USER'S GUIDE

MODEL 5000 SERIES

AQUATRAK®

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Aquatrak Corporation

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USER'S GUIDE APPLICABILITY
This User's Guide covers the Aquatrak Level Measuring System 5000 Series. Within the 5000 Series there are two Models, the difference being the external connectors (see figures 1-1 and 1-2). Otherwise they are physically and functionally the same.
Model 5000 is equipped with waterproof connectors; Model 5001 is equipped with watertight connectors.
The model 5000 series firmware version is 5.XX. Version 5.XX incorporates all of the SDI-12 version 1.3 requirements including Cyclic Redundancy Check (CRC), Concurrent Measurements, and Parity Check on incoming commands.

Warranty
Aquatrak Corporation warrants its products to be free of defects in workmanship and material for a period of 12 months from date of shipment. During the warranty period, Aquatrak will repair or replace defective products at its own expense, subject to the following conditions:

1. The buyer must prepay all shipping, insurance, and associated costs to return the defective item to Aquatrak. Aquatrak pays return shipping and insurance.

2. The product must not have experienced misuse, neglect, and accidental damage or have been altered or repaired by the buyer during the warranty period.

3. This warranty and Aquatrak's obligation are in lieu of all other warranties.

4. Aquatrak is not liable for consequential or incidental damages, labor performed in conjunction with removal and replacement, loss of production, or any other loss incurred because of interruption of service or production of incorrect or incomplete data.

CAUTIONARY NOTES

Note:

Used to call attention to a special feature or procedure, which must be followed for correct operation of the equipment.

Caution:
Used to call attention to a concern where damage to the equipment or injury to personnel may occur unless certain steps are followed.

TYPICAL PARTS & MATERIALS REQUIRED

	Section	✓
Aquatrak Installation Kit	2.1, 2.2, 2.3	____
Protective Well	2.1, 2.3	____
Spacer Blocks for Well	2.1, 2.3	____
CPVC Primer	2.2	____
CPVC Cement	2.2	____
Hacksaw, Fine Tooth	2.2	____
Trimming Knife	2.2	____
Fine Grit Sandpaper	2.2	____
S.S. Hose Clamp, 4 inch	2.3	____
Silicone Grease	2.4	____

METRIC /ENGLISH CONVERSION FACTORS

25.4 mm	=	1 inch	1 mm	=	0.0394 in
0.3048 meter	=	1 foot	1 meter	=	3.2808 ft.
0.454 kg	=	1 pound	1 kilogram	=	2.2 lb.

$$^{o}F = \frac{9(^{o}C)}{5} + 32 \qquad ^{o}C = \frac{5(^{o}F - 32)}{9}$$

1. INTRODUCTION TO THE AQUATRAK LIQUID LEVEL MEASURING SYSTEM

1.1 Improved Ability for Measuring Absolute Liquid Level

> Aquatrak is superior to traditional liquid level sensors and provides unsurpassed reliability and proven performance. Using a patented acoustic ratiometric technique, the Model 5000 Series can be used to measure water level in rivers, lakes, and groundwater, tidal and sea level changes, wave height and sea state and industrial tank ullage.

The AQUATRAK sensor provides accurate measurement of absolute liquid level in all weather conditions. Designed for rugged, unattended operation, the sensor has been field proven for over twenty years in adverse environments around the world for hydrology, oceanography, and hostile environment chemical and nuclear tank control systems.

Acoustic Ratiometric Measurement Benefits

The AQUATRAK sensor is "non-contacting" and is therefore not affected by many of the factors, that cause significant errors and maintenance problems with traditional stilling wells using float or pressure transducers. Traditional gauging stations can all be replaced with the AQUATRAK. The technology is immune to atmospheric effects such as temperature, humidity, and atmospheric pressure changes. Some of the many advantages include:

- ✓ Easy Installation
- ✓ mm Resolution
- ✓ Low Maintenance
- ✓ No Moving Parts
- ✓ Wide Dynamic Range
- ✓ Long Term Stability w/o Calibration
- ✓ Sea State Measurement
- ✓ Interface to RS-232 and SDI-12

Reliability

The AQUATRAK provides reliability unmatched by conventional technologies. Because there are no moving parts such as gears, bearings, or floats to wear out, the reliability is a function of the carefully selected electronic components. Reliability is further enhanced because all electronic components are out of the liquid - in fact, there is no conductive path to the liquid at all. This all but eliminates damage from lightning. Aquatrak has obtained a field proven reliability record of better than 1,000,000 hours mean time between failures (MTBF).

Sensor Configurations.

Figures 1-1 and 1-2 below show the two models of Series 5000 Sensors. They are identical in function and performance; the differences are only in the style of connector used.

Figure 1-1. Model 5003 Sensor, Watertight Connectors

Figure 1-2. Model 5002 Sensor, Waterproof Connectors

Proven Technology

The AQUATRAK sensors are based on technology developed and patented by Bartex and acquired by Aquatrak Corporation. The U.S. National Ocean Services (NOS) and the Australian National Tidal Centre have selected the Aquatrak Model 5000 gauge to be their primary standard instrument for tidal programs.

AQUATRAK Components

The AQUATRAK Model 5000 Series is shipped with the following items:

Model 5000 (Waterproof)	Model 5001 (Watertight)
Sensor	Sensor
Calibration Tube	Calibration Tube
Thermistor Cable, W-107-02(Optional)	Thermistor Cable, W-107-01
Data I/O Cable, W-108-02	Data I/O Cable, W-108-01

1.2 Performance Specifications for the Model 5000 Series

Refer to the Appendix at the end of this manual for detailed performance specifications.

> The Model 5000 Series AQUATRAK measures absolute liquid level in all indoor and outdoor conditions. Measurement is possible in open waters, stilling wells, ground wells, as well as in enclosed tanks.

Figure 1-3 Dimensions of the Model 5003 Series Sensors

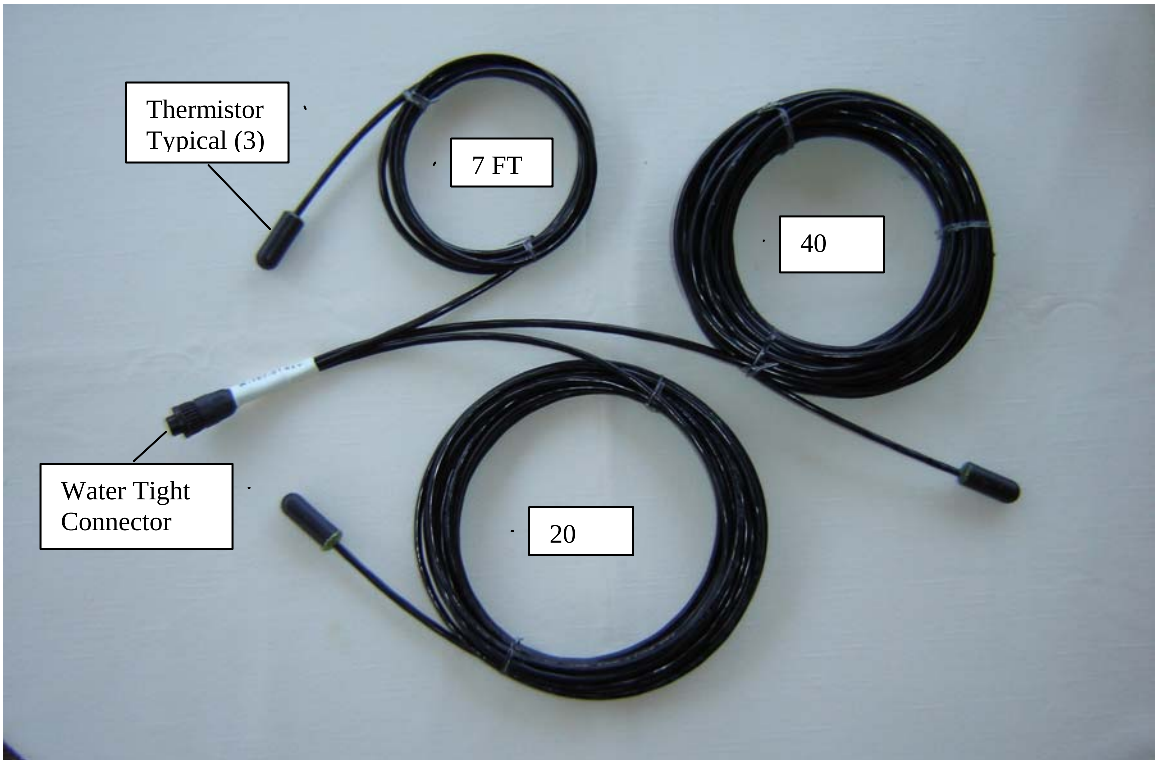

Figure 1-4. Thermistor Cable with Water Tight Connector

Figure 1-5. I/O Cable with Water Tight Connector

1.3 How the AQUATRAK Measures Liquid Level

> The Aquatrak patented ratiometric technique is based on fixed points, and provides high levels of accuracy, resolution, and long term stability.

The AQUATRAK sensor uses a very simple but accurate technology to measure liquid level. Driven by a microprocessor, a series of electrical pulses are transmitted from the Model 5000 internal controller to the acoustic transducer element. The transducer converts the electrical pulses into acoustic pulses and sends them to the liquid surface via a sounding tube.

As shown in figure 1-6, the pulses pass through a calibration tube (Cal Tube), one or more ranging tubes, a trim tube, and a "red brass" tube. The tube protects the acoustic energy from such adverse environmental effects as wind, rain, and snow. The functions of the various tubes (collectively known as the "sounding tube") are as follows:

- ✓ The Cal Tube provides a return echo from a known distance
- ✓ The range tube(s) channel the acoustic pulses to and from the surface
- ✓ The trim tube allows minor corrections to the tube so that the overall tube length is 0.2 meters (0.5 ft) shorter than the protective well orifice.
- ✓ The "red brass" tube provides a measure of antifouling to keep the end of the tube free of marine growth and algae.

As the acoustic signal passes down through the Cal tube an echo at the calibration point is produced that is returned to the Model 5000 Sensor. When the pulse strikes the liquid surface another echo is produced which is also returned to the Model 5000 Sensor. The patented ratiometric technique is based upon a pulse time of travel comparison between the known (through the cal tube) to an unknown distance to the liquid level (through the sounding tube).

Under host control, the Model 5000 Sensor initiates the drive pulse to the transducer, times and stores the calibration return echo, and times and stores the liquid level return echo. The on-board microprocessor calculates the ratio, applies any programmed offsets, performs engineering conversions, and stores the data awaiting a data request from the host data logger or PC. The host computer does not have to perform any calculations to determine the water level because the Model 5000 provides this information in directly readable ASCII engineering units.

Because the velocity of sound is temperature-dependent, a provision for temperature compensation is provided by way of the temperature sensors on the Thermistor Cable. The thermistor elements are to be installed at various points along the sounding tubes. This is useful if the temperature in the sounding tube is not isothermal. The measured temperatures are returned to the host in the form of 10-bit A/D values via the SDI-12 C2, C3 M2, and M3 commands (see Table 3-5).

The sea state (wave height) may be approximated by multiplying the standard deviation from each measurement by a constant whose value is site and installation dependent. For a damped orifice, protected well, the multiple is approximately 5 (depends on dampening). For a fully open, unprotected well (no damping), the multiple is 3.8.

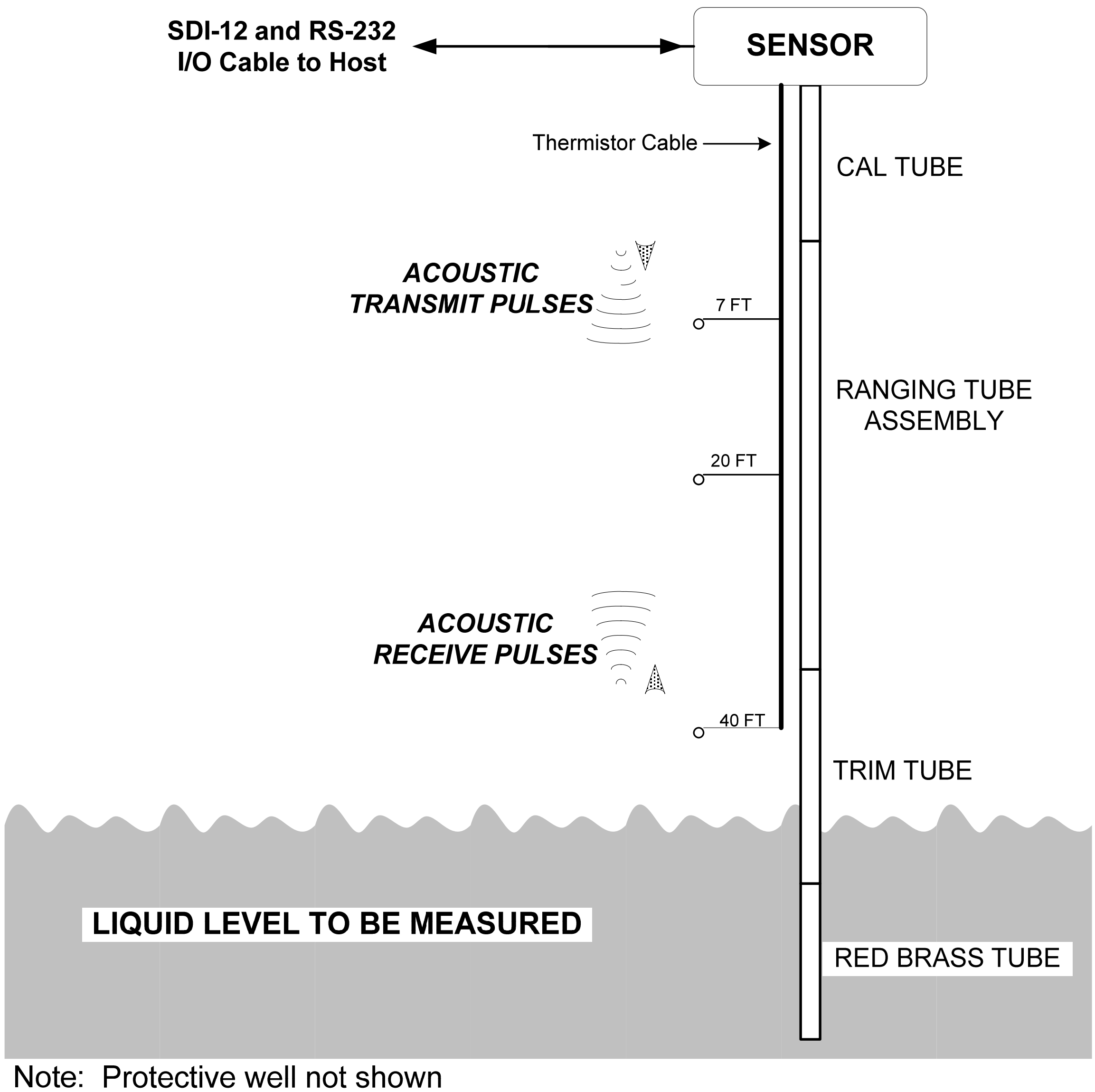

Figure 1-6 AQUATRAK Measurement Diagram

1.4 Accessories for the AQUATRAK Model 5000 Series

Several accessories are available from Aquatrak for the AQUATRAK Model 5000 Series. Contact the Sales Office for more information.

AQUATRAK Installation Kit - P/N 28-3000-NG (x)

Every installation requires the use on an installation kit to properly install the sensor. The "(x)" in the part number refers to the inside diameter of the protective well supplied by Aquatrak or the user. The inside dimension of the protective well is needed so that the correct size centering clip is provided. The parts are supplied with the installation kit (P/N 28-3000-NG-6) are shown below in Figure 1-7. For other accessories, please contact Aquatrak.

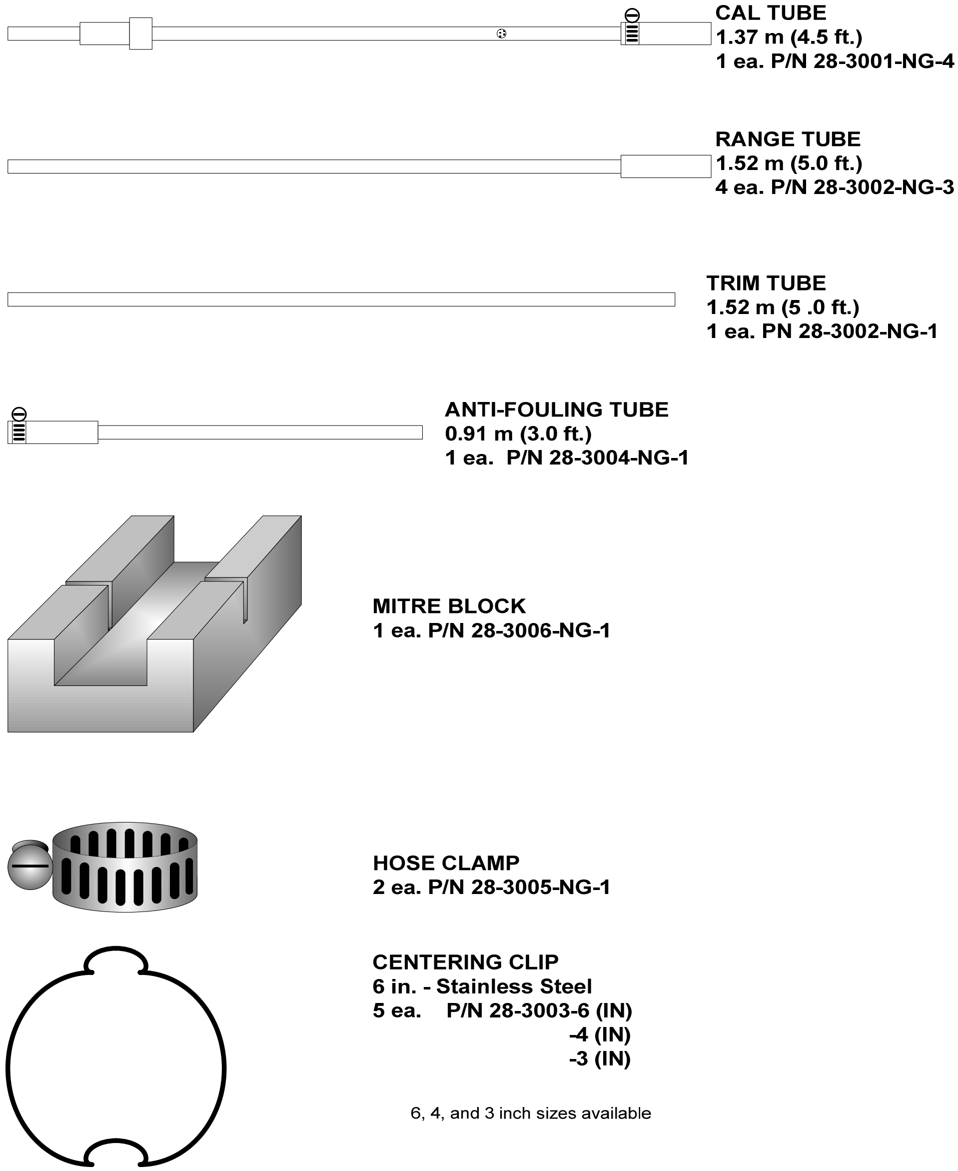

Figure 1-7 Parts Supplied with the Installation Kit

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2. INSTALLATION OF THE Model 5000 AQUATRAK

2.1 Protective Well Installation

> ***Caution:***
> ***The Model 5000 AQUATRAK should be installed in a properly designed protective well to protect it from physically damaging elements and to minimize thermal effects from direct sunlight.***

The protective well may be made from any rigid material or it may be procured from Aquatrak. An example of a suitable material is 3, 4 or 6 inch Schedule 40 PVC pipe. In severe locations where large waves or floating debris may be a problem, Schedule 80 pipe is recommended. Note that the pipe size chosen must match the centering clip diameter in the installation kit. For example, if a P/N 28-3000-NG-4 installation kit was ordered, use 4-inch pipe.

The protective well location is often determined by the availability of a support structure such as a pier or piling. Accessibility and security of the site should also be considered.

The following factors should be considered when locating the protective well:

1. **Thermal Environment -** The optimal installation will insure that the air in the entire protective well is at the same temperature. Temperature differentials may cause small errors in the level measurement. In general, locate the well on the north side of a pier (in the Northern Hemisphere), or on the south side in the Southern Hemisphere. Avoid locations where a portion of the well is in direct sunlight while other portions are shaded.

   Note:

   The goal is to provide an isothermal air environment inside the well. The ambient temperature is immaterial.

2. **Physical Considerations** - The protective well must be braced to the supporting pier to withstand the expected sea state conditions. In river gauging applications, consideration must be made for floating debris. The protective well should be mounted vertically.

3. **Availability of Indoor Location -** Be sure to carefully measure the distance that the Sensor I/O cable will have to run between the Sensor head at the top of the protective well and the desired location of the Data Collection Platform. The standard cable length is 3 meters (10 feet). Up to 300 meters of cable can be provided.

The design of the well depends on several factors such as the highest high and lowest low water levels, bottom depth, and wave height. Several rules apply including:

- ✓ The lower orifice of the well should be approximately 0.5 to 1 meter off the bottom to keep the bottom materials from entering the well.
- ✓ The top of the well should be approximately1 m above the deck level to allow for easy access to the Sensor.
- ✓ The Sensor must be at least 1.5 m (5 ft) above the expected extreme high water

(including wave height).

Calculate the overall length, "W", using the formulas and figure 2-1 below. Remember that the standard installation kit will only extend 9.88 m (32.4 ft). If the protective well length must be longer than 9.88 m, additional range tubes must be purchased.

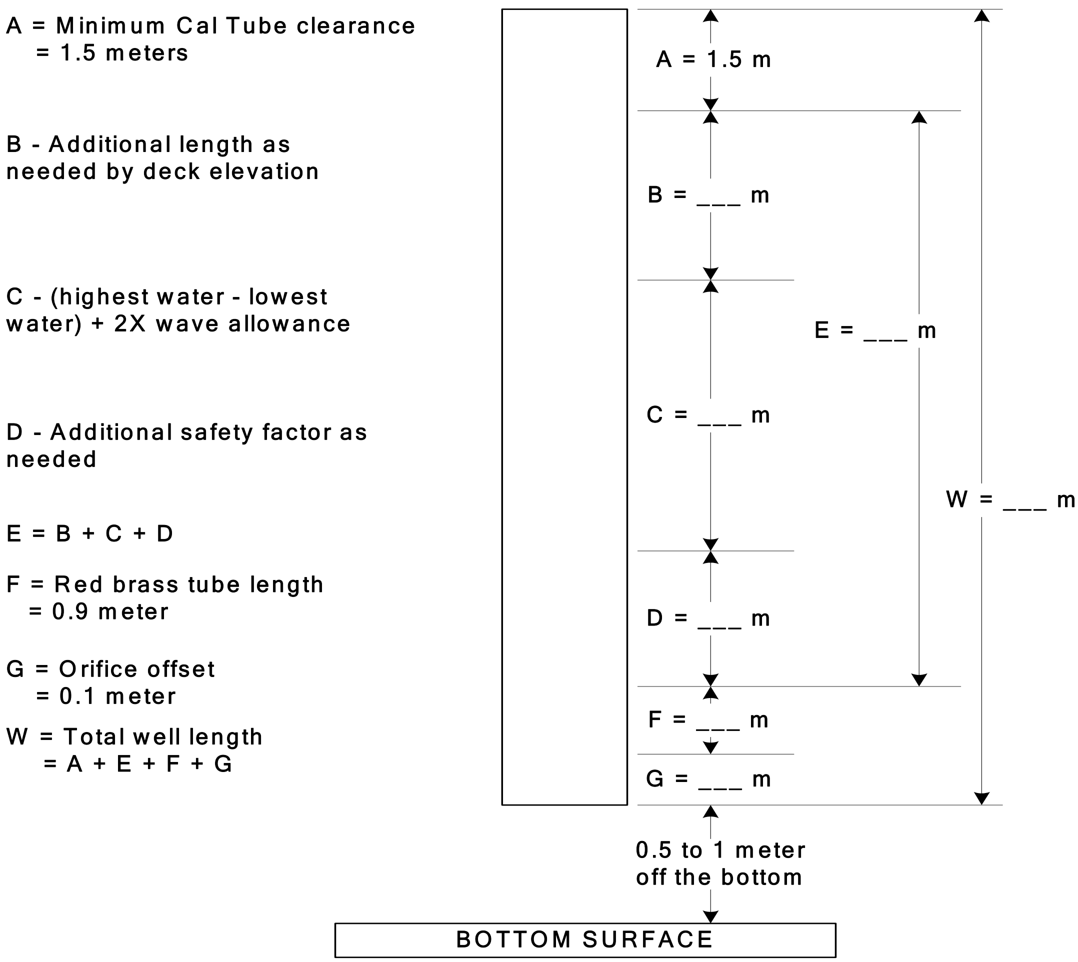


Figure 2-1 Protective Well Length Calculator

Cut the protective well pipe squarely so that the top opening is horizontal when mounted. Securely mount the protective well to a piling using non-corrosive user-supplied straps or clamps every meter of length.

2.2 Assembly of the Sounding Tubes

> ***Caution***
> ***After calculating the tube length, the tubes must be carefully cemented together with no gaps or internal cement beads, which may cause erroneous readings.***

Sounding Tube Length Calculation

The overall sounding tube length is a function of the protective well length calculated earlier and the length of the sounding tubes in the installation kit. The sounding tube is made up of the following tubes:

Calibration tube	(1)	length fixed and is never altered
Red brass tube	(1)	length fixed and is usually not altered
Range tubes	(4)	alter length by using more or less whole tubes
Trim tube	(1)	alter length by using whole, not using, or by cutting to length

Using the protective well length calculated in Section 2.1, calculate the overall sounding tube length as shown below:

> Protective well length ____ meter
> Bottom orifice offset - .1 meter
> ____ meters, sounding tube assembly total length

Now that the length of the sounding tube assembly is known, use the table below to determine the number of range tubes needed and the length to cut the trim tube.

Table 2-1 Required Tube Sections and Trim Tube Length

Sounding Tube Length	**# of Sections** Cal	Rng	Brass	Trim	**Cut Trim Tube for Total Length of:**
= or <2.29 m (7.5 ft)	1	0	0	1	N/A
> 2.29 m (7.5 ft) and < 3.81 m (12.5 ft)	1	0	1	1	Sounding Tube Length – 2.29 m (7.5 ft)
> 3.81 m (12.5 ft) and < 5.33 m (17.5 ft)	1	1	1	1	Sounding Tube Length – 3.81 m (12.5 ft)
> 5.33 m (17.5 ft) and < 6.86 m (22.5 ft)	1	2	1	1	Sounding Tube Length – 5.33 m (17.5 ft)
> 6.86 m (22.5 ft) and < 8.38 m (27.5 ft)	1	3	1	1	Sounding Tube Length – 6.86 m (22.5 ft)
> 8.38 m (27.5 ft) and < 9.91 m (32.5 ft)	1	4	1	1	Sounding Tube Length – 8.38 m (27.5 ft)

Sounding Tube Assembly

Tools and materials needed:

1) AQUATRAK installation kit	2) Hacksaw, fine tooth	3) PVC primer
4) PVC cement	5) Trimming knife	6) Sandpaper

Note:

Before beginning the installation steps below visually inspect and verify that each tube is clean and free of burrs and obstacles. If necessary, use the trim knife or sandpaper to smooth the edges. Layout the tubes on a clean surface and "dry" fit them in the order they will be connected.

✓ Using a hacksaw and miter block cut the trim tube to the length determined in column 4 of Table 2-1. Using the trim knife and/or sandpaper carefully deburr the inside and outside of the cut end. It is essential that the joints between tubes are tight, square, and free of burrs and irregularities, else an unwanted acoustic reflection may return to the Sensor.

✓ Using the PVC primer, lightly coat the outside of the uncut end of the trim tube and the inside of the coupler end of one of the range tubes.

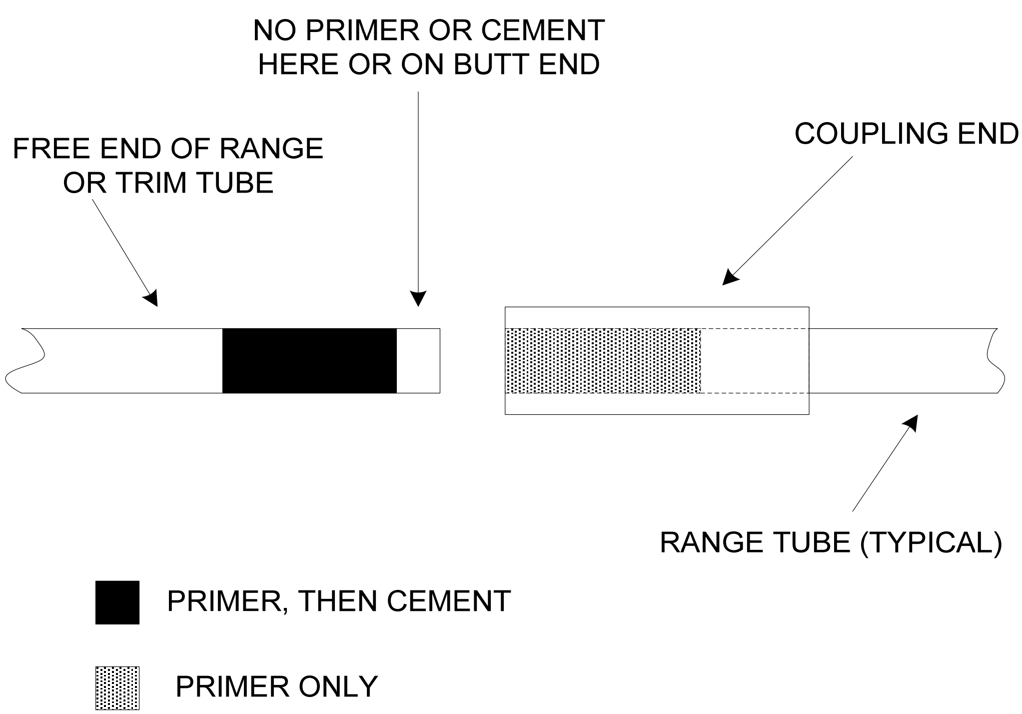


Figure 2-2 Cement Details

✓ Apply PVC cement sparingly to the uncut end of the trim tube in an even band ~1 cm from the end. Do not apply any cement to the butt end of the tube or allow it to enter the inside of tube.

✓

- ✓ Immediately insert the cemented trim tube end into the primed coupler end of the range tube. Use a firm, twisting motion until the tube bottoms out in the coupler.
- ✓ Repeat the previous 3 steps to join the remaining range tubes. The number of range tubes needed was determined in column 2 of table 2-1.
- ✓ Attach the red brass tube coupling to the bottom of the cut end of the trim tube using one of the hose clamps provided in the installation kit.
- ✓ Connect the coupler end of the cal tube to the top end of the range tube using one of the hose clamps provided in the installation kit.
- ✓ Wait at least 30 minutes before moving or handling the sounding tube assembly to allow the cement to cure.
- ✓ Place a hand on either side of each joint and twist firmly to test the integrity of the connection.

2-3. Installation of the Thermistor Cable

If the thermistor cable is to be used in this application, route the thermistor wire pairs down the sounding tube, attaching each to the sounding tube at the appropriate points. This allows the Sensor to measure the temperature environment along the sounding tube in order to correct for the small error if the air column in the protective well is not isolthermal.

2.4 Mounting the Sounding Tube Assembly in the Protective Well

Note:

After cutting the top of the, protective well pipe the assembled Sensor and sounding tube is lowered into the well and secured.

2-5. Preparation of the protective well top orifice

Using a hacksaw, cut the top opening of the protective well to a depth of ~ 4 cm (1.5 inch) making 2 cuts at right angles as shown in Figure 2.3-1. These cuts allow the user-supplied hose clamp to compress and secure the transducer in the well.

If the diameter of the Sensor body does not match the inside diameter of the protective well, the user must supply an adapter-coupler.

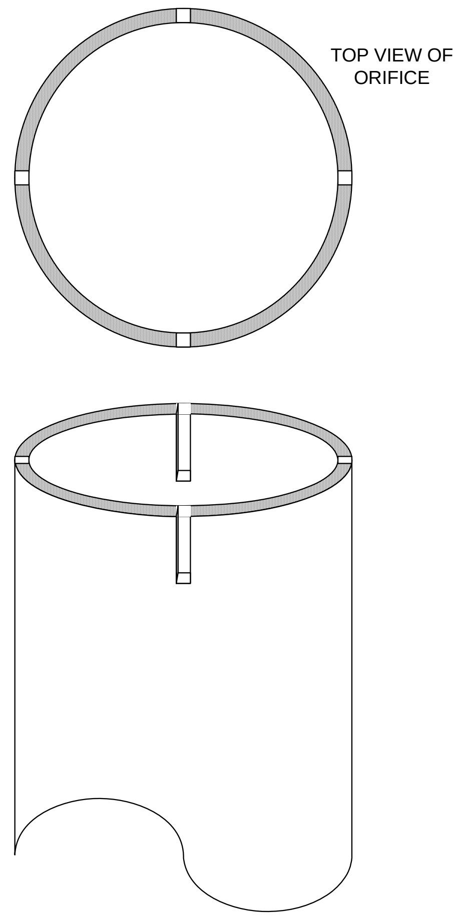


Figure 2-3 Protective Well Cutting Guide

Installing the Sensor in the protective well

Attach the centering clips from the installation kit to the sounding tube assembly by clipping them over the sounding tube sections. **The lowest clip should be just above the red brass/trim tube coupling (i.e.; on the lowest part of the trim tube. Do not install a centering clip on the red brass tube).** Evenly space the remaining clips over the length of the sounding tube with the last of the five clips attached just above the cal tube/top range tube coupling (i.e.; on the lower part of the cal tube). One clip every 1.5 meters (5 ft) is usually adequate. Rotate the clips so that they are at right angles to each other.

Gently lower the assembly into the protective well. Stop lowering the assembly when the top of the tube is ~ 0.5 meter above the top of the well. Slip the stainless steel coupler of the Sensor over the top end of the cal tube. Fully bottom the tube into the seat of the Sensor coupler and tighten the 2 lower set screws securely.
Finish lowering the Sensor and sounding tube assembly into the well until the step flange of the Sensor sits squarely on the top orifice of the protective well. Use a hose clamp (user-supplied) to compress the top of the well until it tightens around the Sensor body and holds it securely.

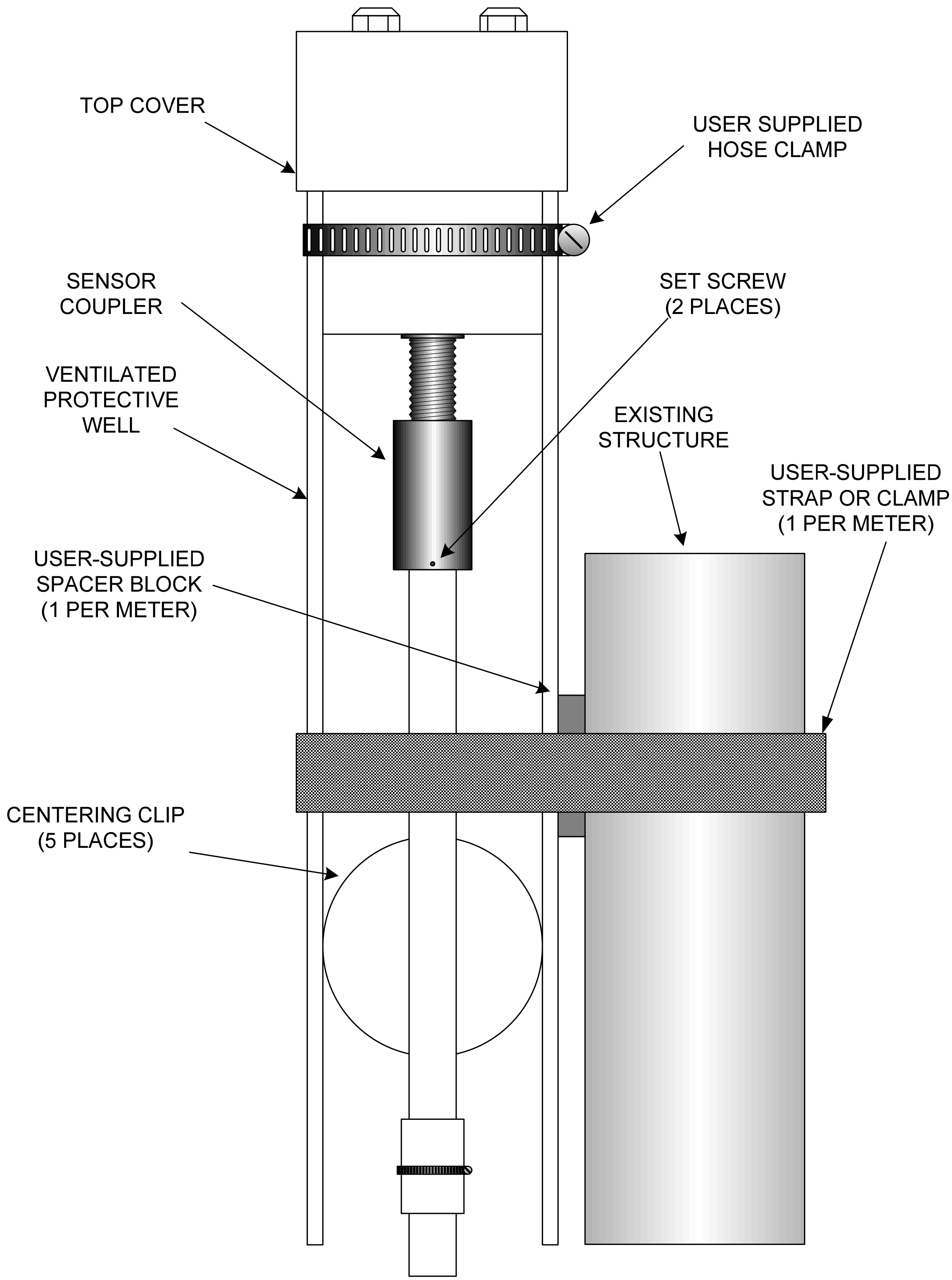
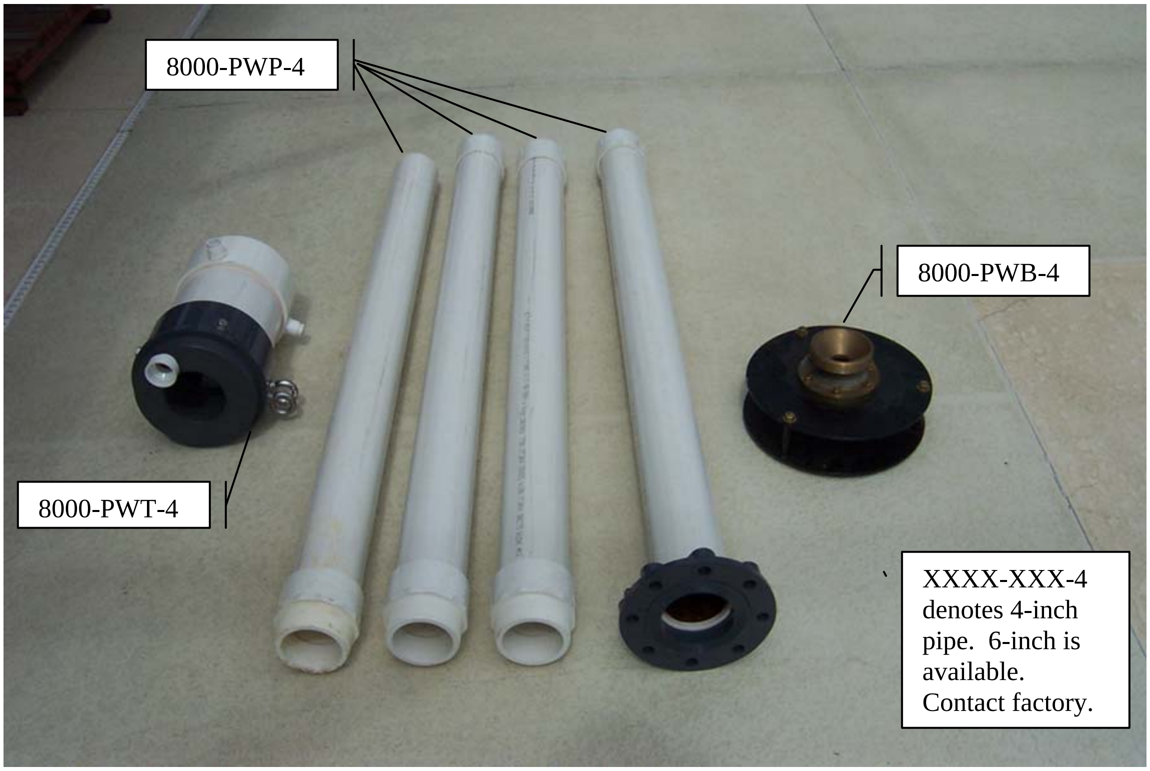


Figure 2-4 Final Installation Diagram

2-6 Installation using Top Adapter and Bottom Assembly.

Figure 2-5 shows the kits/parts available for installing the Sensor in a fully protected configuration.



8000-PWK-4	**Consists of a combined set of 8000-PWT-4, 8000-PWP-4, and 8000-PWB-described below.**
8000-PWT-4	**Adapter assembly for Aquatrak Sensor mates with 4-inch pipe; includes Sensor clamps, protective cover, and assembly hardware with screen vents.**
8000-PWP-4	**Four 5-foot lengths of 4-inch diameter Schedule 40 PVC pipe with threaded connectors and copper insert.**
8000-PWB-4	**Bottom assembly, 4-inch, includes one 4-inch brass cone, two 12-inch diameter PVC parallel plates, and assembly hardware.**
	*********************Options*******************
8001-PWB-4	**Same as 8000-PWB-4 except parallel plates are constructed of corrosion resistant brass.**
8002-PWP-4	**Same as 8000-PWP-4 except pipes are Schedule 80 PVC.**

Figure 2-5. 5000 Sensor Protective Kit Materials.

2.7 Making the Electrical Connections

Note:

The normal installation of the AQUATRAK requires the user to supply a 12 VDC power source and a data collection device capable of operating with either RS-232 or SDI-12 serial communications.

Sensor Connector Styles

The 5000 Series Sensor is equipped with one of two styles of connectors: either water-resistant (commercial-style), or water-proof (NOA style). The electrical functions for either style are identical. Figures 2-6 through 2-9 show the cable configurations and physical pin-out.

Connector Functions

I/O Connector. (See figures 2-6 and 2-8). This connector/cable furnishes: (1) serial SDI-12 data input/output, (2) serial RS-232 TX and RX lines, and (3) +12V power input and ground. These must be connected by the user to the host system.

Thermistor Connector. (See figures 2-7 and 2-9). There are three temperature sensing devices pre-assembled onto three lengths of cable (7-ft, 20-ft, and 40-ft). These are routed down along the ranging tube to permit temperature measurement at desired points below the Sensor and above the liquid surface. This permits precise ranging calculations to compensate for variations of acoustic velocity under varying temperatures.

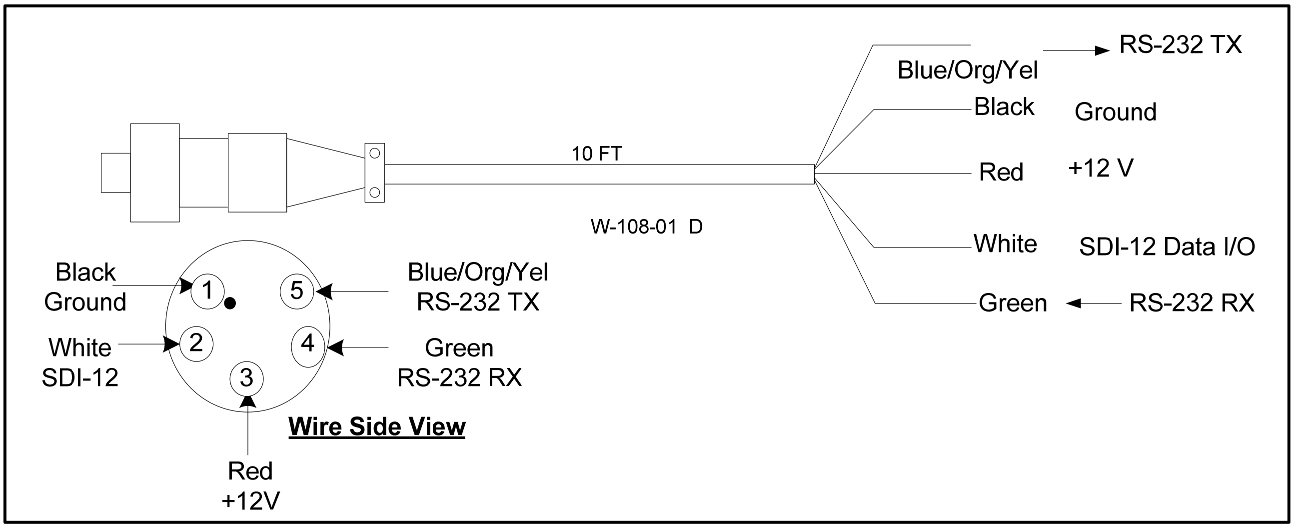


Figure 2-6. Water Tight I/O Cable (W-108-01)

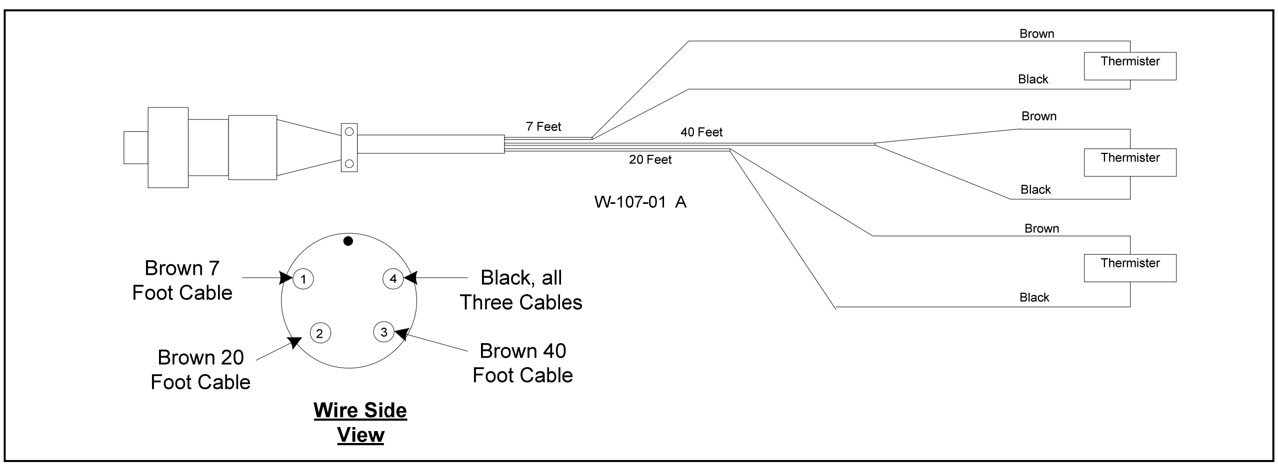


Figure 2-7. Water Tight Thermistor Cable (W-107-01)

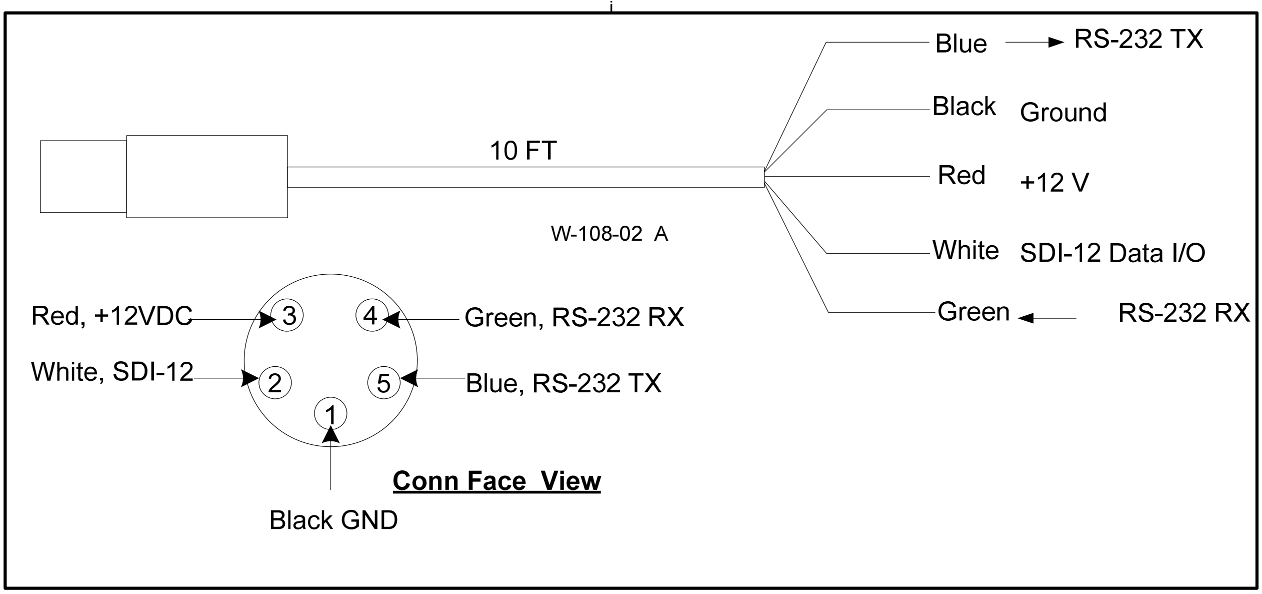


Figure 2-8. Water Proof I/O Cable (W-108-02)

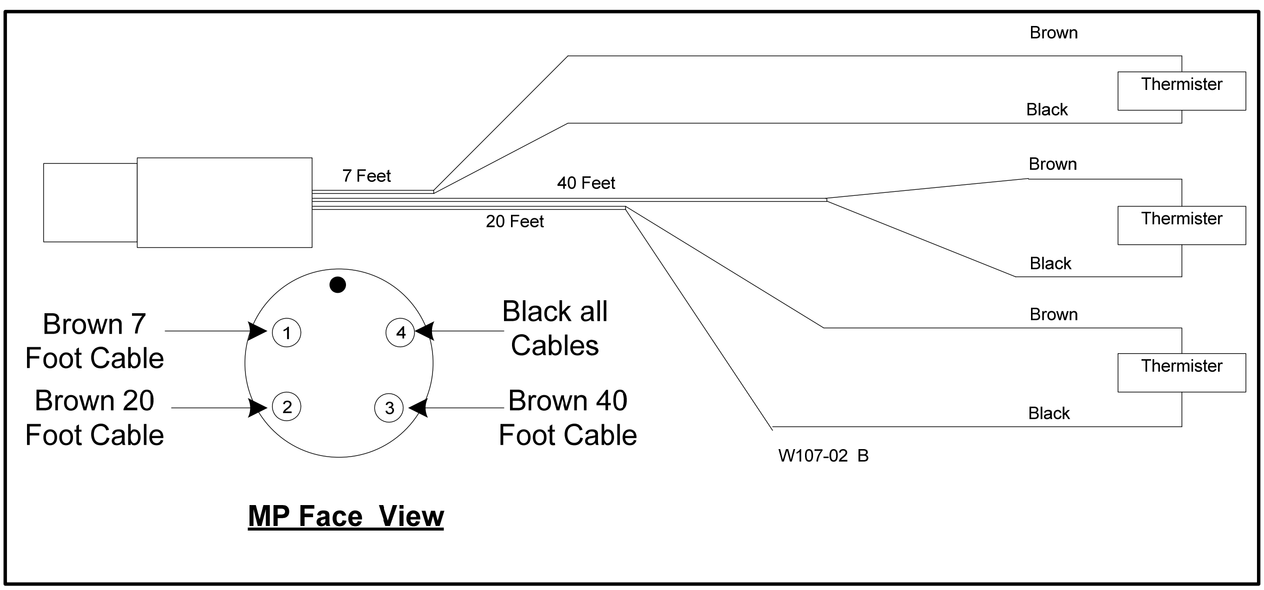


Figure 2-9. Water Proof Thermistor Cable (W-107-02)

3.0 PROTOCOLS & COMMUNICATIONS

3-1. NOTES ON BAUD RATE SELECTION

The Series 5000 Sensor is capable of communicating with either RS-232 or SDI-12 protocols. When communicating via RS-232, the baud rate is selectable over the range of 300 to 9600 baud. *However, if the RS-232 baud rate is changed to any rate other than 1200, and the user desires to use the SDI-12 protocol, the baud rate must be re-set to 1200 baud before attempting to operate with SDI-12.*

This means that while the RS-232 baud rate is selectable, the SDI-12 baud rate is not.
SDI-12 must always operate at 1200 baud.

The sensor is factory configured for SDI-12 communications as follows:
ASCII / 7 bit / Even parity / 1 stop bit / 1200 baud.

The sensor is factory configured for RS-232 communications as follows:
ASCII / 7 bit / Even parity / 1 stop bit / 1200 baud.

3.2 Serial Data I/O.

Figures 2-6 and 2-8 show the I/O cable connections for RS-232 and SDI-12 I/O. If the host Data Acquisition Platform (DAP) is configured to support both formats, the I/O lines for both may be always connected. The 5000 Sensor will respond to whichever host source is active at any given time, but not of course to both simultaneously.

3.2.1 Modes of Operation

✓ Standby

In the Standby state, power to the Model 5000's microprocessor is turned off to reduce power consumption. A <BREAK> signal of at least 12 ms through either the RS-232 or SDI-12 port is required to awaken the Model 5000 from the Standby mode.

✓ Command

In the Awake State, the Model 5000 is in the Command mode, waiting to accept either valid commands or to enter the Menu mode. The Model 5000 will remain in the command mode for 10 seconds after receiving a <BREAK> before returning to the Standby mode.

✓ Menus

From the Command mode, sending an <ESC> will put the Model 5000 in the Menu mode. This feature is only available through the RS-232 port. It is used to establish the user settings and to initiate measurements.

3.3 Operation with the RS-232 Protocol

Note:

When RS-232 is selected as the operating protocol, the Model 5000 can operate in either the command mode or the menu mode.

The signal interface consists of a 3-wire RS-232C connection with the transmit (Tx), receive (Rx), and circuit common pins being used. Connecting the Series 5000 Sensor RS-232 wires to the host system automatically switches from the SDI-12 port to the RS-232 port and **disables SDI-12 operation.**

Basic Steps To Establish RS-232 Communications

✓ Connect the host computer to the RS-232 port on the Model 5000 Sensor.

✓ Establish communications with Hyperterminal or similar communications program. Set the program for the following parameters:

7 bit / Even Parity / 1 Stop bit / 1200 baud / Half or full duplex

Note that data transmittals from the Model 5000 contain blank spaces between data fields for ease of parsing by commonly available spreadsheet programs. Each data transmittal line is terminated with a carriage return <CR> and line feed <LF>.

Table 3-1 RS-232 Data Quality Indicator Table

-DQ Code	Description
0	5000 Inoperative
99	No errors detected
1	Cal undetected
100	Liquid level out of range
101	Out of range and no cal

3.3.2 RS-232 MAIN MENU

Th.1MAIN MENU mode offers a series of menu chorces that allow the operator to command the Sensor to make measurements or change settings.

To enter the MAIN MENU from the Command Mode, press <ESC> and verify that the Model 5000 returns the response shown in the table below.

```
Aquatrack Model 5000 Menu Version 5.03  (Main Menu)

    1.    User Settings.
    2.    Continuous Sampling, Raw Data.
    3.    Continuous Sampling, Scaled Data.
    4.    Continuous NOS Averaging, Sliding Window.
    5.    Continuous Wave Data, Sliding Window.
    6.    Continuous Scalar Average, Sliding Window.
    7.    Dump Sample Array.
    8.    Measurement Command Defaults.
    9.    Dump Setup Information.
    EE.   Initialization Options.
    Q.    Return to Command Mode.
```

The following paragraphs describe the Model 5000 response to each of the menu items. Select by entering the item number and <enter>.

3.3.2 RS-232 User Settings.

Each User Setting may edited by <entering> the appropriate item shown in the following table.

Selection: 1 (Main Menu <1>)

```
USER SETTINGS MENU
1.    Primary Sensor Address:          0
2.    Secondary Sensor Address:        2
3.    Sensor ID, 13 chars:            0000
4.    Slope (x.xxxxxx)                +1.000000
5.    Offset (xxx.xxx)                +0.000
6.    Polarity  (D)own  (U)p          D
7.    Units  (F)eet   (M)eters        F
8.    Wave Multiplier                  4.000
9.    Calculate Offset
10.   Baud Rate:                      1200
11.   Comms Parity  (N)one  (E)ven     E
12.   Menu item not used
13.   Continuous Sampling:            Off
14.   Self-Report with each sample:    Off
Q.    Return to previous menu
Enter Selection:
```

RS-232 MainMenu <2> - Cont Sampling, Raw Data, Model 5000

Selection: 2

Index	Raw Data	Stat	Cal	Water	Celsius
248	1.789	16	25879	37982	27.4
249	1.789	16	25879	37982	27.4

<ESC> to Continue

RS-232 Main Menu <3> - Cont Sampling, Scaled Data

Selection: 3

Index	Raw Data	Stat	Cal	Water	Celsius
248	1.789	16	25879	37982	25.3
249	1.789	16	25879	37982	25.3

<ESC> to Continue

RS-232 Main Menu <4> - Cont NOS Avg, Slide Window

Selection: 4

Mean	Sigma	Out	Bad
1.790	0.000	0	1
1.790	0.000	0	1
1.790	0.000	0	1

<ESC> to Continue

RS-232 Main Menu <5> - Cont Wave Data, Slide Window

Selection: 5
Enter number of samples: 4

Mean	Wave	Bad
1.790	0.000	2
1.790	0.000	1
1.790	0.000	1
1.790	0.000	1

<ESC> to Continue

RS-232 Main Menu <6> - Cont Scalar Avg, Slide Window

```
Selection:  6
Enter number of samples:  3
     Mean         Maximum        Minimum      Bad
    1.790          1.790          1.790        2
    1.790          1.790          1.790        2
    1.790          1.790          1.790        1
 <ESC> to Continue
```

RS-232 Main Menu <7> - Dump Sample Array

```
Selection:  7
Number of Prior samples, <enter> for all:
 Index       Value       Stat
   478       1.790        16
   479       1.790        16
   480       1.790        32
   481       1.790        16
<ESC> to Continue
```

RS-232 Main Menu <8> - Meas Command Defaults

```
Selection:  8
MEASUREMENT COMMANDS MENU
1.   Address A M/C!  Default Command:  1
2.   Address B M/C!  Default Command:  1
3.   NOS Samples to Average:          181
4.   C4 Averaging Period (secs):       15
5.   C5 Averaging Period (secs):       30
6.   C6 Averaging Period (secs):       60
Q.  Return to previous menu
Enter Selection:
```

RS-232 Main Menu <9> - Dump Setup Information

```
Selection:  9
Aquatrak MODEL=5000  Ver=4.03
A_ADD=0   B_ADD=2  ID=0000
SL=1.000000   OF=+0.000   WA=4.000   POL=D   UNIT=M
NOS=181   C4=15   C5=30   C6=60   DEF_A=1   DEF_B=1
BAUD=4   PAR=1
SAMP=0   RPT=0
PW=106   CB=60   LB=100   CL=4   CN=1
<ESC> to Continue
```

RS-232 Main Menu <EE> - EE Init Options

```
Selection:   EE

1.   2 foot cal, Change Transducer settings only.
2.   4 foot cal, Change Transducer settings only.
3.   Complete Default Setup, 2 foot cal.
4.   Complete Default Setup, 4 foot cal.
<ESC> to quit.
```

Following are the four RS-232 returns that result from selecting 1 - 4. in the EE menu above.

```
Selection:  1
Enter to Select 2 ft Cal Setup,  <ESC> to quit

(<ESC> or <ENTER> returns to the Initialization Options
menu shown above.)
```

```
Selection:  2
Enter to Select 4 ft Cal Setup,  <ESC> to quit

(<ESC> or <ENTER> returns to the Initialization Options
menu shown above.)
```

```
Selection:  3
Enter to Select 2 ft Cal Setup,  <ESC> to quit
Changing Baud to 1200…

(<ESC> or <ENTER> returns to the Initialization Options
menu shown above.)
```

```
   Selection:  4
   Enter to Select 4 ft Cal Setup,  <ESC> to quit
   Changing Baud to 1200…

(<ESC> or <ENTER> returns to the Initialization Options
menu shown above.)
```

3.4 Operation with SDI-12 Protocol, Model 5000

3.4.1 Overview of SDI-12 Communications

Following is a general description of the SDI-12 communications transactions between the Host system and the Aquatrak Model 5000 sensors.

Table 3-2 SDI-12 Command Sequence

Host		**Model 5000**
Request Measurement (M command)	→	
	←	Send "address + seconds until ready and # of data points" (a ttt nnn)
	←	Send "Data Ready"
Request Data (D command)	→	
	←	Send Data

- ✓ Character Format: 7 data bits, even parity, 1 stop bit
- ✓ Character Description

HOST COMMAND	**5000 RESPONSE**
a = 5000 address M = Measurement D = Data request	a = 5000 address ttt = Seconds until ready nnn = Number of data points (measurements) in a data string
# = Sub routine ! = Execute	a<CR LF> = Data Ready

Typical Example Sequence to Receive Averaged Data

Assume that the Model 5000 address is 0 and that averaged data is to be requested

Host → Send "0M2!	This will awaken the Model 5000 and have it begin collecting 181 samples of data (averaging default). "0" is the Model 5000 address and "M2!" is the command to initiate averaged measurements.
5000 → Send "0tttn"	This data tells the host that the data will be ready in ttt seconds. "0" is the Model 5000 address and "n" is the number of data points available.
5000→ Send "0 CR/LF"	This data tell the host that data is ready and may be requested (within 10 seconds or the data is lost). The "0" is the Model 5000 address and the CR/LF causes the host to carriage return and skip a line.
Host → Send "0D0!"	This command will cause the Model 5000 to output the averaged water height data only.
5000 → Send "+/-XX.XXX <CR LF>	This data is the height of the water level in the units of measure selected with the USER SETTINGS.

3.4.2 SDI-12 Setup and Test

The Model 5000 is factory configured for SDI-12 operation, a serial digital interface standard for hydrological and environmental sensors. SDI-12 is a commonly used low power, multi-drop (up to 10 sensors) signal and power bus. The interface consists of a 3-wire connection for power, signal, and common. For a complete description of the current SDI-12 specification, visit the U.S. Geological Survey web site at:
www.sdi-12.org.

The Model 5000 supports all SDI-12 commands except those that obviate the host system from performing multi-tasking. Specifically, the AQUATRAK 1) does not abort measurements on the 2nd break command, 2) does not support the "A!" command, and does not lose data after 100 ms (it is held for 10 seconds). In addition, the Model 5000 supports some additional non SDI-12 specific commands, which perform useful functions in the operation of the sensor.

Basic Steps To Establish SDI-12 Communications

7 bit / Even parity / 1 stop bit / 1200 baud

Note that data blocks from the Model 5000 contain leading signs and no blank spaces between data fields. Carriage return <CR> and line feed <LF> are not used for data requests to the Model 5000 but are used in the sensor response.

Quick Check to Test SDI-12 Basic System Operation

✓ Transmit the “0I!” Command to the Model 5000. If the sensor address is "0" (factory default), this command is entered as "0I!”

Verify that the Model 5000 returns the following response:

010 AQUATRAK 5000 xxx yyyyyy

Where xxx is the firmware version number and yyyyyy is the unit ID (may be serial number).

Refer to the SDI-12 command table (Table 3-2).

✓ Transmit an <aMn!> Measurement Command followed by Data Commands <aD0!, aD1!, aD2!>……..

✓ Verify that the Model 5000 returns the proper responses to each data (D) request.

✓ If the reported water level does not appear to be correct, see Section 4.0 for user set-up parameters and offset calculations.

✓ If the number of cal tubes reported is not equal to the number of cal tubes used in the installation, the user set-up parameters will have to be changed as described in Section 3.2.1.2.

✓ If the error code is not '99', interpret the reported numeric code from the data quality (DQ) table below:

Table 3-3. SDI Data Quality Indicator Table

DQ Code	Description	DQ Code	Description
0	5000 inoperative	100	Liquid level out of range
99	No errors detected	101	Out of range & no 1st Cal
1	Cal undetected		

Table 3-4 Error Byte Bit Map

B7	B6	B5	B4	B3	B2	B1	B0
(reserved)	**(reserved)**	**Data Not Calibrated**	**Data Valid**	**Outlier (Reset with each subsequent average)**	**No Water Return**	**Missed Calibration Point**	**No Sensorr Response**
128	**64**	**32**	**16**	**8**	**4**	**2**	**1**

3.5 SDI-12 Command Set

Table 3-5. SDI-12 Commands

	DESCRIPTION	Continuous Sampling	RESPONSE	DATA BUFFER USE Unused data buffers will return: a<CL>	
a!	Return sensor address.	ON/OFF	a<CL>		
aAb!	Reprogram primary sensor address	ON/OFF	b<CL>		
aBb!	Reprogram secondary sensor address	ON/OFF	b<CL>		
aC!	Set to user selected measurement type. Default is C1.	ON/OFF	See user-selected commands (aC1!-aC9!)		
aC1!	Perform Single Sample immediately and return Scaled Distance	ON	a00105<CL>	D0	Level, **+xx.xxx**
				D1	Sample Status, **+xx**
		OFF	a00305<CL>	D2	Calibration Counts, **+xxxxx**
				D3	Water Return Counts, **+xxxxxx**
				D4	Temp. Celsius, **+xx.x**
aC2!	Begin sampling immediately for next nnn samples. (181 sample Default) Perform NOS average. Return Mean Level, Std Dev, Outliers, Error code, Wave Height.	ON	a(time)08<CL> time = nnn + 9 a19008<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
		OFF 182 PINGS	a(time)8<CL> time =nnn + 9 a19005<CL>	D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**
				D5	Temp-7,20,40 ft,+**xxxx+xxxx+xxxx**
aC3!	Return NOS average for last n samples (181 sample Default) n samples is pre-programmed. Continuous Sample Mode must be enabled	ON	a00808<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+x**xx
				D5	Temp-7,20,40 ft,+**xxxx+xxxx+xxxx**
aC4!	Return NOS average for last 60 samples in 4 sample blocks of 15 each. Bad Samples is cumulative for all 4 data blocks. Continuous Sample Mode must be enabled.	ON	a00307<CL>	D0	Mean from 60 to 46 samples ago. **+xx.xxx**
				D1	Mean from 45 to 31 samples ago. **+xx.xxx**
				D2	Mean from 30 to 16 samples ago. **+xx.xxx**
				D3	Mean from 15 to 1 samples ago. **+xx.xxx**
				D4	Bad Samples, **+xxx**
				D5	Start Index, End Index **+xxx+xxx**
aC5!	Return NOS averages for last 60 seconds in two 30 sample blocks. Bad Samples is cumulative for both data blocks. Continuous Sample Mode must be enabled.	ON	a00305<CL>	D0	Mean from 60 to 31 samples ago. **+xx.xxx**
				D1	Mean from 30 to 1 samples ago. **+xx.xxx**
				D2	Bad Samples, **+xxx**
				D3	Start Index, End Index, **+xxx+xxx**
aC6!	Return NOS averages for last n samples (60 sample default) n samples is pre-programmed. Continuous Sample Mode must be enabled.	ON	a00305<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**

Table 3-5. SDI-12 Commands (Cont'd)

aC7!	Perform single sample immediatly and return raw distance to water. (No offset and slope calculation.)	ON OFF	a00104<CL> a00304<CL>	D0	Level, **+xx.xxx**
				D1	Sample Status, **+xx**
				D2	Calibration Counts, **+xxxxx**
				D3	Water Return Counts, **+xxxxxx**
aC8!	Compute Scalar Average on Data Set Continuous Sample Mode must be enabled.	ON	a00304<CL>	D0	Mean, **+xx.xxx**
				D1	Max, **+xx.xxx**
				D2	Min, **+xx.xxx**
				D3	Bad Samples, **+xx**
aC9!	Calibration Tube Temperature	ON	a00102<CL>	D0	Temp. Celsius, **+xx.x**
		OFF	a00302<CL>	D1	Temp. Farenheight, **+xx.x**
aDn!	Return Data Buffer Contents, D0 through D9.	ON/OFF	aDn(+value)…….. (+value)<CL>		
aI!	Return ID String	ON/OFF	A012 Aquatrak 5000_00000(serial number)<CL>		
aM!	Set to user selected measurement type. Default is M1.	ON/OFF	See user-selected default commands (aM1!-aM9!)		
aM1!	Perform Single Sample immediately and return scaled distance to water.	ON	a0015<CL>	D0	Level, **+xx.xxx**
				D1	Sample Status, **+xx**
		OFF	a0035<CL>	D2	Calibration Counts, **+xxxxx**
				D3	Water Return Counts, **+xxxxxx**
				D4	Temp. Celsius, **+xx.x**
aM2!	Compute NOS Average on next n samples. n samples pre-programmed. 181 sample default.	ON/OFF	a(time)8<CL> time =nnn + 9 a1908<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**
				D5	Temp-7,20,40 ft,**+xxxx+xxxx+xxxx**
aM3!	Compute NOS average for last nnn samples. nnn samples is pre-programmed. 181 sample default. Continuous Sample Mode must be enabled	ON	a0088<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**
				D5	Temp-7,20,40 ft,**+xxxx+xxxx+xxxx**
aM4!	Compute NOS average for last 60 samples in 15 sample blocks. Bad Samples is cumulative for all 4 data blocks. Continuous Sample Mode must be enabled.	ON	a0037<CL>	D0	Mean from 60 to 46 samples ago. **+xx.xxx**
				D1	Mean from 45 to 31 samples ago. **+xx.xxx**
				D2	Mean from 30 to 16 samples ago. **+xx.xxx**
				D3	Mean from 15 to 1 samples ago. **+xx.xxx**
				D4	Bad Samples, **+xxx**
				D5	Start Index, End Index, **+xxx+xxx**
aM5!	Return NOS average for last 60 samples in 2, 30 second blocks. Bad Samples is cumulative for both data blocks. Continuous Sample Mode must be enabled.	ON	a0035<CL>	D0	Mean from 60 to 31 samples ago.**+xx.xxx**
				D1	Mean from 30 to 1 samples ago.**+xx.xxx**
				D2	Bad Samples, **+xxx**
				D3	Start Index, End Index, **+xxx+xxx**

Table 3-5. SDI-12 Commands (Cont'd)

aM6!	Return NOS averages for last n seconds, 60 second default. n seconds is pre-programmed. Continuous Sample Mode must be enabled.	ON	a0085<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**
aM7!	Perform single sample immediatly and return raw distaance to water. (No offset and slope calculation.)	ON	a0015<CL>	D0	Level, **+xx.xxx**
				D1	Sample Status, **+xx**
		OFF	a0035<CL>	D2	Calibration Counts, **+xxxx**
				D3	Water Return Counts, **+xxxxx**
				D4	Temp. Celsius, **+xx.x**
aM8!	Compute Scalar Average on Previous Data Set Continuous Sample Mode must be enabled.	ON	a0034<CL>	D0	Mean, **+xx.xxx**
				D1	Max, **+xx.xxx**
				D2	Min, **+xx.xxx**
				D3	Bad Samples, **+xxx**
aM9!	Compute Calibration tube temperature	ON	a0012<CL>	D0	Temp. Celsius, **+xx.x**
		OFF	a0032<CL>	D1	Temp. Farenheight, **+xx.x**
aMAtt!	Compute NOS Average on nnn samples Begin sampling in tt (must be two digits) seconds for next nnn samples. nnn samples is pre-programmed. 181 sample default.	ON/OFF	a(time)5<CL> time =nnn + tt + 9 a1905<CL>	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+x**
aMBnnn!	Compute NOS average on last nnn samples. nnn must be three digits Continuous Sample Mode must be enabled.	ON	a(time)5<CL> time = nnn + 9	D0	Mean, **+xx.xxx**
				D1	Sigma, **+0.0xx**
				D2	Outliers, **+xxx**
				D3	Wave, **+xx.x**
				D4	Bad Samples, **+xxx**
aV1!	Load Data Buffers with Setup Parameters.	ON/OFF	a0018<CL>	D0	Number of samples +181+ 15 samples + 30 samples +60 programmable samples
				D1	Polarity+ 68=(D)own + 85 = (U)p
				D2	+ Slope, + Offset + Wave Multiplier
aV2!	Load Data Buffers with Setup Parameters.	ON/OFF	a0017<CL>	D0	Unit of Measure, + 70 (F)eet, + 77 (M)eters
				D1	+ Drive pulse width + Cal blanking + Liquid Blanking + Cal length
				D2	+ Timing Mode: + 83= (S)trict + 82 = (R)elaxed + Continuous Sampling: 1 = On, 0 = Off,
aX2!	Reset Sensor settings only for 2 foot calibration tube.	ON/OFF	a0021<CL>	D0	+2=Sensor 2 foot cal
aX4!	Reset Sensor settings only for 4 foot calibration tube.	ON/OFF	a0021<CL>	D0	+4=Sensor4 foot cal

Table 3-5. SDI-12 Commands (Cont'd)

aXDAn!	Set M! and C! command response type for virtual Sensor A. n is command type 1 through 9	ON/OFF	a0021<CL>	D0	+n= address A M! response: (0-9)
aXDBn!	Set M! and C! command response type for virtual Sensor B. n is command type 1 through 9	ON/OFF	a0021<CL>	D0	+n= address B M! response: (0-9)
aXE2!	Reset 2 foot calibration tube defaults.	ON/OFF	a0021<CL>	D0	+2= Cal Length 2 foot
aXE4!	Reset with 4 foot calibration tube defaults	ON/OFF	a0021<CL>	D0	+4= Cal Length 4 foot
aXI3chars!	Sensor ID, 13 or less characters.	ON/OFF	a0011<CL>	D0	+1 = success, +2 = failure
aXK!	Kill all measurement processes. Disable sampling and reporting.	ON/OFF	a0021<CL>	D0	+1= Kill Processes
aXLn.nnn!	Automatically takes a reading and sets the offset so that subsequent readings at same level will return n.n	ON/OFF	a0041<CL>	D0	+d.ddd= Offset calculated from desired and sample
			a0041<CL>	D1	+dd= Sample Error, Status
aXMfffffff!	Program Slope	ON/OFF	a0021<CL>	D0	+d.dddddd = Slope
aXN0!	Disable continuous sampling.	ON/OFF	a0021<CL>	D0	+0 = Continuous Sampling OFF
aXN1!	Enable continuous sampling.	ON/OFF	a0021<CL>	D0	+1 = Continuous Sampling ON
aXOfff!	Reprogram measurement offset	ON/OFF	a0021<CL>	D0	+d.ddd = Offset (feet)
aXPU!	Set polarity up for increasing with rising level	ON/OFF	a0021<CL>	D0	+85 = Polarity UP
aXPD!	Set polarity down for decreasing with rising level.	ON/OFF	a0021<CL>	D0	+68 = Polarity DOWN
aXQE!	Set Parity Even	ON/OFF	a0021<CL>	D0	+1 = Parity EVEN, can change from NONE
aXQN!	Set Parity None		a0021<CL>	D0	+0 = Parity EVEN, disabled wont change
aXSiii!	Reprogram number of samples to average	ON/OFF	a0021<CL>	D0	+ddd = number of Samples 0-600
aXUM!	Set controller measurement units	ON/OFF	a0021<CL>	D0	+77 = Meters
aXUF!	Set controller measurement units	ON/OFF	a0021<CL>	D0	+70 = Feet
aXWfff!	Set wave multiplier.	ON/OFF	a0021<CL>	D0	+d.dddddd = Wave Multiplier
aXXiii!	Maximum Range	ON/OFF	a0021<CL>	D0	+ddd = Max Range (1-150 feet)
aXY!	Synchronize sampling.	ON/OFF	a0021<CL>	D0	+1 = Sync Sample
aXZiii!	Program number of C6 samples	ON/OFF	a0021<CL>	D0	+ddd = C6 Samples (1-600)

Table 3-6. SDI-12 Commands Legend

a	Sensor address.
b	New address.
c	Character data field.
d	Single digit (0-9)
fff	fff is float, 1 or more digits (0-9 ea), decimal point allowed. Enter negative value with a minus sign following the value (value- instead of –value). The number of digits may not exceed 40, and the printed output may be truncated. For example, an Offset might be entered as 1.345678- and print as -1.346. The entered value, untruncated, would be used in calculations.
iii	iii is an integer value, 1-5 digits (0-9), up to 65,535.
n	Single digit (0-9).
n.n	Decimal data field.
<CL>	Carriage Return and Line Feed.
Temperatures	Temperatures listed as "Temp Celsius" or Temp Farenheight" are computed from the acoustic travel time to/from the sensor and the 2 or 4-foot calibration tube. "Temp-7,20,40 ft +xxxx+xxxx+xxxx are the measurements from the three thermistors. +xxxx represents 4 BCD characters of the digitized value. See table 3-7 below for temperature versus BCD.

Table 3-7. Temperature vs BCD Digital Value

Temp °C	A/D OUT BCD	Temp °C	A/D OUT BCD	Temp °C	A/D OUT BCD
-40	0033	-6	0191	+28	0540
-39	0035	-5	0199	+29	0550
-38	0037	-4	0207	+30	0561
-37	0039	-3	0215	+31	0572
-36	0042	-2	0224	+32	0582
-35	0044	-1	0233	+33	0592
-34	0047	0	0242	+34	0603
-33	0050	+1	0251	+35	0614
-32	0053	+2	0261	+36	0623
-31	0056	+3	0270	+37	0632
-30	0059	+4	0280	+38	0642
-29	0062	+5	0290	+39	0652
-28	0066	+6	0300	+40	0661
-27	0070	+7	0310	+41	0670
-26	0073	+8	0320	+42	0679
-25	0077	+9	0331	+43	0688
-24	0082	+10	0342	+44	0697
-23	0086	+11	0352	+45	0705
-22	0091	+12	0363	+46	0714
-21	0095	+13	0374	+47	0722
-20	0100	+14	0385	+48	0730
-19	0105	+15	0396	+49	0738
-18	0111	+16	0407	+50	0746
-17	0116	+17	0418	+51	0753
-16	0122	+18	0429	+52	0761
-15	0128	+19	0440	+53	0768
-14	0134	+20	0451	+54	0775
-13	0140	+21	0462	+55	0782
-12	0147	+22	0474	+56	0788
-11	0154	+23	0485	+57	0795
-10	0161	+24	0496	+58	0801
-9	0168	+25	0507	+59	0808
-8	0175	+26	0518	+60	0814
-7	0183	+27	0529		

4. AQUATRAK OPERATION

4.1 Leveling the Sensor to a Known Water Level - Option 1

Note:

Now that the AQUATRAK is installed and communicating with the host, it must be leveled to a known datum point in order to provide meaningful water level information.

If the Model 5000 is being installed in close proximity to a standard water level staff, the AQUATRAK can be offset to read the same water level as the staff. This is the simplest method of leveling the sensor.

In Figure 4-1, the illustration shows an AQUATRAK Sensor collocated with a staff gauge reading a water level of 5.6 feet. If the staff has been surveyed (i.e.; referenced to a bench mark), the automatic offset feature of the Model 5000 may be used to match the reported water level with that read from the staff. Follow the steps below to match the Model 5000 to the staff:

4.1.1 Leveling the Sensor Using RS-232 Commands– Option 1

Send an <ESC> to the Model 5000 to cause it to enter the MAIN MENU.

At the MAIN MENU, enter a "1" to enter the USER MENU.

At the USER MENU, observe line “6” and verify that the polarity selected is "U" for up.

If not set to U, enter a “6” to change the polarity - enter a "U" when prompted..

To change the automatic offset, enter a “9”, then enter the correct water level read from the staff (5.6 in this example).

Enter a "Q" to return to the MAIN MENU.

The Model 5000 will now read the same as the staff since the Model 5000 was offset by exact water height on the staff level. As the water rises on the staff, the Aquatrak Model 5000 water level reading will increase, as the water falls, the Model 5000 reading will decrease.

4.1.2 Leveling the Sensor Using SDI-12 Commands– Option 1

While in the SDI-12 command configuration, program the staff level offset as follows:

Send the aXPU to set the polarity to Up.

Then send the aXLn.nnn to enter the desired offset.

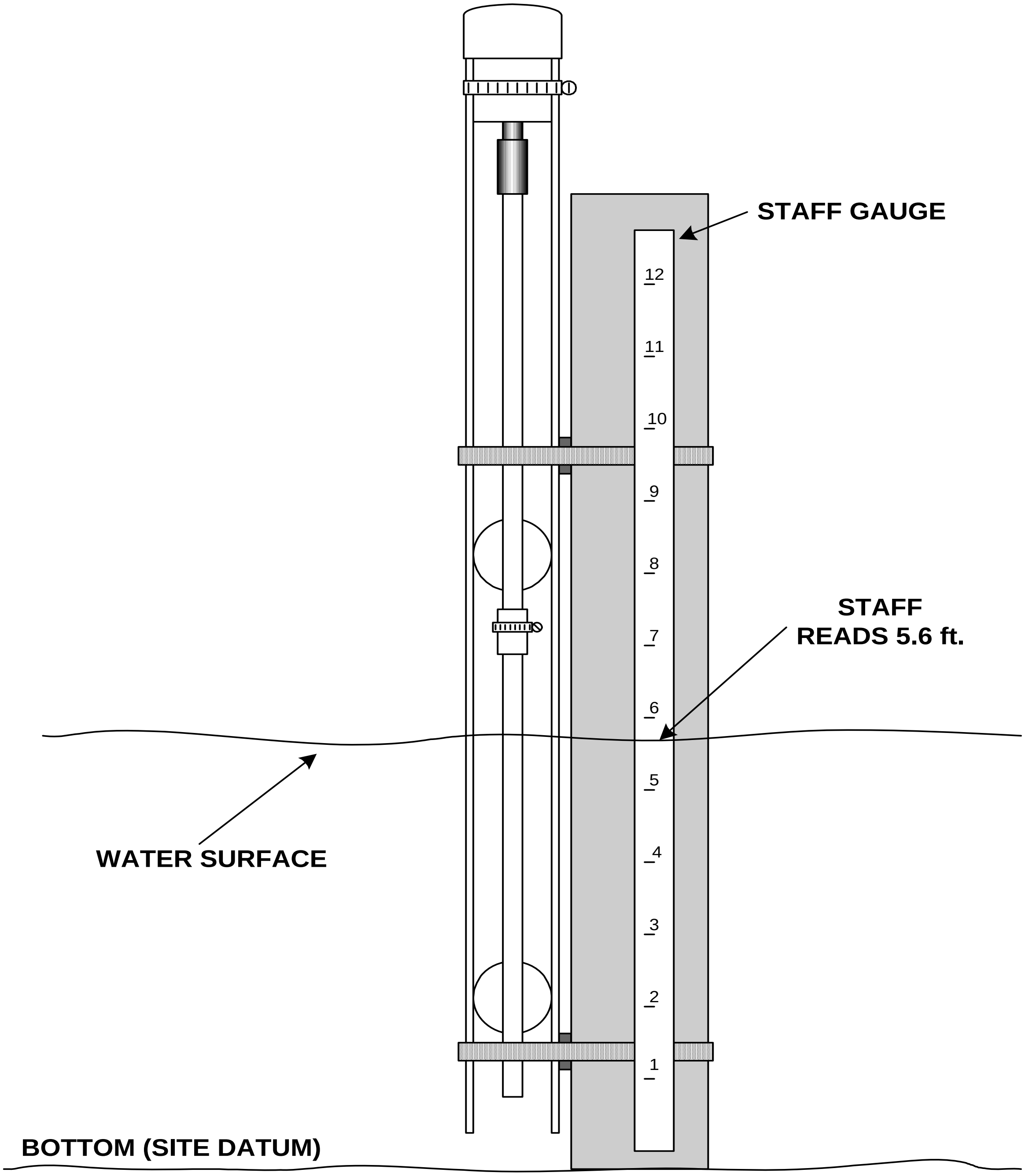


Figure 4-1 Leveling the Sensor to a Staff Gauge

4.2 Leveling the Sensor to a Primary Benchmark - Option 2

Note:

Now that the Model 5000 AQUATRAK is installed and communicating with the host, it must be leveled to a known datum point in order to provide meaningful water level information.

> ***Caution:***
> ***The establishment of the primary bench mark (PBM) may require the services of a trained surveyor.***

If a surveyed water level staff is not available, the Model 5000 must be leveled to another reference. A common reference point is the local primary benchmark (PBM) which may be considered to be the zero datum. When the Model 5000 is first installed and operated, it will correctly report the raw water level height from sensor zero to the surface. But the raw water level must now be referenced to a known point (datum) to have a significant (absolute) meaning to the user.

A convenient leveling reference point on the sensor is at the bottom of the stainless steel collar on the bottom of the Sensor. The distance between the bottom of the collar and the Sensor zero is precisely measured at the factory and recorded on the **AQUATRAK CALIBRATION CERTIFICATE as the '0' Offset.** This distance is shown as the **"S"** dimension in Figure 4.2.

To calculate the offset, determine whether the zero datum point will be above or below the Sensor. Then, survey the length "X" between the zero reference and the bottom of the Sensor collar. Use one of the two formulas below to calculate the offset (depending on zero datum location).

Zero Datum Above			**Zero Datum Below**		
Offset =	-	(X)	Offset =		(X)
	______	(S)		______	(S)
	======			______	

Once the offset is determined, enter the offset value into the Model 5000 using either the RS-232 User Menu as (described in paragraph 4.1.1 above) or enter the offset value using the SDI-12 Commands (described in paragraph 4.1.2 above). Setting the polarity to down (D) will cause falling water levels to show an increasing distance from the zero reference.

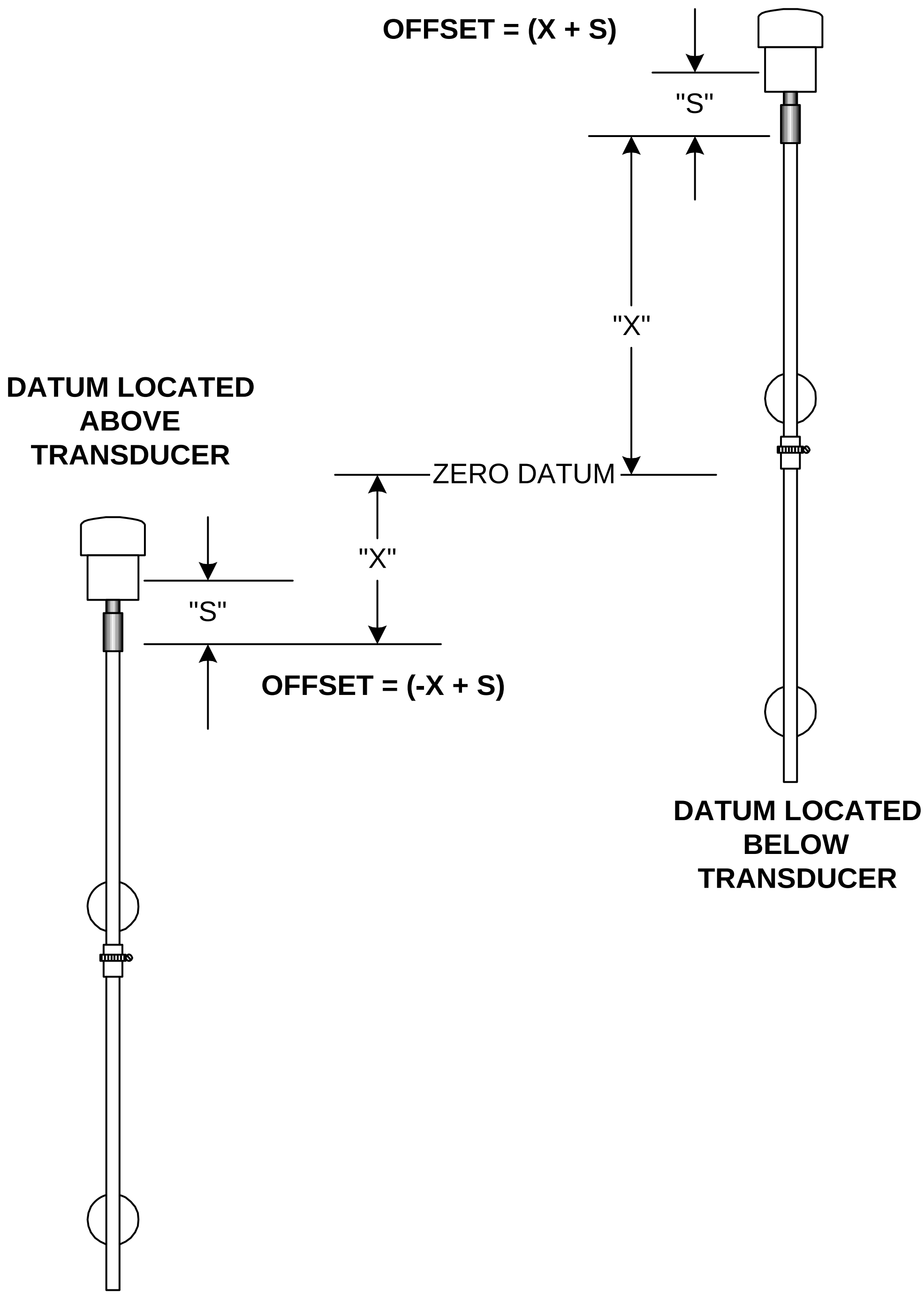


Figure 4-2 Leveling the Sensor to a Datum

APPENDIX

TECHNICAL SPECIFICATION OF MODEL 5000 SERIES AQUATRAK

Measurement		**Accuracy**	
Dynamic Range		Calibration	
Standard	>10 meters (35 feet)	Standard	± 0.025%
Optional	>15 meters (50 feet)	Optional	± 0.01%
Special	23 meters (75 feet)	Nonlinearity	± 0.02%
Rate of Change	± 3 m/sec. (±10 feet)	Precision, Repeatability	± 0.01%
Units	Metric (English)	Stability, Drift, 1 year	0
Resolution	1 mm (0.0033 feet)	Temperature Drift	< 1 ppm/$^{\circ}$C
Rate Proportionate	1.2 = 2.4 per sec.		
Rate Averaged 2 to 255:Samples	1.0 per sec.		
Interval	Host determined		
Electrical		**ASCII Serial Communication**	
Voltage, d.c.	12.5 ± 2 volts	Selectable baud rate:	300 to 9600 (RS-232)
Operating Current	< 7 ma	RS-232	E-7-1
Quiescent Current		SDI-12 (1200 Baud Only)	E-7-1
Environmental		**Physical**	
Operating Temperature	-40 to 55°C	Sensor	8.3 cm dia. 22.8 cm ht.)
		Size	(3.25 in dia. 9 in. ht.)
Storage Temperature	-55 to 60°C	Weight	2.5 lbs. (1.14 kg.)
		Shipping (1 carton)	5 lbs. (2.23 kg.)
Humidity	0 to 100%		

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