

# Submersible Pressure Transducer

Installation and Operation Manual





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## DOCUMENTATION CONVENTIONS

This document uses the following conventions to present information:



### WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



### CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.



### NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

# Section 1: System Description

## Function and Theory

Geotech's Submersible Pressure Transducer (Transducer) incorporates the latest technological advancements in piezoresistive sensing and control. Geotech offers a variety of transducers including, gas, vacuum, sealed gauge, and absolute models.

The transducer contains a laser trimmed, temperature-compensated, pressure-sensing element, providing continuous hydrostatic level measurement in non-pressurized or pressurized liquid environments. It is suitable for all liquids compatible with 316 stainless steel and is designed for ruggedness and long life in the harshest environments.

The Transducer provides a 4-20 mA analog signal (pressure only) and MODBUS RS-485 digital network (pressure and temperature). A 1-5 VDC output process signal option is also available. It can be incorporated into the probe assembly with no external components or can easily be generated by adding a 250Ω local resistor across the output (see *Section 2: System Installation*, Figure 2-3) Pressure and Temperature are available on the MODBUS RS-485 network.

Lightning and surge protection features for transducers are optional. Protection is achieved through the use of two protectors; one integral to the transducer housing and one provided for the outside line located at the surface and grounded to a good earth ground. This option must be selected and installed at the time of order placement and is not available as a factory upgrade.

Featuring quick response and low clamping voltages, these devices protect against fast rising voltage transients as well as severe current surges associated with lightning discharges up to 20,000 amperes. Following a surge, the protector automatically restores the line to normal operation and awaits the next surge without having to reset a breaker or replace a fuse. Location and system operating budget should be considered when ordering should this protection option be necessary.

Transducers installed with this option have a lifetime warranty against damage due to voltage surge when this two-part option is properly installed.



When using the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

## A note on accuracy

Adding it all up: When figuring how accurate system pressure and level measurements are, all sources of error must be considered. Along with consideration of type of sensor used (e.g. Absolute, Sealed Gauge or Vented

Gauge) and nominal sensor error (see *Section 6: System Specifications*). One must also account for measurement device accuracy.

For example: Many common PLC devices offer a nominal  $\pm 0.5\%$  measurement accuracy on analog input lines. This may or may not account for losses due to analog to digital conversion. Be sure to consider all sources of error in your analysis.



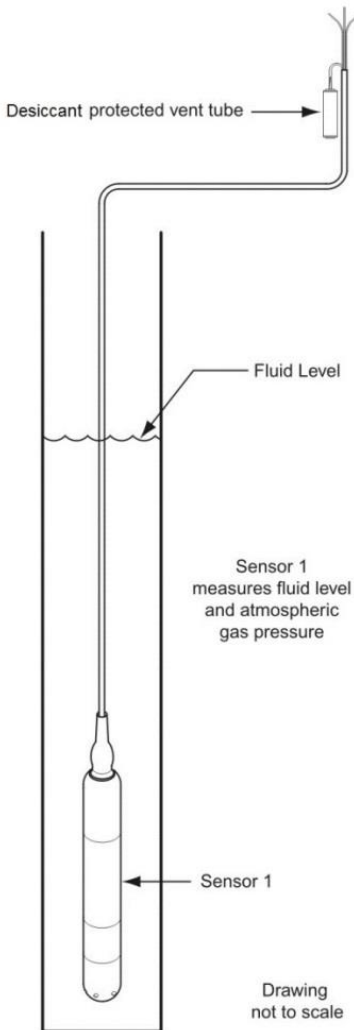
Accuracy calculations are especially important when using pressure sensors for pump control. Be sure to account for a worst-case scenario when placing a sensor in a water column and programming ON/OFF set points to prevent running a pump dry or over filling a receiving tank.



Fluid density must also be considered in fluid level measurement. For example: fresh groundwater is less dense than brackish water which is less dense than heavily saturated seawater. The same level of seawater will register more pressure on a sensor than fresh water.

## Vented Gauge Sensor Application Description

Vented Gauge Sensors are well suited for all pressure range measurements. However, cable length and vent line maintenance become problematic at 500' (152 m). For this reason, it is recommended the Vented Gauge Sensor be employed in applications requiring less than 200PSI (13.8 bar) nominal (or less than 500' (152 m) of vented tubing cable).



When installing a pumping system and transducer with vented cable down well, the cable should be secured to the discharge pipe at 10' (3 m) to 25' (7.6 m) increments. In deep trench or mineshaft applications of over 100' (30 m), vertical auxiliary strain relief cable may be required.

Desiccant replacement frequency is site dependent. Regional humidity levels and cable length will determine desiccant replacement frequency. Higher humidity and longer cable lengths will require more frequent desiccant replacement. Damp wellhead vaults can also increase desiccant replacement frequency.

Bellows are a maintenance-free alternative to the desiccant pack on a vented Transducer. Ask your Geotech Sales Representative for more information.

**Figure 1-1:** Well Schematic with Vented Gauge Sensor



**Figure 1-2:** Example of Desiccant Pack installed on Vented Transducer cable.

*The cartridge will have to be field replaced as site environment requires.*



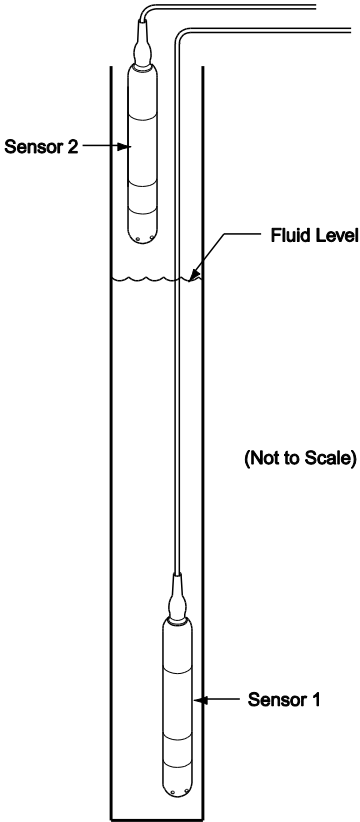
**Figure 1-3:** Example of maintenance-free Bellows installed on Vented Transducer cable.

*The Bellow fluctuates with atmospheric pressure, but is environmentally sealed.*



## Absolute Pressure Application Description

Absolute Pressure Sensors are best suited for use in systems where atmospheric pressure variation is known and accounted for. Absolute Pressure Sensors can be used as atmospheric pressure sensors for compensating local fluid level measurements 30PSI (2 bar) absolute and above. For example:



Sensor 1 measures pressure of fluid column and gas pressure above fluid level. Sensor 2 measures pressure of gas pressure only. To obtain fluid level only: Sensor 1 – Sensor 2 = fluid level only.

Example:

Sensor 1 measures 30PSI and Sensor 2 measures 14PSI.

$$30 - 14 = 16\text{PSI.}$$

$$16\text{PSI} \times 2.31 = 36.96' \text{ of water.}$$

(Use the PSI to feet of water conversion chart found in Appendix A)

**Figure 1-4:** Absolute Pressure Sensor Application



Sensor 2 can be used to compensate for variations in atmospheric pressure and variation in well casing gas pressure in sealed systems (e.g. methane extraction well casing pressure).



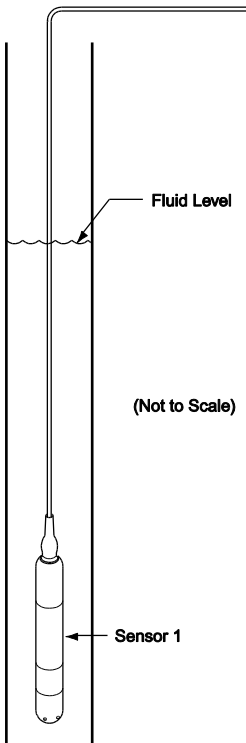
Systems utilizing Absolute Pressure Sensors without accounting for atmospheric or well casing pressure fluctuations are inaccurate by:

$$\text{Pressure fluctuation/ full scale range} \times 100 = \% \text{ error.}$$

## Sealed Gauge Sensor Application Description

Sealed Gauge Sensors are best suited for applications measuring 200 PSI and higher. Sealed Gauge Sensors do not compensate for changes in local atmospheric pressure. They are calibrated to a nominal atmospheric pressure at sea level or 14.696 PSI (see conversion chart for reference to other pressure units).

In applications requiring less than 200 PSI (13.8 bar), a local barometric pressure sensor (an Absolute Pressure Sensor) will be required to correct for variations. However, it is recommended that in this case Absolute Pressure Sensors be deployed. See Absolute Pressure Sensor application description for details.



Example:

Sensor 1 measures both the fluid level and the atmospheric pressure. However, when atmospheric pressure varies it is insignificant to the total measurement. Application requirements may vary. Atmospheric compensation may be required per system requirements.

**Figure 1-5:** Gauge Sensor Application

## System Components



**Figure 1-6:** Transducer (without Surge Suppressor)

## Section 2: System Installation

Geotech's Submersible Pressure Transducer is compatible with all controllers having a 4-20 mA or 1-5 VDC input, or MODBUS RS-485 providing the controller supply voltage is adequate. See *Section 6: System Specifications (Supply Voltage)*. The required range is 12-36 VDC. Check the operations manual for the specific controller being used.

System integrators utilizing isolated power supplies must consider leakage current through the isolated circuit. Systems utilizing isolated power supplies are susceptible to measurement errors when isolation protection circuits are compromised by transient surges. Surge protection on sensor lines is highly recommended in this case.



Prior to installation, it is recommended that a pre-installation test be conducted. See Figure 2-1.

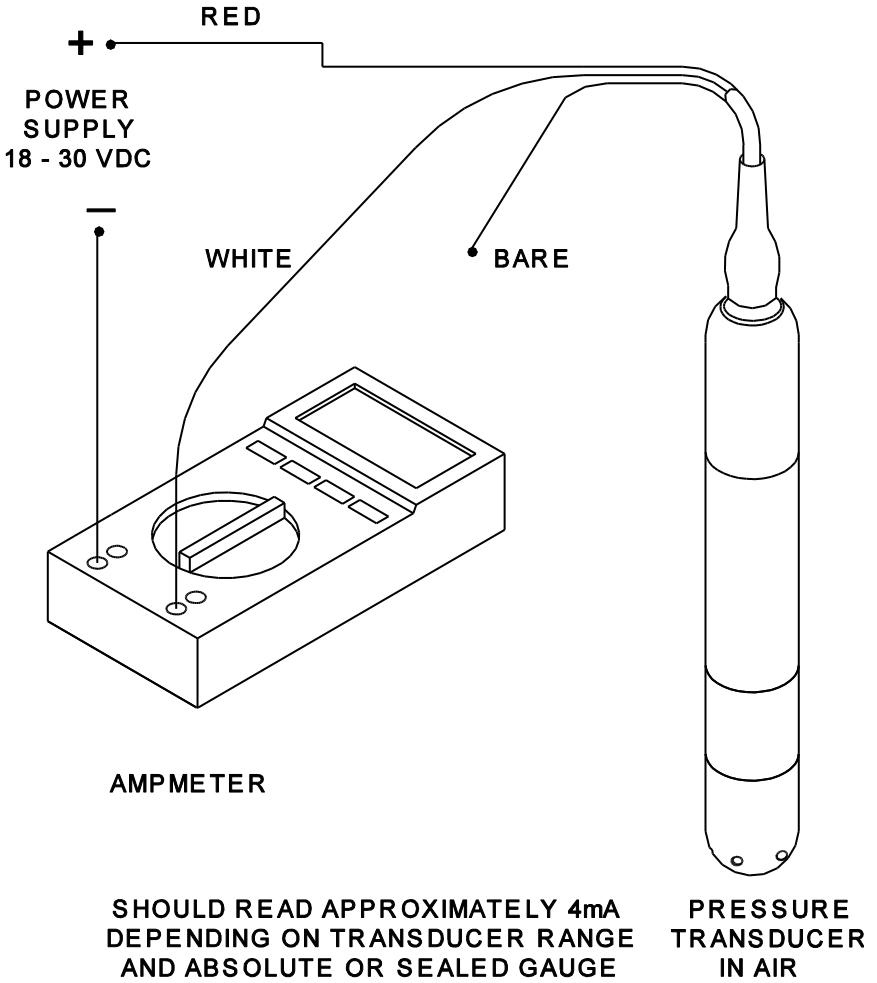
See Figure 2-2 and Figure 2-3 for installation of Geotech's Submersible Pressure Transducer.



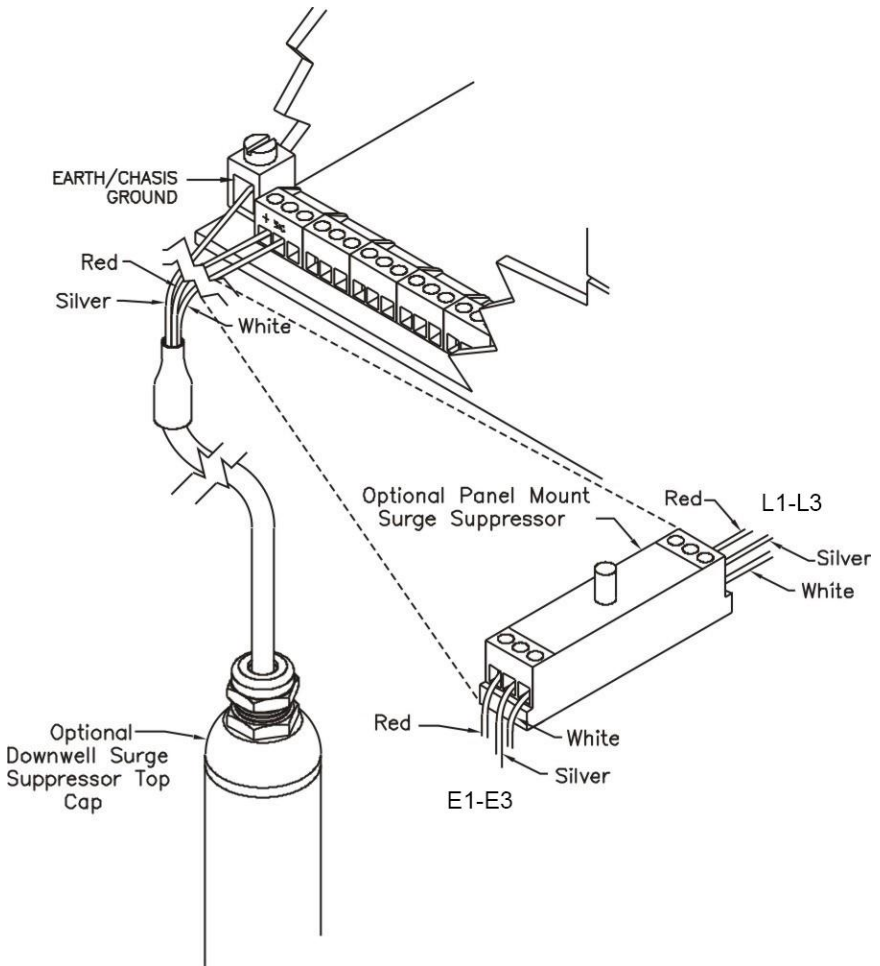
Always consult owners/installation manual on any electronic equipment before installing aftermarket OEM components.

**Pre-Installation Test**

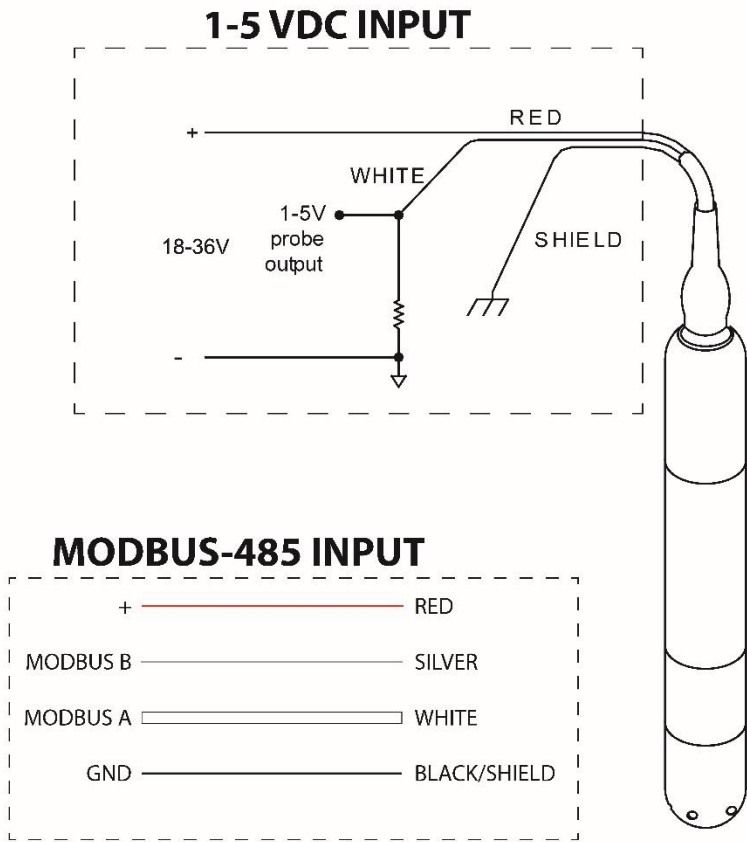
**TO TEST A PRESSURE TRANSDUCER:**



**Figure 2-1:** Pre-installation test



**Figure 2-2:** Transducer connection to controller with 4-20 mA inputs

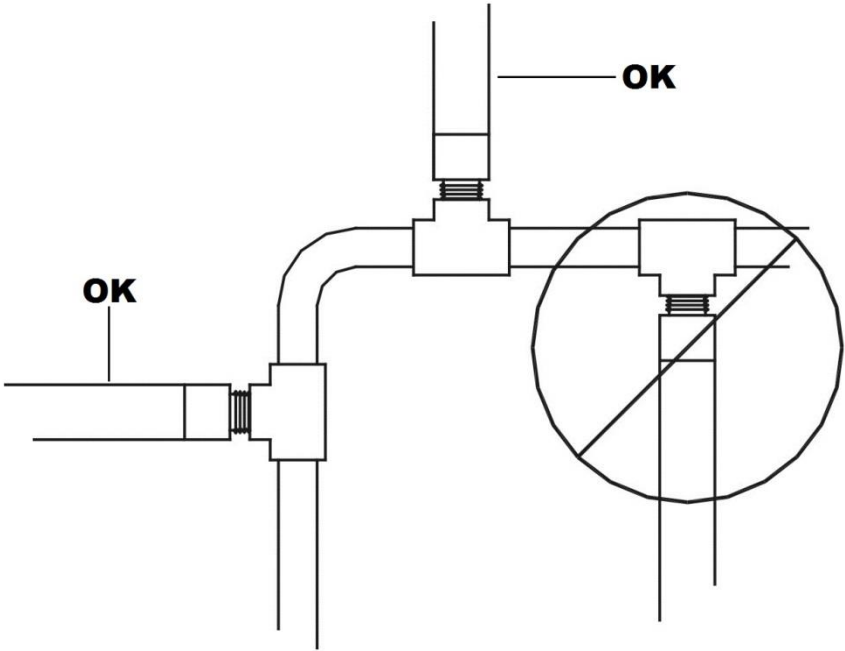


**Figure 2-3:** Transducer connection to controller with 1-5 VDC input or MODBUS-485 input

## Gas Sensor



Geotech strongly recommends that the sensor not be installed with the threads in the upward position. Doing so allows condensation to collect inside the body, allowing the possibility of freezing in cold weather. Figure 2-4 shows an example of proper sensor orientation.



**Figure 2-4:** Gas sensor orientation



### Section 3: System Operation

The Geotech Pressure Transducer consists of a sensing element and signal conditioning electronics enclosed in a stainless steel housing that is .72" (18 mm) in diameter. Pressure is sensed by a stainless steel diaphragm causing a full bridge strain gauge to be deformed. This deformation generates an electrical signal, which is amplified by the signal conditioning electronics and converted to a 4-20 mA output signal.

Sensor cable length needs to be specified at the time of order. If voltage used is below indicated supply requirement, sensor operation will be unreliable.



Cable lengths may be shortened in the field but they cannot be lengthened by splicing. Geotech does not encourage or support spliced transducer cable for any reason.

## **Section 4: System Maintenance**

As with any electronic equipment, some regular maintenance may be required. With Geotech's Submersible Pressure Transducer, regular maintenance has been reduced to simply checking the end cap for clogging or obstructions and cleaning as necessary.

The desiccant packs on vent tube lines for gauge type sensors must be replaced periodically. Frequency will depend on environmental conditions specific to your site. If the desiccants are pink, then they must be replaced to avoid reading inaccuracies and eventual sensor damage. Once moisture collects inside the vent tube, it cannot be removed and the sensor must be replaced.

## Section 5: System Troubleshooting

### Problem

Sensor not outputting any current.

### Solutions

- No supply voltage.
- Sensor wired backwards.
- Blown fuse on power supply.
- Broken sensor wire.

### Problem

Sensor outputting wrong current.

### Solutions

- Check pressure with independent meter.
- Shield not properly connected to good ground.
- Cable cut or scraped allowing water into cable.

### Problem

Sensor output is “noisy”.

### Solution

Shield is broken or improperly connected.

## Section 6: System Specifications

### Pressure Transducer

#### Maximum ratings

Supply voltage	12-36 VDC	
Supply current	25 mA	
Maximum pressure	As specified	PSI absolute, Sealed Gauge, or Gauge
Analog mA Signal Output	4-20 mA	
Analog Voltage Output	1-5 VDC	

### MODBUS RS-485

#### Process Value Read Range (0x0100) 32bit floating point:

- Compatible with Class.Group-version = 5.20-10.XX and later and 5.21-XX.XX
- Same as 0x0000 .. 0x000B but different mapping for accessing data in one cycle (e.g. P1 and T0B1)

MODBUS StAdd (0xHILO)	Channel	Read/ Write	Unit	Description
0x0100	P1	R	Bar	Pressure of sensor1 [bar] HWord
				Pressure of sensor1 [bar] LWord
0x0102	T0B1	R	°C	Temperature of sensor1 [°C] HWord
				Temperature of sensor1 [°C] LWord
0x0104	P2	R	Bar	Pressure of sensor2 [bar] HWord
				Pressure of sensor2 [bar] LWord
0x0106	T0B2	R	°C	Temperature of sensor2 [°C] HWord
				Temperature of sensor2 [°C] LWord
0x0108	P1	R	Bar	Pressure of sensor1 [bar] HWord <i>version 5.21-XX.XX only</i>
				Pressure of sensor1 [bar] LWord <i>version 5.21-XX.XX only</i>
0x010A	T	R	°C	Temperature [°C] HWord <i>version 5.21-XX.XX only</i>
				Temperature [°C] LWord <i>version 5.21-XX.XX only</i>

### MODBUS Communication Basics

<b>Mode</b>	RTU Mode (ASCII is not supported)
<b>Coding System</b>	8-bit binary, hexadecimal 0-9, A-F Two hexadecimal characters (bytes) contained in each 8-bit field of the message
<b>Bits per Byte</b>	1 start bit 8 data bits, least significant bit sent first No parity (default) 1 parity bit: even or odd parity (programmable) 1 stop bit (default) 2 stop bit (programmable) only firmware 5.21-XX.XX
<b>Error Check Field</b>	2 Byte Cyclical Redundancy Check (CRC)
<b>Baudrate</b>	Programmable 9'600 (default) or 115'200

## Bus Addressing

*Unicast addresses:* each slave has address between 1 (default) and 247

*Broadcast addresses:* address 0 is used for broadcast frames, the slave accepts the command but must not generate an answer.

*Special addresses:* addresses 248-255 are reserved. The address 250 is used for non-bus (point-to-point) communication to address a slave with unspecified or unknown address (not MODBUS standard)

## Performance

<u>Pressure Ranges</u>	<u>(PSI)</u>	<u>(bar)</u>
	0-15	0-1
	0-30	0-2
	0-50	0-3.5
	0-100	0-7
	0-150	0-10
	0-200	0-14
	0-350	0-25
	0-500	0-35
	0-1000	0-70
	0-1500	0-100
<u>Accuracy *</u>	0.25	% of full scale
	0.1	% of full scale available
<u>Non-linearity</u>	0.07	% of full scale
<u>Repeatability</u>	0.015	% of full scale
<u>Pressure hysteresis</u>	0.010	% of full scale
<u>Zero error</u>	±0.1	% of full scale
<u>Span error</u>	±0.1	% of full scale
<u>Temperature sensor range</u>	-40 to 257°F (-40 to 125°C)*	
<u>Temperature accuracy</u>	+/- 1.8°F (0.5°C) nominal full scale	

Temperature reporting is only available with RS485 communications and Tefzel or Polyurethane cable configuration.

*\*Installation is not recommended in environments where liquids could freeze solid.*

<u>Response time</u>	2 milliseconds
<u>Life</u>	1 million pressure cycles

## Physical

Sensor length	7.7" (19.6 cm) 8.6" (21.8 cm) w/ Surge Suppressor opt.
Sensor diameter	.72" (1.8 cm)
Sensor weight	4.3 oz. (122 g)
Proof pressure	3x PSI/bar
Burst Pressure	5x PSI/bar
Media compatibility	Liquids or gasses compatible with 316 stainless steel



Probe is protected from reverse polarity supply connection.

*\*Accuracy of the system is highly dependent on the device being used to take the measurement.*

## System Specifications (Cable)

Jacket	Yellow Polyurethane
Diameter	.25" +.010"/-.010" (6.35 mm +.25 mm/-.25 mm)
Conductors	2-24 AWG 7/32 tinned copper Red – White
Drain	24 AWG 7/32 tinned copper bare
Insulation	Polyolefin .012" Nom. Wall (.3 mm)
Vent Tube	Nylon 6/6 Vent tube
Inner Shield	Aluminum/Polyester Tape Wrap
Outer Shield	38 AWG Tinned Copper Spiral, 95% coverage

Jacket	Yellow Tefzel
Diameter	.25" +.010"/-.010" (6.35 mm +.25 mm/-.25 mm)
Conductors	2-24 AWG 7/32 tinned copper Red – White
Drain	24 AWG 7/32 tinned copper bare
Insulation	Polyolefin .012" Nom. Wall (.3 mm)
Vent Tube	Nylon 6/6 Vent tube
Inner Shield	Aluminum/Polyester Tape Wrap
Outer Shield	38 AWG Tinned Copper Spiral, 95% coverage

Jacket	Blue modified PVC blend
Diameter	.375" +.015"/-.015" (9.5 mm +.4 mm/-.4 mm)
Conductors	2-18 AWG 16/30 tinned copper Red – White
Drain	24 AWG 16/30 tinned copper bare
Insulation	Polyolefin .030" Nom. Wall (.76 mm)
Shield	Aluminum/Polyester Tape Wrap

## Section 7: Replacement Parts List

Part Description	Part Number
CAP, DELRIN, BOTTOM, TRANSDUCER	22050018
DESICCANT KIT, TRANSDUCERS	82050128
BELLOWS KIT, TRANSDUCERS	82050129
SURGE SUPPRESSOR, PRES TRANS, UW UPWELL	82050113
RESISTOR, 250 OHM, 1/4W, .01% WW	12050745
MANUAL, PRESSURE TRANSDUCER	12050178

*Contact Geotech for specific pressure ranges and cable lengths.*

## Appendix A – Pressure Conversion Chart

	PSI	Inches of Water (In. H <sub>2</sub> O) 4°C	Feet of Water (Ft. H <sub>2</sub> O) 4°C	bar (bar)	Atmosphere (atm)
<b>1 PSI</b>	1	27.68	2.31	$68.95 \times 10^{-3}$	$68.05 \times 10^{-3}$
<b>1 Inches of Water (In. H<sub>2</sub>O) 4°C</b>	27.68	1	1/12	$2.49 \times 10^{-3}$	$2.46 \times 10^{-3}$
<b>1 Feet of Water (Ft. H<sub>2</sub>O) 4°C</b>	.434	12	1	$29.9 \times 10^{-3}$	$29.5 \times 10^{-3}$
<b>1 bar (bar)</b>	14.50	401.46	33.46	1	.987
<b>1 Atmosphere (atm)</b>	14.696	406.8	33.90	1.01325	1



## Notes

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Previous Release, SP	03/04/2013
Project	Edited specifications to reflect small addition to overall length, SP	04/15/2014
Project	Added Bellows Kit option for vented cable transducers, SP	07/09/2014
Project	Accuracy in Section 6: 0.25% of full scale, 0.1% of full scale available, SP	11/4/2014
2000	Removed vent tube from section 6, minor style changes, SR	11/22/2016
Project 1538	Removed Probe PAL, StellaR	1/25/2017
Project #1559	Corrected specification call outs - StellaR	5/24/2017
Project #2000	Removed Blue Polyurethane cable from specs, added MODBUS – StellaR	5/28/2020
Project #2000	Added MODBUS Communication Basics and Bus Addressing – StellaR	6/8/2020
Project #2100	Removed Conductivity addressing, option not available. – StellaR	2/3/2021
Project #2100	Updated figure 2-3 – StellaR	4/6/2021

## The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

## Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR  
SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Date of Purchase: \_\_\_\_\_

## Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

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