AquiStar® PT2X

Pressure/Temperature Smart Sensor and Datalogger

For PSIG sensors, refer to page 12 regarding desiccant use!

AquiStar™
Data Collection Systems

INW

True data, measure by measure

ISO 9001:2008 CERTIFIED

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Introduction

What is the PT2X?

INW's AquiStar® PT2X Smart Sensor is an integrated datalogger and pressure/ temperature sensor and is ideal for monitoring groundwater, well, tank and tidal levels, as well as for pump testing and flow monitoring. This sensor networks with all of the INW AquiStar® Smart Sensor family. Its compatibility with INW's WaveData® Wireless Data Collection technology makes it ideal for remote monitoring.

This industry standard digital RS485 interface device records up to 520,000 records of pressure, temperature and time data, operates with low power, and features easy-to-use software with powerful features. Constructed with 316 stainless steel or titanium, Viton® and Teflon®, this sensor provides high-accuracy readings in rugged and corrosive field conditions.

Two internal AA batteries power the PT2X. (Auxiliary power supplies are available for data intensive applications.) The unit is programmed using INW's easy-to-use Aqua4Plus control software. Once programmed the unit will measure and collect data on a variety of time intervals.

Replace your analog sensor / datalogger with the AquiStar® PT2X as a stand-alone unit or network with other INW AquiStar® Smart Sensors. Most users will use the PT2X with INW's Aqua4Plus software. However, the PT2X is quite versatile, communicating via either Modbus® or SDI-12 interfaces, allowing you to do the following:
- Read a PT2X via the Modbus® protocol using your own software.
- Read a PT2X via SDI-12 protocol.
- Display readings from a PT2X on a panel meter.

If you want to use one of these methods, please contact INW for further details.

Initial Inspection and Handling

Upon receipt of your smart sensor, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage, such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

Check the etched label on the sensor to be sure that the proper range and type were provided. Also check the label attached to the cable at the connector end for the proper cable length.

Do's and Don'ts

Do handle the device with care.

Do store the device in a dry, inside area when not in use.

Do install a desiccant tube if using a gauge sensor.

Do install the device so that the connector end is kept dry.

Don't support the device with the connector. Use a strain relief device to take the tension off the connectors.

Don't allow the device to free-fall down a well as impact damage can occur.

Don't bang or drop the device on hard objects.

How Pressure Sensors Work

Liquids and gasses do not retain a fixed shape. Both have the ability to flow and are often referred to as fluids. One fundamental law for a fluid is that the fluid exerts an equal pressure in all directions at a given level. Further, this pressure increases with an increasing depth of "submergence". If the density of a fluid remains constant (noncompressible...a generally good assumption for water at "normal" pressures and temperatures), this pressure increases linearly with the depth of "submergence".

We are all "submerged" in the atmosphere. As we increase our elevation, the pressure exerted on our bodies decreases as there is less of this fluid above us. It should be noted that atmospheric pressure at a given level does vary with changes in the weather. One standard atmosphere (pressure at sea level at 20º C) is defined to be 14.7 PSI (pounds per square inch).

There are several methods to reference a pressure measurement. Absolute pressure is measured with respect to an ideal vacuum (no pressure). Gauge pressure is the most common way we express pressure in every day life and is the pressure exerted over and above atmospheric pressure. With this in mind, gauge pressure (Pg) can be expressed as the difference between the absolute pressure (Pa) and atmospheric pressure (Patm):

$$Pg = Pa - Patm.$$

To measure gauge pressure, atmospheric pressure is subjected to one side of the system and the pressure to be measured is subjected to the other. The result is that the differential (gauge pressure) is measured. A tire pressure gauge is a common example of this type of device.

Recall that as the level of submergence increases (in a noncompressible fluid), the pressure increases linearly. Also, recall that changes in weather cause the absolute atmospheric pressure to change. In water, the absolute pressure (Pa) at some level of depth (d) is given as follows:

$$Pa = Patm + kd$$

where k is simply a constant (i.e.: 2.307 feet of water = 1 PSI)

INW's standard gauge submersible pressure devices utilize a vent tube in the cable to allow the device to reference atmospheric pressure. The resulting gauge pressure measurement reflects only the depth of submergence. That is, the net pressure on the diaphragm is due entirely to the depth of submergence.
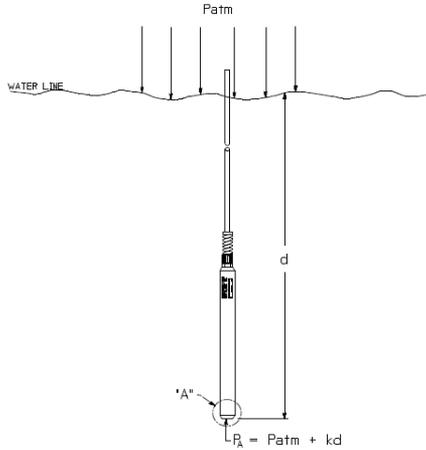
Pressure Diagram: See detail A.
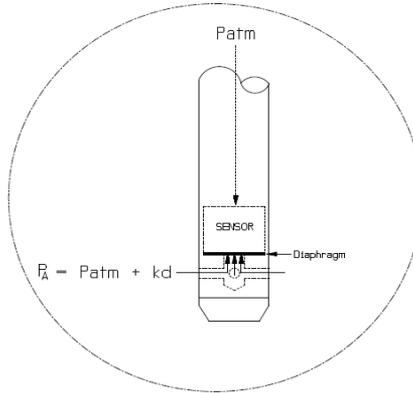
DETAIL "A"

Absolute pressure is given as Pa = Patm + kd (where k is 2.307 feet of water)

Installation and Operation

Connecting External Power

The PT2X comes with two AA internal batteries. This provides enough power for at least one year of operation at the rate of four measurements per hour. (See Battery Life Calculation section in Appendix A for further details.)

If auxiliary power is desired, you can use a 6 - 13 VDC supply that can provide 15 mA. Connect to Vaux++ (pin 1 - white) and Ground (pin 5 - blue) or contact INW for auxiliary power supplies.

Connecting the PT2X to a Computer

Connect the PT2X to your computer's USB port, as shown below. Drivers and instructions come with the adapter. (For alternate connection options, see Appendix D.)
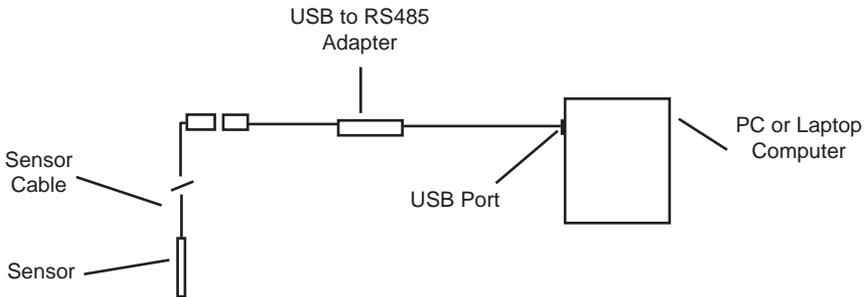
Connect the sensor to your PC using INW's USB to RS485 adapter.
(See Appendix D for alternate connections.)

Installing the Aqua4Plus Software

The PT2X comes with the Aqua4Plus host software that is installed on your PC or laptop. Use this software to program the datalogger, to retrieve data from the logger, to view collected data, and to export data to external files for use with spreadsheets or databases.

Refer to the Aqua4Plus software manual for details on installing and using Aqua4Plus.

Using the PT2X Without Aqua4Plus

Most users will use the PT2X with INW's Aqua4Plus software. However, the PT2X is quite versatile, communicating via either Modbus® or SDI-12 interfaces, allowing you to do the following:

- Read a PT2X via the Modbus® protocol using your own software.
- Read a PT2X via SDI-12 protocol.
- Display readings from a PT2X on a panel meter.

If you want to use one of these methods, please contact INW for further details.

Installing the Sensor

The PT2X measures pressure. The most common application is measuring liquid levels in wells and tanks. In order to do this, the sensor must be installed below the water level at a fixed depth. The installation depth depends on the range of the sensor. One (1) PSI is equal to approximately 2.31 feet of water. If you have a 5 PSI sensor, the range is 11.55 feet of water and the sensor should not be installed at a depth below 11.55 feet. If the sensor is installed below its maximum range, damage may result to the sensor and the output reading will not be correct.

Lower the sensor to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. When securing a vented cable, make sure not to pinch the cable too tightly or the vent tube inside the cable jacket may be sealed off. Take a measurement to insure the sensor is not installed below its maximum range.

Be sure the supplied cap is securely placed on the weather-resistant connector at the top of the cable. Do not install such that the connector might become submerged with changing weather conditions. The connector can withstand incidental splashing but is not designed to be submerged.

If at all possible, install the sensor so that the desiccant tube will not flood or lie in water. (Note: Though the hydrophobic filter will prevent water intrusion via the desiccant tube at one to two feet of submergence, care must still be taken to keep the cable connector from being submerged.)

The sensor can be installed in any position; however, when it leaves the factory it is tested in the vertical position.   Strapping the sensor body with tie wraps or tape will not hurt it.   INW can provide an optional 1/4" NPT input adapter which is interchangeable with the standard end cone for those applications where it is necessary to directly attach the sensor to a pipe, tank or other pipe port. If the sensor is being installed in a fluid environment other than water, be sure to check the compatibility of the fluid with the wetted parts of the sensor.   INW can provide a variety of seal materials if you are planning to install the sensor in an environment other than water.

Collecting Data

Following is a brief overview on using Aqua4Plus to collect data. Please refer to the *Aqua4Plus Instruction Manual* for further details on configuring and using Aqua4Plus.

Real Time Monitor

Click Single to get a single reading.

Click Start to get a reading once a second.

Click Stop to stop the reading.

Note: These are snapshot readings and are not recorded on the sensor. On sensors with firmware versions lower than 2.0, the pressure is displayed in the first column and temperature in the second. On sensors with firmware versions 2.0 and higher, the temperature is displayed in the first column and pressure in the second.

The Real Time Monitor gives a snapshot of the current readings on the sensor.

Setting up a Data Recording Session

Click the ![tool button] tool button. A Session Profile Window will open. Refer to the *Aqua4Plus Instruction Manual* for details in describing your session profile. Click the Start button to save the session to the sensor and begin recording.
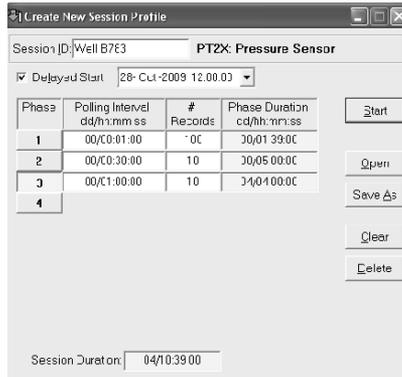
Using the Session Profile Window, describe the test steps for your particular test.

Retrieving Data from the Sensor/Datalogger

- Click on the session you want to upload.
- Click the ![tool button] tool button.
- Select a file location.
- Click Save.
- Click Start.
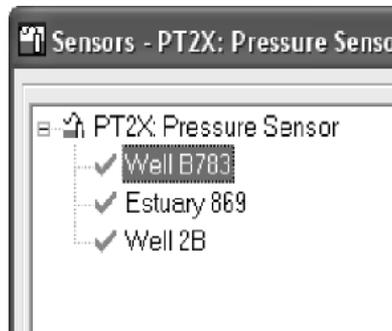
Select the data session you are ready to upload.

Viewing Data

- Click the ⊞ tool button to view data as a table.
- Click the 🔅 tool button to view data as a graph.
- Navigate to the desired file, then click the Open button. (If the File Open box does not appear, click the File Menu, then select Open.)

The File Display window displays your data in a tabular format.
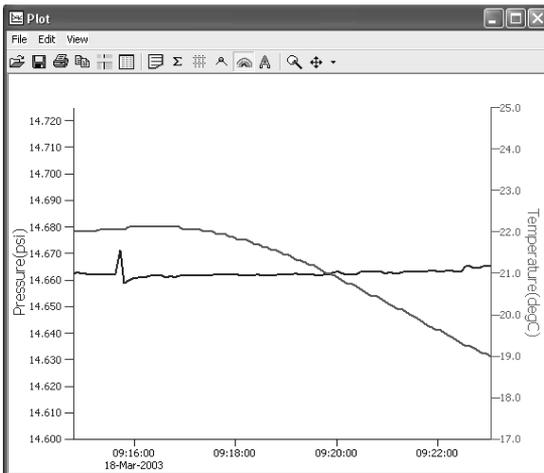
The Graph Window displays your data on an X Y coordinate graph.

Exporting Data to .csv or .xls Files

- Using the File Display window, open the file you want to export.
- Click on the ⬛ tool button.
- Select a file location and enter a name for the file.
- Select a file type.
- Click Save.

A Word About Units

Readings from the PT2X Smart Sensor can be displayed in various units, such as PSI, Ft. H$_2$O, or mm H$_2$O for pressure, or degrees Celsius or degrees Fahrenheit for temperature. Select the units you want from the Options | Units menu.

Maintenance

Changing Batteries

Battery Type: Two standard AA Alkaline batteries.

Because changing the batteries involves opening the water-tight seal, **this must be done in a clean, dry environment to avoid contamination or moisture damage to the circuitry.**

Refer to Appendix F for details on opening the housing and replacing the batteries.

Removing Debris from End Cone

At times mud, silt, or other debris may foul the water inlets to the pressure element. The end cone can be removed to clean out the debris.

Twist Open Housing

1. Gently twist off end cone portion only - do not twist off pressure element!
2. Remove debris. **Take care not to poke anything into the sensor.** This can damage the sensor element and void the warranty.
3. Replace and retighten the end cone.

Pressure element

Water inlet
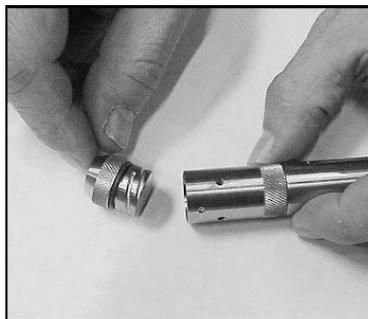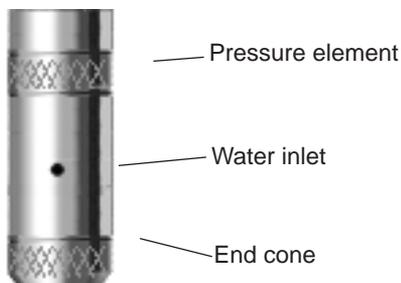
End cone

Gently twist off the end cone, and then carefully remove debris.

Set Screw Housing

1. Remove the two set screws at the bottom of the housing tube, using a 1/16" allen wrench.

2. Gently remove the end cone.

3. Remove debris. **Take care not to poke anything into the sensor.** This can damage the sensor element and void the warranty.

4. Replace the end cone and secure with set screws.

Pressure element

Water inlet
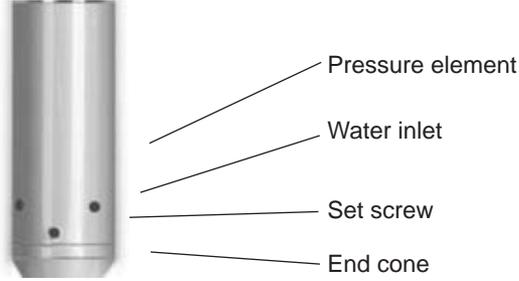
Set screw

End cone

Remove end cone by removing set screws. Gently clean out debris.

Desiccant Tubes

On vented sensors, inspect the desiccant tube at least once every two months. The desiccant tube prevents moisture in the air from being sucked into the vent tube, which can cause erratic readings and sensor damage.

The desiccant tube is filled with blue silica gel beads. A locking barb and a hydrophobic water filter are attached to the end of the desiccant tube. This filter prolongs the life of the desiccant as much as three times over a desiccant tube without the filter.

Install the sensor so that the desiccant tube and cable connector will not flood or lie in water.

The desiccant is a bright blue color when active and dry. As moisture is absorbed the color will begin to fade, becoming a light pink, which indicates full saturation and time to replace. Replacement desiccant and hydrophobic filters can be purchased from INW; please contact an INW sales engineer for more information.

Weather-resistant connector
Vent tube
Desiccant tube
Hydrophobic filter
Cable
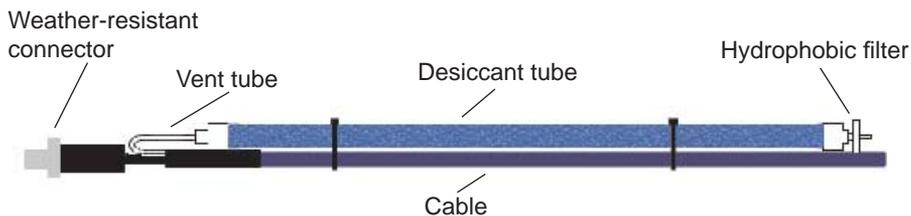
The desiccant tube prevents water intrusion through the vent tube. Be sure to replace the desiccant when it turns pink, as that indicates it is saturated.

Miscellaneous

Sensor: There are no user-serviceable parts, other than the batteries. If problems develop with sensor stability or accuracey, contact INW. If the transducers have been exposed to hazardous materials, do not return them without notification and authorization.

Cable: Cable can be damaged by abrasion, sharp objects, twisting, crimping, crushing, or pulling. Take care during installation and use to avoid cable damage. If a section of cable is damaged, it is recommended that you send your sensor back to replace the cable harness assembly.

End Connections: The contact areas (pins & sockets) of the connectors will wear out with extensive use. If your application requires repeated connections other types of connectors can be provided. The connectors used by INW are not submersible, but are designed to be splash-resistant.

Trouble Shooting

Erratic Readings

Erratic readings can be caused by a poor connection, damaged cable, moisture in the unit, or a damaged transmitter. In most cases, erratic readings are due to moisture getting into the system. The first thing to check is the connection. Look for moisture between contacts or a loose or broken wire. Next, check the cable for cracking or fraying. If the connections and cable appear OK, but the readings are still erratic, the transmitter may be damaged. Contact INW for evaluation and repair. Erratic and erroneous readings can also occur due to improper grounding. See Grounding Issues, below.

Oscillating Readings Over Time

If, after time, your transmitter is functioning normally but your data is showing a cyclic effect in the absence of water level changes, you are probably seeing barometric changes. The amount is usually .5 to 1.5 feet of water. This can be caused by a plugged vent tube in the cable or actual water level changes in the aquifer itself in response to barometric pressure changes. This effect can occur in tight formations where the transmitter will immediately pick up barometric changes but the aquifer will not. If you think you are having this type of problem you will have to record the barometric pressure as well as the water level pressure and compensate the data. If it appears that the vent tube is plugged, consult the factory.

If a desiccant tube is not installed in line with the cable, water may have condensed in your vent tube causing it to plug. After you are finished installing the desiccant tube you can test the vent tube by applying a small amount of pressure to the end of the desiccant tube and seeing if this affects the transmitter reading.

Zero Readings When Pressurized

Continuous zero readings are usually caused by an open circuit which may indicate a broken cable, a bad connection, or possibly a damaged transmitter. Check the connector to see if a wire has become loose or if the cable has been cut. If damage is not readily apparent, contact INW for evaluation and repair.

Grounding Issues

It is commonly known that when using electronic equipment, both personnel and equipment need to be protected from high power spikes that may be caused by lightning, power line surges, or faulty equipment. Without a proper grounding system, a power spike will find the path of least resistance to earth ground – whether that path is through sensitive electronic equipment or the person operating the equipment. In order

to ensure safety and prevent equipment damage, a grounding system must be used to provide a low resistance path to ground.

When using several pieces of interconnected equipment, each of which may have its own ground, problems with noise, signal interference, and erroneous readings may be noted. This is caused by a condition known as a *Ground Loop*. Because of natural resistance in the earth between the grounding points, current can flow between the points, creating an unexpected voltage difference and resulting erroneous readings.

The single most important step in minimizing a ground loop is to tie all equipment (sensors, dataloggers, external power sources and any other associated equipment) to a **single common grounding point.** INW recommends connecting the shield to ground at the connector end.

Appendix A: Technical Specifications

General Specification

The AquiStar® PT2X is a microprocessor based digital intelligent sensor designed to measure and record pressure, temperature and time, utilizing state-of-the-art low power, battery operated circuitry.

Pressure is measured with an extremely rugged and stable piezo-electric media-isolated pressure element combined with a 16-bit delta/sigma analog-to-digital converter. This provides extremely accurate and stable pressure input into the microprocessor on the circuit board. Temperature is measured with a digital temperature chip. The data is stored in non-volatile memory. A serial communication link (RS485) provides communication to the host computer.

Wiring and Component Information

For Modbus® with firmware lower than 2.0 — with 5-pin connector
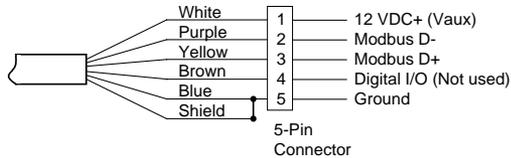
Wire	Pin	Function
White	1	12 VDC+ (Vaux)
Purple	2	Modbus D-
Yellow	3	Modbus D+
Brown	4	Digital I/O (Not used)
Blue	5	Ground
Shield		

5-Pin Connector

For Modbus® with firmware 2.0 or higher — with 5-pin connector
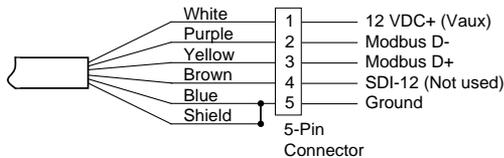
Wire	Pin	Function
White	1	12 VDC+ (Vaux)
Purple	2	Modbus D-
Yellow	3	Modbus D+
Brown	4	SDI-12 (Not used)
Blue	5	Ground
Shield		

5-Pin Connector

For SDI-12 with firmware 2.0 or higher — with 5-pin connector

Wire	Pin	Function
White	1	12 VDC+ (Vaux)
Purple	2	Modbus D- (Not used)
Yellow	3	Modbus D+ (Not used)
Brown	4	SDI-12 Signal
Blue	5	12 VDC – (Gnd)
Shield		
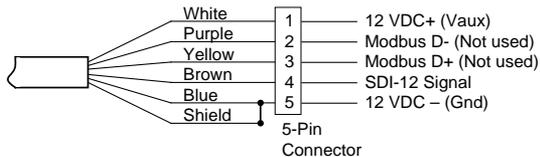
5-Pin Connector

For SDI-12 with firmware 2.0 or higher — without connector

Wire	Function
White	12 VDC+ (Vaux)
Purple	Modbus D- (Not used)
Yellow	Modbus D+ (Not used)
Brown	SDI-12 Signal
Blue	12 VDC – (Gnd)
Shield (may be green)	Earth ground
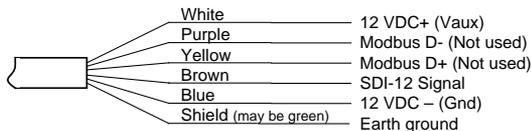
Mechanical:

Transmitter

Length

Cabled	12.175" (30. 881 cm)
Cableless	11.925" (30.281 cm)

Diameter	0.75" (1.9 cm)
Body Material	316 stainless steel or titanium
Wire Seal Materials	Fluoropolymer and PTFE
Desiccant	High- and standard- capacity packs
Terminating Connector	Available
Weight	0.80 lbs.

Cable

OD	0.28" maximum
Break Strength	138 lbs.
Maximum Length	2000 feet
Weight	4 lbs. per 100 feet

Electrical:

Pressure

Static Accuracy	±0.1% FSO (maximum)
(B.F.S.L. 20° C)	±0.05% FSO (typical)
Maximum	±0.25% FSO
Zero Offset at 25° C	
Resolution	16 bit
Ranges Available	1 PSI to 500 PSI
	(contact INW for higher ranges)
Over Range Protection	2x (except 300 PSI and higher)

Compensated Temperature Range	0° C to 40° C
Operating Temperature Range	-5° C to 70° C
Storage Temperature Range	-20° C to 100° C

Contact factory for extended temperature ranges.

Cabled Version   **Cableless Version**

Vented or Unvented Cable

Screw Cap

Patented Cable Harness
(Top-Cap)

O-Rings

Service Connector

User-replaceable
AA batteries

PT2X Sensor/Datalogger
Circuit Board, containing
non-volatile data storage

Pressure Element

Water Inlets

End Cone -
interchangeable with
1/4" NPT

12.175" (30.881 cm) Twist Open Housing

11.925" (30.281 cm) Twist Open Housing

0.75"
Twist Open Housing

0.75"
Twist Open Housing

Sensor Components

Continuous Rate and Filter Settings

Continuous Rate:

The PT2X can take readings more often than once per second. This is known as a "continuous rate." Set the continuous rate for the PT2X from the Configure Menu | Sensor Continuous Rate.

Firmware Version	Available settings
1.0 and above	Exactly 2, 4, or 8 readings per second
0.22, 0.23, 0.24	Approximately 2, 3, 4, 5, 6, or 10 readings per second
0.18	Approximately 10 readings per second

To use the continuous rate during a session, enter a "c" in the Polling Interval.

Filter Settings:

The PT2X has the ability to apply some filtering to incoming data in order to smooth out minor variations in readings. This filter can be from 1 (no filtering) to 8 (maximum filtering.) Different versions of firmware have different filtering options as shown below. For further information on PT2X data filtering, see INW application note *Filter Response on PT2X Smart Sensor* (9C0530).

Firmware Version	Filtering
1.3 and above	Can be set from 1 (no filtering) to 8 (maximum filtering) from the Advanced option on the Configure menu.
1.0 - 1.2	Filter is set to 1 (no filtering). Adjustable filtering can be obtained by upgrading to a higher firmware version.
0.24	Filter is permanently set to 1 (no filtering).
0.23 and lower	Filter is permanently set to 8 (maximum filtering).

Battery Life Calculation

The PT2X has been designed for very low power consumption. When not in active use, the unit goes into a "sleep" mode, waking only to take readings or communicate with the host computer.

It is difficult to know how fresh particular batteries are. Just sitting on a shelf, especially in a warm environment, will cause the batteries to lose energy. If the batteries are stored in a cold environment, the self-discharge will be less, but the batteries won't provide as much energy output when they're cold. Under optimum conditions, two fresh AA alkaline batteries should provide 15,000 Joules of energy. To give yourself some margin, INW recommends that you assume approximately 12,000 Joules.

When sleeping, the PT2X consumes approximately 150 Joules per week. Each reading consumes approximately .075 Joules. Communicating with the sensor for one minute, to upload data or take real-time readings, for instance, consumes approximately two Joules.

Use the following formulas to calculate your battery life:

Compute Weekly usage:
Readings usage = number of readings per hour * 24 hours * 7 days * .075 Joules
Communications usage = minutes of communication per week * 2 Joules
Sleep time usage = 150 Joules
Total weekly usage = reading + communication + sleep usage

Compute life of batteries:
Life of batteries in weeks = 12,000 Joules / Total weekly usage

Example:
4 readings per hour, 1 minute of communication per week

Readings usage = 4 * 24 hours * 7 days * .075 Joules = 50 Joules
Communication usage = 1 * 2 Joules = 2 Joules
Sleep time usage = 150 Joules
Total weekly usage = 50 + 2 + 150 = 202 Joules
Life of battery = 12,000 / 202 = 59 weeks (approximate)

Appendix B: Field Calibration (Pressure)

Calibration can only be done when there are no sessions stored on the sensor. If there are any sessions stored on the sensor, upload any data you want and then erase the session before continuing.

Before leaving the factory, your PT2X has been calibrated using precision pressure sources and thermal chambers. However, you may wish to run a field calibration from time to time for one or more of the following reasons.
- You want to set a specific zero reference point - use a 1- or 2-point calibration.
- You suspect you may have some zero drift on your sensor - use a 1- or 2- point calibration.
- You suspect you may have some gain drift on your sensor (rare) - use a 2-point calibration.
- You are measuring in a fluid with a density other than that of fairly pure fresh water - use a 2-point calibration.

Preparation:
- Run Aqua4Plus and scan for sensors.
- On the Sensor Map, click the sensor you want to calibrate.
- From the Options Menu, select the units you want to use to measure pressure, i.e., psi, feet of water, inches of mercury, etc.
- From the Configure Menu, select Field Calibration.
- Click on Pressure in the left panel.

One-Point Calibration:
— Computing Calibration Value —
- Place sensor in the fluid you are measuring at a precise known level.
- In the *Ref* box for the first point, enter this level or pressure.
- Click first *Measure* button.
- When readings have stabilized to your satisfaction, click the *OK* button in the pop-up box.

— Applying Calibration Value —
- Click the *Apply* button to apply calibration value.
- The computed b value will be transferred to the calibration field.
- Click *OK* to save the value to the sensor.

— Verifying Calibration Value —
- Using the Real Time Monitor, take a few readings while the sensor is still at the precise known level. Readings should be very close to that level.

<u>Two-Point Calibration:</u>

— Compute First Calibration Point —

- Place sensor in the fluid you are measuring at a precise known level.
- In the *Ref* box for the first point, enter this level or pressure.
- Click first *Measure* button.
- When readings have stabilized to your satisfaction, click the *OK* button in the pop-up box.

— Compute Second Calibration Point —

- Place sensor in the fluid you are measuring at a second precise known level.
- In the *Ref* box for the second point, enter this level or pressure.
- Click second *Measure* button.
- When readings have stabilized to your satisfaction, click the *OK* button in the pop-up box.

— Applying Calibration Values —

- Click the *Apply* button to apply calibration values.
- The computed m and b values will be transferred to the calibration fields.
- Click *OK* to save the values to the sensor.

— Verifying Calibration Values —

- Using the Real Time Monitor, take a few readings while the sensor is still at the second precise known level. Readings should be very close to that level.

Appendix C: Measuring Elevation or Depth-to-Water

The purpose of this appendix is to provide a simple description for configuring a PT2X Smart Sensor for monitoring depth-to-water or groundwater elevation, using the Aqua-4Plus Control Software.

In normal configuration, the PT2X returns a pressure measurement relative to the water above the sensor. This can be expressed in psi, feet of water, inches of mercury, or a number of other units - however, it is always relative to the water above the sensor.

Often an engineer will need to know the depth-to-water or the elevation of the water. Using Aqua4Plus' field calibration abilities, the PT2X can be configured to display depth-to-water or elevation.

Depth-to-Water Calibration

> **NOTE: When using Depth-To-Water, you may want to change the channel label at the top of the Field Calibration window to read "Depth". (Label not available on PT2X version 1.5 or earlier.)**

— Computing Offset —
- Checkmark the box labeled ***Compute pressure as depth to water***.
- If you are using a gauge (PSIG) sensor:
    1. Using a water level indicator or other measuring device, determine the depth to water.
    2. Enter this level in the ***Ref*** box.
- If you are using an absolute (PSIA) sensor * :
  (See also important note on next page)
    1. Using a water level indicator or other measuring device, determine the depth to water.
    2. Obtain the current barometric reading from another device. (Note: be sure to use the same units as you are using in Aqua4Plus, e.g., if you are using Ft H2O in Aqua4Plus, use Ft H2O on the barometric reading.)
    3. Subtract the barometric reading from the value you read from the water level indicator.
    4. Enter this level in the ***Ref*** box.
- Click the ***Measure*** button.
- When readings have stabilized to your satisfaction, click the ***OK*** button in the pop-up box.

— Applying Calibration Values —
- Click the ***Apply*** button to apply calibration values.
- The computed m and b values will be transferred to the calibration fields.
- Click ***OK*** to save the values to the sensor.

Groundwater Elevation Calibration

— Computing Offset —
- Place sensor in well
- If you are using a gauge (PSIG) sensor:
    1. Using a water level indicator or other measuring device, determine the depth to water.
    2. Subtract this from the elevation at the top of the casing.
    3. Enter this value in the *Ref* box for the first point.
- If you are using an absolute (PSIA) sensor * :
    (See also important note below)
    1. Using a water level indicator or other measuring device, determine the depth to water.
    2. Obtain the current barometric reading from another device. (Note: be sure to use the same units as you are using in Aqua4Plus, e.g., if you are using Ft H2O in Aqua4Plus, use Ft H2O on the barometric reading.)
    3. Subtract the water level reading (from step 1) from the elevation at the top of the casing.
    4. Add the barometric reading from step 2 to the result of step 3.
    5. Enter this level in the *Ref* box for the first point.
- Click first *Measure* button.
- When readings have stabilized to your satisfaction, click the *OK* button in the pop-up box.

— Applying Offset —
- Click the *Apply* button to apply the offset.
- The computed *b* value will be transferred to the calibration field.
- Click *OK* to save the value to the sensor.

IMPORTANT NOTE!

When taking readings with an absolute sensor:

- You will need to **ADD** the current barometric pressure to the sensor reading to get depth-to-water.
- You will need to **SUBTRACT** the current barometric pressure from the sensor reading to get elevation.

See the Barometric Compensation Utility Application Note (9C0275) for information on how the Barometric Utility can help automate this process.

Appendix D: Alternate Connection Options

Connecting via RS232 Serial Port

In its cabled configuration, the sensor cable is terminated with a weather-resistant connector. In its cableless configuration, the sensor is terminated with a weather-resistant connecter inside a screw-cap. Connect the weather-resistant connector to your computer's serial port as shown below.
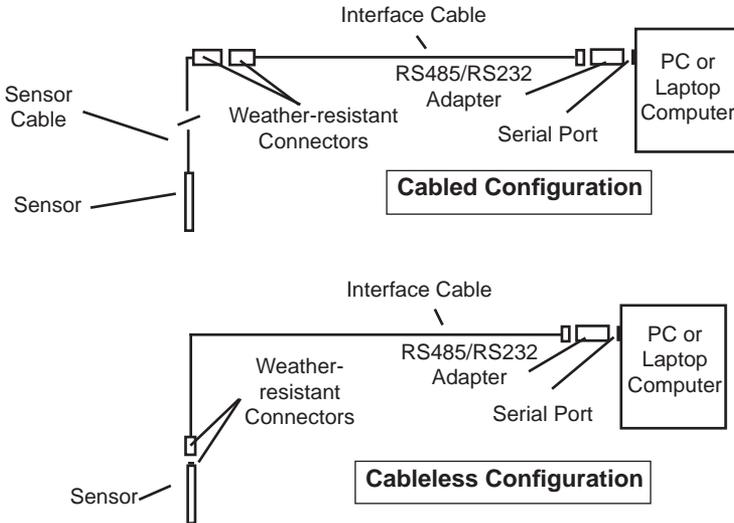
Connect the sensor to your computer using an RS485/RS232 adapter and an interface cable.

Connecting with a USB/Serial Adapter

USB-to-Serial cables are readily available from many electronics and computer stores, as well as numerous sites on the Internet. INW has tested and recommends the Keyspan USA-19HS. It is available from INW as well as from many sites on the Internet. Install as follows:

- Plug into USB port.
- Install the drivers provided with the particular unit.
- Determine the port number to which the adapter is assigned.
  - Right-click on My Computer.
  - From the popup menu, select Manage to open the Computer Management window.

- □ On left panel, click on Device Manager.
- □ On right panel, double-click on Ports.
- □ A list of active COM ports will be displayed. Note the COM number assigned to the adapter you just installed.
  For example: 🖳 Keyspan USB Serial Port (COM4)
- □ Close Manager.
- Connect to the sensor.
- On the Aqua4Plus software, select the COM port noted above. (If you do not see your new COM port in the dropdown box, open the Communications dialog box from the Options menu. Increase the Highest COM port number, up to a maximum of 15.)
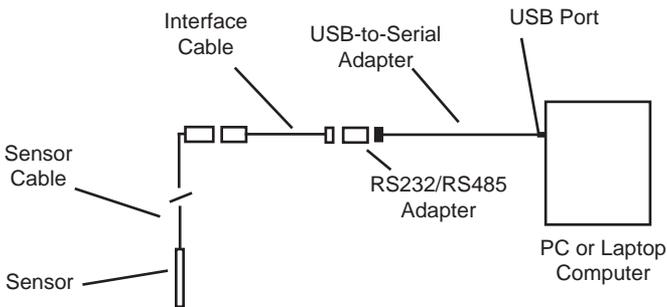
Connection using a USB to Serial Adapter

Appendix E: Reading the PT2X via Direct Read

While the PT2X comes with INW's easy to use Aqua4Plus software, you can also use standard Modbus® RTU or SDI-12 equipment to easily take readings, so as to tie into your existing equipment or networks.

You may need to use Aqua4Plus to make a few settings, prior to directly reading the PT2X with your equipment. For one thing, you may want to change the units for returned values. If reading via Modbus, you may also need to set the baud rate. (You do not need to set the baud rate for SDI-12). These are described in the following sections.

For Modbus direct read, you must have PT2X firmware 1.5 or higher. For SDI-12, you must have firmware 2.0 or higher.

Setting Units for Direct Read

By default, the PT2X uses the following units:

Temperature	Degrees Celsius
Pressure	PSI

However, you can select from a variety of units for direct read measurements. If you want to change to different units, for example, degrees Fahrenheit for temperature or feet of water for pressure, set these units using Aqua4Plus.

- Click on the Configure menu, and then select Advanced.
- From the flyout menu, select Direct Read Units.
- On the popup box, click the down-arrows next to the channel types you want to change, and then select the units you want.
- Click OK
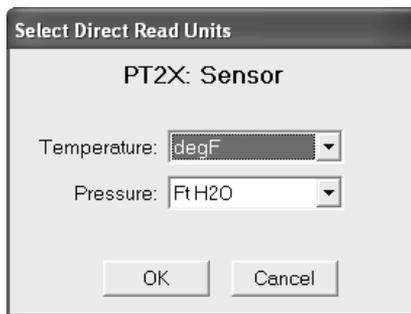
Use Aqua4Plus to select the units for your direct read measurements, whether Modbus or SDI-12.

Once set, these units are saved on the sensor and direct readings, either via Modbus or via SDI-12, will return values using these units. (Note: These settings do not affect the units used on the Aqua4Plus display. Refer to the Aqua4Plus software manual for details on using Aqua4Plus.)

Reading Via Modbus® RTU

Setting Baud Rate
Your PT2X comes configured to communicate at 38,400 baud, with 8 data bits, one stop bit, and no parity. The sensor can also be set to 19,200 or 9600 baud, if needed for your application.

If needed, set your PT2X to the desired baud rate as follows:
- Click on the Configure menu, and then select Advanced.
- From the flyout menu, select Sensor Baud Rate. (You may be asked for a password. Enter admin.)
- On the popup box, click the down-arrow and select the baud rate you need, and then click OK.

Once you have changed the baud rate on the PT2X, you will not be able to talk to it with Aqua4Plus until you change the baud rate for Aqua4Plus, as follows:
- Click the Options menu, and then select Baud Rate.
- On the popup box, click the down-arrow, select the baud rate you need, and then click OK.

The current Aqua4Plus baud rate is displayed in the lower right corner of the main Aqua4Plus window.

Taking Measurements
Reading Registers
Read measurements using Modbus function 03 – Read Holding Registers. Readings are located in two registers each, starting at address 62592. (PT2X register addressing is zero based, i.e., starts at zero. If your equipment uses one based addressing, you will need to add one to the register addresses.)

Register addresses for PT2X

Addresses for PT2Xs with firmware lower than 2.0

	Zero Based	One Based
Pressure	62592	62593
Temperature	62594	62595

Addresses for PT2Xs with firmware 2.0 or higher

	Zero Based	One Based
Temperature	62592	62593
Pressure	62594	62595

Measurement Timing

When you request a reading via Modbus, the sensor wakes up, returns the current values in the registers, and then starts taking new readings and updating the registers. After approximately 10 seconds, if no more readings have been requested, the sensor goes back to sleep.

Because of this, the first reading you get will be old. If you are taking readings at intervals of less than 10 seconds, simply ignore the first reading — all remaining readings will be current. On the other hand, if you are taking readings at intervals of greater than 10 seconds, take a reading, ignore it, wait one second, take another reading. Record this second reading.

Data Format

The data is returned as 32-bit IEEE floating-point values,highword first, also referred to as big-endian or float inverse.

For further information and detailed Modbus examples, see INW application note, *"Modbus Direct Read on Aquistar smart Sensors"* available from our we site at http://www.inwusa.com/appnotes.htm
as big-endian or float inverse.

For further information and detailed Modbus examples, see INW application note, "*Modbus Direct Read on AquiStar Smart Sensors*" available from our web site at http://www.inwusa.com/appnotes.htm.

Reading Via SDI-12

Note: The default units setting for pressure is PSI. The default units setting for temperature is Celsius. To change these, use the Direct Read Units option under the Configure | Advanced menu in the Aqua4Plus Control Software.

Addressing
Default SDI-12 Address: 0

SDI-12 Command Nomenclature
\<a\> = Sensor address
{crc} = SDI-12 compatible 3-character CRC
\<cr\> = ASCII carriage return character
\<lf\> = ASCII line feed character
highlighted values indicate variable data

SDI-12 Commands
//*** Sensor Identification
\<a\>I! \<a\>13 INWUSA PT2X**2.1ssssssssss**\<cr\>\<lf\>
                                                    // note: **2.1** will change to reflect current
                                                             // firmware revision
                                            // ssssssssss = device serial #

//*** Acknowledge Active, Address Query
\<a\>! \<a\>\<cr\>\<lf\>
?! \<a\>\<cr\>\<lf\>

//*** Change Address
\<a\>A\<b\>! \<b\>\<cr\>\<lf\>   // change address to \<b\>

//*** Request measurement
\<a\>M! \<a\>0022\<cr\>\<lf\>   // request all measurements
\<a\>D0! \<a\>**+22.0512+12.0512**\<cr\>\<lf\>   // read temperature
                                            // pressure

\<a\>M1! \<a\>0021\<cr\>\<lf\>   // request temperature measurement only
\<a\>D0! \<a\>**+22.0512**\<cr\>\<lf\>   // read temperature

\<a\>M2! \<a\>0021\<cr\>\<lf\>   // request pressure measurement only
\<a\>D0! \<a\>**12.0512**\<cr\>\<lf\>   // read pressure

```
//*** Request measurement with CRC
<a>MC! <a>0022<cr><lf>                        // request all measurements with CRC
<a>D0! <a>+22.0512+12.0512{crc}<cr><lf>       // read temperature
                                              // pressure

<a>MC1! <a>0021<cr><lf>                       // request temperature measurement only
                                              // with CRC
<a>D0! <a>+22.0512{crc}<cr><lf>               // read temperature

<a>MC2! <a>0021<cr><lf>                       // request pressure measurement only
                                              // with CRC
<a>D0! <a>12.0512{crc}<cr><lf>                // read pressure

//*** Concurrent measurement
<a>C! <a>00202<cr><lf>                        // request all measurements
<a>D0! <a>+22.0512+12.0512<cr><lf>            // read temperature
                                              // pressure

<a>C1! <a>00201<cr><lf>                       // request temperature measurement only
<a>D0! <a>+22.0512<cr><lf>                    // read temperature


<a>C2! <a>00201<cr><lf>                       // request pressure measurement only
<a>D0! <a>12.0512<cr><lf>                     // read pressure

//*** Concurrent measurement with CRC
<a>CC! <a>00202<cr><lf>                        // request all measurements with CRC
<a>D0! <a>+22.0512+12.0512{crc}<cr><lf>       // read temperature
                                              // pressure

<a>CC1! <a>00201<cr><lf>                      // request temperature measurement only
                                              // with CRC
<a>D0! <a>+22.0512{crc}<cr><lf>              // read temperature

<a>CC2! <a>00201<cr><lf>                      // request pressure measurement only
                                              //  with CRC
<a>D0! <a>12.0512{crc}<cr><lf>                // read pressure
```

For further information and SDI-12 examples, see INW application note, "*PT2X SDI-12 Interface Specification*" available from our web site at
www.inwusa.com/pdfs/pt2x_sdi12_spec.pdf

Appendix F: Battery Changing Details

<u>**Battery Type:**</u> Two standard AA Alkaline batteries.

Because changing the batteries involves opening the water-tight seal, **this <u>must</u> be done in a clean, dry environment to avoid contamination or moisture damage to the circuitry.**

Tips

- Never place a tool on the sensor body, it is very thin and will deform causing leaks at o-ring seals and potentially crushing the circuit board!
- Always twist the sensor body off the top cap assembly rather than twisting the top cap assembly off of the sensor body.
- For cabled sensors, always clamp the sensor on the swaged area when applicable, the shoulder above it will allow you to press down without the worry of the sensor slipping out of the clamping device.
- If the sensor body is slippery or you are unable to grip it hard enough to twist, try a piece of rubber cabinet liner for additional friction.

Opening the Housing

There is a black, compressible square ring near the top of the sensor. This ring acts as a spring to lock the cable in. This needs to be compressed in order to allow removal of the top cap. Once this ring is compressed, a gentle counterclockwise twist is all that is needed to remove the cable from the sensor body. Compressing the black square ring does take force, **twisting does not**.
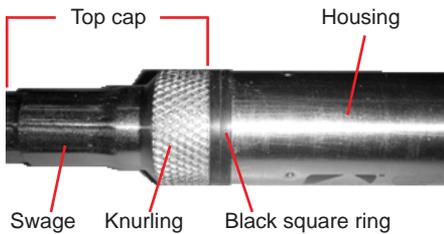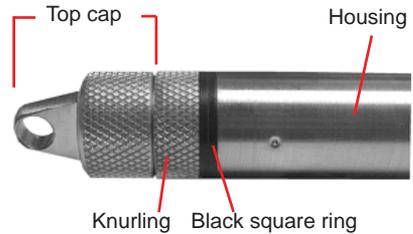
Cabled Sensor   *Cableless Sensor*

Care must be taken to compress the black square ring before attempting to twist the housing. **Forceful twisting of the housing can permantently damage the sensor**.

Securing the sensor

In order to compress the black square ring, the sensor must be secured so that you can apply downward pressure to compress the ring. This can be done by holding in your hand, using a vise, or using pliers, as detailed below.

By Hand - cabled version only

1. Tightly grasp the top cap in one hand.
2. Brace your hand against something such as a table or the ground. (Do not allow the cable to be pinched against the brace.)

Continue to **Removing the Housing** on the next page.

With Vise - recommended method

Cabled Sensor

1. If possible, use a set of soft jaws as shown to prevent marring the surfaces of the top cap assembly.
2. Place the sensor in a vise clamping gently on the swaged area. You do not need to clamp the vise very hard.

Continue to **Removing the Housing** on the next page.

Cabled Sensor - gripping on swage

Cableless Sensor

1. If possible, use a set of soft jaws as shown to prevent marring the surfaces of the top cap assembly.
2. Remove the cableless top cap.
3. Place the sensor in a vise clamping gently on the knurled area. You do not need to clamp the vise very hard.

Continue to **Removing the Housing** on the next page.

Cableless Sensor - gripping on knurled area

With Pliers or Vise Grips - good for field use

Cabled Sensor

1. Grasp the pliers on the swaged area (do not grab the knurled diameter).
2. Find a hard edge and place the tips or side of the jaws of the pliers onto this edge as shown. This will allow you to press down with your weight to compress the square ring.

Continue to **Removing the Housing** below.

Cableless Sensor

1. Leave the cableless cap on in order to protect the pins inside.
2. Grasp the pliers on the knurled area tightly being careful to avoid grabbing the knurled cap.
3. Find a hard surface and place the cableless cap down onto it. This will allow you to press down with your weight to compress the square ring.

Continue to **Removing the Housing** below.

Cabled Sensor

Cableless Sensor

Removing the Housing

1. With your free hand, grasp the sensor body. Press down to compress the square ring. Twist gently. Once the body begins to twist, you can stop the compression action.
2. Finish gently twisting until the sensor body is removed.
3. Carefully disconnect the wiring connector inside from the circuit board in the top cap.

Replacing Batteries and Resealing Sensor

1. Gently pull wiring to one side in order to allow batteries to fall out. Shake gently if needed.
2. Replace batteries with button (+) facing open end.
3. Reinstall wiring connector — it only goes in one way, so make sure not to force it.

Pull wires gently to the side to allow battery removal.

Connector connected properly

4. Hold the top cap assembly at 90° to the housing opening as shown. Depress the spring with your fingertip and tuck the wiring into the cutaway on the circuit board with your thumb to protect it while being installed back into the housing.
5. Rotate the top cap assembly into the opening in the housing being very careful not to nick or pinch any wires.
6. Gently press down until the assembly stops and then twist it into place. It will click in and decompress the gasket when it is fully engaged.

Wires tucked into slot and spring tucked into housing.

Push top cap in before twisting and locking.

Properly completed — black ring uncompressed

Reordering Information

For sales & service offices, please contact:

Instrumentation Northwest, Inc.
www.inwusa.com
800-776-9355

LIMITED WARRANTY/DISCLAIMER - AquiStar® PT2X SUBMERSIBLE PRESSURE /TEMPERATURE SENSOR

A.   Seller warrants that products manufactured by Seller when properly installed, used and maintained **with a properly installed desiccant tube**, shall be free from defects in material and workmanship.   Seller's obligation under this warranty shall be limited to replacing or repairing the part or parts or, at Seller's option, the products which prove defective in material or workmanship within ONE (1) year from the date of delivery, provided that Buyer gives Seller prompt notice of any defect or failure and satisfactory proof thereof.   Any defective part or parts must be returned to Seller's factory or to an authorized service center for inspection.   Buyer will prepay all freight charges to return any products to Seller's factory, or any other repair facility designated by Seller.   Seller will deliver replacements for defective products to Buyer (ground freight prepaid) to the destination provided in the original order.   Products returned to Seller for which Seller provides replacement under this warranty shall become the property of Seller.

This limited warranty does not apply to lack of performance caused by abrasive materials, corrosion due to aggressive fluids, mishandling or misapplication.   Seller's obligations under this warranty shall not apply to any product which (a) is normally consumed in operation, or (b) has a normal life inherently shorter than the warranty period stated herein.

In the event that equipment is altered or repaired by the Buyer without prior written approval by the Seller, all warranties are void.   Equipment and accessories not manufactured by the Seller are warranted only to the extent of and by the original manufacturer's warranty.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY.   IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY.   SELLER'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES THEREUNDER (EXCEPT AS TO TITLE) ARE SOLELY AND EXCLUSIVELY AS STATED HEREIN.   IN NO CASE WILL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES, LABOR PERFORMED IN CONNECTION WITH REMOVAL AND REPLACEMENT OF THE SENSOR SYSTEM, LOSS OF PRODUCTION OR ANY OTHER LOSS INCURRED BECAUSE OF INTERRUPTION OF SERVICE.   A NEW WARRANTY PERIOD SHALL NOT BE ESTABLISHED FOR REPAIRED OR REPLACED MATERIAL, PRODUCTS OR SUPPLIES. SUCH ITEMS SHALL REMAIN UNDER WARRANTY ONLY FOR THE REMAINDER OF THE WARRANTY PERIOD ON THE ORIGINAL MATERIALS, PRODUCTS OR SUPPLIES.

B.   With respect to products purchased by consumers in the United States for personal use, the implied warranties including but not limited to the warranties of merchantability and fitness for a particular purpose, are limited to twelve (12) months from the date of delivery.

Some states do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you.   Similarly, some states do not allow the exclusion or limitation of consequential damages, so the above limitation or exclusion may not apply to you.   This limited warranty gives you specific legal rights; however, you may also have other rights which may vary from state to state.

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