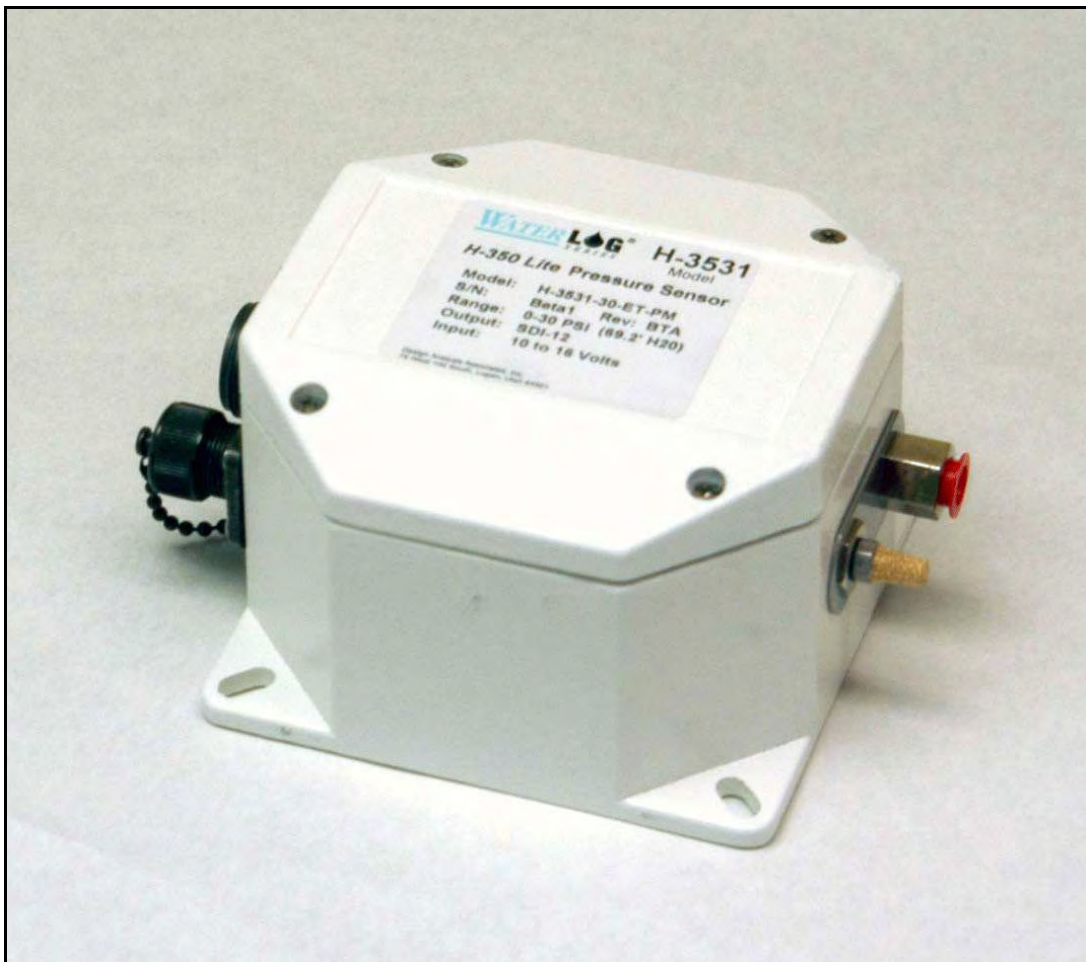


Model
H-3531 FlashLite™



Owner's Manual
Version 1.9



User Agreement/ WATERLOG® Warranty

1. NATURE OF THE PRODUCT

This agreement accompanies a pressure measuring 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.

2. ACKNOWLEDGMENTS BY USER

Opening the package which encloses the accompanying PRODUCT indicates your acceptance of the terms and conditions of this agreement and constitutes an acknowledgment by you of the confidential and proprietary nature of the rights of DESIGN ANALYSIS in the PRODUCT.

3. DUTIES OF YOU, THE USER

In consideration for the access to and use of the PRODUCT extended to you by DESIGN ANALYSIS and to protect the confidential and proprietary information of DESIGN ANALYSIS, USER agrees as follows:

- (a) USER agrees that they will not remove from the exterior of the housing of the PRODUCT any safety warnings or notices of proprietary interest placed thereon by DESIGN ANALYSIS.
- (b) USER agrees that they shall not disassemble or otherwise reverse engineer the PRODUCT.
- (c) USER agrees to treat the PRODUCT with the same degree of care as USER exercises in relation to their own confidential and proprietary information.

4. TERM

USER may enjoy these rights only as long as their possession of the PRODUCT shall continue to be rightful. These rights will cease if the PRODUCT is returned to DESIGN ANALYSIS under the terms of any redemption offer, warranty, or money-back guarantee, or if USER transfers the PRODUCT to another party on terms inconsistent with this agreement.

5. LIMITED WARRANTY

(a) What is Covered

DESIGN ANALYSIS warrants that for a period of twelve months from the time of delivery the functions to be performed by the PRODUCT will be substantially in compliance with USER documentation. DESIGN ANALYSIS also warrants that the PRODUCT will be free from defects in materials and workmanship for a period of ONE YEAR from the date of delivery.

(b) What USER Must Do

If the product fails to satisfy the above warranty, USER must notify DESIGN ANALYSIS in writing within the applicable period specified above and reasonably cooperate with the directions they received from DESIGN ANALYSIS.

(c) What DESIGN ANALYSIS Will Do

DESIGN ANALYSIS will repair the PRODUCT or will endeavor to provide a replacement of same within a reasonable period of time. In the event that DESIGN ANALYSIS is unable to make the necessary repairs or replacement within a reasonable period of time, the original purchase price will be refunded upon the return of the PRODUCT to DESIGN ANALYSIS.

(d) Limitations

- (i) THE ENTIRE REMEDY FOR BREACH OF THIS LIMITED WARRANTY SHALL BE LIMITED TO REPLACEMENT OF THE DEFECTIVE PRODUCT OR REFUNDING OF THE PURCHASE PRICE, AS SET FORTH ABOVE. IN NO EVENT WILL THE LIABILITY OF DESIGN ANALYSIS TO USER OR TO ANY OTHER PARTY EXCEED THE ORIGINAL PURCHASE PRICE OF THE PRODUCT, REGARDLESS OF THE FORM OF THE CLAIM.
- (ii) EXCEPT FOR THE EXPRESS WARRANTIES ABOVE, DESIGN ANALYSIS SPECIFICALLY DISCLAIMS ALL OTHER WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
- (iii) UNDER NO CIRCUMSTANCES WILL DESIGN ANALYSIS BE LIABLE FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT, OR ANY OTHER DAMAGES OR CLAIMS ARISING FROM THE USE OF THIS PRODUCT, THIS INCLUDES LOSS OF PROFITS OR ANY OTHER COMMERCIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. IN NO EVENT WILL DESIGN ANALYSIS BE LIABLE FOR ANY CLAIMS, LIABILITY, OR DAMAGES ARISING FROM MODIFICATION MADE THEREIN, OTHER THAN BY DESIGN ANALYSIS.
- (iv) THIS LIMITED WARRANTY GIVES USER SPECIFIC LEGAL RIGHTS. USER MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS OR THE EXCLUSION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THOSE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY.

6. GOVERNING LAW

This Agreement and its validity and interpretation shall be governed by the laws of the State of Utah, notwithstanding any choice of law rules of Utah or any other state or jurisdiction.

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Chapter 1

Introduction

1.0 Introduction

The **WATERLOG**® H-3531 FlashLite™ is a Highly accurate digital pressure transducer specifically designed for water level monitoring. The H-3531 FlashLite™ directly measures dry gas pressure over a broad temperature range. The typical application of the H-3531 FlashLite™ is to be used with the H-355 Gas Purge System however, the H-3531 FlashLite™ is a easy to setup pressure sensor that can be used in many other applications.

The H-3531 FlashLite™ has SDI-12, RS232, and Modbus “smart” digital interfaces together with Quadrature, 0-5V analog and 4-20mA output options. The H-3531 FlashLite™ makes multiple pressure measurements, averages the results and converts the measurement data into units of PSI, Feet, Meters or other engineering units.

The H-3531 FlashLite™ is easy to use and works with any SDI-12 V1.3 compliant data recorder with the exception of the SDI-12 CRC commands. The “Serial-Digital Interface” is ideal for data logging applications.

The H-3531 FlashLite™ has the following features:

- ! Simple to install, use, and maintain (no on-site calibration required).
- ! Battery operation with minimal drain.(Less than 1 milliamp)
- ! Performs extremely accurate measurements of dry gas.
- ! Linear deviation is less than 0.02%
- ! Up to 250 feet of SDI-12 cable or up to 1000's of feet with the H-423(SDI-12 to RS485 converter).
- ! Resolution is 1 part in 1,000,000
- ! Accuracy over temperature range exceeds ± 0.02 ft. of water.
- ! Enclosure is nonconductive and corrosion proof.
- ! Sensor has an atmospheric vent for compensation of barometric pressure changes.
- ! Extended SDI-12 commands for setting the Stage to the current water elevation.
- ! RS-485 Modbus RTU mode interface.(Industrial mode only)
- ! RS-485 H-355 Gas Purge System control.(Industrial mode only)
- ! Simple RS232 menu interface for quick setup time.(No external module required)
- ! Designed to output a 4-20 mA signal.(Industrial mode only)
- ! Designed to output a 0-5V signal.(No external module required)
- ! Designed to output a Quadrature signal.(No external module required)
- ! Designed to output a RS232 signal.(No external module required)

1.1 Unpacking

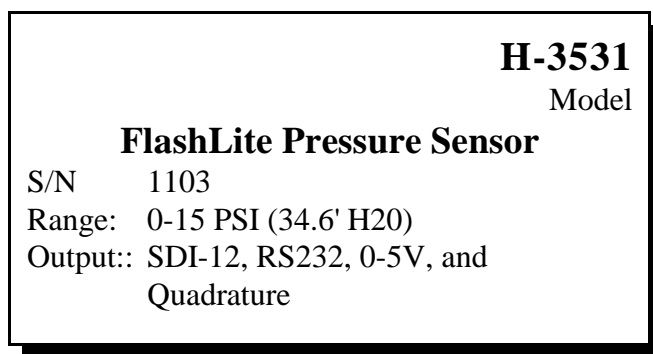
The following is a list of items you should have received:

- ! **WATERLOG**® H-3531 FlashLite™ pressure transducer
- ! Main interface cable
- ! RS232 communication cable.(optional)
- ! Owner's Manual



1.2 Check The Model Number

Before installing your new **WATERLOG**® H-3531 FlashLite™, check the information on the label of the sensor enclosure. Check the model number, the range, and the output type to be sure that you have received the instrument you ordered. The label will look similar to the following:



This example shows that the **WATERLOG**® H-3531 FlashLite™ measures pressure within the range from zero to 15-psi.

1.3 Testing the System

Before installing the H-3531 FlashLite™, you may wish to test the system by connecting it to your data recorder in the shop or lab (See section 2.4 Connecting the Data Recorder). Testing the H-3531 FlashLite™ in the shop or lab and observing the data recorder's readings will familiarize you with the instrument in an environment where it is easy to work and you are near a telephone if questions should arise.

The H-3531 FlashLite™ is shipped from the factory with the SDI-12 address set to zero. You will be able to issue SDI-12 commands using "0" as the address after connecting it to your data recorder. From the "talk" or "transparent" mode of your data recorder or using an optional H-4191 (RS-232 to SDI-12 interface) with a terminal emulator like Hyper Terminal or Procom etc., issue an identify command ("OI!") to verify communication and then a measure command ("OM!") to verify proper measurement operation. When the measurement is complete, the transducer will return a service request which is simply its SDI-12 address. Your support software may not echo the service request to the screen. If not, just wait the allotted amount of time for the measurement to complete (See section 5.1 for interpretation of the SDI-12 response to a measure command). When the measurement has completed, issue a retrieve data command ("OD0!"). This should return your data values.

If you are unable to establish communication with the H-3531 FlashLite™, refer to section 3.3 Trouble Shooting. When you have exhausted all possibilities in the trouble shooting section, feel free to call one of our support personnel at (435) 753-2212 for assistance.

Chapter 2 Installation

2.1 Installing the WATERLOG® H-3531 FlashLite™

The WATERLOG® H-3531 FlashLite™ is a digital pressure transducer specifically designed for water level monitoring. The H-3531 FlashLite™ directly measures dry gas over a broad temperature range. Before proceeding with the installation, please consider several site preparation and maintenance issues:



2.2 Water Depth

The following chart shows the maximum pressure to which the H-3531 FlashLite™ is factory calibrated. The sensor can survive temporary operation up to twice the maximum rated pressure for your model's range. However, any measurements made beyond the rated pressure will be inaccurate. The H-3531 FlashLite™ will be damaged if it is subjected to twice the maximum rated pressure.

Model	Pressure Range	Water Depth Range *	Accuracy
H-3531-15	0 to 15 psi	0 to 34.60 ft.	±0.007 ft
H-3531-30	0 to 30 psi	0 to 69.20 ft.	±0.014 ft.

* NOTE: Depth calculations are derived from the standard equation that one PSI is generated by a column of water 27.680 inches deep at 39.4°F.

2.3 General Installation Recommended Steps

1. Find a suitable location for the H-3531 FlashLite™. Care should be taken to place it where it will not be jarred, crushed or dropped. Remember, the H-3531 FlashLite™ is a precision instrument. If mounted vertically, the sides of the enclosure with connectors should not be facing up. The enclosure of the H-3531 FlashLite™ is designed to be water resistant but not water proof. If the H-3531 FlashLite™ is mounted vertically, the possibility of damage to the circuit boards due to condensation, if moisture does penetrate the enclosure, is greatly reduced.
2. Connect the pressure line between the H-3531 FlashLite™ and the bubbler system. This can be done using the H-350-Install kit, where all the required hardware is provided. If you did not purchase the H-350-Install kit, you will need to procure the parts from your local plumbing supplier. 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-3531 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 called for. The NPT threads of these fittings need a coat of Teflon tape or anaerobic thread dope. This helps in preventing leaks.

We strongly recommend that you use a pressure relief valve on the pressure input. If you purchase one, make sure that the pressure rating matches the pressure range of your H-3531 FlashLite™. The pressure input requires a 1/8" NPT Male fitting. You should be careful not to over-tighten the connector when installing it.

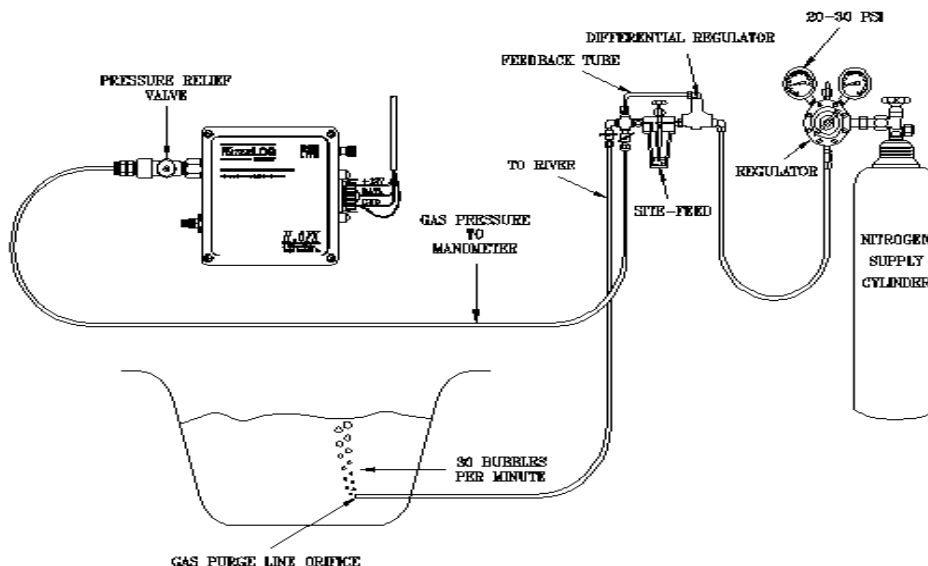


Figure 2-1 Gas-Purge Stream Gauge Installation

Components of the H-350-Install kit:

- 6 feet of 1/8" copper tubing
 - 1/8" Tubing to 1/8" Male NPT fitting
 - 1/8" Tubing to 1/4" NPT female fitting
 - 1/8" Street "T"
 - 1/8" NPT Male Pressure-relief valve (Rated for the pressure range of your H-3531 FlashLite™)
3. Connect the main interface cable to your battery and/or data logger using the appropriate pins shown in the table on the following page. If you are using the SDI-12 interface, also connect the SDI-12 data line to the appropriate terminal on the data recorder(see Section 2.4.1 SDI-12 Interface).
 4. Make the connection to your data recorder as explained in Section 2.4.
 5. Now you are ready to field test your H-3531 FlashLite™.

2.4 Connecting Your Data Logger

The H-3531 FlashLite™ has SDI-12, RS232 and Modbus “smart” digital interfaces together with quadrature, 0-5V analog and 4-20mA output. The H-3531 FlashLite™ is a SDI-12 V1.3 compliant sensor excluding the CRC commands. It connects directly to any data recorder with SDI-12 capability. The instrument housing has a 7 pin main interface connector and a 3 pin RS232 communication connector.



7-pin Circular Connector			3-pin Circular Connector		
Pin	Color	Function	Pin	Color	Function
1	Orange	Phase A/RS485+	1	N/A	RS232(TxD)
2	Brown	Phase B/RS485-	2	N/A	RS232(RxD)
3	Blue	0-5V Out/4-20mA+	3	N/A	GND
4	Green	Analog Gnd/4-20mA-			
5	Black	GND			
6	Red	+12V Power			
7	Yellow	SDI-12 Data			

2.4.1 SDI-12 Interface

The user must connect pins 5,6, and 7 to the data recorder or the user can power the H-3531 FlashLite™ separate of the data recorder and connect just the SDI-12 data line(pin 7).

2.4.2 RS-232 Output

When the user wakes up the H-3531 FlashLite™ with this port while in sleep mode the H-3531 FlashLite™ makes a new measurement and updates the outputs if enabled and then prints out the measured stage and temperature value. If the user sends a carriage return(CR) following the wake up then the H-3531 FlashLite™ simple menu interface is

initiated and the H-3531 FlashLite™ waits for a command from the menu for 3 minutes and then times out.

2.4.3 Quadrature Output

Pins 1 and 2 of the main interface connector are for simulating a quadrature shaft encoder output. The user can enable this option by sending the appropriate SDI-12 command or by using the simple RS232 menu interface as explained in section 4.3.5/5.12. The quad output uses signals Phase A and Phase B and is updated every new measurement. The user can also put the H-3531 FlashLite™ in power mode 3, which is a continuous loop mode that causes the H-3531 FlashLite™ to update the quadrature output at a user defined rate which is the measure rate(see section 5.17).

2.4.4 0-5 Volt Analog Output

Pins 3 and 4 of the main interface connector are for outputting a 0-5V analog signal based on the stage. This is also an option that the user must enable by sending the appropriate SDI-12 command or by using the simple RS232 menu interface as explained in section 4.3.12/5.13. This output is also only updated following a new measurement. The user can put the H-3531 FlashLite™ in power mode 3, which will update the 0-5V output based on the measure rate.

2.5 Industrial Mode

When the user orders the H-3531 FlashLite™ the user must specify industrial mode if 4-20mA output, Modbus/H-355 bubbler control is desired, otherwise the user must send the H-3531 FlashLite™ back to Design Analysis Associates to change to industrial mode.

2.5.1 4-20mA Output(Industrial Mode Only)

Current loop sensors output a current rather than a voltage. The 4-20mA output will drive standard industrial telemetry and process control instrumentation. Since the signal to noise margin of 4-20mA is not large, take care to protect the wiring from noise and interference. The loop power supply must be sufficient to maintain 8.5 to 35V across the H-3531 FlashLite™'s output wires, in addition to whatever voltage is needed to maintain 20mA across the loop receiver and interconnect wiring. The +12.0V SDI-12 power source will work only if the resistance of your loop receiver and wiring is less than 150 ohms.

$$8.5V + (150\text{ohms} * 20\text{mA}) = 11.5V$$

The 4-20mA output is reverse diode protected. The H-3531 FlashLite™ is not loop powered, continuous +12V instrument power must be supplied via the 7pin circular connector.

- ! Make certain there is 8.5 to 35V across the 4-20mA output wires.
- ! Make certain the H-3531 FlashLite™ is receiving +12V power.
- ! Use shielded 4-20mA cables in noisy environments.

2.5.2 RS-485 Interface(Industrial Mode Only)

2.5.2.1 Modbus

Modbus is an industry standard serial digital interface for interconnecting Programmable Logic Controllers (PLCs), intelligent sensors and other devices. The H-3531 FlashLite™ is a Modbus slave and has a serial RS-485 port for connecting to a Modbus compatible host device. See Appendix B for the Modbus register definitions. Continuous +12Volt power must be supplied to the H-3531 FlashLite™.

To activate the Modbus interface, the user must issue an extended SDI-12 command/change the power mode to 4 using the simple RS-232 menu interface(see chapter 4 and 5) and set *Power_Mode=4*. This setting causes the H-3531 FlashLite™ to remain awake and monitor the RS-485 port for Modbus messages. This setting can be made at the factory if requested.

2.5.2.2 H-355 Control

The H-355 Control interface allows the user to program the H-355 Gas Purge System to meet the environment that it is installed in. This is also an option that the user must enable by sending the appropriate SDI-12 command or by using the simple RS232 menu interface as explained in chapter 4 and 5. Once enabled this feature makes setting up the H-3531 FlashLite™ with the H-355 Gas Purge System quick and easy. As shown in Figure 2.1 on page 2-2.

2.6 Wiring and Installation Precautions

- ! The data recorder must be earth grounded.
- ! The H-3531 FlashLite™ requires that the water be at ground potential. Mother Nature takes care of this for surface and ground water.
- ! Make certain the pressure port connection is tight
- ! Make certain the sintered bronze vent port is not painted or covered

2.7 Programming Your SDI-12 Data Recorder

You must prepare your data recorder to receive and record the H-3531 FlashLite™ data. Since data recorders differ widely, refer to your recorder manufacturer's directions. In general, program the data recorder to input four values via the SDI-12 port. Usually only one or two of the parameters are actually recorded. Your data recorder must issue an "aM!" command, then collect the data with a "aD0" command, as explained in chapter 5. The H-3531 FlashLite™ places four parameters in its data buffer:

```
a+AA.AA+BB.BBBB+CC.C+DD.D<cr><lf>
```

Where:

a	=	SDI-12 address 0-9, A-Z
AA.AA	=	Stage (feet, inches, meters etc.)
BB.BBBB	=	Pressure (PSI)
CC.C	=	Temperature (C)
DD.D	=	Input Supply Voltage (Volts)

2.7.1 Programming the SDI-12 Address

If more than one sensor is to be connected to the SDI-12 bus, make certain each sensor has a different sensor address. The H-3531 FlashLite™ comes from the factory with its address set to zero. The address can be edited using the RS-232 menu interface or using the extended SDI-12 command. Refer to chapter 4 and 5.

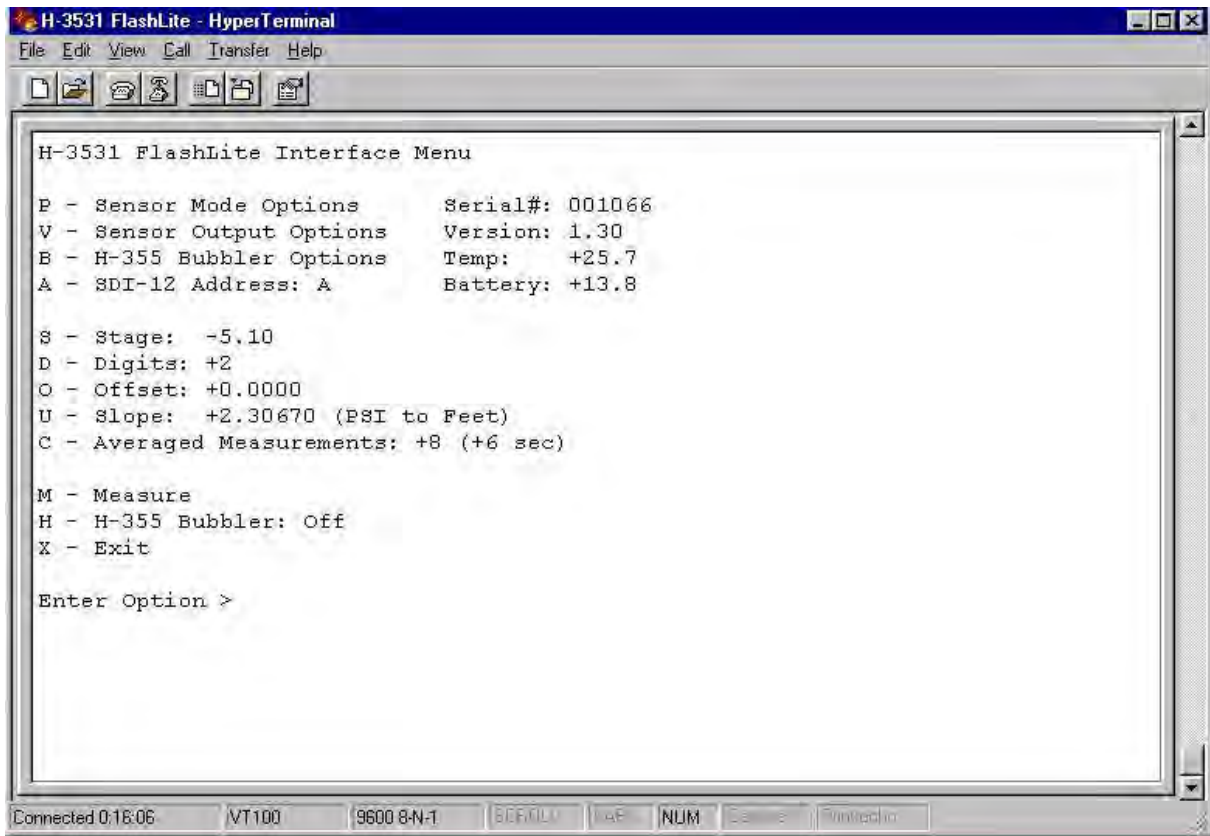
2.8 Programming the H-3531 FlashLite™ Sensor

The H-3531 FlashLite™ comes from the factory with the following programmable settings:

SDI Address:	0
<i>Slope:</i>	2.3067 (feet of H ₂ O)
<i>Offset :</i>	0.00
<i>MeanCount:</i>	8
Power_Mode:	0 = "Sleep"
<i>0-5V_Hi:</i>	34.6 (feet, 0-15psi)
<i>0-5V_Lo:</i>	0.0
<i>4-20mA_Hi:</i>	34.6 (feet, 0-15psi)
<i>4-20mA_Lo:</i>	0.0

With these values the *Stage* will be in units of feet when used in clean water. The slope can be changed to accommodate other engineering units such as inches or meters. The setups are stored in EEPROM within the H-3531 FlashLite™ and will not be lost if the power is disconnected. The extended commands for changing these setups are described in detail in Chapter 5 and most of these settings can be changed using the simple RS232 menu, see Chapter 4.

MeanCount is the number of raw pressure measurements averaged together to make one measurement sequence. This setting determines how long the sensor will take to make a measurement. *MeanCount* can be changed as described in chapter 4 and 5.



```
H-3531 FlashLite - HyperTerminal
File Edit View Call Transfer Help
H-3531 FlashLite Interface Menu
P - Sensor Mode Options      Serial#: 001066
V - Sensor Output Options    Version: 1.30
E - H-355 Bubbler Options    Temp: +25.7
A - SDI-12 Address: A       Battery: +13.8

S - Stage: -5.10
D - Digits: +2
O - Offset: +0.0000
U - Slope: +2.30670 (PSI to Feet)
C - Averaged Measurements: +8 (+6 sec)

M - Measure
H - H-355 Bubbler: Off
X - Exit

Enter Option >
```

2.8.1 Setting the Stage

Many applications use the pressure sensor to measure water level in a gauge or reservoir. The sensor translates water pressure to water level. When the H-3531 FlashLite™ is first installed, you will want to adjust the *Offset* such that the measurement data (*Stage*) corresponds to the current water elevation or stage as determined with a staff gauge or other datum.

One of the ways to do this is by using the RS232 simple menu interface ran from Hyperterminal or similar terminal program. See chapter 4 Connecting to the H-3531 FlashLite™ section. Once you have established connection your screen will look similar

to the above screen image. When the user sets the stage the H-3531 FlashLite™ to make a fresh measurement and automatically updates the *Offset* as needed to produce the desired *Stage*. To set the stage using the RS-232 menu press ‘S’ for “S - Stage:” and enter in the current stage value and then press enter. Then press the ‘M’ key for “M - Measure” and verify that the set stage command did execute. You should see that the offset value has changed. The other way to set the stage is to send the extended SDI-12 “Set Current Stage” command. The “aXSCSdd.d!” command is discussed in more detail in chapter 5.

Example of a H-3531 FlashLite™ Extended "Set Current Stage" command:				
Command	Response	Time	Values	Description
"aXSCS2.3!"	"a0061<cr><lf>"	6sec	1	Set the <i>Stage</i> to 2.3
Subsequent Command	Response			Description
"aD0"	a+12.80<cr><lf>			The new <i>Offset</i>

2.8.2 0-5V Analog Output

The H-3531 FlashLite™ has a 12-bit digital-to-analog converter (DAC) and a precision voltage reference. The *Stage* is scaled into a 12-bit value and loaded into the digital-to-analog converter. The 0-5V analog output is updated whenever a measurement is made. If no measurements are made, the 0-5V analog output becomes “stale”. For industrial applications where the H-3531 FlashLite™ is connected to a SCADA or PLC system instead of a SDI-12 data logger, the H-3531 FlashLite™ can be programmed to automatically make continuous measurements. To program the H-3531 FlashLite™ to make continuous measurements, issue an extended SDI-12 command and set *Power_Mode*=3 or use the RS-232 menu interface. See chapter 4 and 5 for details. This setting can be made at the factory if requested.

Note: When the H-3531 FlashLite™ is first powered up and the 0-5V analog output is enabled, the output voltage is set to 0 volts. It remains at 0 volts until the first measurement sequence.

2.8.2.1 Programming the 0-5V Output Range

The H-3531 FlashLite™ scales the current *Stage* data to drive the 0-5V analog output. The *0-5V_Hi* and *0-5V_Lo* settings control how the *Stage* data is processed. The *0-5V_Lo* should be set to the desired *Stage* corresponding to a 0.00 volt output. The *0-5V_Hi* should be set to the desired *Stage* corresponding to a 5.00 volt output. See chapter 4 and 5 for details on programming these settings.

2.8.3 4-20mA Output(Industrial Mode Only)

The H-3531 FlashLite™ has a 12-bit digital-to-analog converter (DAC), precision voltage reference and a 4-20mA current transmitter. The SDI-12 and 4-20mA sections are isolated from each other with a high voltage digital opto-coupler. The *Stage* is scaled into a 12-bit

value and loaded into the digital-to-analog converter to control the current transmitter. The 4-20mA output is updated whenever a measurement is made. If no measurements are made, the 4-20mA output becomes “stale”. For industrial applications where the H-3531 FlashLite™ is connected to a SCADA or PLC system instead of a SDI-12 data logger, the H-3531 FlashLite™ can be programmed to automatically make continuous measurements. To program the H-3531 FlashLite™ to make continuous measurements, issue an extended SDI-12 command and set or use the RS-232 menu interface. See chapter 4 and 5 for details. This setting can be made at the factory if requested.

Note: When the H-3531 FlashLite™ is first powered up, the output current is set to 4.0mA. It remains at 4.0mA until the first measurement sequence. The digital-to-analog converter is powered from the loop side of the opto-isolator. If the loop power is disconnected or is applied after the SDI-12 side is powered up, the data in the digital-to-analog converter will be lost. When the loop power is restored, the 4-20mA output will be at an unknown value. Once a fresh SDI-12 measurement is made, the digital-to-analog converter is loaded with new valid data.

2.8.3.1 Programming the 4-20mA Output Range

The H-3531 FlashLite™ scales the current *Stage* data to drive the 4-20mA output. The *4-20mA_Hi* and *4-20mA_Lo* settings control how the *Stage* data is processed. The *4-20mA_Lo* should be set to the desired *Stage* corresponding to a 4.00mA output. The *4-20mA_Hi* should be set to the desired *Stage* corresponding to a 20.00mA output. See chapter 4 and 5 for more details.

2.9 Testing

Before installing the H-3531 FlashLite™ in your field location, you may wish to first test the sensor and data logger in your shop or lab. This allows you to become familiar with H-3531 FlashLite™ and the data logger in a controlled environment. The H-3531 FlashLite™ can be tested with a pressure standard or water filled standpipe. However, for this test to work correctly, the standpipe must be connected to the chassis ground of the data recorder. The wire establishes a ground connection between the water and the data logger. Water and other conductive objects isolated by a plastic bucket or table surface pick up AC noise from nearby lighting and power lines. The AC noise is coupled by the water to the stainless diaphragm in the pressure sensor. If a plastic or non-conductive tube is used to connect to the pressure source to the H-3531 FlashLite™, the sensor will be electrically isolated from the water media. The AC noise may affect the pressure measurement due to large voltages between the water media and the sensor (data logger) ground. This precaution is not necessary for field installations because surface water and ground water are not isolated from earth ground.

Chapter 3

Maintenance/Troubleshooting

3.1 Maintenance

Sustained operation of the H-3531 FlashLite™ pressure sensor is almost maintenance free. As with any precision instrument, the calibration should be checked on a regular basis. The instrument has no filters or user serviceable internal parts.

3.2 Precautions

- ! Check for leaks, make certain the connections to the pressure port are tight.
- ! Make certain the atmospheric vent is not covered or blocked.
- ! Make certain the gauge station enclosure is open to the atmosphere. If the sensor is placed in a cabinet or sealed enclosure, the cabinet must have a screened vent or other opening to the atmosphere.

3.3 Troubleshooting

Experience over the years with pressure sensors has identified several common problems:

No SDI-12 response or intermittent data

1. Check all wiring including power and ground connections. Battery connections can become corroded. Check for corrosion in the connectors and terminal strips.
2. The H-3531 FlashLite™ measures and reports it's internal power supply voltage along with *Stage, Pressure and Temperature*. Make a measurement and check to see if the voltage is between 10.0 and 16.0 Volts.
3. Check the connections between your data recorder and the H-3531 FlashLite™ sensor. The power connections are made on the 7-pin circular connector.
4. Verify that there is not another SDI-12 sensor on the SDI-12 bus with the same SDI-12 address as the H-3531 FlashLite™. Try communicating with the H-3531 FlashLite™ without any other SDI-12 devices on the bus. Sending a “*!” or “?!” should cause the H-3531 FlashLite™ to return its own address as long as there are no other SDI-12 devices on the SDI-12 bus.

Please feel free to call the factory for technical assistance and also with solutions you have found to past problems.

Chapter 4

Simple Menu Interface

4.0 Simple Menu Interface

The H-3531 FlashLite™ has a RS-232 interface which is convenient for setup and testing. This chapter is a description of the Simple Menu interface. Included is a description of the menu and each setup option.

4.1 Connecting to the H-3531 FlashLite™

The Simple Menu interface is designed to work with a terminal program such as Hyper-Terminal, Procom or other similar terminal programs. The following table shows the settings that are needed for communication with the H-3531 FlashLite™.

COMMUNICATION SETTING	H-3531 FlashLite™ SETTINGS
BAUD RATE:	9600
DATA BITS:	8
STOP BITS:	1
PARITY:	None
DUPLEX:	Full
TERMINAL EMULATION:	VT-100
FLOW CONTROL:	Software (Xon / Xoff)

After the computer is connected, pressing any key ONCE! (while the H-3531 FlashLite™ is in sleep mode) will cause the H-3531 FlashLite™ to wake up, make a new measurement and print the following message:

```
Stage = +/-X.XX  
Temp = +/-XX.X
```

When the ENTER key is pressed after the H-3531 FlashLite™ is awake it will invoke the H-3531 FlashLite™ Simple Menu. You will see a “Measuring...” message displayed as the H-3531 FlashLite™ makes a fresh measurement. Then the H-3531 FlashLite™ will display the Simple Menu as shown on the following page.

Note: When the P key is pressed after the H-3531 FlashLite™ is awake it will invoke a purge if the H-355 bubbler is enabled and present.

4.2 General Operations

The H-3531 FlashLite™ settings can be made either via the Simple Menu or with extend SDI-12 commands. This chapter focuses on the Simple Menu interface.

The menu displays a list of available options. The right column is status information and cannot be edited. At the bottom of the screen is an "Enter Option >" prompt. Enter the desired menu option here, the ENTER key does not have to be pressed.

Some options, when selected act as a toggle and will change when selected. These options only have two choices such as: On/Off. Options with brackets "[]" allow the user to set or change a value. After entering the requested value within the brackets, press ENTER to make the change. If you do not want to edit the option that has been selected, press the ESC key and the edit will be aborted.

```
H-3531 FlashLite Interface Menu

P - Sensor Mode Options      Serial#: 001000
V - Sensor Output Options    Version: 1.90
B - H-355 Bubbler Options    Temp:    +72.2
A - SDI-12 Address: 0       Battery: +13.8

S - Stage:  +46.13
D - Digits:  +2
O - Offset:  +0.0000
U - Units:   Feet
L - Slope:   +2.30670

C - Averaged Measurements: +8 (+6 sec)

M - Measure
H - H-355 Bubbler: Off
X - Exit

Enter Option >
```

4.3 Menu Options

4.3.1 P - Sensor Mode Options

In this sub-menu you can view the current H-3531 FlashLite™ power mode settings or other modes if available and change the modes if desired. Refer to section 4.4 for the Sensor Mode Options sub-menu options.

4.3.2 V - Sensor Output Options

In this sub-menu you can view the current H-3531 FlashLite™ output options and enables. In this sub-menu you can change these options and enables. Refer to section 4.5 for the Sensor Output Options menu options.

4.3.3 B - H-355 Bubbler Options

In this sub-menu you can view and edit H-355 bubbler settings if the option is enabled and the bubbler is present. If the bubbler option is not enabled you will see the following message after pressing the B key.

```
Enter Option >H-355 Bubbler not enabled.  
Press Any Key...
```

When the bubbler is enabled the screen will refresh and the following message will be displayed.

```
Gathering H-355 Bubbler Data...
```

This message means the H-3531 FlashLite™ is attempting to establish communication with the H-355 Gas Purge System and then it will gather all the available H-355 bubbler data. If the communication and data retrieval was not successful then the main menu will be displayed. If the communication was successful then the user will see the H-355 Bubbler Setup Menu. Refer to section 4.6 for details.

4.3.4 A - SDI-12 Address

This option is for editing the SDI-12 sensor address of the H-3531 FlashLite™. The following prompt appears the bottom of the menu.

```
Enter Option >Enter New SDI-12 Address [ ]
```

Enter the desired SDI-12 sensor address (0-9, a-z, A-Z), the menu will refresh with the new address.

4.3.5 S - Stage

This option is for displaying the last measured stage value and also for setting the current stage. The following prompt at the bottom of the menu.

```
Enter Option >Enter Stage Value[      ]
```

Enter the stage setting you desire and press the ENTER key. The message "Calculating New Offset..." will then be displayed. The H-3531 FlashLite™ makes a new measurement and then calculates the offset needed to obtain the desired stage setting. When the measurement is complete the offset value will have changed. You must make a new measurement "M" to see the results of the new offset.

4.3.6 D - Digits

This option is for displaying the current stage digits to the right of the decimal and also for editing the number of digits to the right of the decimal. After pressing the D key the user will see the following prompt at the bottom of the menu.

```
Enter Option >Stage Digits [      ]
```

Then the user can enter in the desired digits to the right of the decimal and press the ENTER key to input the value. The screen will then refresh with the digits value changed.

4.3.7 O - Offset

This option is for displaying the current stage offset value and also for editing the stage offset value manually. The following prompt appears at the bottom of the menu.

```
Enter Option >Enter Offset Value[      ]
```

Enter the desired stage offset value and press the ENTER key to input the value. The screen will refresh and show the new offset. You must make a new measurement “M” to see the results of the new offset.

4.3.8 U - Units

This option is for displaying the current stage units and also for editing the stage units. The following prompt appears at the bottom of the menu.

```
Enter Option >Stage Units [Feet  ]
```

Using the up and down arrows select the desired units for stage. The available stage units are feet, meters, inches, millimeters, centimeters, psi, and user defined. After selecting the desired units the slope will get set to the required slope to accomplish the desired units.

4.3.9 L - Slope

This option is for displaying the current stage slope and also for editing the stage slope. The following prompt appears at the bottom of the menu.

```
Enter Option >Enter Slope Value[      ]
```

Enter the new stage slope and press the Enter key to input the value. The screen will refresh and show the new slope. You must make a new measurement “M” to see the results of the new stage slope.

4.3.10 C - Averaged Measurements

This option is for displaying the current Averaged Measurements/Meancount value and for editing the value. The option also displays the estimated time that the measurement will take due to the amount of averaging. The following prompt at the bottom of the menu.

```
Enter Option >Averaged Measurements [      ]
```

Enter the new averaged measurements/meancount and press the ENTER key. Refer to Chapter-5 for more details on the meancount value.

4.3.11 M - Measure

Pressing the M key causes the H-3531 FlashLite™ to make a new measurement and refresh the screen with the new measurement data. The user will see the following

message after pressing the M key.

```
Enter Option >Measuring...
```

4.3.12 H - H-355 Bubbler

This is the enable for the H-355 bubbler option. Once enabled the user can use H-3531 FlashLite™ to edit the settings in a H-355 Gas Purge System. After pressing the B key the screen will refresh with the option changed.

4.3.13 X - Exit

Pressing the X key causes the H-3531 FlashLite™ to exit the Simple Menu mode. The user will see the following message after pressing the X key.

```
Enter Option >
```

```
H-3531 FlashLite Off
```

4.4 Sensor Mode Options Menu

This setup menu is for viewing and editing the H-3531 FlashLite™ power modes and other mode enables.

```
Sensor Mode Options Menu

P - Power Mode: 0
F - Fast Mode:  Off
N - NOAA Mode:  Off

D - Reset to Defaults

Enter Option >
```

4.4.1 P - Power Mode

This option is for changing the H-3531 FlashLite™. The following prompt at the bottom of the menu.

```
Enter Option >Power Mode Value(0-4) [ ]
```

Enter in the desired power mode.

Power Modes:

- 0 = Sleep between measurements
- 1 = Sleep with sensor bias On (reserved for factory use)
- 2 = Sleep with sensor bias and reference On (reserved for factory use)
- 3 = Wait mode. Make measurements and update all outputs based on the measure rate
- 4 = Wait mode. Power profile for Modbus

The menu will refresh with the new power mode.

4.4.2 F - Fast Mode

This option is the enable for putting the H-3531 FlashLite™ in a special mode called Fast Mode. Fast Mode causes the H-3531 FlashLite™ to complete measurements in 1 second vs. the normal mode which takes about 6 seconds. This mode is not recommended because the atmospheric pressure and temperature values are only updated every 3 minutes and the H-3531 FlashLite™ does not average as many measurements. When in this mode the Meancount/Averaged measurements value are not used. But if there is an application where the user needs the H-3531 FlashLite™ to measure that fast this mode does work. Therefore, the user may lose some accuracy using this mode because the H-3531 FlashLite™ is calibrated in the normal mode with the atmospheric pressure and temperature measured every measurement. After pressing the F key the screen will refresh with the option changed.

4.4.3 N - NOAA Mode

This options is the enable for putting the H-3531 FlashLite™ in NOAA Mode. NOAA

Mode causes the H-3531 FlashLite™ to complete measurements in less than 1 second. This mode is for NOAA applications where the data collection platform requests a measurement/second for 3minutes and then requests no measurements for 3 minutes. When in this mode the Meancount/Averaged measurements variable is not used. But this is a requirement for NOAA application. After pressing the N key the screen will refresh with the option changed.

4.4.4 R - Measure Rate (Power Mode 3)

This option is a hidden menu option that is **only** available when the H-3531 FlashLite™ is on power mode 3. This option is viewing and editing the current measure rate value. After pressing the R key the user will see the following prompt at the bottom of the menu.

```
Enter Option >Measure Rate(0-255)[    ]min
```

Then the user can enter in the desired measure rate. After entering the desired measure rate press the ENTER key to submit the value and then the screen will refresh with the option changed if the value was valid. If the user does not want to change the measure rate then press the ESC key to abort.

4.4.5 M - Modbus Settings (Power Mode 4)

This option is a hidden menu option that is **only** available when the H-3531 FlashLite™ is on power mode 4 (modbus mode). Pressing the M key will take the user to the “Modbus Settings” menu. The is shown below.

```
Modbus Settings Menu
A - Address:    1
B - Baud Rate: 9600
P - Parity:     Even

Enter Option >
```

4.4.5.1

Modbus Settings Menu

This menu is for viewing and editing the current Modbus settings.

4.4.5.2 A - Address

This option is for displaying or changing the current modbus address. The valid range for the modbus address is 1 - 247. Pressing the A key will show the following prompt at the bottom of the screen.

```
Enter Option >Modbus Address(1-247)[    ]
```

Enter the desired modbus address, the menu will refresh with the new address.

4.4.5.3 B - Baud Rate

This option is for displaying or changing the current baud rate for the RS-485 Modbus communications port. Pressing the B key will show the following message at the bottom of the screen.

```
Enter Option >Modbus Baud Rate [9600]
```

Press the up or down key to change the baud rate selections and then press the ENTER key to accept the selection.

4.4.5.3 P - Parity

This option is for displaying or changing the current parity for the RS-485 Modbus communications port. Pressing the P key will show the following message at the bottom of the screen.

```
Enter Option >Modbus Parity [Even]
```

Press the up or down key to change the parity and then press the ENTER key to accept the selection.

4.4.6 D - Reset to Defaults

This option will reset the H-3531 FlashLite™ back to factory user defaults. The following message will be displayed.

```
Enter Option >Resetting to Defaults...
```

4.5 Sensor Output Setup Menu

```
Sensor Output Setup Menu

0-5v Output Options:
Slope = +.144506
V - 0-5v Output: Off
H - Max Stage: +34.60
L - Min Stage: +0.00

4-20mA Output Options:
Slope = +.462427
M - Max Stage: +34.60
N - Min Stage: +0.00

Quad Output Options:
Q - Quad Output: Off

U - Update Outputs

Enter Option >
```

This setup menu is for viewing or editing the current settings for the 0-5v analog output and 4-20mA output.

4.5.1 0-5v Output Options

4.5.1.1 Slope

This is the current slope that the H-3531 FlashLite™ has calculated based on the max and min stage values.

4.5.1.2 V - 0-5v Output

This option is the enable for the 0-5v analog output. Once the 0-5v output is enabled the H-3531 FlashLite™ will update the 0-5v output based on stage following a new measurement. After pressing the V key the screen will refresh with the option changed.

4.5.1.3 H - Max Stage

This option is the max stage value that the 0-5v output will be scaled up to. After pressing the H key the user will see the following message.

```
Enter 0-5v Max Stage[      ]
```

Then the user can enter in the 0-5v max stage value and press the ENTER key to submit the value. If the user does not want to edit the 0-5v max stage value then press the ESC key to abort. Refer to section 5.14 in SDI-12 commands for more details about editing this value.

4.5.1.4 L - Min Stage

This option is the min stage value that the 0-5v output will be scaled down to. After pressing the L key the user will see the following message.

```
Enter 0-5v Min Stage[      ]
```

Then the user can enter in the 0-5v min stage value and press the ENTER key to submit the value. If the user does not want to edit the 0-5v min stage value then press the ESC key to abort. Refer to section 5.14 in SDI-12 commands for more details about editing this value.

4.5.2 4-20mA Output Options

4.5.2.1 Slope

This is the current slope that the H-3531 FlashLite™ has calculated based on the max and min stage values.

4.5.2.2 M - Max Stage

This option is the max stage value that the 4-20mA output will be scaled up to. After pressing the M key the user will see the following message.

```
Enter 4-20mA Max Stage[      ]
```

Then the user can enter in the 4-20mA max stage value and press the ENTER key to submit the value. If the user does not want to edit the 4-20mA max stage value then press the ESC key to abort. Refer to section 5.15 in the SDI-12 command and Response protocol chapter for more details about editing this value.

4.5.2.3 N - Min Stage

This option is the min stage value that the 4-20mA output will be scaled down to. After pressing the N key the user will see the following message.

```
Enter 4-20mA Min Stage[      ]
```

Then the user can enter in the 4-20mA min stage value and press the ENTER key to submit the value. If the user does not want to edit the 4-20mA min stage value then press the ESC key to abort. Refer to section 5.15 in SDI-12 command and Response protocol chapter for more details about editing this value.

4.5.3 Q - Quad Output

This option is the enable for the Quadrature Shaft Encoder output. Once enabled the H-3531 FlashLite™ will output quad counts based on a change in stage following a measurement. After pressing the Q key the screen will refresh with the option changed.

4.5.4 U - Update Outputs

This option is for forcing the H-3531 FlashLite™ to make a new measurement which causes the enabled outputs to be updated. After pressing the U key the user will see the following message.

```
Enter Option >Measuring...
```

4.6 H-355 Bubbler Setup Menu

The H-355 Bubbler Setup Menu is for viewing or editing the current settings in H-355 Gas Purge System. The following screen is what the user will see upon successful communication with the H-355. In this section we will discuss the different options found on this menu.

```
H-355 Bubbler Setup Menu

Tank Pressure:      +2.44
Line Pressure:     -.09
B - Bubble Rate:   +60
P - Purge Pressure: +40
D - Purge Duration: +50
A - Auto Purge:    Off
T - Purge Threshold: +20

M - Manual Purge
U - Update All Values

Enter Option >
```

4.6.1 Tank Pressure

This is a bubbler status value and cannot be edited by the user. This is the tank pressure value that was measured by the H-355.

4.6.2 Line Pressure

This is a bubbler status value and cannot be edited by the user. This is the line pressure that was measured by the H-355.

4.6.3 B - Bubble Rate

This option is for displaying the current bubble rate and also for editing the bubble rate. After pressing the B key the user will see the following prompt at the bottom of the menu.

```
Enter Bubble Rate(30-120)[  ]
```

Then the user can enter in the new bubble rate and press the Enter key to input the value. After the bubble rate is entered the screen will refresh with the bubble rate changed. If the user does not want to edit the bubble rate then press the ESC key to abort. The user can change the bubble rate from 30 to 120 bubbles/minute.

4.6.4 P - Purge Pressure

This option is for displaying the current purge pressure and also for editing the purge pressure. After pressing the P key the user will see the following prompt at the bottom of the menu.

```
Enter Purge Pressure(15-80)[  ]
```

Then the user can enter in the new purge pressure and press the Enter key to input the value. After the purge pressure is entered the screen will refresh with the purge pressure changed. If the user does not want to edit the purge pressure then press the ESC key to abort. The user can change the purge pressure from 15 to 80 psi.

4.6.5 D - Purge Duration

This option is for displaying the current purge duration and also for editing the purge

duration. After pressing the D key the user will see the following prompt at the bottom of the menu.

```
Enter Purge Duration(10-240)[    ]
```

Then the user can enter in the new purge duration and press the Enter key to input the value. After the purge duration is entered the screen will refresh with the purge duration changed. If the user does not want to edit the purge pressure then press the ESC key to abort. The user can change the purge duration from 10 to 240 seconds.

4.6.6 A - Auto Purge

This option is for enabling/disabling auto purge. When enabled the H-355 Gas Purge System will purge automatically when the line pressure meets or exceeds the purge pressure value. After pressing the A key the screen will refresh with the option changed.

4.5.7 T - Purge Threshold

This option is for displaying the current purge threshold for the auto purge and also for editing the purge threshold. After pressing the T key the user will see the following prompt at the bottom of the menu.

```
Enter Purge Threshold(10-65)[    ]
```

Then the user can enter in the new purge threshold and press the Enter key to input the value. After the purge threshold is entered the screen will refresh with the purge threshold changed. If the user does not want to edit the purge threshold then press the ESC key to abort. The user can change the purge threshold from 10 to 65 psi.

4.6.8 M - Manual Purge

This option is for requesting the H-355 Gas Purge System to purge. After pressing the M key the user will see the following message at the bottom of the menu.

```
Initiating Purge...
```

The screen will refresh once the request has been made successfully and the H-355 Gas Purge System will purge shortly following the refresh.

4.6.9 U - Update All Values

This option is for requesting all new updated values from the H-355 Gas Purge System. After pressing the U key the screen will be cleared and the user will see the following message at the top of the screen.

```
Gathering H-355 Bubbler Data...
```

The screen will refresh with the new values once the request has been made successfully.

Note: If there is a communication error while reading or editing the H-355 Gas Purge System values the user will see the following message.

Communication Error...
Press Any Key...

This message will stay for about 5 seconds and then the H-3531 FlashLite™ will try to establish communication again and if this is unsuccessful the H-3531 FlashLite™ will return to the main menu. If this happens check the cables for the H-355 Gas Purge System for loose connections.

SDI-12 Command and Response Protocol

5.0 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-3531 FlashLite™ sensor. Included is a description of the commands and data format supported by the H-3531 FlashLite™.

Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR MICROPROCESSOR-BASED SENSORS." Version 1.3 July 25, 2004 Prepared by the SDI-12 Support Group, 165 East 500 South River Heights, Utah.(<http://www.sdi-12.org>)

Note: The H-3531 FlashLite™ incorporates V1.3 with the exception of the CRC request.

During normal communication, the data recorder sends an address together with a command to the H-3531 FlashLite™ SDI-12 sensor. The H-3531 FlashLite™ 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 terminators are defined as follows:

- "a" Is the sensor address. The following ASCII Characters are valid addresses: "0-9", "A-Z", "a-z", "*", "?". Sensors will be initially programmed at the factory with the address of "0" for use in single sensor systems. Addresses "1 to 9" and "A to Z" or "a to z" can be used for additional sensors connected to the same SDI-12 bus. Address "*" and "?" are "wild card" addresses which select 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/responses 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.

5.1 Measure Command

The Measure Command causes a new measurement sequence to be executed. 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", "C", or "V" command is executed.

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

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
M	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 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.

Example of a H-3531 "aM!" command:

Command	Response	Time	Values	Description
"aM!"	"a0064<cr><lf>"	6 sec	4	Make measurement
Subsequent Command	Response			
"aD0"	a+AA.AA+BB.BBBB+CC.C+DD.D<cr><lf>			

Where:

AA.AA	= Stage (feet, inches, meters etc.)
BB.BBBB	= Pressure (PSI)
CC.C	= Temperature (C)
DD.D	= Power Supply Voltage (Volts)

Example of a H-3531 "aM1!" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aM1!"	"a0064<cr><lf>"	6 sec	4	Make measurement
<u>Subsequent Command</u>		<u>Response</u>		
"aD0"	a+AA.AAAA+BB.B+CCCCCCC.CC+DDDDDDD.DD<cr><lf>			

Where:

- AA.AAAA = Pressure (PSI)
- BB.B = Temperature (C)
- CCCCCCC.CC = Raw Pressure A/D Counts
- DDDDDDD.DD = Raw Temperature A/D Counts

5.2 Measure H-355 Gas Purge System

This Measure Command causes a new measurement sequence to be executed in the H-355 Gas purge system. The Data values generated are the Tank and Line PSI as well as the difference. Data values 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", "C", or "V" command is executed.

Command	Response	Description
"aM2!"	"atttn<cr><lf>"	Measure H-355 Tank and Line PSI

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
M	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 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.

Example of a H-3531 "aM2!" command:

Command	Response	Time	Values	Description
"aM2!"	"a0053<cr><lf>"	5 sec	3	Make measurement

Subsequent Command	Response
"aD0"	a+AA.A+BB.B+CC.C<cr><lf>

Where:

AA.A	= Tank Pressure (PSI)
BB.B	= Line Pressure (PSI)
CC.C	= Difference between Tank and Line (PSI)

5.3 Concurrent Measurement Command

This is a new command since the release of Version 1.2 SDI-12 Specification. A concurrent measurement is one which occurs while other SDI-12 sensors on the bus are also taking measurements. This command is similar to the "aM!" command, however, the nn field has an extra digit and the sensor does not issue a service request when it has completed the measurement. Communicating with other sensors will NOT abort a concurrent measurement. 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", "C", or "V" command is executed.

Command	Response	Description
"aC!"	"atttnn<cr><lf>"	Initiate measurement

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- C 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 measurement data available in its buffer.
- nn is a two digit integer (00-99) 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.

The data recorder may wake the sensor with a break and collect the data anytime after the specified processing time has elapsed.

Example of a H-3531 "aC!" command:

Command	Response	Time	Values	Description
"aC!"	"a00604<cr><lf>"	6 sec	04	Make measurement
Subsequent Command		Response		
"aD0"	a+AA.AA+BB.BBBB+CC.C+DD.D<cr><lf>			

Where:

- AA.AA = Stage (feet, inches, meters etc.)
- BB.BBBB = Pressure (PSI)
- CC.C = Temperature (C)
- DD.D = Power Supply Voltage (Volts)

5.4 Send Data Command

The Send Data command returns sensor data generated as the result of previous "aM!", "aC!", or "aV!" commands. Values returned will be sent in 33 characters or less. The sensor's data buffer will not be altered by this command.

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

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- D0..D9 are upper-case ASCII characters.
- p Is a polarity sign (+ or -)
- d.d represents numeric digits before and/or after the decimal. A decimal may be used in any position in the value after the polarity sign. If a decimal is not used, it will be assumed to be after the last digit.

For example: +3.29 +23.5 -25.45 +300

If one or more values were specified and a "aD0!" returns no data (<CR><LF> only), it means that the measurement was aborted and a new "M" command must be sent.

Example of a H-3531 "aD0!" command:

<u>Previous Command</u>	<u>Response</u>
"aM!"	"a0064<cr><lf>"
<u>Subsequent Command</u>	<u>Response</u>
"aD0"	a+AA.AA+BB.BBBB+CC.C+DD.D<cr><lf>

Where:

- AA.AA = Stage (feet, inches, meters etc.)
- BB.BBBB = Pressure (PSI)
- CC.C = Temperature (C)
- DD.D = Power Supply Voltage (Volts)

5.5 Continuous Measurements

This is a new command for the Version 1.2 SDI-12 Specification. Sensors that are able to continuously monitor the phenomena to be measured, such as a cable position, do not require a start measurement command. They can be read directly with the R commands (R0!...R9!). The R commands work exactly like the D (D0!...D9!) commands. The only difference is that the R commands do not need to be preceded with an M command.

The H-3531 FlashLite™ **does not** support the aR0! continuous measurement commands because the measurement and math operations require several seconds to complete..

5.6 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 ("0-9", "A-Z", "a-z", "*", "?").

Example of H-3531 "a!" command:

Command	Response	Time	Values	Description
"a!"	"a<cr><lf>"	0 sec	0	Return the address of sensor

5.7 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 "M", "C", or "V" command is executed.

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

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- 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

Example of a "aV!" command:

Command	Response	Time	Values	Description
"aV!"	"a0014<cr><lf>"	1 sec	4	Return fixed data and diagnostic data for testing purposes.
Subsequent Command		Response		
"aD0"	a+123.456+78.9+dddd+y<cr><lf>			
Key	Description	Units		
+123.456	Fixed test data			
+78.9	Fixed test data			
+dddd	ROM checksum value	(0-99999)		
+y	ROM checksum test	0 = Failed, 1 = Passed		

5.8 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.

<u>Command</u>	<u>Response</u>
"aI!"	"aIccccccmmmmmvvxx...xx<cr><lf>"

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- I is an upper-case ASCII character.
- II is the SDI-12 version compatibility level, e.g. version 1.2 is represented as "12".
- cccccc is an 8 character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.
- mmmmm 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.

Example of a "aI!" command:

```
"a13 DAA H3531vvvS#nnnnnnVkkk<cr><lf>"
```

H-3531 FlashLite™ implementation of the optional 13 character field:
S#nnnnnnVkkk (12 bytes total)

Where:

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

5.9 Change Sensor Address Command

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-3531 FlashLite™ will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

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

Where:

- a is the current (old) sensor address ("0-9", "A-Z", "a-z", "*", "?"). 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 is an upper-case ASCII character.
- n is the new sensor address to be programmed ("0-9", "A-Z").

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

Example of a "Change Sensor Address" command:

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

5.10 Extended Set Current Stage Command

The H-3531 FlashLite™ processes the pressure sensor input and computes *Pressure* in PSI units. *Stage* is computed with a $Stage = m * Pressure + b$ equation. During installation it is convenient to quickly set the H-3531 FlashLite™'s *Stage* reading to match the current stage, elevation or pressure of the water as determined by a staff gauge or other datum. This command causes the H-3531 FlashLite™ to make a fresh measurement and automatically update the *Offset* (b) term as needed to produce the desired *Stage*.

Command	Response	Description
"aXSCSddd!"	"a0061<cr><lf>"	Set current <i>Stage</i>

Where: a
XSCS
ddd
is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
are upper case characters.
is the new current stage value.

Example of a H-3531 Extended "Set Current Stage" command:

Command	Response	Time	Values	Description
"aXSCS2.3!"	"a0061<cr><lf>"	6 sec	1	Set the <i>Stage</i> to 2.3
Subsequent Command	Response			Description
"aD0"	a+1.80<cr><lf>			The new <i>Offset</i>

5.11 Extended Read/Write *Offset* and Read/Write *Slope*

The H-3531 FlashLite™ processes the pressure sensor input and computes *Pressure* in PSI units. *Stage* is computed with a $Stage = m * Pressure + b$ equation. The *Slope* (m) and *Offset* (b) terms are programmable, allowing the user to scale the reading into other engineering units. These commands allow the user to read or write (change) the *Slope* and *Offset* terms. The slope is set to 2.3067 and the offset to 0.00 at the factory. With the factory default (2.3067) the *Stage* will be in units of water depth (in feet). The new values are stored in non-volatile EEPROM within the sensor. Once the new *Slope* or *Offset* value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To verify these settings any other time, use the "XRS" or "XRO" commands. This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the new slope or offset.

Command	Response	Description
"aXRS!"	"a0011<cr><lf>"	Read <i>Slope</i>
"aXRO!"	"a0011<cr><lf>"	Read <i>Offset</i>
"aXWSddd!"	"a0061<cr><lf>"	Write <i>Slope</i>
"aXWOddd!"	"a0061<cr><lf>"	Write <i>Offset</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRS are upper case characters.
 XRO are upper case characters.
 XWS are upper case characters.
 XWO are upper case characters.
 ddd is the new slope or offset value (For example: 20.0, 195)

Example of a H-3531 Extended "Read *Slope*" command:

Command	Response	Time	Values	Description
"aXRS!"	"a0011<cr><lf>"	1 sec	1	Read <i>Slope</i>

Command	Response	Description
"aD0!"	"a+1.00<cr><lf>"	<i>Slope</i> is 1.00

Example of a H-3531 Extended "Write *Slope*" command:

Command	Response	Time	Values	Description
"aXWS1.234!"	"a0061<cr><lf>"	6 sec	1	Write <i>Slope</i>

Command	Response	Description
"aD0!"	"a+1.234<cr><lf>"	<i>Slope</i> is 1.234

5.12 Extended Read/Write Stage Digits

This is for reading or writing the stage digits to the right of the decimal point. The stage digits by default is set to 2.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRSD!"	"a0011<cr><lf>"	Read Stage Digits
"aXWSDd!"	"a0021<cr><lf>"	Write Stage Digits

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRSD are upper case characters.
 XWSD are upper case characters.
 d is the new enable value(0-9)

Example of a H-3531 Extended "Read Stage Digits" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRSD!"	"a0011<cr><lf>"	1 sec	1	Read Stage Digits

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+2<cr><lf>"	Stage digits = 2

Example of a H-3531 Extended "Write Stage Digits" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWSD3!"	"a0021<cr><lf>"	2 sec	1	Set Stage digits to 3

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+3<cr><lf>"	Stage digits = 3

5.13 Extended Read/Write Quadrature Output Enable

The H-3531 FlashLite™ scales the current *Stage* data to Quadrature counts and simulates a Quadrature shaft encoder output when *Stage* changes. This extended command is for reading/writing the Quad out enable. When the enable value is set to a '1' then the Quadrature shaft encoder output is enabled and when it is set to a '0' then the Quadrature shaft encoder output is disabled.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRQE!"	"a0011<cr><lf>"	Read Quad enable
"aXWQEd!"	"a0021<cr><lf>"	Write Quad enable

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRQE are upper case characters.
- XWQE are upper case characters.
- d is the new enable value(0/1)

Example of a H-3531 Extended "Read Quad Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRQE!"	"a0011<cr><lf>"	1 sec	1	Read Quad Enable

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+0<cr><lf>"	Quad out disabled

Example of a H-3531 Extended "Write Quad Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWQE1!"	"a0021<cr><lf>"	2 sec	1	Enable Quad out

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+1<cr><lf>"	Quad out enabled

5.14 Extended Read/Write 0-5V Output Enable

The H-3531 FlashLite™ scales the current *Stage* data to drive the 0-5V analog output. This extended command is for reading/writing the 0-5V output enable. When the enable value is set to a '1' then the 0-5V analog output is enabled and when it is set to a '0' then the 0-5V analog output is disabled.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRVE!"	"a0011<cr><lf>"	Read 0-5V enable
"aXWVEd!"	"a0021<cr><lf>"	Write 0-5V enable

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRVE are upper case characters.
- XWVE are upper case characters.
- d is the new enable value(0/1)

Example of a H-3531 Extended "Read 0-5V Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRVE!"	"a0011<cr><lf>"	1 sec	1	Read 0-5V Enable

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+0<cr><lf>"	0-5V out disabled

Example of a H-3531 Extended "Write 0-5V Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWVE1!"	"a0021<cr><lf>"	2 sec	1	Enable 0-5V out

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aD0!"	"a+1<cr><lf>"	0-5V out enabled

5.15 Extended Read/Write 0-5V_{Hi} and Read/Write 0-5V_{Lo}

The H-3531 FlashLite™ scales the current *Stage* data to drive the 0-5V analog output. The 0-5V_{Hi} and 0-5V_{Lo} settings control how the *Stage* data is processed. The 0-5V_{Lo} should be set to the desired *Stage* corresponding to a 0.00V output. The 0-5V_{Hi} should be set to the desired *Stage* corresponding to a 5.00V output. These settings are stored in non-volatile EEPROM within the sensor. Once the new value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "aD0" command. To verify these settings any other time, use the "XR VH" or "XR VL" commands. The H-3531 FlashLite™ comes from the factory with 0-5V_{Hi} = 34.6 feet and 0-5V_{Lo} = 0.00 feet.(0-15 psi sensor range)

Command	Response	Description
"aXR VH!"	"a0011<cr><lf>"	Read 0-5V _{Hi}
"aXR VL!"	"a0011<cr><lf>"	Read 0-5V _{Lo}
"aXWVHddd!"	"a0061<cr><lf>"	Write 0-5V _{Hi}
"aXWVLddd!"	"a0061<cr><lf>"	Write 0-5V _{Lo}

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XR VH are upper case characters.
 XR VL are upper case characters.
 XWVH are upper case characters.
 XWVL are upper case characters.
 ddd is the new value.

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the slope or offset.

Example of a H-3531 Extended "Read 0-5V _{Hi} " command:				
Command	Response	Time	Values	Description
"aXR VH!"	"a0011<cr><lf>"	1 sec	1	Read 0-5V _{Hi}
Command	Response	Description		
"aD0!"	"a+34.60<cr><lf>"	0-5V _{Hi} is 20.00		

Example of a H-3531 Extended "Write 0-5V _{Hi} " command:				
Command	Response	Time	Values	Description
"aXWVH34.6!"	"a0061<cr><lf>"	6 sec	1	Write 0-5V _{Hi} and make new measurement
Command	Response	Description		
"aD0!"	"a+34.6<cr><lf>"	0-5V _{Hi} is 34.6		

5.16 Extended Read/Write 4-20mA_Hi and Read/Write 4-20mA_Lo

The H-3531 FlashLite™ scales the current *Stage* data to drive the 4-20mA output. The 4-20mA_Hi and 4-20mA_Lo settings control how the *Stage* data is processed. The 4-20mA_Lo should be set to the desired *Stage* corresponding to a 4.00mA output. The 4-20mA_Hi should be set to the desired *Stage* corresponding to a 20.00mA output. These settings are stored in non-volatile EEPROM within the sensor. Once the new value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "aD0" command. To verify these settings any other time, use the "XRIH" or "XRIL" commands. The H-3531 FlashLite™ comes from the factory with *the 4-20mA_Hi* = 34.6 feet and *4-20mA_Lo* = 0.0 feet.(0-15 psi sensor range)

Command	Response	Description
"aXRIH!"	"a0011<cr><lf>"	Read 4-20mA_Hi
"aXRIL!"	"a0011<cr><lf>"	Read 4-20mA_Lo
"aXWIHddd!"	"a0061<cr><lf>"	Write 4-20mA_Hi
"aXWILddd!"	"a0061<cr><lf>"	Write 4-20mA_Lo

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRIH are upper case characters.
 XRIL are upper case characters.
 XWIH are upper case characters.
 XWIL are upper case characters.
 ddd is the new value.

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the slope or offset.

Example of a H-3531 Extended "Read 4-20mA_Hi" command:				
Command	Response	Time	Values	Description
"aXRIH!"	"a0011<cr><lf>"	1 sec	1	Read 4-20mA_Hi
Command	Response	Description		
"aD0!"	"a+34.60<cr><lf>"	4-20mA_Hi is 34.60		

Example of a H-3531 Extended "Write 4-20mA_Hi" command:				
Command	Response	Time	Values	Description
"aXWIH34.6!"	"a0061<cr><lf>"	6 sec	1	Write 4-20mA_Hi and make new measurement
Command	Response	Description		
"aD0!"	"a+34.6<cr><lf>"	4-20mA_Hi is 34.6		

5.17 Extended Read *Power_Mode* and Write *Power_Mode*

The Quad, 0-5V output, and 4-20mA output are updated whenever a measurement is made. For industrial applications such as 4-20mA where the H-3531 FlashLite™ is connected to a SCADA or PLC system and low-power is not of concern, the H-3531 FlashLite™ can be programmed to make continuous measurements. This command is used to change the power mode. The H-3531 FlashLite™ comes from the factory with the power mode set to the *Sleep* mode. Once a new value is written, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "aD0" command. To read or verify the value any other time, use the "XRPM" command.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRPM!"	"a0011<cr><lf>"	Read <i>Power_Mode</i>
"aXWPMn!"	"a0011<cr><lf>"	Write <i>Power_Mode</i>

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRPM are upper case characters.
- XWPM are upper case characters.
- n is the new setting (0, 3 or 4):
 - 0 = Sleep between measurements
 - 1 = Sleep with sensor bias On (reserved for factory use)
 - 2 = Sleep with sensor bias and reference On (reserved for factory use)
 - 3 = Make measurements and update all outputs based on measure rate
 - 4 = Power profile for Modbus

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read *Power_Mode*" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRPM!"	"a0011<cr><lf>"	1 sec	1	Read <i>Power_Mode</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+0<cr><lf>"	Mode = Sleep		

Example of a H-3531 Extended "Write *Power_Mode*" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWPM3!"	"a0011<cr><lf>"	1 sec	1	Write <i>Power_Mode</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+3<cr><lf>"	Mode 3 = Continuous mode		

5.18 Extended Read *Measure Rate* and Write *Measure Rate*

When the H-3531 FlashLite™ is put in power mode 3 it makes continuous measurements based on a measure rate. This command is for reading/writing that measure rate value. The measure rate range is 0-255 minutes. When the user sets the measure rate to 0 then the H-3531 FlashLite™ makes continuous measurements as fast as the H-3531 FlashLite™ will measure, which is about 6 seconds by default. The factory default is 1 minute measure rate.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRMR!"	"a0011<cr><lf>"	Read <i>Measure Rate</i>
"aXWMrnnn!"	"a0021<cr><lf>"	Write <i>Measure Rate</i>

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRMR are upper case characters.
- XWMr are upper case characters.
- nnn is the rate in minutes that the sensor will update all outputs.

Example of a H-3531 Extended "Read <i>Measure Rate</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRMR!"	"a0011<cr><lf>"	1 sec	1	Read <i>Measure Rate</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+1<cr><lf>"	Measure Rate = 1 minute		

Example of a H-3531 Extended "Write <i>Measure Rate</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWMr2!"	"a0021<cr><lf>"	2 sec	1	Write <i>Measure Rate</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+2<cr><lf>"	Measure Rate = 2 minutes		

5.19 Extended Read *Mean_Count* and Write *Mean_Count*

The H-3531 FlashLite™ makes multiple raw sensor measurements, discards the high and low values, integrates (averages) the measurement data and computes *Pressure* (PSI). The number of raw sensor measurements made for each SDI-12 measurement sequence is programmable. When measuring turbulent water, tides or other special applications *Mean_Count* can be changed to increase or decrease the number of pressure measurements made during the SDI-12 measurement sequence.

The H-3531 FlashLite™ makes 7.3 pressure measurements per second (137ms/ measurement). The *ttt* field in the SDI-12 sensor response is computed by the H-3531 FlashLite™ and indicates how much time the H-3531 FlashLite™ will require to complete the measurement sequence. The *ttt* field will automatically change if *Mean_Count* is changed.

The H-3531 FlashLite™ comes from the factory with *Mean_Count* set to 8. The factory default *ttt* field is computed internally by the H-3531 FlashLite™ as follows:

Raw Measurements:	+1.1 sec (0.137 sec/measurement X 8 psi measurements)
Discarded Data:	+1.0 sec (Hi and Low values and warmup measurements)
Atmospheric Valve:	+1.5 sec (Pressure settling time)
Atmospheric Offset:	+1.1 sec (0.137 sec/measurement X 8 (4 psi, 4 temp) measurements)
Math Overhead:	+0.3 sec
Round Upwards	+1.0

<i>ttt</i>	6.0 Seconds

The “aXRMC!” and “aXWMC!” extended commands allow the number of raw sensor measurements for each SDI-12 measurement sequence to be monitored or changed.

Once a new *Mean_Count* value is written, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To read or verify the value any other time, use the "XRMC" command.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRMC!"	"a0011<cr><lf>"	Read <i>Mean_Count</i>
"aXWMCn!"	"a0011<cr><lf>"	Write <i>Mean_Count</i>

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRMC are upper case characters.
- XWMC are upper case characters.
- n is the number of raw measurements wanted

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the “aD0” command to collect and view the current value.

Example of a H-3531 Extended "Read Mean_Count" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRMC!"	"a0011<cr><lf>"	1 sec	1	Read <i>Mean_Count</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+8<cr><lf>"			Count = 8

Example of a H-3531 Extended "Write Mean_Count" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWMC4!"	"a0021<cr><lf>"	2 sec	1	Write <i>Mean_Count</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+4<cr><lf>"			Count = 4

5.20 H-355 Bubbler Commands

The H-3531 FlashLite™ can be used to setup the H-355 Gas Purge System. The user can attached the H-355 bubbler to the RS-485 interface of the H-3531 FlashLite™. The H-3531 FlashLite™ must also be in industrial mode to have the RS-485 interface available. This option is decided when the user orders the H-3531 FlashLite™.

5.20.1 H-355 Read/Write *Bubbler Enable* Command

This command is for reading or writing the H-355 bubbler enable. If the H-355 bubbler option is not enabled the user will see the response of "a0000<cr><lf>" when a command is sent to the H-355 Gas Purge System. When this value is set to a "0" then the H-355 bubbler option is disabled and if the value is set to a "1" then the H-355 bubbler option is enabled.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRBE!"	"a0011<cr><lf>"	Read <i>Bubbler enable</i>
"aXWBE!"	"a0011<cr><lf>"	Write <i>Bubbler enable</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRBE are upper case characters.
 XWBE are upper case characters.
 n is bubbler enable value(0 = disabled, 1 = enabled)

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read <i>Bubbler Enable</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRBE!"	"a0011<cr><lf>"	1 sec	1	Read <i>Bubbler Enable</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+0<cr><lf>"			0 = Disabled

Example of a H-3531 Extended "Write <i>Bubbler Enable</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWBE1!"	"a0021<cr><lf>"	2 sec	1	Write <i>Bubbler Enable</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+1<cr><lf>"			1 = Enabled

5.20.2 H-355 Read/Write Bubble Rate Command

This command is for reading the current bubble rate and also for editing the bubble rate. The user can change the bubble rate from 30 to 120 bubbles/minute. Refer to H-355 Gas Purge System manual for more details.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRBR!"	"a0051<cr><lf>"	Read <i>Bubbler rate</i>
"aXWBRddd!"	"a0051<cr><lf>"	Write <i>Bubbler rate</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRBR are upper case characters.
 XWBR are upper case characters.
 ddd is bubbles/minute value.

This command takes 005 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read <i>Bubbler Rate</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRBR!"	"a0051<cr><lf>"	5 sec	1	Read <i>Bubbler Rate</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+60<cr><lf>"	60 bubbles/minute		

Example of a H-3531 Extended "Write <i>Bubbler Rate</i>" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWBR80!"	"a0051<cr><lf>"	5 sec	1	Write <i>Bubbler Rate</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+80<cr><lf>"	80 bubbles/minute		

5.20.3 H-355 Read/Write Purge Pressure Command

This command is for reading the current purge pressure and also for editing the purge pressure. The user can change the purge pressure from 15 to 80psi. Refer to H-355 Gas Purge System manual for more details.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRPP!"	"a0051<cr><lf>"	Read <i>Purge Pressure</i>
"aXWPPdd!"	"a0051<cr><lf>"	Write <i>Purge Pressure</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRPP are upper case characters.
 XWPP are upper case characters.
 dd is the purge pressure value desired(15-80).

This command takes 005 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read Purge Pressure" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRPP!"	"a0051<cr><lf>"	5 sec	1	Read <i>Purge Pressure</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+60<cr><lf>"	60 PSI		

Example of a H-3531 Extended "Write Purge Pressure" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWPP80!"	"a0051<cr><lf>"	5 sec	1	Write <i>Purge Pressure</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+80<cr><lf>"	80 PSI		

5.20.4 H-355 Read/Write Purge Duration Command

This command is for reading the current purge duration and also for editing the purge duration. The user can change the purge duration from 10 to 240 seconds. Refer to H-355 Gas Purge System manual for more details.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRPD!"	"a0051<cr><lf>"	Read <i>Purge Duration</i>
"aXWPDddd!"	"a0051<cr><lf>"	Write <i>Purge Duration</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRPD are upper case characters.
 XWPD are upper case characters.
 ddd is the purge duration value desired(10-240).

This command takes 005 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read Purge Duration" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRPD!"	"a0051<cr><lf>"	5 sec	1	Read <i>Purge Duration</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+30<cr><lf>"	30 seconds		

Example of a H-3531 Extended "Write Purge Duration" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWPD60!"	"a0051<cr><lf>"	5 sec	1	Write <i>Purge Duration</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+60<cr><lf>"	60 seconds		

5.20.5 H-355 Read/Write Auto Purge Enable Command

This command is for reading the current auto purge enable and also for editing the auto purge enable. The user can change the auto purge enable. Refer to H-355 Gas Purge System manual for more details.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRAP!"	"a0051<cr><lf>"	Read <i>Auto Purge Enable</i>
"aXWAPn!"	"a0051<cr><lf>"	Write <i>Auto Purge Enable</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRAP are upper case characters.
 XWAP are upper case characters.
 n is the auto purge enable value(0 = disabled, 1 = enabled).

This command takes 005 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read Auto Purge Enable" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRAP!"	"a0051<cr><lf>"	5 sec	1	Read <i>Auto Purge Enable</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+0<cr><lf>"	0 = Auto Purge Disabled		

Example of a H-3531 Extended "Write Auto Purge Enable" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWAP1!"	"a0051<cr><lf>"	5 sec	1	Write <i>Auto Purge Enable</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+1<cr><lf>"	1 = Auto Purge Enabled		

5.20.6 H-355 Read/Write Purge Threshold Command

This command is for reading the current purge threshold and also for editing the purge threshold. The user can change the purge threshold from 10 to 65 psi. Refer to H-355 Gas Purge System manual for more details.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRPT!"	"a0051<cr><lf>"	Read <i>Purge Threshold</i>
"aXWPTdd!"	"a0051<cr><lf>"	Write <i>Purge Threshold</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
 XRPT are upper case characters.
 XWPT are upper case characters.
 dd is the purge threshold desired(10-65)

This command takes 005 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Read Purge Threshold" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRPT!"	"a0051<cr><lf>"	5 sec	1	Read <i>Purge Threshold</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+15<cr><lf>"			15 PSI Purge Threshold

Example of a H-3531 Extended "Write Purge Threshold" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWPT20!"	"a0051<cr><lf>"	5 sec	1	Write <i>Purge Threshold</i>
<u>Command</u>	<u>Response</u>			<u>Description</u>
"aD0!"	"a+20<cr><lf>"			20 PSI Purge Threshold

5.20.7 H-355 Initiate Purge Command

This command is for initiating the H-355 bubbler to purge. Refer to H-355 Gas Purge System manual for more information on purging.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXP!"	"a0011<cr><lf>"	Initiate <i>Purge</i>

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
XP are upper case characters.

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-3531 Extended "Initiate Purge" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXP!"	"a0011<cr><lf>"	1 sec	1	Initiate <i>Purge</i>
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+0<cr><lf>"	Initiated successfully		

5.21 Extended Read/Write Fast Mode Enable

The H-3531 FlashLite™ can be put into a Fast Mode. In this mode the atmospheric pressure and temperature values are updated about every 3 minutes. When Fast Mode is enabled the H-3531 FlashLite™ measurement response time is 1 second. In Fast Mode the Meancount/Averaged measurements value is not used. When the enable value is set to a '1' then the Fast Mode is enabled and when it is set to a '0' then Fast Mode is disabled.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRFE!"	"a0011<cr><lf>"	Read Fast Mode enable
"aXWFE1!"	"a0061<cr><lf>"	Write Fast Mode enable

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRFE are upper case characters.
- XWFE are upper case characters.
- d is the new enable value(0/1)

When the user enables Fast Mode it takes 6 seconds because it updates the Atmospheric and Temperature values until the next 3 minute update.

Example of a H-3531 Extended "Read Fast Mode Enable" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRFE!"	"a0011<cr><lf>"	1 sec	1	Read Fast Mode Enable
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+0<cr><lf>"	Fast Mode disabled		

Example of a H-3531 Extended "Write Fast Mode Enable" command:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWFE1!"	"a0061<cr><lf>"	6 sec	1	Enable Fast Mode
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+1<cr><lf>"	Fast Mode enabled		

Example of a H-3531 "aM!" command in <i>Fast Mode</i>:				
<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aM!"	"a0014<cr><lf>"	1 sec	4	Measure sensor in Fast Mode
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+AA.AA+BB.BBBB+CC.C+DD.D<cr><lf>"	See Measure command for Data response details		

5.22 Extended Read/Write NOAA Mode Enable

The H-3531 FlashLite™ can be put into a NOAA Mode. This mode is for applications that require NOAA. In NOAA mode the data collection platform requests data from the H-3531 FlashLite™ every second for 3 minutes and then is done for 3 minutes. In this mode the atmospheric pressure and temperature values are updated during the 3 minutes that the data collection platform is not requesting any data. When NOAA Mode is enabled the H-3531 FlashLite™ measurement response time is less than 1 second. Meaning that the Data command can be sent within 1 second after the measure command is issued. When the enable value is set to a '1' then the NOAA Mode is enabled and when it is set to a '0' then NOAA Mode is disabled.

<u>Command</u>	<u>Response</u>	<u>Description</u>
"aXRNE!"	"a0011<cr><lf>"	Read NOAA Mode enable
"aXWNEd!"	"a0061<cr><lf>"	Write NOAA Mode enable

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- XRNE are upper case characters.
- XWNE are upper case characters.
- d is the new enable value(0/1)

When the user enables NOAA Mode it takes 6 seconds because it updates the Atmospheric and Temperature values until the 3 minute no activity gap.

Example of a H-3531 Extended "Read NOAA Mode Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXRNE!"	"a0011<cr><lf>"	1 sec	1	Read NOAA Mode Enable
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+0<cr><lf>"	NOAA Mode disabled		

Example of a H-3531 Extended "Write NOAA Mode Enable" command:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aXWNE1!"	"a0061<cr><lf>"	6 sec	1	Enable NOAA Mode
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+1<cr><lf>"	NOAA Mode enabled		

Example of a H-3531 "aM!" command in NOAA Mode:

<u>Command</u>	<u>Response</u>	<u>Time</u>	<u>Values</u>	<u>Description</u>
"aM!"	"a0011<cr><lf>"	1 sec	1	Measure in NOAA Mode
<u>Command</u>	<u>Response</u>	<u>Description</u>		
"aD0!"	"a+AA.AA<cr><lf>"	Returns Stage		

5.23 Extended “XTEST”

This command is used for installation or production testing and requires the use of a H-4191 Sidekick interface and a PC. This command causes the H-3531 FlashLite™ to transmit unsolicited real-time data for testing purposes. The test mode is used to help troubleshoot the installation by providing a continuous readout of pressure data. This is not compliant with the SDI-12 specification and is not used with data loggers. To activate the test mode, send the command “aXTEST!” from the PC. The H-3531 FlashLite™ will enter the test mode and make continuous measurements. The test mode is exited by sending a break or any new command on the SDI-12 bus. It may take a few tries to exit if the command is sent at the same time data is being sent from the H-3531 FlashLite™. Removing power from the H-3531 FlashLite™ also causes it to exit this mode.

Format:

SensorAdr + Stage + Pressure + Temperature + RawPressure (counts) + RawTemperature (counts)

“XTEST” displays the following data:

```
0: +1.202 +3.222 +23.0 +12345 +67890
0: +1.212 +3.232 +23.0 +12345 +67890
0: +1.222 +3.342 +23.0 +12345 +67890
0: +1.232 +3.352 +23.0 +12345 +67890
0: +1.232 +3.352 +23.0 +12345 +67890
```

5.24 Extended “XDEF”

This command is used to set all the user settings back to factory defaults. This is useful in troubleshooting when nothings seems to be working.

5.25 Extended “XCFG”

This command is used for installation or production testing and requires the use of a H-4191 Sidekick interface and a PC. This command returns the current configuration of the H-3531 FlashLite™.

“XCFG” displays the following data:

```
H-3531 FlashLite Configuration
013      DAAH-3531001S#000000V100
Power Mode = +0
Fast Mode = Off
NOAA Mode = Off
Mean Count = +8.
User Slope = +2.306700
User Offset = +0.000000
Max PSI = +20.0
Quad Output = Off
0-5v Output = Off
0-5v Slope = +.144506
4-20mA Slope = +.462427
```

Appendix A Specifications

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 $\pm 1^\circ\text{C}$ over temperature range

Resolution

(Smallest change detectable in output signal)

Pressure: 1 part in 1,000,000 (0.0001%)

Temperature: 1 part in 1,000,000 (0.0001%)

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 $\pm 0.05\%$ of FSO per year

Standard Pressure Ranges

Pressure	Depth	Accuracy
0 to 15 PSI	0 to 34.6 ft.	± 0.007 ft.
0 to 30 PSI	0 to 69.20 ft	± 0.014 ft.

Custom calibration ranges available from 5 - 100 PSI

Pressure Overload

Less than 2 times the rated pressure

SDI-12 Interface

Baud Rate: 1200

Protocol: SDI-12 V1.3, 7-bit even parity, 1 stop bit

Output Voltage Levels:

Minimum high level:	3.5 volts
Maximum low level:	0.8 volts

Response Time

SDI-12: 6-second measurement sequence (programmable)

RS-485 Interface(Industrial Mode Only)

Protocol: Modbus RTU/H-355 Control

Port: RS-485

Baud Rate: Programmable (default=9600)

RS232 Interface

Protocol: RS232, 8bit, No Parity, 1 stop bit

Baud Rate: 9600

0-5V Analog Output

Resolution: $4\mu\text{V}$ (12-bit DAC)

4-20mA Output(Industrial Mode Only)

Type: 4-20mA, optically isolated

Loop Voltage: 8.0V min, 35V max

Resolution: $4\mu\text{A}$ (12-bit DAC)

Quadrature Output

Output Voltage:

Low: 0.4(Max)@-5mA

High: 2.5(Min)@5mA

Power Requirements

Voltage Input: 10 to 16.0 Volts DC

Supply Current:

Sleep Mode	750 μA max
Active (measuring)	80mA max

Surge Protection: Built in, 1.5 KVA

Environmental

Operating Temperature: -40°C to 60°C

Compensated Range: -40°C to 60°C

Storage Temperature: -40°C to 80°C

Media Compatibility

Non-corrosive dry gases only

Mechanical

Material: Fiberglass

Size: 4.76" x 4.76" x 2.5" high

Rating: NEMA 4 enclosure

Connectors: Sealed Bendix type circular

Pressure Inlet: 1/8" female NPT

Atmospheric Vent: Sintered bronze, #10-32

Connections

7-pin circular: Power, SDI-12, Quad, and 0-5V

3-pin circular: RS232 Communications port

Cables: Main Connector cable with 6-ft pigtail is provided. RS-232 Connector cable optional.

The **WATERLOG**® H-3531 FlashLite™ is warranted against defects in materials and workmanship for one year from date of shipment.

Notes

Specifications subject to change without prior notice due to ongoing commitment to product testing and improvement.

Appendix B

Modbus Protocol

B.1 Modbus Interface

Modbus is an industry standard field bus for interconnecting Programmable Logic Controllers (PLCs), intelligent sensors and other devices. The H-3531 FlashLite™ is a Modbus slave and has a serial RS-485 port for connecting to a Modbus compatible host device. See Chapter 2 for the proper connections. Continuous +12Volt power must be supplied to the H-3531 FlashLite™.

B.2 Modbus RTU Transmission

The H-3531 FlashLite™ supports RTU (Remote Terminal Unit) transmission mode. The host must support RTU mode to communicate with the H-3531 FlashLite™. The RTU framing format for each byte is fixed at 11-bits and is as follows: 1 start bit, 8 data bits, 1 parity bit, and 1 stop bit. The H-3531 FlashLite™ defaults to even parity but the user can change this setting. In RTU transmission mode all request and response bytes are sent as two 4-bit hexadecimal characters. RTU transmission mode also defines certain message frame timing constraints, this will not be discussed in this document but the user can find the RTU mode transmission specifications online at www.modbus.org.

B.3 Modbus Function codes

The H-3531 FlashLite™ supports two Modbus function codes as shown in the table below.

Table 1 - Supported Function Codes

Function Code	Description	# of Registers to R/W
03	Read Holding Registers	33
16	Write Multiple Registers	33

B.4 Holding Registers

There are 33 holding registers in the H-3531 FlashLite™, some are Read/Write registers and some are Read Only registers. The user configurable settings are found in the Holding Registers. Table 2 below shows the contents on the Holding Registers followed by a description of each register.

Table 2 - Holding Registers

Info in Register	Start Address	# of 16-bit Registers	Data Type
ID String	0 / "0000"	16	Char String
Modbus Address	17 / "0011"	1	Short Integer
Stage Units Select	18 / "0012"	1	Short Integer
Reserved	19 / "0013"	1	Short Integer
Modbus Baudrate	20 / "0014"	1	Short Integer
Parity	21 / "0015"	1	Short Integer
User Stage Offset	22 / "0016"	2	32bit Float
User Stage Slope	24 / "0018"	2	32bit Float
Stage	26 / "001A"	2	32bit Float
Pressure	28 / "001C"	2	32bit Float
Temperature	30 / "001E"	2	32bit Float
Battery	32 / "0020"	2	32bit Float

B.4.0 ID String(RO)

The first registers in the Holding Registers are the ID string registers, this is the same ID string that the SDI-12 ID command returns. Refer to SDI-12 ID command to see details of the response. The ID string consists of 16, 16-bit registers. These registers can be read separately but to get the full ID string the user must read all 16-registers at once. These registers are RO (read only) registers. As shown in Table 2 the response to reading the ID string is sent as a ASCII character string. Example, to read the full ID string the host must send the request as follows: "aa0300000010crcc"

H-3531 FlashLite™ Response: "113 DAA H-3531001S#000000V011"

B.4.1 Modbus Address(R/W)

This holding register allows the user to change the Modbus address of the H-3531 FlashLite™. The programmable address range is: 1 - 247. The assigned Modbus address factory default is: '1'. Address "0" is reserved for the broadcast address meaning that all Modbus sensors will respond to address "0".

B.4.2 Stage Units Select(R/W)

This holding register allows the user to change the units of the stage that is reported in the holding registers. Below shows what values to write to the register to change to the desired units.

Stage Units Select Register: = 00 (stage in feet)* *factory default*
= 01 (stage in meters)
= 02 (stage in inches)
= 03 (stage in mm)
= 04 (stage in cm)
= 05 (psi)
= 06 (user defined)

B.4.3 Reserved(R/W)

This holding register is reserved space for future use.

B.4.4 Modbus Baud rate(R/W)

This holding register allows the user to change the baud rate of the Modbus RS-485 port. This register for H-3531 FlashLite™ defaults to 00, which is 9600 baud. When the user changes the baud rate it does not take effect until the power is cycled. The list below shows what values to write to select the desired baud rate.

Modbus Baud rate Select Register: = 00 (9600) * *factory default*
= 01 (4800)
= 02 (2400)
= 03 (1200)

B.4.5 Parity(R/W)

This holding register allows the user to change the parity bit. The list below shows what values to write to select the desired parity.

Modbus Parity Select Register: = 00 (No Parity)
= 01 (Even Parity) * *factory default*
= 02 (Odd Parity)

B.4.6 User Stage Offset(R/W)

This holding register allows the user to enter a user defined stage offset. The factory default is 0. This holding register is a 32-bit holding register, therefore the value sent to write to this register must be in a 64-bit floating point number format.

B.4.7 User Stage Slope(R/W)

This holding register allows the user to enter a user defined stage slope. Writing to this register is only applicable when the Stage Units Select Register is set to 06, which indicates the user defined mode for the units. This holding register is a 32-bit holding register, therefore the value sent to write to this register must be in a 32-bit floating point number format. The factory default slope is 2.3067, which sets stage units to feet.

B.4.8 Stage(RO)

This holding register holds the current measured stage in the desired units.

B.4.9 Pressure(RO)

This holding register holds the current measured pressure before any slope or offset is applied, therefore it holds the raw psi value.

B.5.0 Temperature(RO)

This holding register holds the current measured temperature. This temperature reading is the temperature of the internal pressure sensor and may not accurately reflect air temperature.

B.5.1 Battery Voltage(RO)

This holding register holds the current input voltage.

Example Reading Holding Register Command:

Format: "aabbccccddddeeee"

Where: aa = 1 byte Modbus address
 bb = 1 byte function code
 cccc = 2 byte start address
 dddd = 2 byte quantity of registers
 eeee = 2 byte crc check

example: 010300010001xxxx

Example Writing Multiple Registers Command:

Format: "aabbccccddddeeffffgggg"

Where: aa = 1 byte Modbus address
 bb = 1 byte function code
 cccc = 2 byte start address
 dddd = 2 byte quantity of registers
 ee = byte count
 ffff = 2 byte data value
 gggg = 2 byte crc value

example: 01100001000120001xxxx