - ID Tag

Tx Tag 1 [AlarmX]->

Each sensor sending data should have a unique ID/Tag. The ID will let the user know what alarm is being triggered. For example, an ID like “Fld” might be the name of an alarm that indicates a flood or high water in the river.

PC Interface View

Built In Display Screen

B - Site Number

S# 1 [0]->

This option is for entering a site number. Notice it is available for each column so it can be the same for each column so it identifies the site or can be unique for each column to help identify the data values.

PC Interface View

Built In Display Screen

C - Connection

Com 1 [Direct]->

This option is for determining how the data is going to sent. There are several different options to send the data and are as follows.

Direct: This option sends/prints the data directly out Com Port 1. It does not look for any feedback to see if it was received or if an alarm is acknowledged.

Example of data being sent using Direct:
Alarm 1 Active at SiteID Stage = 999.999
Alarm 2 Active at SiteID Totcnt = 999.999

Direct3: This option sends/prints the data directly out Com Port 3. This is just like the ‘Direct’ option except it is on com port 3, not com port 1.

NZ GPRS: This option sends/prints the data direct out Com Port 1 but in a different format defined by New Zealand.

Example of data sent by NZ GPRS:
DAA SiteID Stage 99.99

NZ Phone - This option sends the data to a modem out Com Port 1 in a different format defined by New Zealand.

Phone 1 - This option sends data to a modem on Com Port 1.

PC Interface View

Built In Display Screen

P - Phone Number

Ph# 1 [N/A] ->

This is where the user would enter a phone number to callout when it was time to send data. This is only applicable when using the NZ Phone or Phone 1 mode of sending data. The user cannot edit the value when N/A is in the brackets which indicates this option is not used for the selected communication option.

PC Interface View

Built In Display Screen

F - Force Alarm

Force Alarm 1?

During the installation it may be desirable to force data to be sent in order to test the system. Pressing the ENTER key here will cause the data for the selected column to be sent using the ID/Tag programmed as described above and using the data based on the data source.

Chapter 20

Data Card Options

20.1 Data Card Options

The following menu structure represents all the sub menus under the “Data Options” header. These sub menus allow you to check the status of the data memory and card memory. They are also used to copy data to the external card and to erase both sets of memory.

Built in Menu Structure: Data Options Menu.

Data Options	->	Data Memory Ok	
		Data Card Ok	
		View current file->	MM/DD/YY HH:MM:SS
		Copy Data To Card ?	
		Copy .New To Card?	
		Erase All Int Data?	
		Erase Int Data File?	
		Erase All Card Data?	
		Erase Card File?	
		Calc DataBytes Free?	
		Calc CardBytes Free?	

PC Menu Screen: GOES Main Menu Options.

```

Data Options           (Esc to Return)

Internal Data Status: Ok (10.2% Full)
Data Card Status:     No Card In Slot

C - Copy Data To Card
T - Transmit Data
N - Transmit New Data
E - Erase Data Card
I - Erase Internal Data
F - Erase Individual Files
D - Directory Of Files
V - View End Of Data File

Enter Option >
```

20.2 Data Card / Memory Options

The options below describe how to use the data card and memory options. The order of the options follow that of the PC menu listed above. Any options available on the built in menu that are not on the PC menu will be listed at the end of the options.

PC Interface View

Built In Display Screen

Internal Data Status:

Data Memory OK

The first message displayed here is a status message indicating the condition of the internal memory used for data storage. The message “Data Memory Ok” is the most common message and indicates all is well with the internal data memory. The other status message would be “Data Memory Error“. This message should never be encountered. It may be seen if this menu screen was accessed at the same time the unit was storing data to memory, then this could happen. Back out of the menu and try again. If this message continues to be displayed then try removing power from the system and re powering the unit after about a minute and see if it still displays the error message. Consult the factory if the error continues to show up.

Note: On the PC menu the percentage full is also listed.

PC Interface View

Built In Display Screen

Data Card Status:

Data Card OK

This is a status message screen for the external data card. It has the same messages and meanings as the internal memory status screen. The message “Card Memory Ok” is the most common message and indicates all is well with the external data card. The other status message would be “Card Memory Error“. This message will be encountered if the external data card is not installed, or if this menu screen was accessed at the same time the unit was storing data to memory, otherwise it should not be encountered. With a card installed, back out of the menu and try again. If this message continues to be displayed then try removing power from the system and re powering the unit after about a minute and see if it still displays the error message. Consult the factory if the error continues to show up.

Note: On the PC menu the percentage full is also listed.

PC Interface View

Built In Display Screen

View End Of Data File

View Current File ->

This option works a little differently when using the built in menu verses the PC menu interface.

When using the built in menu, this option allows the user to enter into the data file and see what is being stored to the card. When first entering the file the last line will be displayed. If more than 20 characters are in the line then the first 20 characters are displayed. Using the four arrow keys the user can move around through the data. If this option is in use and a scan starts, then the system will back out of this option allowing the scan process access to the file. Reentering the option will display the newest data just scanned.

When using the PC menu interface, this option will display the last 15 lines of the current data file. The data will be displayed until any key is pressed and then the system returns to the menu.

PC Interface View

Built In Display Screen

Copy Data To Card

Copy data To Card ->

One method of data retrieval is to use an external card and copying the data from the internal memory to the external card. When this option is used a message similar to "Copying FILE_01.A00" will be displayed indicating which file is being copied to the external card. When using the PC menu the messages will scroll down for each file copied. On the built in display the screen will be updated with each new file copied. Once the file transfer has completed the external card can be removed, placed in other systems for continued data retrieval, and then taken back to the office for transferring data to a main computer system and data analysis.

Data files use the text entered into the "Site ID" option as the filename. Data file extensions always start at .000 and increment .001, .002 and so on. Each time scanning is turned on and logging is enabled a new file will be started and the extension will be one more than the last file. When copying files from internal memory to the external data card be aware file extensions will be modified. The first character of the extension will be changed to a letter starting with "A". If the file already exists, then the first character is bumped to a "B". This continues until the file is finally saved on the external card. This allows a user to copy data from the same data logger to the same card over and over again without overwriting older data. For example the user copies data to the card one day, visits the site in one month and copies the data to the same card again. Now the original data will be on the card with a file name of Site_ID.A00, and the new data with a file name of Site_ID.B00. This also protects the data from being overwritten if the same card is used to retrieve data from two sites that have the same 'Site ID' name.

There may also be a file copied to the external data card with a .NEW extension. This file is provided for users who write there own data dump utility program on a PC that will

automatically download the newest data. This file is reset each time the file is transferred over the serial port using the send new command and erase new data command.

Other files like system configuration files may also be copied from the internal memory to the external data card. Configuration files have a .CFG extension.

PC Interface View

Built In Display Screen

T - Transmit Data

Not Available in Built In Menu

This option is only available on the PC menu interface. This is used to transmit a file from the XL to the connected PC over the serial port. The file may be stored on internal data memory or on the external data card. When this option is first selected the system prompts the user to select the location of the file. The following messages will be displayed.

```
Transmit Data                (Esc to Return)

I - Internal Data
D - Data Card

Transmit Which Data: _
```

Once the user selects the internal data memory or the external data card, the system will display all the files on the selected source, see the following example.

```
=> LOGAN01.000                59,350 09/04/08 14:15
   LOGAN01.001                12,987 09/07/08 08:45
   LOGAN01.CFG                14,739 09/07/08 08:47
```

At this point use the up and down arrows on the PC to select which file to transmit. When the pointer on the screen is pointing at the desired file press the ENTER key to move on to the next option. The next option is to select what type or transfer protocol to use, ASCII or Xmodem.

```
ASCII Transfer or XModem Transfer (A/X)?
```

After the protocol has been selected a message prompt will be displayed asking if the complete file or only data from a specified date should be sent.

```
ASCII Transfer or XModem Transfer (A/X)?  
Transmit Complete File or from Selected Date? (C/D)?
```

If the file transfer protocol is an ASCII transfer, then the following screen will be displayed. The method to set the file capture options is dependent on the terminal emulation program in use. In Hyperterm use the mouse to select the 'Transfer' option at the top of the window. Then select the 'Capture Text' sub option and follow the prompts for entering a file name on the PC. Once this is done press the 'S' key to start the transfer. The data will scroll across the screen. When it is done the message 'Done, Close File' will be displayed. At this point use the mouse again to select 'Transfer' and then select the sub option 'Capture Text' and select 'Stop'. The data will be stored in the file and directory specified when first setting up the transfer options in windows.

```
ASCII Transfer or XModem Transfer (A/X)?  
Transmit Complete File or from Selected Date? (C/D)?  
  
Set File Capture Options, Press 'S' To Start  
Any other key to abort
```

If the file transfer protocol is an XModem transfer, then the following screen will be displayed. The method to initiate the transfer is dependent on the terminal emulation program in use. In Hyperterm use the mouse to select the 'Transfer' option at the top of the window. Then select the 'Receive File' sub option and follow the prompts for entering a directory and file name on the PC and selecting the Xmodem protocol. Once this is done use the mouse to select the 'Start' button and the transfer will start. A new box will appear showing the status of the transfer. When it is done the new box will disappear. Press any key to return to the main data options menu. The data will be stored in the file and directory specified when first setting up the transfer options in windows.

```
ASCII Transfer or XModem Transfer (A/X)?  
Transmit Complete File or from Selected Date? (C/D)?  
  
Initiate XModem Download Now (Esc to Cancel)
```

PC Interface View

Not Available Using PC Menu

Built In Display Screen

```
Copy .New To Card ->
```

This option allows the user to copy the .New file to the data card. Once the copy is complete, the XL™ will prompt the user to erase the .New file, pressing enter will erase the .New file and

pressing cancel will not erase it. The use of the .New file is explained in the logging options section of the manual.

PC Interface View

Built In Display Screen

I - Erase Internal Data

Erase All Int Data?

This option will cause all the internal data to be erased and the memory space freed up for new data. Make sure the data has been retrieved one way or another before the data is erased. **Note;** *once erased the data cannot be retrieved.* This option cannot be used while scanning is enabled. The message "Not With Scanning On" will be displayed if the user tries to erase the internal data while scanning is turned on.

PC Interface View

Built In Display Screen

I - Erase Data Card

Erase All Card Data?

This option will cause all the data on the external card to be erased and the memory space freed up for new data. Make sure the data on the card is no longer needed before the data is erased. Once erased the data cannot be retrieved. The external data card can be erased while scanning is turned on.

PC Interface View

Built In Display Screen

F - Erase Individual Files

Erase Int Data File?

This option works a little differently when using the built in menu verses the PC menu interface.

Using the built in menu, pressing the ENTER key will cause a list of internal files to be viewed starting with the first file on the internal card. To view the other files press the UP and DOWN keys to scroll through the files. When a file is displayed the is to be erased, press the ENTER key and the listed file will be erased. **Note;** *once erased the data file cannot be retrieved.* This option cannot be used while scanning is enabled. The message "Not With Scanning On" will be displayed if the user tries to erase the internal data while scanning is turned on.

Using the PC menu a message is displayed allowing the user to select the internal data files or the

external data files. Once the desired memory location has been selected, a list of files for that location will be displayed with an arrow pointing to the first file. Use the UP and DOWN arrow keys to select a file to delete and then press the ENTER key to actually delete the file. Press the ESC key to abort this process. If the internal data memory is selected and scanning is on then the system will not allow files to be erased.

PC Interface View

Built In Display Screen

F - Erase Individual Files

Erase Card File?

This is just like the option to erase internal data listed above except it is working with the external data card. This option works a little differently when using the built in menu verses the PC menu interface.

Using the built in menu, pressing the ENTER key will cause a list of internal files to be viewed starting with the first file on the external data card. To view the other files press the UP and DOWN keys to scroll through the files. When a file is displayed the is to be erased, press the ENTER key and the listed file will be erased. **Note**; *once erased the data file cannot be retrieved*. This option can be used while scanning is enabled.

Using the PC menu a message is displayed allowing the user to select the internal data files or the external data files. Once the desired memory location has been selected, a list of files for that location will be displayed with an arrow pointing to the first file. Use the UP and DOWN arrow keys to select a file to delete and then press the ENTER key to actually delete the file. Press the ESC key to abort this process. If the internal data memory is selected and scanning is on then the system will not allow files to be erased.

PC Interface View

Built In Display Screen

See Notes Below

Calc DataBytes Free?

This option is indirectly available from the PC menu. See the note below. From the built in menu, pressing the ENTER key will cause the system to calculate the number of bytes free and available for data storage on the internal data card. This option may take several seconds to complete depending on the size of internal memory card in use. In most cases this should not be an issue as the internal data card is large enough to store several years of data for the simpler applications . The following gives an example of how to determine memory usage:

Suppose 4 megabyte memory space is used to store the data. Also the data to be stored is the date, time, stage, temperature, rain, and battery voltage at 15 minute intervals. One line of data would look like the following:

07/23/2000 11:45:00 9.87 23.5 0.00 12.2

Notice this is 39 characters and we have to add two more for the carriage return and line feed to move to the next line. This gives a total of 41 characters. At 15 minute intervals this would mean 96 scans per day, so $96 * 41 = 3936$ bytes or characters used per day. Now divide that into a 4 megabyte data space, $4,000,000 / 3936 = 1016$ days. The system will have to run for over 1000 days to fill the memory using these settings.

NOTE: When using the PC menu interface use the option “D - Directory of Files” to list the files and to see how much data space is still available. This is described in more detail below.

PC Interface View

Built In Display Screen

See Notes Below

Calc CardBytes Free?

This option is much like the one listed above, “Calc DataBytes Free?”. This option is indirectly available from the PC menu. See the note below. From the built in menu, pressing the ENTER key will cause the system to calculate the number of bytes free and available on the data card. This option may take several seconds to complete depending on the size of card in use.

NOTE: When using the PC menu interface use the option “D - Directory of Files” to list the files and to see how much data space is still available. This is described in more detail below.

PC Interface View

Built In Display Screen

D - Directory Of Files

Not Available in Built In Menu

This option is only available on the PC menu interface. This is used to list the files on the internal data memory card or the external data card. This will list each file with the file size and time and date of the last file write operation. On the bottom of the listing will be the number of bytes used and the number of bytes free. Below is a sample listing.

SITE_ID.000	253	11/08/07	06:36
SITE_ID.001	73,430	11/09/07	13:43
LOGAN01.000	5,313	11/17/07	17:12
LOGAN01.CFG	15,685	11/19/07	12:54
LOGAN01.LOG	1,115	11/19/07	12:54
LOGAN01.001	22,555	11/17/07	17:12
118351 Bytes Used			
3829760 Bytes Free			
Press Any Key To Continue...			

Adding up the bytes used and the bytes free ends up with 3,948,111. This indicates the internal memory on this unit is using a 4 megabyte data card. A 4 megabyte data card would take over three years to fill up logging 4 data values every 15 minutes. A 4 megabyte card was the smallest card shipped in the XL series data logger and as of 2008 most units are shipped with a 16 megabyte card or bigger depending on availability. The smaller cards are harder to find so the trend is always towards the larger sizes.

The XL Series data logger will use or create a few different file types. This are listed below.

Data Files

Data files on the internal data card will have a number extension of .000 to .099. As data files are copied to the external data card the extension will change to a letter followed by the old extension number such as .A00, .A01, etc. If the file already exists on the external data card the letter will be increased by one character value.

Configuration Files

Configuration files will have a .CFG file extension. The file name will be the same as the site ID of the unit the file was created with. Configuration files may also be edited and renamed on a PC and then copied back to a data card.

.NEW File

The .NEW file is created if the “Log .NEW File” option is set to Yes. The .NEW file will contain the same data that is in the main data file, but this file can be automatically transmitted and erased by using the DUMPNEWDATA and ERASENEWDATA commands in the command mode. This file will automatically be recreated again on the next scan. See the section below under logging options for more information on the .NEW file.

.BIN Files

Firmware upgrades will be binary files with a .BIN extension. The file name will normally be “xxxXLVVV.BIN” where xxx is the model type and VVV is the firmware version number.

XL-BASIC Files

XL-BASIC program files may also exist and will normally have a filename that relates to the operation of the program and the extension is normally .BAS.

.LOG Files

When the XL detects major changes in operation it will log that change in a file with an extension of .LOG. The events that may be logged can be user changes such as the user turning on or off the scanning option. Other events may be detected without user actions such as a low battery detection or a system reset. This log file is useful to see what has been happening with the unit.

NOTE: The XL™ does not support subdirectories and other operations available on a PC. It is strongly recommended that data cards used in a PC not be set up with subdirectories or have individual files erased or deleted as some PC systems may try to create a recycle folder which would be considered a subdirectory. It is also best to format the cards on the XL™ and not on a PC as a PC may do so using different block and cluster sizes than what is optimal for the XL™. Using the option to erase all the data on the data card or internal memory actually reformats the selected memory as it erases it.

Chapter 21

Operation With the H-355 "Smart Gas" System

21.1 Introduction to the H-355

The XL™ has special functions for operation with the *WATERLOG*® Model H-355 gas purge system. The *WATERLOG*® Series Model H-355 (hereafter "H-355") is a self-contained "SMART GAS" purge system used to measure fluid levels in applications such as surface water (streams and lakes, etc.), ground water, and tanks. It contains a small holding tank and a compressor, and is designed to replace the Nitrogen tank and regulators used in traditional gas purge systems.

When combined, the XL™ and H-355 communicate back and forth via the RS-485 link. The XL™ has a submenu dedicated to changing the configuration of the H-355.

21.2 H-355 Menus

The following is a description of the submenu used for configuring the H-355. Each of these menu items may be changed or edited using the normal XL™ editing techniques.

Built in Menu Structure: Gas Purge Setup Menu.

Accessory Setup	->	Gas Purge Setup	->	Auto Purge Enbl[OFF]
				Bubble Rate[XXX]/min
				Purge Thresh[XXX]PSI
				Purge Presur[XXX]PSI
				Purge Time [XXX] Sec
				Manual Purge?
				Timed Prg [XX] days
				Tank PSI = X.XX
				Line PSI = XX.XX
				Last Prg=MM/DD HH:MM
				Purged 001 Times

PC Menu Screen: Gas Purge Setup Options.

```
Gas Purge Setup          (ESC To Return)

Last Purge At:          MM/DD HH:MM
Tank Pressure:          X.XX PSI
Line Pressure:          X.XX PSI
B - Bubble Rate:        60
P - Purge Pressure:     40 PSI
D - Purge Duration:     45 Seconds
S - Timed Purge:        7 Days
A - Auto Purge:         Off
T - Purge Threshold:    30 PSI
M - Manual Purge

N - Number of Purges:  000
U - Update All Values

Enter Option >
```

21.3 H-355 Options

The options below describe how to setup and use the H-355 bubbler system. The order of the options follow that of the PC menu listed above. Any options available on the built in menu that are not on the PC menu will be listed at the end of the options.

PC Interface View

Built In Display Screen

Last Purge At: MM/DD HH:MM

Last Prg=MM/DD HH:MM

This is a status screen that indicates when the last purge happened. This will only be updated if the purge was caused or initiated by the XL™. If the purge was caused by pressing the button provided on the H-355 then this will not be updated.

PC Interface View

Built In Display Screen

Tank Pressure: XX.XX PSI

Tank PSI = XX.XX

This is the current pressure of the H-355's internal air tank in PSI. This value is informative only and cannot be edited. The tank pressure should be approximately 3 to 5 PSI greater than the orifice line pressure. This pressure should be in the range of about 1 PSI up to about 50 PSI depending on the bubble rate, the water level and the PSI range of the system. The tank pressure will vary based on the water level, if the water level is low then the tank pressure will be relatively low also and if the water level is high then the tank pressure will also be high. The mechanical dial gauge in the bubbler unit will be close to this value also.

PC Interface View

Built In Display Screen

Line Pressure: XX.XX PSI

Line PSI = XX.X

This is the current pressure the H-355 sees on the orifice line. This pressure should always be less than the tank pressure. The difference between this pressure and the tank pressure is what determines the bubble rate. The difference should be about 3 to 5 PSI. As the water level rises the line pressure will increase, approaching the tank pressure. The H-355 detects this rise in pressure and will turn on the compressor in order to rise the tank pressure, therefore maintaining the desired bubble rate.

PC Interface View

Built In Display Screen

Bubble Rate

Bubble Rate [XXX]/Min

This refers to the average number of bubbles per minute that are flowing from the end of the orifice tube. The programmable range is 30 to 120 bubbles per minute using a standard 1/8 inch ID orifice line.

One reason for changing the bubble rate is to set how quick the system will respond to a rise in stage. The following table shows the approximate time needed to react to a one foot rise in stage for the different bubble rates. Note this is at a depth of one foot. At greater depths the time will increase slightly.

Bubble Rate (Bubbles Per Minute)	Response Time For 1.0 Foot Stage Rise (at a depth of one foot)
30 Bubbles / Min	25 Seconds
60 Bubbles / Min	20 Seconds
120 Bubbles / Min	15 Seconds

Another reason for changing the bubble rate may be to reduce noise in the data. Some sites have turbulent water conditions creating water level data that looks jittery. The bubble rate may be changed, up or down, to find an optimal point to reduce this noise. Normally it is a combination of changing the bubble rate and the averaging time to produce the best results. The default values work best in the majority of the applications providing desirable results in a timely manor.

PC Interface View

Built In Display Screen

Purge Pressure

Purge Pressur[XXX]/Min

This is the pressure that the H-355 uses to purge the orifice line. The range is 15 to 80 PSI. This must be set higher than the purge threshold if the auto purge option is enabled. When adjusting the purge PSI the purge duration will automatically change to make sure it is set long enough to handle the new purge pressure.

When the H-355 purges it sequences through a series of operations. First it isolates the sensor from the pressure line to protect the sensor from the high purge pressure. Then the compressor turns on and builds the pressure up to the level indicated by this option, "Purge Pressure." When the pressure is at the desired level another valve opens applying the full tank pressure to the orifice line without any restrictions. The line is now being purged. The purge will continue for several seconds based on the value in the "Purge Duration" option. After the purge, the purge valve is turned off and the line pressure is again applied to the sensor. The compressor may turn on again if needed to maintain the desired bubble rate. If the compressor does turn on it is a good indication the purge duration is set long enough to properly purge the line and return to normal operation. If the compressor does not turn on after the purge then increase the purge duration by 10 or 20 seconds to make sure the line pressure has stabilized.

PC Interface View

Built In Display Screen

Purge Duration

Purge Time: [XXX]sec

This is the duration of a purge in seconds. The range is 30 to 240 seconds. Higher purge pressure values require more time for the purge to complete properly. If the purge time is too short the pressure in the tank will be abnormally high causing a much higher bubble rate. The abnormally high bubble rate may cause stage readings that are slightly higher than expected. If the H-355 compressor turns on after the purge is done then the purge time is long enough. The worst case would also be at lower water levels as more air would have to be released from the tank. The purge duration is set automatically when ever the purge pressure is changed. The following table shows the minimum time to build up the purge pressure, the minimum purge duration that should be used based on purge pressure and the total minimum time a purge should take based on the different purge pressures. Note that battery conditions, orifice line length, temperature and other factors may affect these times.

Purge Pressure	Minimum Time To Build Up Purge Pressure	Minimum Purge Duration	Total Time To Complete Purge (Minimum)
15 to 19 PSI	15 Seconds	40 Seconds	55 Seconds
20 to 29 PSI	25 Seconds	50 Seconds	75 Seconds
30 to 39 PSI	40 Seconds	60 Seconds	100 Seconds
40 to 49 PSI	55 Seconds	70 Seconds	125 Seconds
50 to 59 PSI	75 Seconds	80 Seconds	155 Seconds
60 to 69 PSI	100 Seconds	90 Seconds	190 Seconds
70 to 79 PSI	120 Seconds	100 Seconds	220 Seconds
80 PSI	125 Seconds	110 Seconds	235 Seconds

PC Interface View

Built In Display Screen

Timed Purge

Timed Prg [XX] days

This option is used to force a purge every XX days. The limits are 00 to 99 days. If the option is set to 00 then this option is disabled. A value of 01 will cause a purge every day, a value of 07 would be once a week, and so on. The purge will happen immediately following the scan at or just past 12 noon.

PC Interface View

Built In Display Screen

A - Auto Purge: Off

Auto Purge Enbl [Off]

The XL™ can sense when the orifice line is restricted or plugged. The H-355 can be configured to do an automatic purge of the orifice line when it becomes necessary. This menu item turns the auto purge on or off. This does not control the timed purge option.

PC Interface View

Built In Display Screen

Purge Threshold: 20 PSI (46.13 feet)

Purge Thresh [XXX]PSI

The purge threshold is the amount of pressure required to cause the H-355 to automatically purge the line. This must be set to a value above the highest water level possible. For example if a river may reach 30 feet but not higher, this is the same as 13 PSI, in this case the purge threshold could be set to 15 PSI, (or 34.6 feet). If the orifice line pressure reaches the purge threshold, indicating a blocked line, the XL™ will initiate an auto purge. If the purge is successful, normal operation will continue. If the purge fails, the H-355 will not try another purge until 24 hours later. The H-355 enters this mode of operation to preserve the battery in case of a plugged orifice. The range of "Purge Thresh" is 10 to 65 PSI.

PC Interface View

Built In Display Screen

Manual Purge

Manual Purge?

Using the PC menu, pressing the 'M' key or pressing <Enter> when using the built in menu will cause the H-355 to perform a purge immediately using the current purge settings. If the battery voltage is approximately 11.25 volts or less, then the purge will not happen.

PC Interface View

Built In Display Screen

N - Number of Purges: XXX

Purged XXX Times

This is a status screen that indicates how many times the H-355 has purged. Pressing the ENTER key will reset this value to zero when using the built in menu. When using the PC menu press the 'N' key to reset the counter back to zero. This is useful to see that the unit has been purging since the last visit.

PC Interface View

Built In Display Screen

U - Update All values

Not Available In Built In Menu

The status values on this screen are not updated automatically due to the time it takes to read the values from the H-355 bubbler system. In order to update the status values using the PC menu the 'U' key must be pressed. This will take a couple of seconds.

When using the built in menu, the user must exit this section of the menu and reenter the H-355 options to see the updated values.

21.4 H-355 Configuration Drawing

Figure 21-1 shows the H-350XL™ model and the H-355 connected as a system. Follow the instructions in Chapter 2 of this manual and the H-355 user's manual to make connections between the two devices.

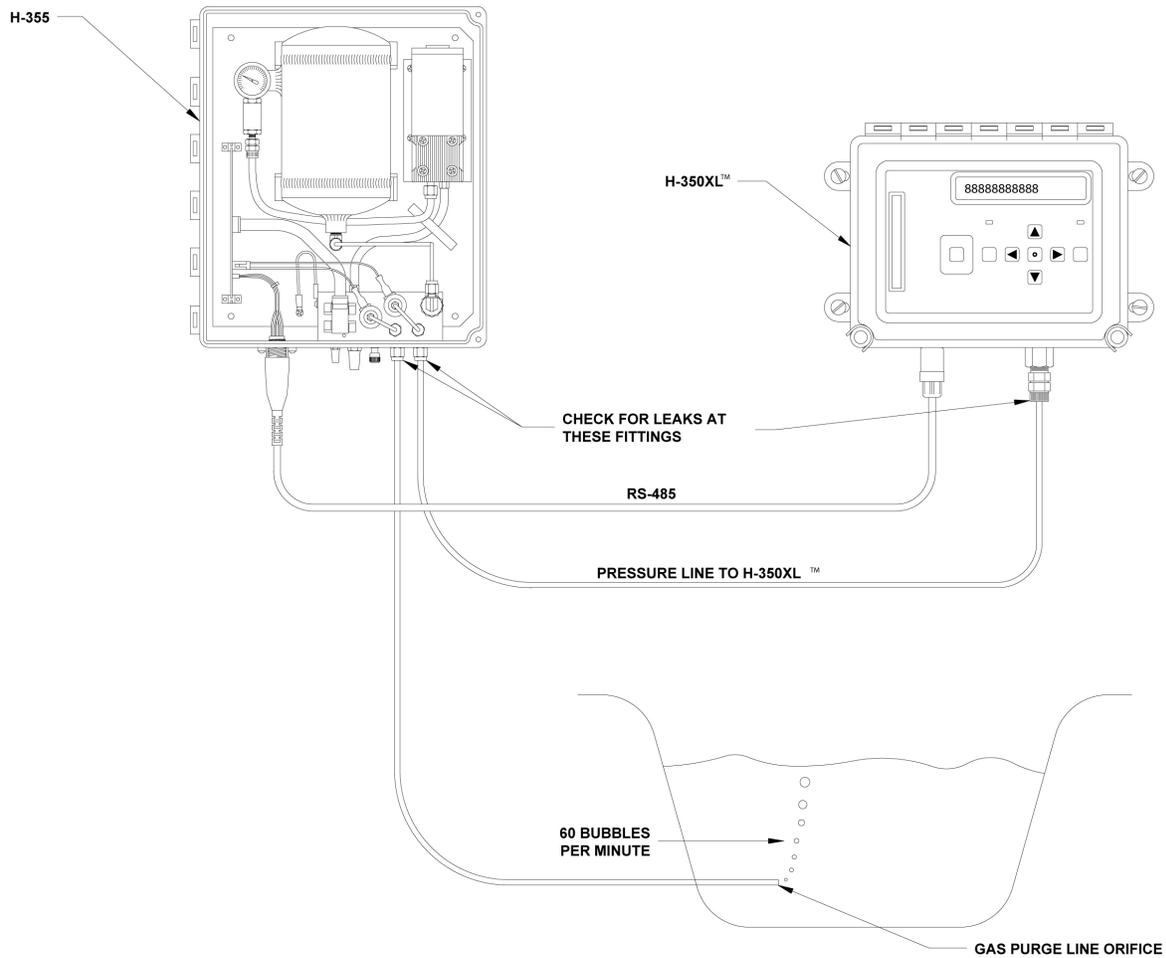


Figure 21-1. H-350XL / H-355 Pressure Measurement System

Note: This figure shows the model H-350XL™ connected to the H-355 bubbler system. The H-350XL™ is the only XL series model with the internal pressure transducer. Other models of the XL series data loggers can be used to control the bubbler, but would need an external pressure transducer like a H-350Lite connected to the H-355 pressure line and the electrical connection of the H-350 Lite connected to the XL™ series logger to function properly.

Chapter 22

Functions

22.1 Introduction

There are 40 general purpose user definable functions and three specific purpose functions. The general purpose functions are named Fnt01 to Fnt40. These functions are normally used for non linear sensor configurations, but may be used for other advanced operations and applications as described later. Two of the specific functions are used for the two digital I/O signals and the other is used to see if a GOES random transmission should be sent. Each function can be 31 characters long. If a function expression is more than 31 characters it will automatically use space from the next function(s) as needed for a total of 127 characters.

The functions use standard mathematical operators for standard conversions and logical operators for decision making applications. The default expression for each of the functions is the text "0". A function is an expression that is a user entered string of text of some mathematical and / or logical equation. An example of the expression is "9/5*temp+32". After an equation is entered into the selected function press the ENTER key to save the new equation. If there is an error in the function then a message will prompt the user of the possible position of the error.

There are a few conditions when the XL does not evaluate the expression and just returns a value. For example, if a divide by zero occurs in the expression, the function will return a value of -99.99. There may be other invalid expressions that result in a value of -99.99. In most cases a user is not at the site testing each result to see if it was valid or not, so the system must return some value to be logged or used later for some other reason. In these cases a -99.99 should be easy to spot in a data file.

22.2 Function Menus

Built in Menu Structure: Functions menu.

System Setup	->	Functions Options	->	Fnt 1	[0]
				Fnt xx	[0]
				Fnt 40	[0]

Each function will be displayed on a separate screen. The function expression may be edited using the standard editing technics. When an expression is edited, press the ENTER key to cause the expression to be tested and display the resulting value. If an error is encountered, then a message will be displayed indicating where the error is located. For example, if the message reads "Error at pos 6" then look at the expression around the sixth position for possible problems. The functions are much easier to enter, test and edit using the PC interface. Most of this chapter will be geared around the PC interface.

PC Menu Screen: Functions Menu.

```
Functions Menu  01 to 10      (Esc to Return)

1 - Fnt01 = ana1*72.0
2 - Fnt02 = 9/5*pttemp+32
3 - Fnt03 = 0
4 - Fnt04 = 0
5 - Fnt05 = 0
6 - Fnt06 = 0
7 - Fnt07 = 0
8 - Fnt08 = 0
9 - Fnt09 = 0
0 - Fnt10 = 0

N - Next
V - View Values

Enter Option >
```

The 40 functions will be displayed on four screens with 10 functions each. The functions menu provides an easy way to edit and test the functions. A function screen showing the first two functions changed by the user with the others set to default could look like the above screen. In this case $fnt01 = ana1 * 72$ is the conversion from volts to degrees for a wind vane that outputs 0 to 5 volts. Multiplying the analog voltage (0 to 5 volts) by 72 results in a value between 0 and 360. The second function is the conversion from temperature in degrees C to degrees F where $pttemp$ is the internal temperature probe on the H-350XL™ reported in degrees C. The rest of the function expressions are set to the default of '0'.

There are two sections to a function; first is the function expression and the second is the function value. The expression is a user entered string of text of some mathematical or logical equation. An example of the expression is "9/5*temp+32". The value of a function is normally the mathematical result of the expression. In the example above, if the internal temperature sensor on an H-350XL™ read 23.5, the value for the function would be 74.3. Again, the default expression of a function is the ASCII text character '0', which would evaluate to a numerical value of 0.00.

Math Evaluator Operations:

Before discussing the user interface for entering and testing functions any further at this point, lets look at the operations available, their priority and how the math section is tied to the hardware. The following lists include all the functions, operators, variables, and constants used by the math evaluator. Notice that all the functions and variables are in lower case. They may be entered in either upper or lower case but the system will convert them to lower case before storing them in memory, and will display them afterwards in lower case.

Highest Level Of Priority:

Trigonometry Functions:

sin(x)	Sine of x based on degrees, SIN(30) = 0.5
cos(x)	Cosine x based on degrees, COS(30) = 0.866025
tan(x)	Tangent x based on degrees, TAN(30) = 0.57735
asin(x)	Arc sine x based on degrees, ASIN(0.5) = 30.0
acos(x)	Arc cosine x based on degrees, ACOS(0.5) = 60.0
atan(x)	Arc tangent x based on degrees, ATAN(0.5) = 26.565051
sinr(x)	Sine of x based on radians, SINR(1) = 0.841471
cosr(x)	Cosine x based on radians, COSR(1) = 0.540302
tanr(x)	Tangent x based on radians, TANR(1) = 1.557408
asinr(x)	Arc sine x based on radians, ASINR(0.5) = 0.523599
acosr(x)	Arc cosine x based on radians, ACOSR(0.5) = 1.047198
atanr(x)	Arc tangent x based on radians, ATANR(0.5) = 0.46348

Logarithmic Functions:

log(x)	Log base 10 of x, LOG(1000) = 3.0
ln(x)	Natural log of x, LN(1000) = 6.90775
exp(x)	Natural log base of 2.718282 raised to the power of x, EXP(3) = 20.08554

Basic Math Functions:

abs(x)	Absolute value of x, ABS(-55.67) = 55.67
sqrt(x)	Square root of x, SQRT(100) = 10.0

Logical functions:

if(x,y,z)	If condition x is true then return y else return z
	IF (anal>2.5,10,-10) = 10.0 if analog 1 is greater than 2.5 = -10.0 if analog 1 is less than 2.5

Built In Specific Sensor Functions:

When a sensor is used in several applications it may be easier to build an equation into the operating system for that sensor rather than have customers enter the equation every time the sensor is used. The following temperature equations are for thermistor based temperature probes. When using one of these temperature probes see the app note for its full details.

h377c(anaX): Convert the voltage on analog channel X from the H-377 thermistor probe to temperature in degrees Celsius. The following is the actual equation used:

$$R = \ln\left(20000.0 * \left(\frac{5.0}{anaX} - 1\right)\right)$$
$$T = \left(\frac{10000}{10.29164 + 2.39125 * R + 0.00157 * R^3}\right) - 273.15$$

h377f(anaX): Convert the voltage on analog channel X from the H-377 thermistor probe to temperature in degrees Celsius. This function uses the same equation as the function above, but uses the following conversion from degrees C to degrees F:

$$F = \frac{9}{5} * C + 32$$

tp20b(anaX): Convert the voltage on analog channel x to a temperature based on the built in voltage to temperature equation TP20B. The following is the actual equation:

$$R = \ln\left(\frac{20000.0}{\frac{5.0}{anaX} - 1}\right)$$
$$T = \left(\frac{10000}{10.29164 + 2.39125 * R + 0.00157 * R^3}\right) - 273.15$$

tp20m(anaX): Convert the voltage on analog channel x to a temperature based on the built in voltage to temperature equation TP20M. This is a temperature probe used by the Maine district of the United States Geological Survey. The actual equation is:

$$R = \ln \left(\frac{20000.0}{\frac{5.0}{anaX} - 1} \right)$$

$$T = \left(\frac{10000.0}{9.69446 + 2.32945 * R + 0.00080 * R^3} \right) - 273.15$$

Next Level Of Priority:

Powers:

x^y : x raised to the power of y, $3^5 = 243$

Next Level Of Priority:

Multiplication / Division:

$x * y$: x multiplied by y, $20 * 30 = 600$

x / y : x divided by y, $20 / 30 = 0.666667$

Next Level Of Priority:

Addition / Subtraction:

$x + y$: x added to y, $20 + 30 = 50$

$x - y$: x subtract y, $20 - 30 = -10$

Next Level Of Priority:

Low Level Logic:

$x == y$: Is x equal to y? (Notice double equal signs) 1 if true 0 if false

$x != y$: x does not equal y? 1 if true 0 if false

$x > y$: Is x greater than y? 1 if true 0 if false

$x >= y$: Is x greater than or equal to y? 1 if true 0 if false

$x < y$: Is x less than y? 1 if true 0 if false

$x <= y$: Is x less than or equal to y? 1 if true 0 if false

$x \& y$: Logical AND operation, **If** x does not equal 0.0 **AND** y does not equal 0.0 **then** return 1.0, **else** return 0.0. For example, $(ana1 > 2.5) \& (ana2 > 3.5)$ returns 1.0 **if** analog channel 1 is greater than 2.5 **AND** analog channel 2 is greater than 3.5, **else** it returns 0.0

$x | y$: Logical OR operation, **If** x does not equal 0.0 **OR** if y does not equal 0.0 return 1.0, **else** return 0.0. For example,

$(ana1 > 2.5) | (ana2 > 3.5)$ returns 1.0 **if** analog channel 1 is greater than 2.5 **OR if** analog channel 2 is greater than 3.5, **else** it returns 0.0

Lowest Level Of Priority:

Assignments:

Fnt01 = 12.34 Assign the value of 12.34 to function 01

System Variables:

All system source variables can be used with the math functions. For example an analog input channel can be used in a function such as $Fnt01 = 10 * ana1 + 32$. The following is a complete list of all the system source variables.

date	This is the current date in a YYMMDD format
time	This is the current time in a HHMMSS format
seconds	This is the current seconds, 0 to 59
minutes	This is the current minutes, 0 to 59
hours	This is the current hours, 0 to 23
day	This is the current day, 1 to 31
month	This is the current month, 1 to 12
year	This is the current year, 00 to 99, 2000 to 2099
stage	This is the last measured stage value and is adjusted using the slope and offset. Using this variable in a function will not cause a new measurement.
psi	This is the last measured psi value. Using this variable in a function will not cause a new measurement.
pttemp	This is the last measured temperature value of the internal temperature sensor in degrees C or F as configured by the user. Using this variable in a function will not cause a new measurement.
batt	This will cause the system to take a new battery measurement, convert it to volts, and return the results.

counts	This will cause the system to read the latest summation count value and return the results. The results are adjusted for the count slope coefficient.
totent	This will cause the system to read the last total count value and return the results. The results are adjusted for the count slope coefficient.
digioX	This will cause the system to read the digital I/O X and return a 1.0 if it is high and a 0.0 if it is low. X is a 1 or a 2 representing digital I/O 1 or 2.
anaX	This will cause the system to read analog channel X, apply the slope and offset for analog channel X, and return the results. X is from 1 to 4.
freq	The system will read the frequency input, apply the slope and offset for the frequency input, and return the results.
encodr	The unit can use the two digital inputs to read the older style quadrature shaft encoders. If the system is configured for this type of encoder, this would cause the encoder to be read and the results to be returned.
tscans	This is the total number of scans since logging started. This can be used as a counter or to initialize some variables at the start of scanning.
sdiAP	This will cause the system to scan the sensor at SDI-12 address A and return parameter P as the result. The address is in the range of 0 to 9 and the parameter is in the range of 1 to 9.
fntXX	Functions may be called from other functions or used as variables for other functions. The value of the referenced function is returned but the referenced function is not reevaluated. See the section on advanced operations for details. The value of XX is 01 to 40 for fnt01 to fnt40.

System Constants:

There are a few constants the system recognizes so the user does not have to type them in directly. They are all implemented to the highest precision possible.

pi The value for **pi** is 3.14159265359.

e The value for e is 2.71828182846.

Entering Functions:

The main functions can only be entered or edited using the menu or command interface over the serial port, not from the built in display/keypad. As stated above, to change a function press a key 0 to 9 for the desired function. The unit will prompt the user with the following text “E - Edit T - Test Function.” Pressing the ‘E’ key allows the user to edit the function expression. Once the function is entered, press the ENTER key and the function expression will be evaluated and any errors in the function will be displayed. If there are no errors the calculated value will be displayed. If a function needs minor editing, use the Left and Right Arrow keys to move back and forth through the function, and the Delete key to remove unwanted characters. **Note:** no spaces can be used when entering a function.

There are 31 bytes of memory reserved for each function. If a function expression is more than 31 bytes then space from the next function will be used. A single function can be up to 127 characters long, but remember this would use the space from three additional functions. If a function is greater than the 31 bytes, the display will not list the next function as a usable function. Notice how function 04 on the following screen is not listed because function 03 has more the 31 characters in its expression.

```
Functions Menu 01 to 10      (Esc to Return)

1 - Fnt01 = ana1*72.0
2 - Fnt02 = 9/5*pttemp+32
3 - Fnt03 = 23.5*ana1^3+45.32*ana1^2-87.4*ana1+76.32

5 - Fnt05 = 0
6 - Fnt06 = 0
7 - Fnt07 = 0
8 - Fnt08 = 0
9 - Fnt09 = 0
0 - Fnt10 = 0

N - Next
V - View Values

Enter Option >
```

User Defined Constants:

A function may also be used as a user defined constant. For example, lets say a constant of 23.76258 is used repeatedly, then enter for fnt01, “fnt01 = 23.76258.” Now use fnt01 in other functions such as, “fnt02 = fnt01 * ana1 + fnt01 * ana2.” This would be the same as the function “fnt02 = 23.76258 * ana1 + 23.76258 * ana2”. The more the constant is used the more useful this becomes.

Specific Purpose Functions:

There are three special purpose functions: one to define when a GOES random transmission should be sent an one for each of the two digital I/O outputs. The function for the GOES random

transmission is entered and tested under the GOES option menus and the digital I/O conditional output functions are entered and tested under the digital I/O setup menus.

Complex Functions:

functions can have more than one expression section. A standard function has the following form.

fntXX = expression

A complex expression will have the following form.

fntXX = expression1;expression2;expressionX

The function being edited will take on the results of the first expression automatically. Normally the second expression is an assignment type of expression for assigning a value to another function or variable; for example, fnt01=10*ana1;fnt02=fnt01/5.

@ Functions:

Functions that start with the '@' character will be evaluated automatically at the beginning of each scan, and will not be evaluated again if used as a log column source or GOES column source, etc. Normally to evaluate a function, it must be used as the data source for a logging or a GOES column, but not so with an @ function. @ functions are used for counters or running averages where if it was evaluated more than once a scan it could create errors in the returned value and it is not desirable to include the information in the logging report. The following example functions will count up on each scan and reset to 0 every day.

Fnt01 = 0

Fnt02 = @if(fnt01==day, fnt02+1,0);fnt01=day

When scanning is started function 1 is set to 0, function 2 is set to 0 then function 1 is set to the current day. On each scan function 2 is incremented if the same day, else reset to 0.0, and then function 1 is set the to current day again.

Functions:

Functions that start with the '#' character will not be evaluated but the current value of the equation will be returned. The function value may be changed by other functions or operations that are using this function as a storage location. For example in the following function definition, function 01 will calculate the temperature in both degrees C and degrees F and will return degrees C for function 01 and used function 02 as a storage location for the temperature in degrees F.

fnt01=h377c(ana1);fnt02=h377f(ana1)

fnt02=#temperature in degrees F.

Now normally function 01 would be called before function 02 so that both values are updated but when function 02 is called it will not evaluate the expression but just return the value already stored. In this case the expression for function 02 can be a note describing what is happening and the system allows it.

This is especially handy when using an XL-BASIC program that needs to return several values.

\$ Functions:

Functions that start with the '\$' character will not be evaluated but are used for text strings. This is normally only used to place a label in a data file. If this function is used as the source in the logging options, then the text following the '\$' character will be placed in the data file. The text is limited to 8 characters. This type of function will always equate to a value of -1357.2468.

Math Function Example 1 (Temperature Conversion):

An SDI-12 temperature probe reports the temperature in degrees F, but the desired units are degrees C. The probe has an SDI-12 address of 5 with one value returned for temperature. Enter an equation that will convert the temperature from degrees F to degrees C.

$$\mathbf{Fnt01 = (sdi51 - 32)/9*5}$$

Fnt01 can now be used as a data source in the log report and the reported value will be temperature in degrees C.

Math Function Example 2 (Rating Curve):

Most rating curves are developed by taking several discharge measurements versus stage for a variety of stage readings. A typical rating curve will take on the form as follows:

$$\mathbf{Q = p(h - e)^b}$$

Where		Q	=	discharge
h	=	gauge height		
e	=	gauge height of zero flow		
p	=	constant which is numerically equal to the discharge when h - e = 1 (This is 1 foot of gauge height over the zero flow point)		
b	=	slope of the rating curve		

After several discharge measurements, p is calculated to be 45.24 and b is calculated to be 0.6667 or 2/3. The zero flow point is the gauge level at zero flow, and for this example could be 3.75. With this information we can enter the function into the system as follows.

$$\mathbf{Fnt02 = 45.24*(stage - 3.75)^(2/3)}$$

As the stage value varies up and down so will the calculated discharge value.

Math Function Example 3 (GOES Random Transmission Function):

A GOES random transmission is desired if the stage level is greater than 20.5 feet and the rain is greater than or equal to 0.10 inches. The following equation would be entered for the alarm condition in the random options of the GOES submenu.

$$\text{Alarm Condition} = (\text{Stage} > 20.5) \& (\text{Counts} \geq 0.10)$$

If the stage level is higher than 20.5 (true) **and** the rain is 0.10 or higher (true), then a random transmission will be sent.

Also notice this function is entered under the GOES random menu, not in the general purpose functions menu as this function has a very specific purpose.

Chapter 23

XL-BASIC Programming Guide

Version Changes (available on version 2.07 of the XL series data logger)

- Changes to the 'input' command to not change the variable value if no input was received
- Added 'printsdi' command, print to the SDI-12 port without any retries.
- Added 'p12vxon' command, turn on the 12 volt excite, (Only available on newer hardware).
- Added 'p12vxoff' command, turn off the 12 volt excite, (Only available on newer hardware).
- Added 'settimeout (x)' command, set the system time out value from 15 to 600 seconds.
- Added 'opencom2', 'print2' and 'closecom2' commands, allows printing to com port two.
- Added 'logvalx' variable, an indirect variable normally based on a log column function.
- Added 'reset' variable, returns the number of times the system has reset.
- Described the 'basicx' variable.

Version Changes (available on version 2.10 of the XL series data logger)

- Added input commands for com port 2 and 3
- Added flushcom1, flushcom2, and flushcom3 commands.
- Updated This document.

XL-BASIC Programs:

The XL™ series data loggers have a built in BASIC interpreter for handling specialized operations outside the normal use of the data logger. Since this BASIC interpreter is specific to the XL™ series of data loggers it is called XL-BASIC. XL-BASIC handles many of the standard BASIC commands, but also provides access to the I/O and other features of the XL™ series data logger.

Basic1 to Basic5 There are five basic programs that can be called any time the system is collecting data to log or to send to the GOES radio, etc. To execute one of the five programs, select it from the source list just as "Stage" or "Ana1" is selected. Each XL-BASIC program has a defined variable that will be used as a return value for the function that caused the XL-BASIC program to execute. For example, as the system processes the data to log, it looks at the source for each column. The first column is normally set to "Date" so the current date is placed in column 1. Column 2 is normally time and a time stamp is placed in this column. If column 3 source was set to "Basic1", then the BASIC 1 program would execute and the value in variable "Basic1" would be placed in the third column.

A BASIC program is written using a standard text editor on a PC and then loaded into the XL series data logger. Each BASIC program must be 8K bytes or less in size. The size of the

program includes all commands, comments, remarks, and spacing. If the size of the file becomes too big then cut down on the remarks or the spacing, or break the tasks into two separate programs.

Variables:

Since the system is limited on RAM, and to keep the operation of the BASIC programming simple, only predefined variables will be used. All variables types will be double precision floating point variables. All standard system variables will be accessible to the XL-BASIC interpreter plus some generic variables used only by the XL-BASIC interpreter system. In the program the variables may be upper or lower case, here they are shown in lower case.

Main BASIC Program Variables:

Variable Name	Type	Description
basic1 basic2 basic3 basic4 basic5	Read / Write	These variables are used to return values from Basic program 1 to 5 to the menu option calling the BASIC program. These variables are initialized to 0.0 when scanning is enabled, and will retain any modifications between scans. On return the value will depend on the users BASIC program.

The basicx Variable:

This is not a separate variable but is actually an indirect link to one of the normal basic variables, 1 to 5. A program can return a value using the variable associated to the location number where the basic program is loaded. For example a program loaded into basic program location 1 must use the variable basic1 as the return variable. Now a program can use the name basicx as the return variable which allows the program to be loaded in any program location. If loaded into program location three, then when the program updates the basicx variable it is actually updating the variable basic3.

General Purpose Variables:

Variable Name	Type	Description
a to z	Read / Write	26 General purpose variables initialized to 0.0 when scanning is enabled. Any value changes will be retained between program execution and between scans

Standard Input Variables:

Variable	Type	Description
Stage	Read / Write	The last measured stage value is returned. (Only available on the H-350XL and the H-510XL)
RemStage	Read / Write	The last measured value for the remote stage variable is returned.
LastStage	Read / Write	The stage value measured on the previous scan will be returned. Only available on the H-350).
PtTemp	Read / Write	The last measured PtTemp value is returned. (Only on the H-350XL)
PSI	Read / Write	The last measured PSI value is returned. (Only on the H-350XL)
AnaX	Read / Write	The last measured value for analog channel X (X = 1 to 4) is returned.
Freq	Read / Write	The last measured freq value is returned.
Digio1	Read / Write	The last measured input state for digital channel 1 is returned.
Digio2	Read / Write	The last measured input state for digital channel 2 is returned.
Counts	Read / Write	The last measured count value is returned.
Totent	Read / Write	The last measured total count value is returned.
Countrate	Read / Write	The current count rate on the counter input.
Encodr	Read / Write	The last measured encoder input value is returned.
Tscans	Read / Write	The total scans value is returned.
SdiAP	Read / Write	The last measured value for the selected SDI-12 variable is returned A = address 0 to 9, P = parameter 1 to 9
FntXX	Read / Write	The last calculated value for function XX is returned. (XX = 01 to 40)
BasicX	Read / Write	The value of one program can be used in other programs. (X = 1 to 5)

Note: Standard input variables are normally read only but may also be assigned a new value directly in the XL-BASIC program regardless of the variables corresponding hardware input condition. Be aware that based on system configuration the input variable could be updated by the system after the variable was set by the XL BASIC program. Writing to these variables should be avoided or only used in advanced applications. For example, in the following segment of code, the second line makes the first line useless.

```

measure(ana1)      measurement analog input 1 now and update its variable.
ana1 = 12.34      Sets variable ana1 to 12.34 regardless of the voltage on analog 1.
  
```

Read Only Variables:

Variable	Type	Description
Date	Read Only	The date is returned in the format YYMMDD.0000
Time	Read Only	The time is returned in the format HHMMSS.0000
seconds	Read Only	Return the current seconds in the format SS.0000
minutes	Read Only	Return the current minutes in the format MM.0000
hours	Read Only	Return the current hours in the format HH.0000
day	Read Only	Return the current day in the format DD.0000
month	Read Only	Return the current month in the format MM.0000
year	Read Only	Return the current year in the format YY.0000
Batt	Read Only	The current battery voltage reading is returned
minbatt	Read Only	Return the minimum battery voltage measured since option was reset.
maxbatt	Read Only	Return the maximum battery voltage measured since option was reset.
tankpsi	Read Only	Return H-355 tank PSI if an H-355 is connected.
linepsi	Read Only	Return H-355 line PSI if an H-355 is connected.
purgepsi	Read Only	Returns H-355 purge PSI setting.
purgedur	Read Only	Returns H-355 purge duration setting.
bubrate	Read Only	Returns H-355 bubble rate setting.
Purge	Read Only	Returns H-355 purge status, 0 = bubbler communication error. 1 = request for purge accepted. 2 = already purging.
Resets	Read Only	Returns the number of times the system has reset.
LogvalX	Read Only	Returns the value associated to a log column when the column is setup to perform some function on the data like calculating the average, etc. The 'X' is the log column 01 to 25.

Note: The read only variables may be read but should not be written. Trying to set or write one of these variables to some value will have no affect, and the program will continue on under normal operation. If one of these variables is set to some value and then read again, the value returned will not be the value set by the program but will be a value based on the function behind the variable.

Math Functions:

Basic Math Operations

+, -, *, /. Standard Math operators

% Modulo divide, returns the remainder from the standard division

^ Power operation, X^Y is X raised to the power of Y, for example $2^8 = 256$

Trigonometry Operations (Degrees)

sin(x) cos(x) tan(x)

asin(x) acos(x) atan(x)

Trigonometry Operations (Radians)

sinr(x) cosr(x) tanr(x)

asinr(x) acosr(x) atanr(x)

Logarithmic Operations

log(x) ln(x)

Misc Function Operations

abs(x) Absolute value of x.

int(x) Integer portion of x.

sqrt(x) Square root of x.

int(x) Integer portion of x.

h377f(anaX) Convert voltage on analog channel X to a temperature in degrees (f) based on math equation for a model H-377 temperature probe.

h377c(anaX) Convert voltage on analog channel X to a temperature in degrees (c) based on math equation for a model H-377 temperature probe.

XL-BASIC Command Summary:

PROGRAM FLOW / CONTROL COMMANDS	
COMMAND	DESCRIPTION
REM	Add remarks to the program for documentation.
DELAY(XXXX)	Delay or wait for XXXX milliseconds, 1 to 65000.
GOSUB XXXX	Go to a subroutine at line number 'XXXX'.
RETURN	Return from the subroutine.
GOTO XXXX	Go to line number 'XXXX'.
FOR / TO / NEXT	Loop commands
IF / THEN	Conditional program execution
END	End marker for all programs.

SENSOR INPUT COMMANDS	
MEASURE(XXXXXX)	Take a new measurement from the selected input.
VXON	Turn on the 5.0 volt excitation.
VXOFF	Turn off the 5.0 volt excitation.
P12VXON	Turn on the 12 volt excitation. (Hardware Rev N and newer only)
P12VXOFF	Turn off the 12 volt excitation. (Hardware Rev N and newer only)
SETDIG1	Set digital I/O 1 high.
SETDIG2	Set digital I/O 2 high.
CLEARDIG1	Clear digital I/O 1 to a low state.
CLEARDIG2	Clear digital I/O 2 to a low state.
CURRENTLOOP(a)	Set the 4 to 20 mA current output level to 'a'.

COM PORT COMMANDS	
OPENCOMx	Open RS-232 Com Port x for Input and Print operations. (x = 1 to 3)
CLOSECOMx	Turn off com port x (x = 1 to 3)
FLUSHCOMx	Clear out the input buffer for Com Port x (x = 1 to 3)
PRINT	Send text and data to com port 1.
PRINT2	Send text and data to com port 2
PRINT3	Send text and data to com port 3
PRINT4	Send text and data to com port 4, this is the RS485 port and it will turn on automatically as needed. This port has no input options.
INPUT	Get numeric values from com port 1.
INPUT2	Get numeric values from com port 2.
INPUT3	Get numeric values from com port 3.
INPUTDELAY(x)	Set how long to wait for input on the serial ports, or keypad.
DIGITS(x)	Set the number of digits to the right of the decimal point to display.

BUILT IN DISPLAY / KEYPAD COMMANDS	
DISPLAY	Send text and data to the local display
DISPCLEAR	Clear the local display.
DISPCURSER(x)	Set the curser position for the local display to 'x'.
DISPOFF	Turn off the local display.
INKEY	Get a key press input from the local display.
LEDON	Turn on the Error LED.
LEDOFF	Turn off the Error LED.

DATA CARD AND FILE COMMANDS	
OPENFILE	Open a data file for WRITEFILE operations.
WRITEFILE	Write text and data to the open data file.
CLOSEFILE	Close the data file.

H-355 BUBBLER COMMANDS	
SETBUBBLERT(x)	Set the H-355 bubble rate to 'x' bubbles per minute.
SETPURGEPSI(x)	Set the H-355 purge pressure to 'x' PSI.
SETPURGEDUR(x)	Set the H-355 purge duration to 'x' seconds.

MISCELLANEOUS COMMANDS	
POKE(a,d)	Set system address 'a' equal to 'd'
PEEK(a)	Read system address 'a'.
WRITESDI "string"	Send text and data to the SDI-12 port using SDI-12 timing and retries.
PRINTSDI "string"	Send text and data to the SDI-12 port one time only, no retries.
GETSDIDATA "string"	Send a measurement command as a text string to the SDI-12 port and collect the data for that command.
SETTIMEOUT(x)	Set the system timeout time to x seconds.
SCANRT()	Get the current scan rate in seconds, a 15 minute rate would be 900.
SETSCANRATE(x)	Set the scan rate to x where x is in seconds from 0 to 86399.

XL-BASIC Language Command Descriptions:

Except for functions that have parameters using parentheses, all commands should be followed by a space. Normally keeping only one command on a line will make the program easier to read and understand. This also will cut down on programming errors. Commands may be entered in either upper or lower case.

--- Program Flow / Control Commands ---

REM This is a 'Remark' command. This is used to document the program and is used the same as in standard BASIC. Any text after the 'REM' command will be ignored until the next line. It is always a good practice to document the program. This helps explain the purpose of the program and documents any special operations of the program. Program flow should always be documented so it can be easily followed in debugging.

DELAY(#####) Delay ##### milliseconds, where ##### is 0 to 65000

Example: Delay(1000) Rem delay for 1.0 second

GOSUB ##### Go to a subroutine indicated by ##### where ##### is a numeric label at the beginning of a line, (no alpha characters. See the GOTO command for more information on the label limitations). There should be a return statement at the end of the subroutine. There can be 5 nested GOSUB sections.

Example: gosub 2000
end

2000
print "this is a subroutine"
return

RETURN Each subroutine must end with a return statement.
See the gosub command.

GOTO ##### Go to a different part of the code indicated by ##### where ##### is a numeric label at the beginning of a line, (no alpha characters). There is no automatic return operation like the gosub uses. There must be a space between the command and the line number label. There may be up to 50 numeric labels in a program. Labels must be whole numbers in the range of 0000 to 9999.

Example: goto 1000
 end
 1000
 print "code execution continues here"

FOR / TO / NEXT This is a “For To” loop with the following form:

```
FOR var = start value TO end value
Command(s)
NEXT
```

Example: for x = 1 to 10
 Print x
 Next

The start value and end value must be whole numbers with the start value less than the end value. There can be 5 nested FOR / TO / NEXT sections.

IF / THEN IF condition THEN action. Condition is a logical expression that evaluates to true or false. If the condition is true then the desired action is executed. Valid conditional operators are:

Operator	Example	
<	a < b	a less than b
>	a > b	a greater than b
<=	a <= b	a less than or equal to b
>=	a >= b	a greater than or equal to b
==	a == b	a equal to b
!=	a != b	a not equal to b

Example: if stage>10 then print "stage is greater than 10"

Most commands can be used after the THEN statement. A few possibilities are listed below:

```
Then goto #####
Then gosub #####
Then measure(x)
Then delay(#)
```

END All programs should end with this statement.

--- **Sensor Input / Misc I/O Functions** ---

MEASURE(x) Measure selected input. Some inputs are normally only measured once per scan in order to speed program execution, and to make sure all secondary actions using the input value do so using the same value, as a second measure operation may result in slightly different values. If it is desirable to measure an input again, then this command must be used. Inputs that normally only get measured only once per scan are the analog inputs, the stage input, the PtTemp input the PSI input, and the SDI-12 inputs. Other input variables like battery or seconds will be updated each time they are used.

x = Ana1 to Ana4, Stage, PtTemp, psi, SDIap, FntXX etc.

VXON Turns the 5.0 volt excitation on.

VXOFF Turns the 5.0 volt excitation off.

P12VXON Turns on the 12 volt excitation if it was off. (Only valid on Hardware Rev N and newer. On older revisions the 12 volt excitation was always on).

P12VXOFF Turns off the 12 volt excitation if it was on. (Only valid on Hardware Rev N and newer. On older revisions the 12 volt excitation was always on).

SETDIGx Set digital output x (1 or 2) to a high state. The digital I/O must be configured as an output or this will have no affect.

CLEARDIGx Turn off digital output x (1 or 2).

Example: if stage > 10 then setdig1

CURRENTLOOP(x) Sets the 4 to 20 mA output current to 'x' where 'x' is between 4 and 20. Values greater than 20 will result in an output of 20 mA and values less than 4 will result in an output level of 4 mA.

the quotes, and the line is again terminated with a carriage return line feed because of the lack of a comma or semicolon.

In the last example the first value is formatted to 8 characters, (due to using the ‘;’ option) and the second value is printed using no extra spaces, and the line is NOT terminated since it ends with a comma.

Normally ASCII text is sent out the serial port but at times it may be necessary to send special control codes, for example to initialize a serial display. To send out a single character control code in HEX format use a ‘&’ character as a prefix to the HEX data. The HEX data is in the range of 00 to FF.

`print &hh` where & indicates to the system a two character hex value follows, and the hh is the hex value from 00 to FF.

Example: `print &0D` sends a carriage return
 `print &0A` sends a line feed.

PRINT2 Same as print except the output is to com port 2.

PRINT3 Same as print except the output is to com port 3.

PRINT4 Same as print except the output is to com port 4, the RS-485 port.

INPUT Waits for a numeric value to be entered on com port 1. If no input is received within the timeout period defined by the INPUTDELAY command then program execution continues and the variable used with the INPUT command will remain unchanged. Like standard BASIC this command can be used to print a prompt to the user.

Example: `opencom 1`
 `input "Enter First Value ",a`
 `input "Enter Second Value",b`
 `print "Sum = ",a+b`
 `end`

INPUT2 Waits for a numeric value to be entered on com port 2. See the Input command for more information.

INPUT3 Waits for a numeric value to be entered on com port 3. See the Input command for more information.

INPUTDELAY(x) Set a timeout delay for serial input operations. The range is 1 to 60000 milliseconds. The default is 10000 or 10 seconds.

DIGITS(#) Set the number of digits to display to the right of the decimal point. The

default value is 2, and the range is 0 to 6. This option is used by the PRINT, PRINT2, PRINT3 commands, the DISPLAY command, and the WRITESDI and PRINTSDI commands.

Example: print 5.00000 (prints 5.00 (default set to 2))
 digits(5)
 print 5.00000 (prints 5.00000)
 digits(0)
 print 5.00000 (prints 5)

--- Built In Display / Keypad Commands ---

DISPLAY Basically the same as print except the output is to the local display. The cursor will be left at the end of the printed string. Also no carriage returns or line feeds will be sent at the end of the string as they would clear the display. If the display is not turned on before this command is used then the display will be turned on automatically.

DISPCLEAR Clear all text from the display and position the cursor at the home position. If the display is not turned on before this command is used then the display will be turned on automatically. Using this command is an easy way to turn on the display.

DISPCURSER(##) Position the cursor at position ## where ## is 00 to 19. This allows a message to be displayed once and some portion of the screen updated as needed without having to redisplay the whole screen.

Example: dispclear
 display "Battery Volts = "
 for x = 1 to 1000
 dispcurser(16)
 display batt
 next
 dispoff
 end

DISPOFF: Turn off the display now. If this command is not used the display will turn off automatically when the system has no more tasks to perform.

INKEY: Wait for a key to be pressed on the built in key pad. If no key is pressed within 30 seconds, a 0.00 is returned and program execution continues. The following table lists the values that will be returned for the different key presses.

KEY	VALUE	KEY	VALUE
Right	1.0	Up	10.0
Enter	2.0	Left	20.0
Down	4.0	Cancel	40.0
Dot	8.0	On / Off	80.0

Example:

```

dispopen
dispclear
display "If Raining Press ENT"
x = inkey
if x=2.0 then goto 100
dispoff
end

100
digits(0)
openfile "B:\SERVICE.LOG"
writefile "Date ";date,
writefile " Time ";time,
writefile " Currently raining"
closefile
dispoff
end

```

LEDON Turn on the Error LED. Note the led will not turn on if the display is not turned on.

LEDOFF Turn off the Error LED.

--- Data Card And File Commands ---

OPENFILE “filename” This command opens a file based on the parameter “filename”. The “filename” parameter specifies if the file will be on the internal data card or the external data card, and the name of the file. The format for the filename follows the DOS file format where a drive is also specified. A drive letter of ‘A’ refers to the external card and a drive letter of ‘B’ refers to the internal card. Only one file may be opened at a time. Valid examples are as follows.

A:\testfile.txt
B:\service.log

WRITEFILE This command is used to write data or text to the already opened file on the internal or external data card. This works basically the same as the PRINT command except the output is to the open file.

CLOSEFILE Closes the file opened using the OPENFILE command.

--- H-355 Bubbler Commands ---

SETBUBBLERT(x) Sets the H-355 bubble rate to value x. The bubble rate may be set between 30 and 120. A value less than 30 will result in a bubble rate of 30, and a value greater than 120 will result in a bubble rate of 120.

SETPURGEPSI(x) Sets the H-355 purge pressure in PSI to value x. The PSI value may be set between 15 and 80. A value less than 15 will result in a purge pressure of 15, and a value greater than 80 will result in a purge pressure of 80.

SETPURGEDUR(x) Sets the H-355 purge duration time in seconds to value x. The duration value may be set between 30 and 240. A value less than 30 will result in a purge duration of 30, and a value greater than 240 will result in a purge duration of 240.

--- Miscellaneous Commands ---

POKE(&adrs,&hh) Poke hex address adrs with hex data hh.

Example: poke(&1000,&01)

PEEK(&adrs) Peek hex address adrs

Example: r = peek(&1000)

WRITESDI This command is used to send text out the SDI-12 port to smart sensors. The command is preceded with a standard SDI-12 break. If the response is not recognized then normal SDI-12 retries will be sent. Normally the first character of the string is the address of the sensor the message is meant for, and if this address matches a standard SDI-12 address that has been redirected to a serial port, then this command will be sent out the serial port and not the SDI-12 port. The string format for this command is much the same as the 'print' command.

Example: `writesdi "0I!"`

PRINTSDI This command is used to send text out the SDI-12 port to smart sensors. Proper SDI-12 timing is used but the command is only sent one time, no retries are sent if the response is not recognized. This is always sent out the SDI-12 port even if the address has been redirected. The string format for this command is much the same as the 'print' command.

Example: `printsdi "0I!"`

GETSDIDATA "string" This command is normally used to send a measurement command as a text string out the SDI-12 port to smart sensors and then collects the data from the sensor and stores it in variables a to i. This allows the logger to collect data from sensors that have addresses other than the ten allowed for in the normal menu options. The command is preceded with a standard SDI-12 break. If the response is not recognized then normal SDI-12 retries will be sent.

Example: `getsdidata "aM!"`

SETTIMEOUT(x) This command is used to set the system timeout period. It can be set from 15 to 600 seconds.

SCANRT() This command gets the current scan rate in seconds.

Example: `a = scanrt()`

SETSCANRT(x) This command is used to change the scan rate. This may be used to speed up the scan rate based on some predefined condition. For example if the stage is greater than some level then scan at a faster than normal rate.

Example: `if stage>10 then setscanrt(300)`

CREATING XL-BASIC PROGRAMS:

XL-BASIC programs are created using text editors like NOTEPAD that comes with most PC's, or the "EDIT" program on most older PC's. Word processors in normal mode will NOT work as they will add several formatting codes to the text. Some word processors have a mode for editing basic text files and should work fine.

When creating a basic program file use a file name that describes the operation of the program. This will help when several files reside in the same folder. Also the file extension must be .BAS. When the XL™ series data logger looks for files to load for basic programs it uses the file mask *.BAS so only the .BAS files are listed.

XL-Basic Menu Screens

Menu options are available on both the built in display and on the PC menu interface to load and test the basic programs.

Built in Menu Structure: XL-Basic Menu

System Setup ->	XL-BASIC Options ->	Load XL-Basic Code?
		Get XL_Basic Code?
		XL-Basic1 = x.xx
		XL-Basic2 = x.xx
		XL-Basic3 = x.xx
		XL-Basic4 = x.xx
		XL-Basic5 = x.xx
		Debug Stepping Off

PC Menu Screen: XL-Basic Options.

```
XL-BASIC Code Options      (Esc to Return)

L - Load Code: From PC Card to Memory:
G - Get Code: From Memory to PC Card:

      Pgm Number          Pgm Name          Pgm Value
1 - Test XL-Basic1:      TMEAS            0.000
2 - Test XL-Basic2:      STG_AVG          0.000
3 - Test XL-Basic3:                        0.000
4 - Test XL-Basic4:                        0.000
5 - Test XL-Basic5:                        0.000
S - Single Step Mode: Disabled

Enter Option >_
```

PC Interface View

Built In Display Screen

L - Load Code: From PC Card to Memory

Load XL-Basic Code?

This menu option is used to load XL-BASIC code. Not all five programs have to be loaded. When this option is activated the system performs the following tasks:

- 1 - Make sure an external PC card is installed and functional.
- 2 - Erase all XL-BASIC programs currently loaded into internal memory.
- 3 - The data logger prompts the user to select a file to load for XL-BASIC program 1.
- 4 - Using the UP, DOWN, and ENTER key the user selects a file to load.
- 5 - The data logger prompts for files 2, 3, 4, and 5 in the same manner until all are loaded.

PC Interface View

Built In Display Screen

G - Get Code: From Memory to PC Card

Get XL-Basic Code?

This menu option is used to get XL-BASIC code out of the XL back onto a data card. When this option is used the system looks for an external data card and copies the XL-BASIC programs in main memory to the external data card.

PC Interface View

Built In Display Screen

1 - Test XL-Basic 1: Name XX.XX

XL-BASIC1 = XX.XX

This menu option is used to execute the different programs. When the program finishes running any value associated to the program will be updated and redisplayed. Remember there is a

variable for each basic program. The value of the variable is represented by the XX.XX above. The above screen shows Basic Program number 1, and programs 2 to 5 look and act the same as this one.

If there is a problem with a program it may be necessary to ‘step’ through the program line by line. When the single step mode is enabled, com port 1 is turned on and waits for a program to be executed. When the program is executed each line of the program is printed to the serial port of the PC and then the program waits for the user to press the PC ENTER key to actually execute the listed line of code. The stepping operation cannot be activated if scanning is on and is automatically turned off when scanning is enabled. In most cases it is best to just use the PC menu to test the XL-Basic programs since it must be connected anyway.

Example XL-BASIC Programs:

Example Program #1 Send Formatted Data To Remote Display

This example give the XL-Basic code for a program that will output the head (pool) and tail gauge heights (measured using SDI-12 Shaft encoders) to a remote display using the RS-232 Com Port 3 of the H-350XL™. All lines that begin with REM are remarks or comments that are used to document the program. These lines are not executed / interpreted by the Basic interpreter. In the logging options of the H-350XL™ could have the following columns defined for reporting: Date, Time, SDI11, SDI21, and BASIC1. SDI11 and SDI21 are the shaft encoders used to measure the head and tail gauge levels. BASIC1 would call the XL-Basic program named xlbasic1.bas which would output the gauge levels to the remote display. Also note that at the end of the XL-BASIC program the battery voltage is assigned to the variable BASIC1. The battery voltage value will then be logged into the data file once the XL-BASIC program has terminated. This eliminates the need to select Batt as a source in the logging options and it also eliminates an extra column in the data file.

```
REM XL-BASIC PROGRAM TO DISPLAY STAGE LEVELS (POOL AND TAIL)
REM MEASURED FROM TWO SDI-12 SHAFT ENCODERS TO A IEE 2 X 20
REM REMOTE VACUUM FLUORESCENT DISPLAY CONNECTED TO RS-232 PORT 3.

REM OPEN COM PORT 3 FOR COMMUNICATION
OPENCOM3

REM REMOTE DISPLAY CONTROL COMMANDS
REM 0AH = LF (VERTICAL SCROLL FROM BOTTOM LINE; CURSOR POSITION STAYS)
REM 0DH = CR (RETURN CURSOR TO LEFT MOST POSITION OF CURRENT LINE)
REM 0EH = TURN CURSOR OFF
REM 12H = TURN OFF AUTO CR
REM 14H = RESET DISPLAY

REM REMOTE DISPLAY INITIALIZATION
REM RESET DISPLAY, TURN OFF AUTO CR, TURN CURSOR OFF
PRINT3 &14,&12,&0E

REM PRINT POOL VALUE ON TOP LINE AND TAIL VALUE ON BOTTOM LINE
PRINT3 "POOL = ",SDI11+125.25," FEET"
PRINT3 "TAIL = ",SDI21+125.25," FEET";
```

```

REM ASSIGN BATTERY VOLTAGE TO BASIC1 VARIABLE FOR LOGGING
BASIC1 = BATT

REM CLOSE COM PORT 3
CLOSECOM3
END

```

Example Program #2 Post Purge Every Scan:

It may be desirable to purge more often than once a day as provided by options in the menu interface. The following example shows how to purge from once every scan to once every 'n' scans, where 'n' is set by the user as needed. Make sure this basic program is the last item in the report list. In this case the purge happens at the end of the scan. This is because the purge will create a lot of noise on the orifice line and this gives the most amount of time from the purge to the next measurement for the noise to dissipate.

```

REM Program to purge every 4th scan

REM this value sets the number of scans to make before a purge should be done.
REM In this example a purge will be done every 4 scans.
REM If scanning every 15 minutes, then a purge every hour will be done

if a > 4 then a = 4          REM make sure counter is in range
if a < 0 then a = 4

a = a - 1                    REM decrement the counter
if a == 0 then goto 100 REM if zero then purge
basic1 = 0;                    REM default status flag to No Purge
end

100
purge                        REM start purge
basic1 = 1                    REM set status flag to indicate purging

a = 4
end

```

Chapter 24

Maintenance/Trouble Shooting

24.1 Maintenance

Sustained operation of the XL™ is almost maintenance-free. There are no desiccant or serviceable parts to maintain. As with any precision instrument, the calibration should be checked or verified on a regular basis. Slight modifications to the Stage slope and offset variables can help with the accuracy of the XL™ in the field. This can be accomplished by taking two measurements at each end of the pressure range and doing a two point calculation to generate a slope and offset. The accuracy achieved by this method is a function of how accurate the measurements are recorded, etc. A field-calibrated instrument may not meet the manufacturer's specification for accuracy.

24.2 Trouble Shooting

It is unlikely that this manual will ever contain trouble shooting tips to cover every problem that will be encountered. Feedback from customers is very valuable and greatly aids in the quest for constant product enhancement. Please feel free to call the factory for technical assistance and also with solutions you have found to past problems.

Our experience with pressure transducers has taught us a lot about the problems associated with field installed equipment. The following list of problems and possible solutions will undoubtedly grow with subsequent revisions of this manual and may be helpful to you.

No SDI-12 Response:

- 1- Verify power to the XL™.
- 2- Check all SDI-12 connections, including DATA and GND.
- 3- Check the pin out of your Data Recorder for correct wiring.
- 4- Make sure all sensors have a unique address.

Intermittent Data:

- 1- Check your power and ground connections. Moisture over time will oxidize and corrode connectors and pins.
- 2- Verify your power supply or battery voltage. As the power supply approaches the lower threshold of the XL™ supply range, it may begin to miss readings intermittently.
- 3- Read the status messages, Min, and Max values, and system resets of the XL™ for a possible malfunction or clue to the problem.

Artificially High Data:

- 1- This could be an indication that the orifice in the water is restricted or plugged. Contact the manufacturer of your gas purge system to find out how to purge the orifice. You may want to change your supply gas from dry Nitrogen to Carbon Dioxide (CO₂) for a short period of time. This will create Carbonic Acid at the end of the orifice and will serve as a cleaning agent to remove deposits.
- 2- If you have entered a User Units Slope and/or Offset, either in our data recorder or in the XL™, verify that they are calculated and entered correctly.
- 3- Verify that the orifice line has not moved.

Artificially Low Data:

- 1- This could be an indication of a leak somewhere in your system. Check all of your plumbing connections with a soapy water solution or a commercial leak detection solution such as SNOOP®. Because the XL™ has laboratory quality accuracy, even the smallest leak will show up as an error in your data.
- 2- If you have entered a User Unit Slope and/or Offset, either in your data recorder or in the XL™, verify they are calculated and entered correctly.
- 3- Verify that the orifice line has not moved.

Wrong or Erratic Data:

- 1- Check the sensor status window for possible errors. (See section 3.6)
- 2- Check battery voltage and all connections.

GOES not transmitting:

- 1- Check power to the GOES radio, do so under a load.
- 2- See if the GOES time is correct, if it is stopped, it indicates power to the radio was lost, stopping the clock. The radio will not transmit if the GOES clock is not running.
- 3- Check all antenna wires.
- 4- Check antenna alignment.
- 5- Use a power meter to measure the power output of the radio, and the reflected power.

Appendix A

XL Series Specifications

Sensor I/O Performance

General Analog Input (All Units)

Channels:	4 (Single Ended)
Resolution:	16-Bit Resolution (1 Part in 65536)
Accuracy:	±0.02% FS
Input Ranges:	0 to 5 Volts (All Channels) 0 to 500 mV (Additional Input Range Only Available on Channel 1) Accuracy ± 0.15%
Excitation	5.0V Switched, Ratiometric with 10mA (max load)
Accuracy	± 1.0 mV Over Load and Temperature Range

Frequency Input (All Units)

Input Range:	1 to 10 KHz at ± 75mVolts or greater 1 to 15 KHz at ± 1 Volt or greater
Input Amplitude:	± 5.0 V Max
Accuracy:	± 0.1%
Resolution:	1/10000 * Reading

Counter Input (All Units)

Type:	Switch closure or voltage pulse, Internal 50k pull up resistor, falling edge triggered.
Input Voltage:	0-5 Volts
Minimum Pulse Width:	5 mS
Input Frequency:	100Hz (max)

Digital I/O (All Units)

Channels:	2, Independently configured for input or output
Input Voltage:	0-5 Volt
High Level:	3.5 V (min)
Low Level:	0.8 V (max)
Output Voltage	
Low:	0.4 V (max)@ -5mA
High:	3.5V (min)@+5mA

4-20 mA Output (All Units)

Resolution:	0.25 µA
-------------	---------

Pressure Sensor (H-350XL Only)

Accuracy

(Maximum percent of error in measurement)

Pressure:	Less than or equal to 0.02% of full scale output (FSO) over temperature range referenced to a straight line stretched from zero psi to maximum pressure
Temperature:	Internal temperature ± 1°C over temperature range

Resolution

(Smallest change detectable in output signal)

Pressure:	1 part in 65,536 (0.002%)
Temperature:	1 part in 65,536 (0.002%)

Linearity

Less than 0.02% deviation from a straight line referenced to end points

Pressure Hysteresis

Less than 0.01% of FSO

Long-term Stability

Accuracy drift is less than ± 0.05% of FSO per year

Response Times

Pressure only:	10-second measurement sequence
Pressure & Temp.:	10-second measurement sequence
Temperature only:	5-second measurement sequence

Pressure Range Options

Pressure	Depth	Accuracy
0 to 15 psi	0 to 34.60 feet	± 0.007 feet
0 to 30 psi	0 to 69.20 feet	± 0.014 feet

Custom calibration ranges available from 5 to 100 psi

Pressure Overload: Less than 2 times the rated pressure

Pressure Inlet: 1/8 in. NPT female fitting

Media Non-corrosive dry gases only

Hardware: Pressure inlet plumbing installation kit available (H-350-INS)

Shaft Encoder (H-510XL Only)

Resolution:	200 counts/rev
Max rate:	15 rev/second

Miscellaneous Performance

Data Storage (All Units)

Type: Non-Volatile ATA Compact FLASH Card
Size: 4 Mega Byte Minimum (Expandable)

SDI-12 Interface (All Units)

Mode: Supports Master and Slave modes
Protocol: SDI-12, 7-bit even parity, 1 stop bit
Baud Rate: 1200

RS-232 Interface (All Units)

Number of Ports: 3 RS-232 External Communication Ports
1 RS-232 Internal Port.
Protocol: RS-232, 8-bit, no parity, 1 stop bit
Baud Rate: Programmable
Function: Programable for each external port

Power (All Units)

Input Voltage: 10.0 to 16.0 volts DC
Auto shut-off: Programmable

Power (H-350XL Only)

Input Current: Sleep Mode: 10 mA typical
Active: 70 mA average (display off)
250 mA average (display on)

Power (H-500XL / H-510XL)

Input Current: Sleep Mode: 5 mA Max
Active: 70 mA average (display off)
250 mA average (display on)

Power (H-522 Plus)

Input Current: Sleep Mode: 15 mA Max (GPS Off)
45 mA Max (GPS On)
Active: 70 mA average (display off)
250 mA average (display on)

Power (H-522)

Input Current: Sleep Mode: 15 mA Max (GPS Off)
45 mA Max (GPS On)
Active: 70 mA average

Warranty

The *WATERLOG*[®] XL™ is warranted against defects in materials and workmanship for one year from date of shipment.

Mechanical Data

Physical (H-350XL Only)

Enclosure: Sealed, corrosion resistant fiberglass with clear Lexan[®] window
Size: 7.0 in. wide x 8.5 in. long x 4.3 in. deep
Weight: 4.25 lbs
Mounting: Hardware supplied for wall mounting

Physical (H-500XL / H-522)

Enclosure: Sealed, corrosion resistant fiberglass with clear Lexan[®] window
Size: 7.0 in. wide x 8.5 in. long x 4.3 in. deep
Weight: 4.25 lbs (H-500XL)
7.50 lbs. (H-522)
Mounting: Hardware supplied for wall mounting

Physical (H-510XL / H522 Plus)

Enclosure: Sealed, corrosion resistant fiberglass with clear Lexan[®] window
Size: 8.0 in. wide x 10.0 in. long x 6.0 in. deep
Weight: 14.0 lbs
Mounting: Hardware supplied for wall mounting

Environmental (All Units)

Temperature: Extended Operating Range: -40 to 60°C
Storage: -40 to 80°C
Humidity: 0-95% non-condensing

Options And Accessories

Options

GOES: H-222SE (Signal Engineering Radio)
H-222DA (Microcom Radio)
H-222DASE (Signal Engineering Radio)

Note: The H522/H522+ model has integrated GOES radio.

Accessories

Cables: - Power/SDI-12 cable supplied with base unit
- 9-pin D connector cable required for RS-232 communication available (H-350-RSC)
- 9-pin D Male to Male Gender Changer
- RS-232 Null Modem Adaptor
- Sensor Terminal Block

Note: Specifications subject to change without prior notice due to ongoing commitment to product testing and improvement.