INSTRUCTION MANUAL

AquiStar® PT12

Pressure/Temperature Sensor

For PSIG sensors, refer to page 7 regarding desiccant use!

AquiStar™
Data Collection Systems

INW™ True data, measure by measure

ISO 9001:2008 ISO CERTIFIED

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Introduction

PT12 Pressure/Temperature Transducer

The PT12 Pressure Transducer represents the latest state-of-the-art technology and has been designed to provide trouble-free submersible operation in liquid environments, when properly installed and operated. This sensor communicates via SDI-12 (v1.3) or Modbus® protocol.

INW also carries a special version of the PT12 designed to measure barometric pressure in reference to absolute pressure. If you are using an absolute PT12, contact your INW representative for details on how our PT12-BV or PT12-BV/Compensator can facilitate obtaining barometrically compensated pressure/level.

Please take the time to read through this manual if you are not familiar with this product.

Initial Inspection and Handling

Upon receipt of your transducer, 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 transducer 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 you are doing long-term outdoor monitoring.

Don't install the device so that the connector end is submerged.
Don't support the device with the connector or with the connectors of an extension cable. Use a strain relief device to take the tension off the connectors.
Don't allow the device to free-fall down a well at high velocities as impact damage can occur.
Don't bang or drop the device on hard objects.
Don't disassemble the device. (The warranty is void if transducer is disassembled.)

How Pressure Sensors Work

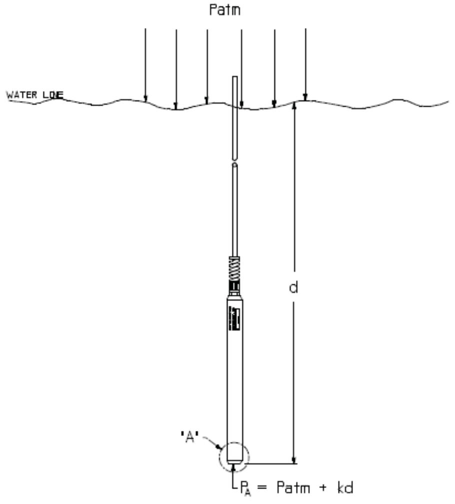
The following paragraphs outline the basics of how pressure is measured using submersible pressure transducers:

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 on a "normal" day) 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):

$$Pg = Pa - Patm$$



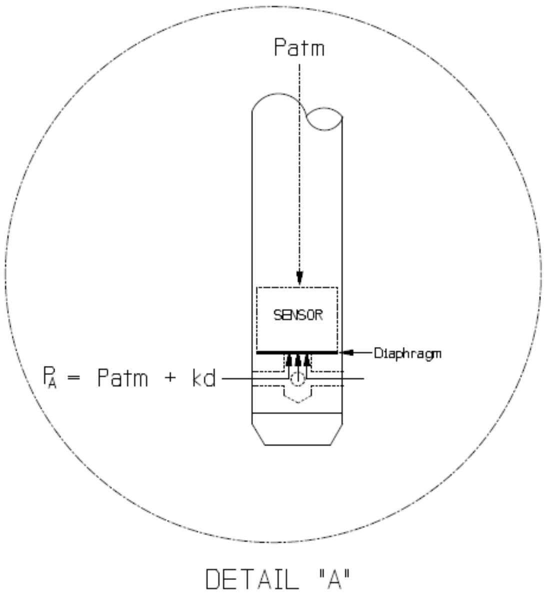
Pressure Diagram

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 an incompressible 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 ft of water = 1 PSI)



Pressure Diagram, Detail "A"

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.

Installation & Operation

The PT12 measures pressure, temperature, and supply voltage. The most common application is measuring liquid levels in wells and tanks. In order to do this, the transducer must be installed below the water level at a fixed depth. The installation depth depends on the range of the transducer. One (1) PSI is equal to approximately 2.31 feet of water. If you have a 5 PSI transducer, the range is 11.55 feet of water and the transducer should not be installed at a depth below 11.55 feet. If the transducer is installed below its maximum range, damage may result to the transducer and the output reading will not be correct.

Sensor/Datalogger Configuration

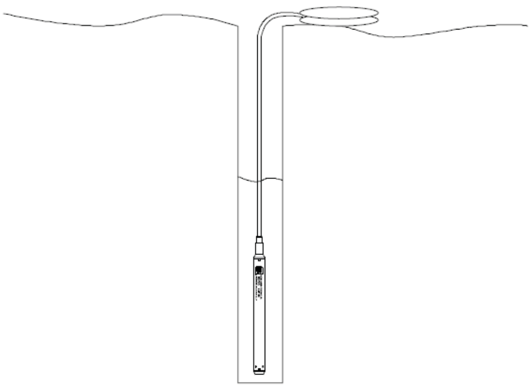
The PT12 submersible pressure/temperature transducer is designed for use with SDI-12 or Modbus® dataloggers. See Appendix A for wiring information. See Appendix B for SDI-12 communication or Appendix C for Modbus® communication.

Every sensor is individually calibrated at the factory, using an environmental test chamber and dead-weight tester. Sensor specific calibration values are stored in the sensor. When taking measurements, the internal microprocessor uses these calibration values to thermally compensate the pressure readings.

In addition to the factory set calibration values, the user can enter a field calibration slope and offset for the pressure and temperature channels. Pressure readings default to psi and temperature readings to degrees Celsius. The user can enter a units conversion slope and offset to change units, if desired. See Appendix B or Appendix C for details on changing these values.

Well Installation

Lower the transducer to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. When securing the 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 transducer is not installed below its maximum range. It is recommended that several readings be taken to insure proper operation after installation.



Installation

Notes:

- If the transducer is to be left in the well for a long-term monitoring application and the connector end is not in a dry, thermally-stable environment, a desiccant tube must be installed in line with the cable to prevent condensation in the cable vent tube. Water in the vent tube will cause inaccurate readings and, in time, will work its way into the transducer and damage it.
- **Proper grounding is very important!** INW recommends the following: (1) the sensor cable shield (the wrapped shield inside the cable) be attached to the power ground on the datalogger and (2) the grounding lug be connected via a 12 AWG or larger wire, to a grounding rod driven into the earth. It is also recommended that if you are using an external power supply to power the datalogger that it be tied to the same earth ground. (See also: Grounding Issues in the Trouble Shooting section of this manual.)

Other Installations

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

Maintenance

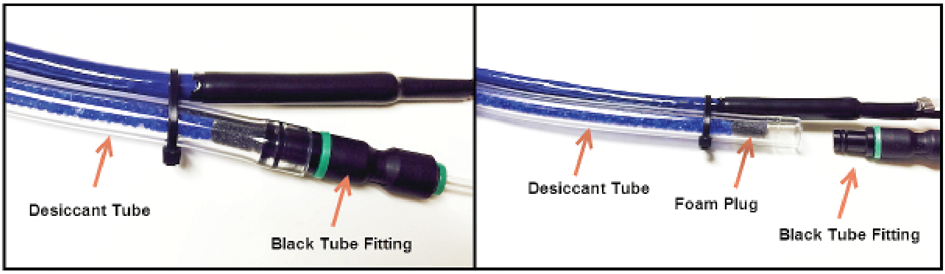
Transducer: There are no user-serviceable parts. If problems develop with sensor stability or accuracy, contact INW. If the transducers have been exposed to hazardous materials, do not return them without notification and authorization.

Cable: Cable can be damaged by abrasion, sharp objects, twisting, crimping or crushing and 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.

Connectors (if used): 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.

To Change the Desiccant

- Pulling gently remove the black tube fitting from the clear desiccant tube.
- Using needle-nose pliers, remove the dark gray foam plug. Do not discard the plug.
- Dump out the old desiccant beads and refill with new desiccant beads - tapping desiccant tube frequently during refilling to ensure that the beads are fully seated in tube.
- Push the foam plug back into the tube.
- Reinsert the black fitting.



Change the desiccant by gently removing the black tube fitting and the dark gray foam plug.

Troubleshooting

Erratic Readings

Erratic readings can be caused by a damaged transducer, damaged cable, poor connections or improper operation of readout equipment. In most cases, erratic readings are due to moisture getting into the system. Assuming that the readout equipment is working correctly, the first thing to check is the connection. Look for moisture between contacts or a loose or broken wire. If the connection appears OK, pull the transducer up a known distance while monitoring its output. If the transducer responds approximately as it should, but the reading is still erratic, most likely the cable is damaged. If the transducer does not respond approximately as it should, it is most likely that the sensor is damaged. In either case, consult the factory.

Erratic and erroneous readings can also occur due to improper grounding. See Grounding Issues, next page.

Oscillating Readings Over Time

If, after time, your transducer 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 transducer 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 transducer reading.

Zero Readings When Pressurized

Continuous zero readings are caused by an open circuit which usually indicates broken cable, a bad connection, or possibly a damaged transducer. Check the connector to see if a wire has become loose, or if the cable has been cut. If neither of these appears to cause the problem, the transducer needs factory repair.

Grounding Issues

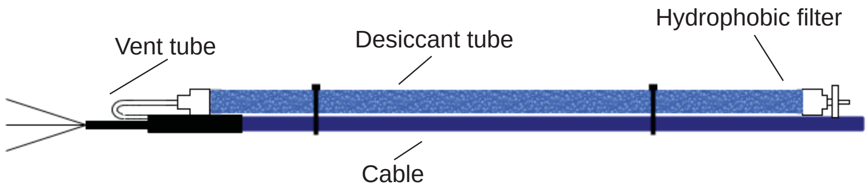
It is commonly known that when using electronic equipment, both personnel and equipment need to be protected from high power spikes that may be caused by lightning, power line surges, or faulty equipment. Without a proper grounding system, a power spike will find the path of least resistance to earth 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 the following: (1) the sensor cable shield (the wrapped shield inside the cable) be attached to the power ground on the datalogger and (2) the grounding lug be connected via a 12 AWG or larger wire, to a grounding rod driven into the earth. It is also recommended that if you are using an external power supply to power the datalogger that it be tied to the same earth ground.

Appendix A: Technical Specifications

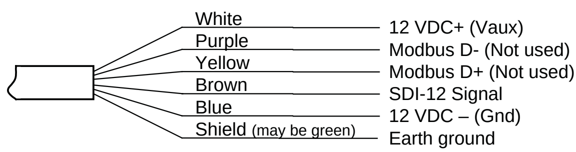
Transducer Components



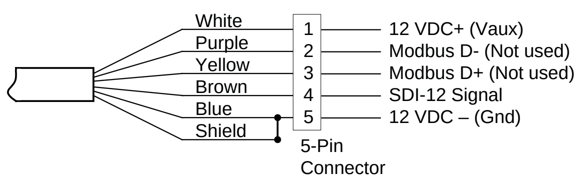
Components

Wiring Information

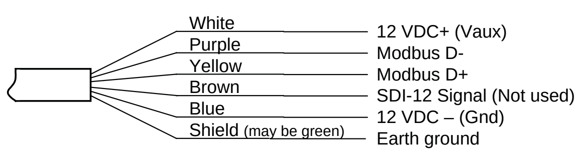
For SDI-12
— without connector



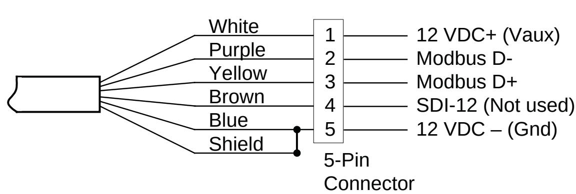
For SDI-12
— with 5-pin connector



For Modbus®
— without connector



For Modbus® with
— with 5-pin connector



Connections

Electrical Specifications

Pressure Static Accuracy	±0.1% FSO (maximum) *B.F.S.L. 25° C*
	(±0.25% for 1 PSIg, 2.3 FtH$_2$o, 0.7 mH$_2$o)
	±0.06% FSO (typical)
Maximum Zero Offset	±0.25% FSO *at 25° C*
Temperature Accuracy	± 0.5° C
Resolution	16 bit
Over Range Protection	3x FS (for > 300psi, contact INW)[1]
Burst Pressure	1000 psi (approx. 2000 feet or 600 meters)
Compensated Temperature Range	0° C to 40° C
(for extended ranges, contact INW)	
Operating Temperature Range	-15° C to 55° C
(Freeze protection kit required if water is freezing)	
Storage Temperature Range	-40° C to 80° C

[1] Approx. 650 feet or 200 meters

Mechanical Specifications

<u>Transducer:</u>

Length	8.3 inches (21.081 cm)
Diameter	0.75 inches (1.9 cm)
Body Material	316 stainless steel (Titanium available)
Wire Seal Material	Fluoropolymer and PTFE
Desiccant Tube	Included
Terminating Connector	Available Option
Weight	0.8 lbs. (0.4 kg)

<u>Cable:</u>

O.D.	0.28 inch maximum (0.7 cm)
Cable Jacket	Polyurethane, Polyethylene, or PTFE
Conductor Type	9-conductor, vented
Vent Tube	Nylon
Break Strength	138 lbs. (62.7 kg)
Weight	4 lbs. per 100 feet (1.8 kg per 30 m)

Power Supply

Voltage	9.0 to 16.0 VDC
Current - Active	3 mA Avg / 10mA Peak
Current - Sleep	150uA

Miscellaneous

Measurement Latency	Approx. 1.3 seconds
Default Address	See documentation supplied with each sensor.

Appendix B: Reading via SDI-12

Power Consideration

If your sensor is not powered continuously by an auxiliary power supply, then you must turn power on to the sensor at least two seconds before a reading is to be taken to allow the sensor to warm up.

SDI-12 Command Nomenclature

a = Sensor address
{crc} = SDI-12 compatible 3-character CRC
<cr> = ASCII carriage return character
<lf> = ASCII line feed character

Following commands are shown in the format of:
cmd response // comments

SDI-12 Commands

Query and Setup Commands

//*** Sensor Identification
aI! a13 INWUSA PT120.7ssssssssss<cr><lf> // note: 0.7 will change to reflect current firmware revision
ssssssssss = device serial #

//*** Acknowledge Active
a! a<cr><lf>

//*** Address Query
?! a<cr><lf>

//*** Change Address
aAb! b<cr><lf> // change address from a to b

Request measurement

aM! a0023<cr><lf> // request pressure/temperature/voltage measurement
aD0! a+7.15863+25.0000+12.0512<cr><lf> // read pressure (psi), temperature (°C), voltage (V)

aM1! a0021<cr><lf> // request pressure measurement only
aD0! a+7.15863<cr><lf> // read pressure (psi)

aM2! a0021<cr><lf> // request temperature measurement only
aD0! a+25.0000<cr><lf> // read temperature (°C)

aM3! a0021<cr><lf> // request power supply voltage measurement
aD0! a+12.0512<cr><lf> // read power supply voltage (V)

aM4! a0ttt4<cr><lf> // request averaged data. ttt depends upon programmed average duration

aD0! a+7.15863+7.23215+7.05128+25.0000<cr><lf>
// read Ave Pressure, Max Pressure, Min Pressure, Ave Temperature*M5!, M6!, and M7! only available on PT12-BV/PT12 combination units!*

aM5! a0023<cr><lf> // request barometrically compensated down-hole pressure, down-hole temperature, surface temperature measurement

aD0! a+2.58613+19.2100+21.0512<cr><lf> // read barometrically compensated down-hole pressure, down-hole temperature, surface temperature

aM6! a0024<cr><lf> // request non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature measurement

aD0! a+17.31813+19.2100+14.732+21.0512<cr><lf>
// read non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature

aM7! atttl<cr><lf> // request averaged, barometrically compensated pressure. ttt depends upon programmed average

aD0! a+7.12050<cr><lf> // averaged barometrically compensated pressure

<u>Request measurement with CRC</u>

aMC! a0023<cr><lf> // request pressure/temperature/voltage measurement

aD0! a+7.15863+25.0000+12.0512{crc}<cr><lf> // read pressure (psi), temperature (°C), voltage (V)

aMC1! a0021<cr><lf> // request pressure measurement only
aD0! a+7.15863{crc}<cr><lf> // read pressure (psi)

aMC2! a0021<cr><lf> // request temperature measurement only
aD0! a+25.0000{crc}<cr><lf> // read temperature (°C)

aMC3! a0021<cr><lf> // request power supply voltage measurement
aD0! a+12.0512{crc}<cr><lf> // read power supply voltage (V)

aMC4! a0ttt4<cr><lf> // request averaged data. ttt depends upon programmed average duration

aD0! a+7.15863+7.23215+7.05128+25.0000{crc}<cr><lf>
// read Ave Pressure, Max Pressure, Min Pressure, Ave Temperature

MC5!, MC6!, and MC7! only available on PT12-BV/PT12 combination units!

aMC5! a0023<cr><lf> // request barometrically compensated down-hole pressure, down-hole temperature, surface temperature measurement

aD0! a+2.58613+19.2100+21.0512{crc}<cr><lf>
// read barometrically compensated down-hole pressure, down-hole temperature, surface

aMC6! a0024<cr><lf> // request non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature measurement

aD0! a+17.31813+19.2100+14.732+21.0512<cr><lf> // read non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature

aM7! atttl<cr><lf> // request averaged, barometrically compensated pressure. ttt depends upon programmed average

aD0! a+7.12050<cr><lf> // averaged barometrically compensated pressure

Concurrent measurement

aC! a00203<cr><lf> // request pressure/temperature/voltage measurement

aD0! a+7.15863+25.0000+12.0512<cr><lf> // read pressure (psi), temperature (°C), voltage (V)

aC1! a00201<cr><lf> // request pressure measurement only

aD0! a+7.15863 // read pressure (psi)

aC2! a00201<cr><lf> // request temperature measurement only

aD0! a+25.0000<cr><lf> // read temperature (°C)

aC3! a00201<cr><lf> // request power supply voltage measurement

aD0! a+12.0512<cr><lf> // read power supply voltage (V)

aC4! a0ttt04<cr><lf> // request averaged data. ttt depends upon programmed average duration

aD0! a+7.15863+7.23215+7.05128+25.0000<cr><lf> // read Ave Pressure, Max Pressure, Min Pressure, Ave Temperature

C5!, C6!, and C7! only available on PT12-BV/PT12 combination units!

aC5! a00203<cr><lf> // request barometrically compensated down-hole pressure, down-hole temperature, surface temperature measurement

aD0! a+2.58613+19.2100+21.0512<cr><lf> // read barometrically compensated down-hole pressure, down-hole temperature, surface temperature

aC6! a00204<cr><lf> // request non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature measurement

aD0! a+17.31813+19.2100+14.732+21.0512<cr><lf> // read non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature

aC7! attt01<cr><lf> // request averaged, barometrically compensated pressure. ttt depends upon programmed average

aD0! a+7.12050<cr><lf> // averaged barometrically compensated pressure

Concurrent measurement with CRC

aCC! a00203<cr><lf> // request pressure/temperature/voltage measurement

aD0! a+7.15863+25.0000+12.0512{crc}<cr><lf> // read pressure (psi), temperature (°C), voltage (V)

aCC1! a00201<cr><lf> // request pressure measurement only

aD0! a+7.15863{crc}<cr><lf> // read pressure (psi)

aCC2! a00201<cr><lf> // request temperature measurement only

aD0! a+25.0000{crc}<cr><lf> // read temperature (°C)

aCC3! a00201<cr><lf> // request power supply voltage measurement

aD0! a+12.0512{crc}<cr><lf> // read power supply voltage (V)

aCC4! a0ttt04<cr><lf> // request averaged data. ttt depends upon programmed average duration

aD0! a+7.15863+7.23215+7.05128+25.0000{crc}<cr><lf> // read Ave Pressure, Max Pressure, Min Pressure, Ave Temperature

CC5!, CC6!, and CC7! only available on PT12-BV/PT12 combination units!

aCC5! a00203<cr><lf> // request barometrically compensated down-hole pressure, down-hole temperature, surface temperature measurement

aD0! a+2.58613+19.2100+21.0512{crc}<cr><lf> // read barometrically compensated down-hole pressure, down-hole temperature, surface temperature

aCC6! a00204<cr><lf> // request non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature measurement

aD0! a+17.31813+19.2100+14.732+21.0512{crc}<cr><lf> // read non-barometrically compensated down-hole pressure, down-hole temperature, surface pressure, surface temperature

aCC7 attt01<cr><lf> // request averaged, barometrically compensated pressure. ttt depends upon programmed average

aD0! a+7.12050<cr><lf> // averaged barometrically compensated pressure

Extended Commands

//*** Set duration for averaging reading
aXAttt! attt<cr><lf> // set duration of averaged data for M4 command
// ttt = 1..997 seconds

//*** Read/Modify Calibration Values
aXCnn{=<value>}! a<value><cr><lf> // read{modify} calibration value nn

examples:
aXC00! a+1.591600e-5<CR><LF> // read value of calibration register 00
aXC00=1.704e-4! a+1.704000e-4<CR><LF> // set value of calibration register 00

//*** Set number of significant digits
aXSt! at<cr><lf> // set # of significant digits for SDI-12 report data
// t = 1..7

Calibration Register Definitions

All calibration registers contain floating point values.

SDI-12 REG ID	Mnemonic	Description	Default Value
00	Scale	Units scale *(Counts * Scale = base units, default psi)*	1.591600E-5
01	a	Factory cal-linearized correction factor 1	0.000000E+00
02	b	Factory cal-linearized correction factor 2	1.000000E+00
03	m0	Factory cal-slope coefficient 0	1.000000E+00
04	m1	Factory cal-slope coefficient 1	0.000000E+00
05	m2	Factory cal-slope coefficient 2	0.000000E+00
06	b0	Factory cal-offset coefficient 0	0.000000E+00
07	b1	Factory cal-offset coefficient 1	0.000000E+00
08	b2	Factory cal-offset coefficient 2	0.000000E+00
09	mField	Field pressure cal-slope	1.000000E+00
10	bField	Field pressure cal-offset	0.000000E+00
11	mT	Field temperature cal-slope	1.000000E+00
12	bT	Field temperature cal-offset	0.000000E+00
13	T_Alpha	Factory Temperature Cal-Alpha	0.000000E+00
14	T_Offset	Factory Temperature Cal-Offset	0.000000E+00
15	T_ZeroSlope	Factory Temperature Cal-ZeroSlope	0.000000E+00
16	P_mUnits	Pressure units conversion slope	1.000000E+00
17	P_bUnits	Pressure units conversion offset	0.000000E+00
18	T_mUnits	Temperature units conversion slope	1.000000E+00
19	T_bUnits	Temperature units conversion offset	0.000000E+00

Factory calibration values are set at the factory.
Writing to Factory Calibration registers will void calibration!!

Field calibration values can be set by user. If set, these values will be applied to readings before values are returned.

Appendix C: Reading via Modbus® RTU

Power Consideration

If your sensor is not powered continuously by an auxiliary power supply, then you must turn power on to the sensor at least two seconds before a reading is to be taken to allow the sensor to warm up.

Register Definitions

Communication settings and Modbus® functions

The PT12 is configured to communicate with 8 data bits, one stop bit, and no parity. Default baud rate is 19200.

A Word about Register Addressing

The physical register addresses on the PT12 start numbering from zero – the first address is 0, the second is 1, etc. On the other hand, Modbus protocol considers the first logical address to be 1, the second logical address to be 2, etc. For example, to take a pressure reading you have to read the physical address 0.

Some programs and equipment when asked to read address 0 will read that physical address. Others however will read that logical address, which is actually the physical address -1 (which does not exist). With these programs and equipment you must add a one to the address – thus in this example you would request a read at address 1.

Still other programs and equipment require the addition of 40,000 or 400,000 to the address to indicate reading holding registers. These usually also require the addition of one to the physical address. Check with your program and/or equipment documentation to determine what style of register addressing is required.

Like many common Modbus devices the PT12 returns readings starting at register address 0 (or 1 if using one-based addressing). For compatibility with other INW Smart Sensor equipment, the PT12 also returns these same readings starting at a register address 62592 (or 62593 if using one-based addressing).

All readings are obtained using Modbus function 03-Read Holding Registers. Readings are located in two registers each. The data is returned as a 32-bit IEEE floating-point value, high word first, also referred to as big-endian, float inverse, or Float AB CD.

Parameter Registers Using Standard Addressing

	Zero-Based	One-Based	+40,001	+400,001
Pressure	0	1	40001	400001
Temperature	2	3	40003	400003
Power Supply Voltage	4	5	40005	400005
Averaged Pressure	6	7	40007	400007
Maximum Pressure	8	9	40009	400009
Minimum Pressure	10	11	40011	400011
Averaged Temperature	12	13	40013	400013

Parameter Registers Using High Addressing to Match INW Smart Sensors

(Available with firmware 0.13 and higher)

	Zero-Based	One-Based	+40,0001
Pressure	62592	62593	462593
Temperature	62594	62595	462595
Power Supply Voltage	62596	62597	462597
Averaged Pressure	62598	62599	462599
Maximum Pressure	62600	62601	462601
Minimum Pressure	62602	62603	462603
Averaged Temperature	62604	62605	462605

Calibration and conversion constants

The data is returned as a 32-bit IEEE floating-point value, high word first, also referred to as big-endian, float inverse, or Float AB CD.

Zero-Based	One-Based	+40,001	Description
200-01	201-02	40201-02	Factory Calibration* - Pressure Scale
202-03	203-04	40203-04	Factory Calibration* - Pressure Linearization 1
204-05	205-06	40205-06	Factory Calibration* - Pressure Linearization 2
206-07	207-08	40207-08	Factory Calibration* - Pressure Slope 0
208-09	209-10	40209-10	Factory Calibration* - Pressure Slope 1
210-11	211-12	40211-12	Factory Calibration* - Pressure Slope 2
212-13	213-14	40213-14	Factory Calibration* - Pressure Offset 0
214-15	215-16	40215-16	Factory Calibration* - Pressure Offset 1
216-17	217-18	40217-18	Factory Calibration* - Pressure Offset 2
218-19	219-20	40219-20	Field Calibration - Pressure Slope
220-21	221-22	40221-22	Field Calibration - Pressure Offset
222-23	223-24	40223-24	Field Calibration - Temperature Slope
224-25	225-26	40225-26	Field Calibration - Temperature Offset
226-27	227-28	40227-28	Factory Calibration* - Temperature Alpha
228-29	229-30	40229-30	Factory Calibration* - Temperature Offset
230-31	231-32	40231-32	Factory Calibration* - Tempearture Slope
232-33	233-34	40233-34	Pressure Units - Conversion Slope
234-35	235-36	40235-36	Pressure Units - Conversion Offset
236-37	237-38	40237-38	Temperature Units - Conversion Slope
238-39	239-40	40239-40	Temperature Units - Conversion Offset

Field calibration values and units conversion values can be set by user. If set, these values will be applied to readings before values are returned.

*Factory calibration values are set at the factory.
Writing to Factory Calibration registers will void calibration!!

Sensor configuration/control

Zero-Based	*One-Based*	*+40,001*	*Description*
300=n	301=n	40301=n	Set **averaging**: This enables sensor for n seconds. Each second, the statistical data registers will be updated to contain new averages, max and min. At the completion of n seconds, the final statistical values will be left in the registers, and the sensor will be put to sleep. n = 0..10,800. If n = 0, the sensor is put to sleep, and the statistical data values are not updated.
400=a	401=a	40401=a	Set **sensor address** = a (Write Only)
500=b	501=b	40501=b	Set **baud rate** = b (Write only) 0=38400, 1=19200 (default), 2=9600, 3=4800, 4=2400, 5=1200
600=w	601=w	40601=w	Set **auto-enable**. Causes sensor to be enabled automatically for w seconds after a read of any parameter data register. W=0 disables auto-enable. (This is normally set to 10 seconds at the factory.) For lowest power usage, set this to zero. For fastest readings while still retaining as much power savings as possible, set slightly longer than your read frequency. See section on next page for information on how this setting affects your readings.
700=L	701=L	40701=L	Set **serial number**. L= unsigned longword value 0x0000000 .. 0xFFFFFFF (0 .. 4,294,967,295)
800	801	40801	Read **sensor firmware revision**. Word MSB = Major revision, LSB = minor revision. E.g., 0013 = revision 0.13

Readings and the Auto-Enable Setting

When a reading is requested, four things happen:

1. The sensor wakes up.
2. The current value in the register is returned.
3. The sensor turns on the analog portion, begins sampling, and begins putting the new values in the registers.

4a. If auto-enable is set to a positive value *w*, the sensor stays awake for *w* seconds, sampling and moving values into the registers all the while, and then goes to sleep.

4b. If auto-enable is set to zero, the sensor immediately goes to sleep after putting the reading in the register.

If your read frequency is less than the auto-enable value, the sensor will stay on continuously, and your readings will always be fresh, with the exception of the very first reading.

If your read frequency is greater than the auto-enable value, the following reading sequence is recommended:

1. Request a reading. This begins the wakeup process on the sensor and returns the value currently in the register, which will be old data. Throw this value away.
2. Wait one second, then take another reading. This reading will have fresh data. Record this reading.

Note: This sequence applies only to Modbus® direct read. If reading the sensor via SDI-12, the warmup timing is automatically taken care of.

Reordering Information

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(Continued on the next page)

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Notes

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