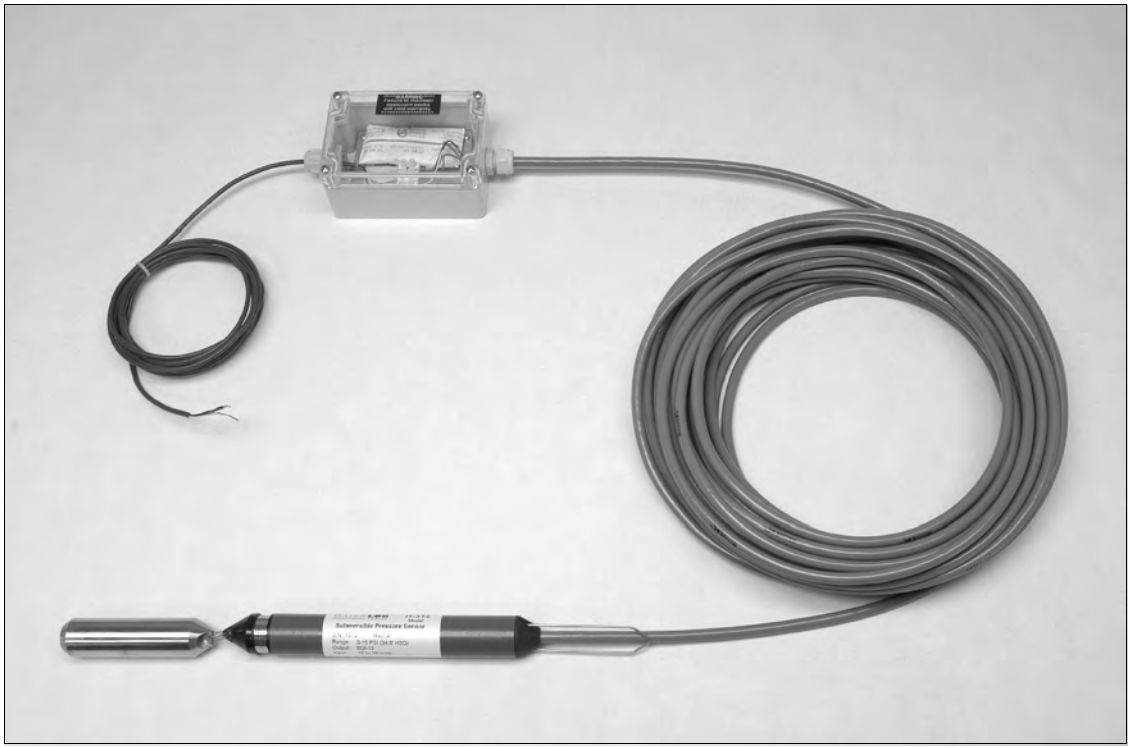
# Model
# H-312 and H-312-22

## Submersible Pressure Sensor
## With SDI-12 Output

WATERLOG® SERIES

## Owner's Manual
Version 1.1



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# User Agreement/ *WATER*LOG® 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.

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(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.

# Chapter 1
# Introduction

## 1.0 Introduction

The ***WATER*LOG®** H-312 is a submersible pressure transducer specifically designed for water level monitoring. The H-312 is easy to use and works with any SDI-12 data recorder. The "Serial-Digital Interface" is ideal for data logging applications with the following requirements.

- Battery powered operation with minimal current drain
- Pressure measurement data is transmitted digitally over long cable lengths without error
- Multiple sensors on a simple three-wire cable
- Up to 250 feet of cable between a sensor and the data recorder
  (Use of H-423, SDI-12 to RS485 converter extends the range to 1000's of feet)

The H-312 has the following features:

- Simple to install, use, and maintain (no on-site calibration required)
- Performs extremely accurate measurements.
- Linear deviation is less than 0.05%
- Resolution is 1 part in 1,000,000
- Accuracy over temperature range exceeds ±0.02 ft. of water
- Enclosure is nonconductive and corrosion proof
- Stainless steel sensor diaphragm
- Sensor cable has internal atmospheric vent for compensation of barometric pressure changes
- Junction box provides access for inspection and maintenance of dry-air desiccant
- Low current operation (less than 150 microamps typical standby)
- Suspension bail provides positive control of the sensor depth independent of temperature and age dependent changes to the sensor cable.
- Extended SDI-12 commands for setting the Stage to the current water elevation.

## 1.1 Unpacking

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

- ***WATER*LOG®** H-312 pressure transducer with polyurethane vented cable and dry air junction box
- Stainless steel ballast
- Spare desiccant packs
- Owner's Manual
- Stainless steel suspension cable and miscellaneous hardware (optional)

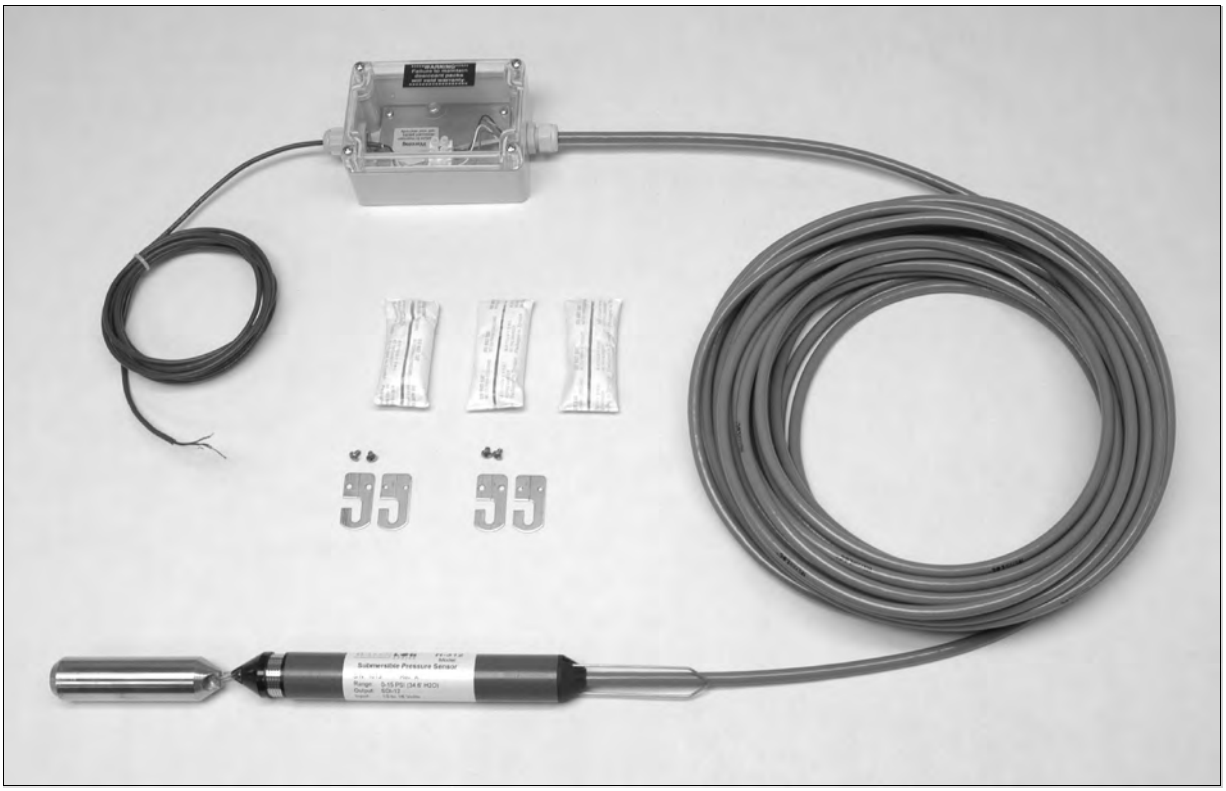

**Figure 3 H-312 Pressure Sensor Components**

### 1.2 Check The Sensor Cable

Be sure that the vented cable is long enough to reach from the submerged location selected to the junction box of the dry air system. Also, be sure that the data logger cable is long enough to reach from the dry air junction box to your data recorder

### 1.3 Check The Model Number

Before installing your new ***WATER*LOG®** H-312, 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:

**H-312**
Model

**Submersible Pressure Sensor**

S/N 1103
Range: 0-15 PSI (34.6' H20)
Output:: SDI-12
Input: 10 to 16.0 Volts

.

This example shows that the ***WATER*LOG®** H-312-15 measures pressure within the range from zero to 15 psi. This model works with a recording device that follows the SDI-12 protocol.

# Chapter 2
# Installation

## 2.1 Installing the *WATER*LOG® H-312

The H-312 submersible pressure sensor is very versatile and can be used in many water monitoring applications.

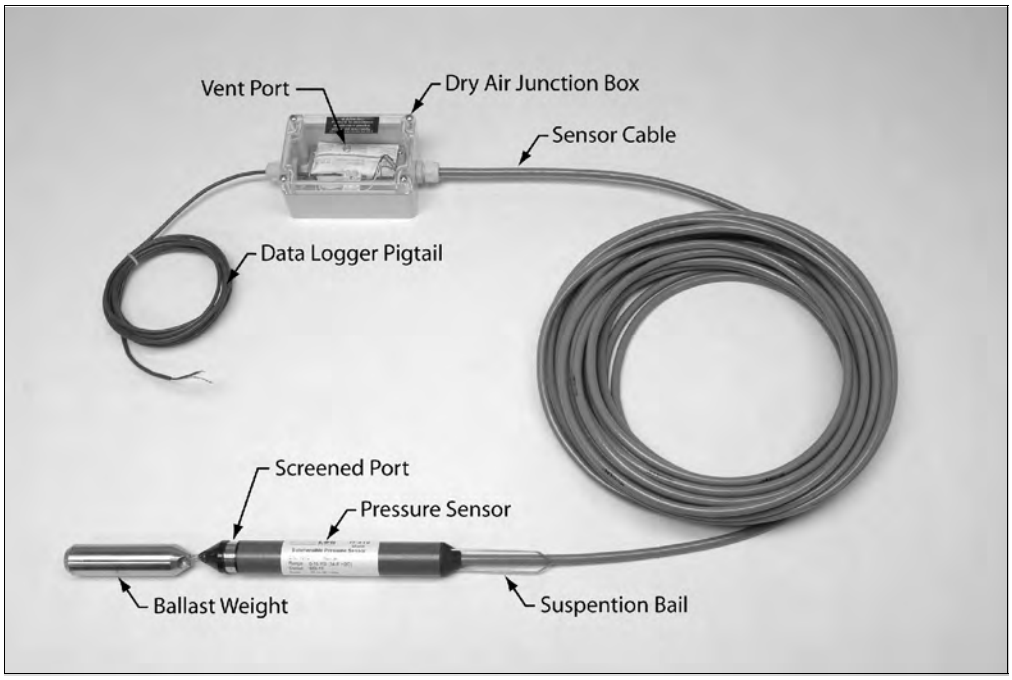


**Figure 4** H-312 System Components

Before proceeding with the installation, please consider several site preparation and maintenance issues:

**2.2 Water Depth**

The following chart shows the maximum depth to which the H-312 is factory calibrated. The sensor can survive temporary operation up to twice the maximum rated depth for you model's range. However, any pressure measurements made beyond the rated depth will be inaccurate. The H-312 will be damaged if it is placed deeper than twice the maximum rated depth.

| Model | Pressure Range | Depth Range * | Accuracy |
|---|---|---|---|
| H-312-15 | 0 to 15 psi | 0 to 34.60 ft. | ±0.017 ft |
| H-312-30 | 0 to 30 psi | 0 to 69.20 ft. | ±0.035 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 Recommendations**

The sensor must be located where there is no velocity flow. Changes in water flow cause pressure changes. Thus, if the sensor is subjected to open flow there is a good chance your water level measurements will be inconsistent. To obtain accurate and reliable data, use stilling wells, sand points, or other "no flow" installation techniques.

The H-312 submersible pressure transducer is not recommended for use in applications where silt and mud are problematic. In addition, if the sensor is used in a shallow water application and happens to dry out with mud coating the sensor diaphragm, the diaphragm compliance will be altered and the factory calibration spoiled.

The H-312 sensor will be permanently damaged if it is frozen. Transducers which are installed in geographical areas with harsh winters should be removed for the winter unless they are installed deep enough in the water that there is no danger of freezing. Ice may form around the sensor cable without causing damage or performance degradation. However, the cable should be protected so as to minimize the possibility of it being damaged as the ice shifts or breaks up during times of thawing.

The polyurethane drop cable is suitable for immersion, direct burial and is somewhat ultraviolet (UV) resistant. Whenever possible, precautions should be taken to protect the cable from direct sunlight, rodents and mechanical damage.

Experience has shown that if a portion of the H-312 housing or the sensor cable is installed above the water and exposed to sunlight (e.g. installed in shallow water), a temperature gradient can occur inside the enclosure and vent tube. As the air temperature changes the air density changes. A change in the air density inside the sensor or vent tube column causes a partial pressure on the reference side of the sensor which will raise or lower the H-312's pressure reading. This is a "law of physics" problem not unique to ***WATER*LOG®** Series transducers. It can be avoided by installing the transducer horizontal so that the entire enclosure is covered by water. Cover or

protect the sensor cable so it remains at the temperature of the surrounding air and is not heated directly by the sun.

**2.4 Stilling Wells**

The H-312 can be hung in well bores, stilling wells and stand-pipes. The H-312 should be installed by suspending the sensor using a small stainless steel cable, not by its polyurethane electrical cable. A weighted ballast or sinker, such as the one that is provided will pull the cable tight at the desired depth and will help the sensor to hang straight down. The stainless cable and the miscellaneous hardware can be purchased from Design Analysis Associates, or from a number of other sources.

The polyurethane cable has internal kevlar strength members however, the plastic cable construction has a large thermal coefficient of expansion. This coupled with the fact that the cable will stretch with applied weight, make the use of the stainless steel drop cable necessary for all precision measurements.

Attach one end of the stainless steel support cable to the support bail on the sensor and fasten the other end to a fixed reference point at the surface. Attach the ballast to the sensor using the stainless steel ring on the bottom nose of the sensor.

When installing the H-312 in wells or stand pipes, make certain the surface of the water in the pipe is open to the atmosphere. Well pipes are often capped with a sanitary well seal or locking cap, make certain the well cap has a suitable hole or screened vent.

## 2.5 Dry Air Junction Box

Because the surface of the water being measured is exposed to atmospheric pressure, submersible pressure sensors must provide correction for changes in barometric air pressure. Several industry designs employ a sealed sensor housing and measure the atmospheric pressure separately. This scheme however, doubles the offset drift because two pressure sensors are needed. To provide the best accuracy possible, the H-312 uses an atmospheric referenced pressure sensor design. The submerged pressure sensor in the H-312 has a vent tube connected to the back side it's pressure diaphragm.. The vent tube passes up the drop cable and is open to the atmosphere at the top. Vent tube designs however, are susceptible to moisture condensation in the tube. As the atmospheric pressure changes small amounts of air flow up and down the vent tube. Convection can also contribute to airflow within the vent tube. If the vent tube is colder than the dew point of the air, moisture will condense in the tube. This condition occurs continually because the submerged portion of the vent tube is maintained at the water temperature. The temperature of both surface and ground water are normally well below the dew point of the surrounding air.

The H-312 dry air junction box provides for terminating the polyurethane sensor cable and houses desiccant for keeping the atmospheric vent tube dry. The enclosure has a transparent lid which allows visual inspection of the desiccant packs. The enclosure has a small screened vent port in the top cover which exposes the sensor vent tube to the atmosphere.

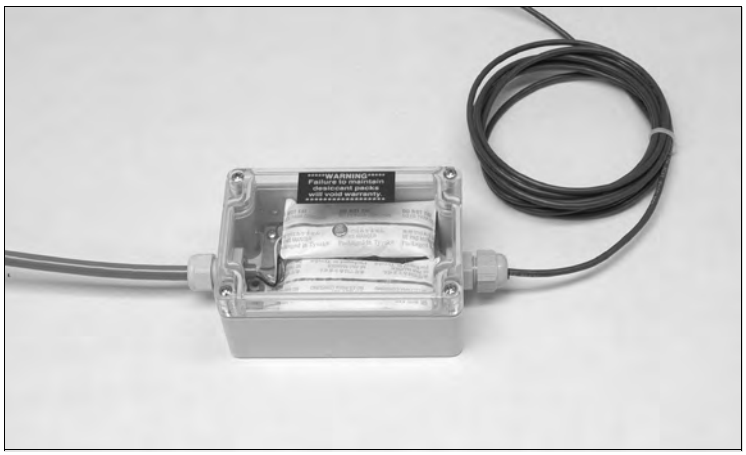


**Figure 6** Dry Air Junction Box

The dry air junction box should be installed in a protected, dry, location such as an instrument shelter. The installation should provide easy access and facilitate regular inspection and maintenance of the desiccant.

## 2.6 Making Connections to the H-312

The H-312 is a SDI-12 V1.2 compliant sensor. It connects directly to any data recorder with SDI-12 capability. The dry air junction box has a 4-conductor pigtail cable for making connections to your data logger. The pigtail cable can be modified or replaced in the field. The table below shows the proper connections to the pigtail. The power for the H-312 is supplied by the SDI-12 +12V input. The connections are also shown on a wiring diagram inside the dry air junction box.

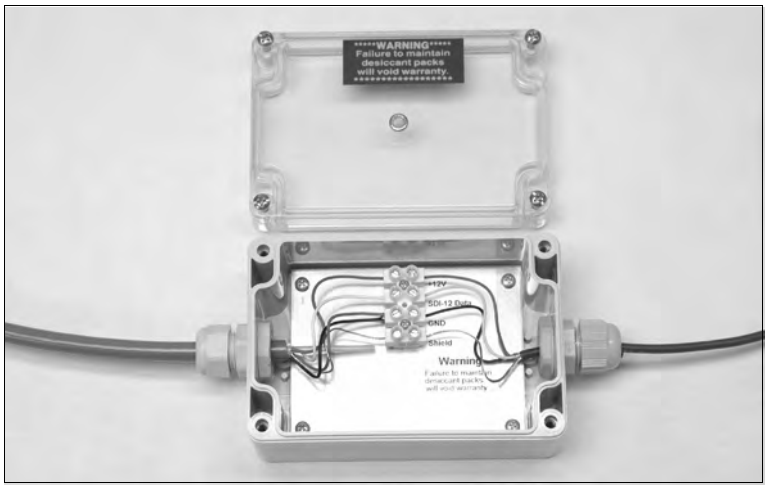


**Figure 7** Dry Air Junction Box Wiring

| **Data Logger Connections** | |
|---|---|
| **Wire** | **Name** |
| Red | +12Volt DC |
| White | SDI-12 Data |
| Black | Ground |
| Shield | Ground |

If the polyurethane cable between the H-312 sensor and the dry air junction box must be routed thru a conduit or small hole, the polyurethane cable can be temporarily disconnected from the dry air junction box as needed. Reconnect the sensor cable as shown below:

| **H-312 Sensor Connections** | |
|---|---|
| **Wire** | **Name** |
| Red | +12Volt DC |
| White | SDI-12 Data |
| Black + Green | GND |
| Shield | Shield |

## 2.7 Wiring and Installation Precautions

- The shield in the hook-up cable must be connected to the data logger ground.
- The data recorder must be earth grounded.
- The H-312 requires that the water be at ground potential. Mother Nature takes care of this for surface and ground water.
- Make certain the seals in the liquid tight cable fittings on the dry air junction box are tight.
- Make certain the dry air junction box lid is screwed on and sealed properly.
- Make certain the screened vent port on the lid of the dry air junction box is not covered or blocked.
- Make certain the end of the vent tube inside the dry air junction box is not plugged or blocked.
- Check the desiccant packs. Replace if necessary

## 2.8 Programming Your Data Recorder

You must prepare your data recorder to receive and record the H-312 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 is actually recorded. Your data recorder must issue an “aM!” command, then collect the data with a “aD0" command, as explained in Chapter 4. The H-312 places four parameters in its data buffer:

a+AA.AAA+BB.BBB+CC.C+DD.D<cr><lf>

Where:

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

## 2.9 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-312 comes from the factory with its address set to "0". The address can be changed with an extended SDI-12 command (see Chapter 4).

## 2.10 Programming the H-312 Sensor

The H-312 comes from the factory with the following settings:

| | |
|---|---|
| SDI Address: | 0 |
| *Slope*: | 2.3067 (feet of $H_20$) |
| *Offset* : | 0.00 |
| *MeanCount*: | 16 |

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-312 and will not be lost if the power is disconnected. The extended commands for changing these setups are described in detail in Chapter 4.

*MeanCount* is the number of raw pressure measurements averaged together to make one SDI-12 measurement sequence. This setting determines how long the sensor will take to make a measurement. *MeanCount* can be changed as described in Chapter 4.

## 2.11 Setting the Stage

Many applications use the pressure sensor in a stilling well. The submerged sensor translates pressure to water level. When the H-312 is first installed, you will want to adjust the *Offset* such that the SDI-12 measurement data (*Stage*) corresponds to the current water elevation or stage as determined with a staff gauge or other datum.

An extended SDI-12 command is convenient to quickly set the H-312's *Stage* reading to match the current water level. The "aXSCSdd.d!" command causes the H-312 to make a fresh measurement and automatically update the *Offset* as needed to produce the desired *Stage*. See Chapter 4 for details.

**Example of a H-312 Extended "Set Current Stage" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXSCS2.3!" | "a0031<cr><lf>" | 3sec | 1 | Set the *Stage* to 2.3 |

| Subsequent Command | Response | Description |
|---|---|---|
| "aD0" | a+12.80<cr><lf> | The new *Offset* |

**2.12 Testing**

Before installing the H-312 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-312 and the data logger in a controlled environment. The H-312 can be tested in a bucket of water. However, for this test to work correctly, you must run a wire from inside the bucket that comes in contact with the water back 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 submerged pressure sensor. Because the H-312 has a non-conductive housing it is electrically isolated from the surrounding water. 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

### 3.1 Maintenance

Sustained operation of the H-312 pressure sensor is almost maintenance-free. Experience has shown that moisture condensing in the atmospheric reference tube creates the largest percentage of field problems. The desiccant in the H-312 junction box dry air system should be changed on a fixed schedule, normally every three to six months. Different areas in the world have widely varying humidity and temperature fluctuations. Pay close attention to the desiccant condition in your particular installation. The desiccant packs contain indicating silica gel and have a transparent window that allows the condition of the desiccant to be observed. The silica gel has a blue color when dry and changes to pink as it absorbs moisture.

### 3.2 Changing the Desiccant

The desiccant in the H-312 junction box dry air system is easy to change.

Step 1 Remove the clear plastic lid.

Step 2 Replace the desiccant packs

Step 4 Reinstall the clear plastic lid.

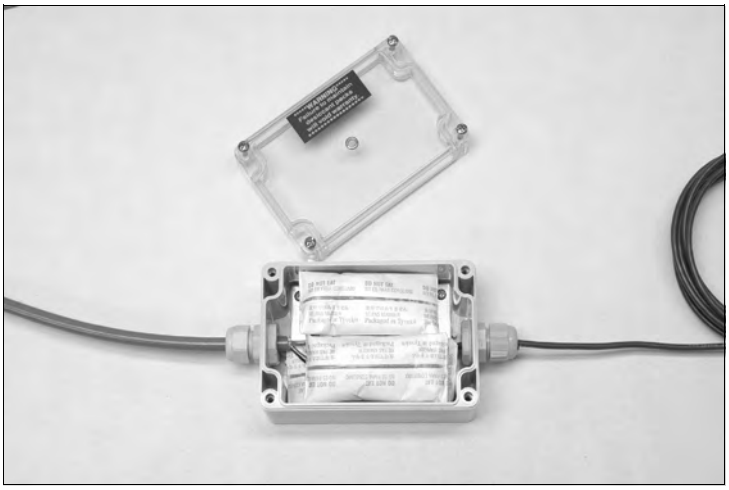

**Figure 8** Dry Air Junction Box

**Precautions**

- Make certain the seals in the liquid tight cable fittings on the dry air junction box are tight.
- Make certain the dry air junction box lid is screwed on and sealed properly.
- Make certain the screened vent port on the lid of the dry air junction box is not covered or blocked.

### 3.3 Maintaining Desiccant Packs

The desiccant bags have a transparent strip which allows the condition of the desiccant to be visually checked. The desiccant has a dark blue color when dry and changes to pink as it absorbs moisture. The desiccant packs can be reused by drying them in an oven at 180°F to 220°F for 4 to 8 hours or until the desiccant returns to a dark blue color.

### 3.4 Cleaning the Port Screen

The H-312 has a port screen to help prevent dirt, sediment and insects from entering the sensor pressure port. The screen is a circular stainless steel band with .025 square holes. A 149 micron polypropylene plastic screen is located underneath the stainless screen.

Occasionally the port screen and the pressure ports may need to be cleaned, rinsed out or replaced . Replacement stainless steel and polypropylene screens are available if needed. The photo below shows the dissembled components at the bottom end of the sensor housing. Do not remove the rubber grommet on the cable end of the sensor housing, the snap-ring or any of the internal components. If the sensor is disassembled the pressure sensor generally must be re-calibrated at the factory. To service the port screen perform the following steps.

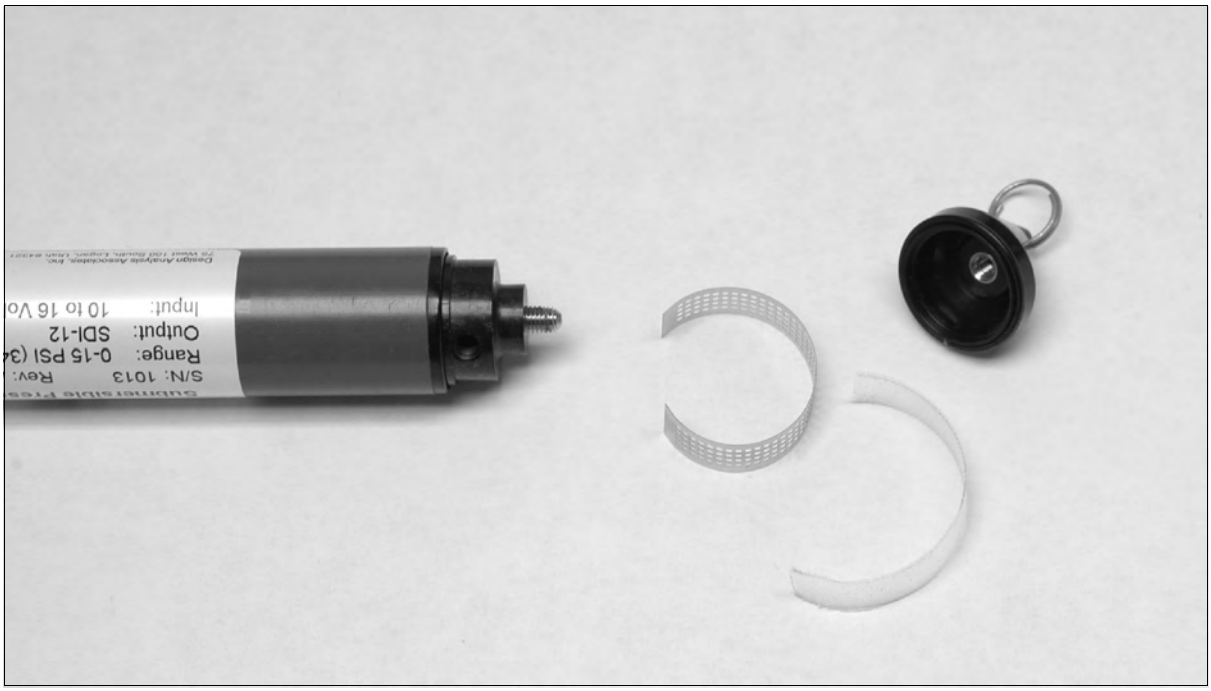

**Figure 9 Cleaning the Port Screen**

Step 1 Unscrew the lower end-piece from the sensor housing (the tapered end cap).

Step 2 Remove the stainless and polypropylene screens.

Step 3 Clean or replace the screens as needed.

Step 4 The internal nose of the H-312 has two threaded pressure ports located 180° apart. These ports are used in the factory to make connections in the calibration oven. Rinse the pressure ports with water to clear mud and silt. You may want to swish the sensor in a bucket of water or in the stream it is monitoring to rinse out the pressure ports.

**CAUTION: Do not use sticks and the like to push sediment out of the ports. This may cause a hydraulic effect and over pressure the internal sensor. <u>Use common sense.</u>**

Step 5 Reinstall the plastic and the stainless steel screens. Position the joints of the stainless and plastic screens 180° apart. One end of the stainless steel screen has a slight bend. Position the bent end on the outside to help keep the sharp end from protruding out. Compress the screen with a turning action and slip both screens into the shallow groove in the sensor housing..

Step 6 Screw the nose piece into place until it contacts the screens. Twist the screens until both screens slip into the grooves of both the sensor housing and the nose piece. Continue to tighten the nose piece while being careful to not crinkle the screens. You may need to twist the screens now and then to keep the screens centered in the grooves. Fully hand tighten the nose piece.

### 3.5 Trouble Shooting

Experience over the years with submersible 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.

2. The H-312 measures and reports it's internal power supply voltage along with *Stage* and *Pressure*. 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-312 sensor.

| Wire | Name |
|---|---|
| Red | +12Volt DC |
| White | SDI-12 Data |
| Black | Ground |
| Shield | Ground |

**Offset Drift**

Check the desiccant packs. If moisture accumulates in or blocks the vent tube, barometric pressure changes will affect the pressure measurement. If this is the case, you should contact Design Analysis for instructions as how to proceed.

# Chapter 4
# SDI-12 Command and Response Protocol

## 4.0 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 ***WATER*LOG**® Series Model H-312 sensor. Included is a description of the commands and data format supported by the H-312.

Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR HYDROLOGIC AND ENVIRONMENTAL SENSORS." Version 1.2 April 12, 1996 Coordinated by the SDI-12 Support Group, 135 East Center, Logan, Utah.

During normal communication, the data recorder sends an address together with a command to the H-312 SDI-12 sensor. The H-312 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.

### 4.1 Measure Command

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

| Command | Response | Description |
|---|---|---|
| "aM!" | "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-312 "aM!" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aM!" | "a0034<cr><lf>" | 3 sec | 4 | Make measurement |

| Subsequent Command | Response |
|---|---|
| "aD0" | a+AA.AAA+BB.BBB+CC.C+DD.D<cr><lf> |

Where:

| | |
|---|---|
| AA.AAA | = Stage (feet, inches, meters etc.) |
| BB.BBB | = Pressure (PSI) |
| CC.C | = Temperature (C) |
| DD.D | = Sensor Supply Voltage (Volts) |

### 4.2 Concurrent Measurement Command

This is a new command for the 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.

### 4.3 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.

| Command | Response |
|---|---|
| "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.<br><br>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-312 "aD0!" command:**

| Previous Command | Response |
|---|---|
| "aM!" | "a0034<cr><lf>" |

| Subsequent Command | Response |
|---|---|
| "aD0" | a+AA.AAA+BB.BBB+CC.C+DD.D<cr><lf> |

Where:

| | |
|---|---|
| AA.AAA | = Stage (feet, inches, meters etc.) |
| BB.BBB | = Pressure (PSI) |
| CC.C | = Temperature (C) |
| DD.D | = Sensor Supply Voltage (Volts) |

### 4.4 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-312 **does not** support the aR0! continuous measurement commands because the measurement and math operations require several seconds to complete..

### 4.5 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", "*", "?").

### 4.6 Initiate Verify Command

The Verify Command causes a verify sequence to be performed. The result of this command is similar to the "aM!" command except that the values generated are fixed test data and the results of diagnostic checksum tests. The data generated in response to this command is placed in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "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!" | "a0013<cr><lf>" | 1 sec | 3 | Return fixed data and diagnostic data for testing purposes. |

| Subsequent Command | Response |
|---|---|
| "aD0" | a+123.456+78.9+y<cr><lf> |

| Key | Description | Units |
|---|---|---|
| +123.456 | Fixed test data | |
| +78.9 | Fixed test data | |
| y | ROM checksum test | 0 = Failed, 1 = Passed |

### 4.7 Send Identification Command

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

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

Where:

| | |
|---|---|
| a | is the sensor address ("0-9", "A-Z", "a-z", "*", "?"). |
| I | is an upper-case ASCII character. |
| ll | is the SDI-12 version compatibility level, e.g. version 1.2 is represented as "12". |
| cccccccc | is an 8 character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation. |
| mmmmmm | is a 6 character field specifying the sensor model number. |
| vvv | is a 3 character field specifying the sensor version number. |
| xx...xx | is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder. |

**Example of a "aI!" command**:

"a12 DAA H-312vvvS#nnnnnnVkkk<cr><lf>"

H-312 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

### 4.8 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-312 will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

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

Where:

a — is the current (old) sensor address ("0-9", "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:**

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

### 4.9 Extended Set_Current_Stage Command

The H-312 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-312's *Stage* reading to match the current stage or elevation of the water as determined by a staff gauge or other datum. This command causes the H-312 to make a fresh measurement and automatically update the *Offset* (b) term as needed to produce the desired *Stage*.

**Example of a H-312 Extended "Set Current Stage" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXSCS2.3!" | "a0031<cr><lf>" | 3 sec | 1 | Set the *Stage* to 2.3 |

| Subsequent Command | Response | Description |
|---|---|---|
| "aD0" | a+12.80<cr><lf> | The new *Offset* |

### 4.10 Extended Read/Write *Stage_Offset* and Read/Write *Stage_Slope*

The H-312 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 *Stage_Slope* and *Stage_Offse*t 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 *Stage_Slope* or *Stage_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 *StageSlope* |
| "aXRO!" | "a0011<cr><lf>" | Read *StageOffse*t |
| "aXWSddd!" | "a0011<cr><lf>" | Write *StageSlope* |
| "aXWOddd!" | "a0011<cr><lf>" | Write *StageOffset* |

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-312 Extended "Read *Stage_Slope*" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXRS!" | "a0011<cr><lf>" | 1 sec | 1 | Read *StageSlope* |

| Command | Response | Description |
|---|---|---|
| "aD0!" | "a+1.00<cr><lf>" | *StageSlope* is 1.00 |

**Example of a H-312 Extended "Write *Stage_Slope*" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXWS1.234!" | "a0011<cr><lf>" | 1 sec | 1 | Write *StageSlope* |

| Command | Response | Description |
|---|---|---|
| "aD0!" | "a+1.234<cr><lf>" | *StageSlope* is 1.234 |

### 4.11 Extended Read *Mean_Count* and Write *Mean_Count*

The H-312 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-312 makes 7-1/2 pressure measurements per second (133ms/ measurement). The ttt field in the SDI-12 sensor response is computed by the H-312 and indicates how much time the H-312 will require to complete the measurement sequence. The ttt field will automatically change if *Mean_Count* is changed.

The H-312 comes from the factory with *Mean_Count* set to 16. The factory default ttt field is computed internally by the H-312 as follows:

| | |
|---|---|
| Raw Measurements: | +2.13 sec (0.133 sec/measurement X 16 measurements) |
| Math Overhead: | +0.3 sec |
| Round Upwards | +1.0 |
| | - - - - - - - |
| ttt | 3.0 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.

| Command | Response | Description |
|---|---|---|
| "aXRMC!" | “a0011<cr><lf>" | Read *Mean_Count* |
| "aXWMCn!" | “a0011<cr><lf>" | Write *Mean_Count* |

| | | |
|---|---|---|
| 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-312 Extended "Read *Mean_Count*" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXRMC!" | "a0011<cr><lf>" | 1 sec | 1 | Read *Mean_Count* |

| Command | Response | Description |
|---|---|---|
| "aD0!" | "a+16<cr><lf>" | Count = 16 |

**Example of a H-312 Extended "Write *Mean_Count*" command:**

| Command | Response | Time | Values | Description |
|---|---|---|---|---|
| "aXWMC8!" | "a0011<cr><lf>" | 1 sec | 1 | Write *Mean_Count* |

| Command | Response | Description |
|---|---|---|
| "aD0!" | "a+8<cr><lf>" | Count = 8 |

### 4.12 Extended "XTEST"

This command is used for installation or production testing and requires the use of a H-419 Sidekick interface and a PC. This command causes the H-312 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-312 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-312. Removing power from the H-312 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
```

etc.

# Appendix A
# H-312 Specifications

**Accuracy**
(Maximum percent of error in measurement)

| | |
|---|---|
| Pressure: | Less than or equal to 0.05% of full scale output (FSO) over temperature range referenced to a straight line stretched from zero PSI to maximum pressure |
| Temperature: | Internal temperature ±1° C over temperature range |

**Resolution**
(Smallest change detectable in output signal)

| | |
|---|---|
| Pressure: | 1 part in 1,000,000 (0.0001%) |
| Temperature: | 1 part in 1,000,000 (0.0001%) |

**Linearity**
Less than 0.05% deviation from a straight line referenced to end points

**Pressure Hysteresis**
Less than 0.02% of FSO

**Long-term Stability**
Accuracy drift is less than ±0.10% of FSO per year

**Standard Ranges**

| Pressure | Depth | Accuracy |
|---|---|---|
| 0 to 15 PSI | 0 to 34.6 ft. | ±0.017 ft. |
| 0 to 30 PSI | 0 to 69.20 ft | ±0.035 ft. |

Custom calibration ranges available from 5 to 75 PSI

**Pressure Overload**
Less than 2 times the rated pressure

**Response Time**
SDI-12: 3-second measurement sequence (programmable)

**SDI-12 Output**
Baud Rate: 1200
Protocol: SDI-12, 7-bit even parity, 1 stop bit
Output Voltage Levels:

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

**Power Requirements**
Voltage Input: 10 to 16.0 Volts DC
Supply Current:

| | |
|---|---|
| Sleep Mode | 150$\mu$A max |
| Active (measuring) | 50mA max |
| Surge Protection: | Built in, 1.5 KVA |

**Environmental**

| | |
|---|---|
| Operating Temperature: | 0° C to 40° C (non freezing) |
| Compensated Range: | 0° C to 40° C |
| Storage Temperature: | -10° C to 75° C |

**Media Compatibility**
Liquids and gases compatible with PVC, ABS, RTV and stainless steel. Polyurethane cable is not compatible with water having high concentrations of chlorine.

**Mechanical**

| | |
|---|---|
| Material: | Corrosion proof, PVC and ABS plastic |
| Size | 1.05 in. max diameter x 8.5 in. long |
| Pressure Port | Stainless steel screen with 149 micron filter (field replaceable) |
| Ballast: | Stainless steel, 0.81 LB (0.36 KG) |

**Sensor Cable** (Sensor to junction box):

| | |
|---|---|
| Type: | 4-conductor, 22awg, foil shield, internal polyethylene vent, kevlar strength members, water-block tape |
| Material: | Polyurethane jacket |
| Diameter: | 0.310" typ, .0.320" max |

**Dry Air System**
Prevents moisture from condensing in the submersible pressure transducer, provides compensation for changes in atmospheric pressure without impairing the sensor's accuracy. Periodic maintenance is required.

| | |
|---|---|
| Enclosure: | Polycarbonate box with transparent lid |
| Desiccant: | Indicating silica gel (field replaceable) |

**Warranty**
The ***WATER*LOG®** H-312 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. Design Analysis Associates, Inc. does not recommend the use of submersible pressure transducers in surface water monitoring applications where silt or mud are problematic.

# Appendix A
# H-312-22 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 ±1° 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 ±0.05% of FSO per year

**Standard Ranges**

| Pressure | Depth | Accuracy |
|---|---|---|
| 0 to 22 PSI | 0 to 50.75 ft. | ±0.01 ft. |

**Pressure Overload**
Less than 2 times the rated pressure

**Response Time**
SDI-12: 3-second measurement sequence (programmable)

**SDI-12 Output**
Baud Rate: 1200
Protocol: SDI-12, 7-bit even parity, 1 stop bit
Output Voltage Levels:
Minimum high level: 3.5 volts
Maximum low level: 0.8 volts

**Power Requirements**
Voltage Input: 10 to 16.0 Volts DC
Supply Current:
Sleep Mode 150$\mu$A max
Active (measuring) 50mA max
Surge Protection: Built in, 1.5 KVA

**Environmental**
Operating Temperature: 0° C to 40° C (non freezing)
Compensated Range: 0° C to 40° C
Storage Temperature: -10° C to 75° C

**Media Compatibility**
Liquids and gases compatible with PVC, ABS, RTV and stainless steel. Polyurethane cable is not compatible with water having high concentrations of chlorine.

**Mechanical**
Material: Corrosion proof, PVC and ABS plastic
Size 1.05 in. max diameter x 8.5 in. long
Pressure Port Stainless steel screen with 149 micron filter (field replaceable)
Ballast: Stainless steel, 0.81 LB (0.36 KG)

**Sensor Cable** (Sensor to junction box):
Type: 4-conductor, 22awg, foil shield, internal polyethylene vent, kevlar strength members, water-block tape
Material: Polyurethane jacket
Diameter: 0.310" typ, .0.320" max

**Dry Air System**
Prevents moisture from condensing in the submersible pressure transducer, provides compensation for changes in atmospheric pressure without impairing the sensor's accuracy. Periodic maintenance is required.
Enclosure: Polycarbonate box with transparent lid
Desiccant: Indicating silica gel (field replaceable)

**Warranty**
The ***WATER*LOG®** H-312-22 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.

Design Analysis Associates, Inc. does not recommend the use of submersible pressure transducers in surface water monitoring applications where silt or mud are problematic.