



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 incorporates the latest technological advancements in piezoresistive sensing and control. Geotech offers a variety of transducers including gauged (vented) 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) or 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 250 Ω local resistor across the output (see System Installation).

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, grounded at the surface. 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 Ω .

A Note on Accuracy

When figuring out 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 or Gauged) 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.

Section 2: System Installation

Geotech's Submersible Pressure Transducer is compatible with all controllers having a 4-20 mA, 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 below.

Pre-Installation Test

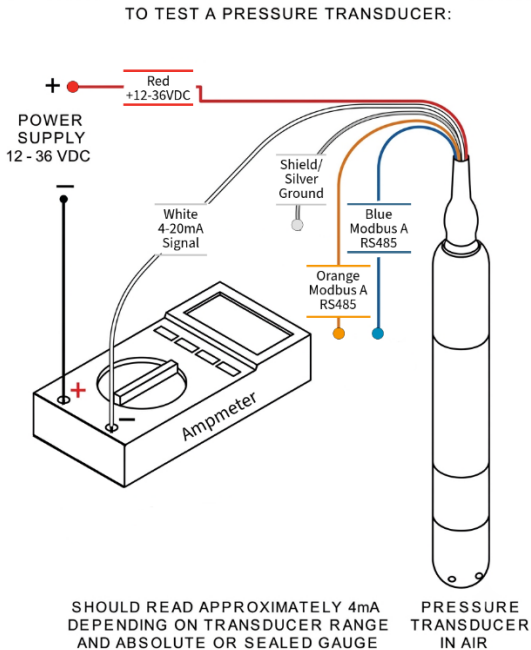


Figure 2-1: Pre-Installation Test



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

To connect multiple transducers, wire them in parallel (A-to-A, B-to-B, Vcc-to-Vcc, and Ground-to-Ground).

Unique Addressing: Every device must have a unique Address/Unit ID. *Factory Default ID: 1*
See *Modbus (RS-485 Serial Interface)* in Section 3.

Physical Wiring

Table 2-1: Wiring Modbus RS-485 OR 4-20mA

Wire Color	Function	Connection Point
Red	Vcc (12-36 VDC)	Power Supply (+)
White	DC (-) / Common (Modbus RS-485) OR 4-20mA Signal (-) (4-20mA)	Power Supply (-) (Modbus RS-485) OR Analog Input(+) on PLC (4-20mA)
Orange	MODBUS A (+)	RS-485 A (+) on Client
Blue	MODBUS B (-)	RS-485 B (-) on Client
Shield	Shield & Ground	Chassis Ground (Controller side only)

In 4-20mA mode, the transducer acts as a variable resistor in a 2-wire current loop.

Table 2-2: Wiring 1-5 VDC

Wire Color	Function	Connection Point
Red	Vcc (12-36 VDC)	Vcc on Power Supply (+)
White	1-5V Probe Output/Ground (-)	Analog Input (+) on PLC
Shield	Shield & Ground	Chassis Ground (Controller side only)

Termination Guidelines

To ensure signal integrity across the transmission line, follow these layout and resistance specifications:



These pressure transmitters do not include internal termination resistors. Any required termination must be added externally during installation.

Configuration and Layout

- **Placement:** Termination resistors must be installed between Terminal A and Terminal B at both the absolute beginning and the absolute end of the transmission line.
- **Impedance Matching:** The resistor value should match the characteristic impedance of the cable. The value for this installation is 120 Ω .

Requirements and Exceptions

While termination is generally required for stable communication, there are specific scenarios where requirements change:

- **Stable Environments:** In noise-free environments using a fail-safe client driver (such as a PC interface converter), termination resistors may not be strictly mandatory.
- **Short Cable Runs:** You may omit termination if the environment is free of electromagnetic interference and the cable length is limited to a few meters.
- **Client Drivers:** At least one termination resistor is typically required for stability; this is frequently integrated into the client RS-485 driver.

Power Consumption and Current Peaks

Standard termination (2 x 120 Ω) draws approximately 50 mA during transmission. To reduce current peaks or overall power consumption, you may:

1. Increase the resistor value to 1 k Ω .
2. Omit the resistors entirely (only if the environment and cable length allow, as noted above).



If you wire your transducer and find that the client device is reporting bad data or constant framing errors, the most likely culprit is that the A and B lines are swapped. Swapping them won't damage the hardware, but it will invert the logic and prevent communication.

Bias Resistors (Fail-Safe Biasing)

To ensure the communication lines remain in a defined voltage state when no data is being transmitted, biasing resistors can be added to the circuit.

- **Terminal A:** Connect a pull-up resistor to **+5V**.
- **Terminal B:** Connect a pull-down resistor to **GND**.

When is Biasing Necessary?

- **Standard Requirement:** These resistors are required only when using older or "non-fail-safe" RS-485 drivers to prevent the bus from floating in an indeterminate state.
- **Geotech Products:** If your client device (e.g., PC interface converter) features a fail-safe driver, external biasing resistors are not required for use with our transmitters.

Common-Mode Voltage and Grounding

The reliability of the data circuit depends heavily on staying within the "Common-Mode" voltage limits. The allowable range for the data lines relative to Ground (GND) is +12V to -7V.

Mandatory Grounding

To ensure the system operates within these safe voltage limits:

- You must establish a common reference. Always connect the GND of the client RS-485 converter to the GND of the pressure transmitter.



Operating the system without a shared ground can lead to voltage offsets that exceed the common-mode range, resulting in communication failure or hardware damage.

Table 2-3: Designation of Data Circuit Line Signals

Signal	Designation of Geotech Transducers	Designation of the EIA Standard
Inverted (-)	B	A
Non-inverted (+)	A	B

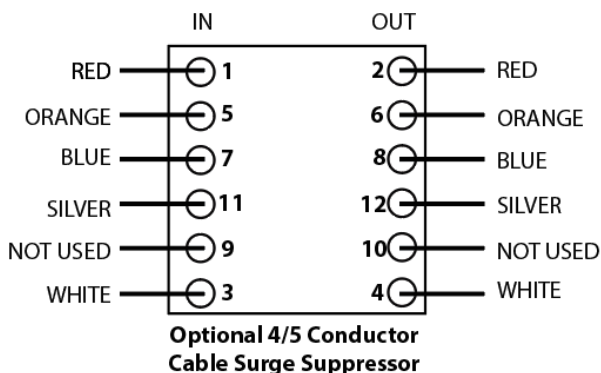


Figure 2-2: Transducer Connection to Controller with 4-20 mA inputs or RS-485

Gas Sensor Installation



Geotech recommends installing threads in the downward or horizontal position. Doing so prevents condensation from collecting inside the body, further preventing the possibility of freezing in cold weather. Figure 2-3 shows an example of proper sensor orientation.

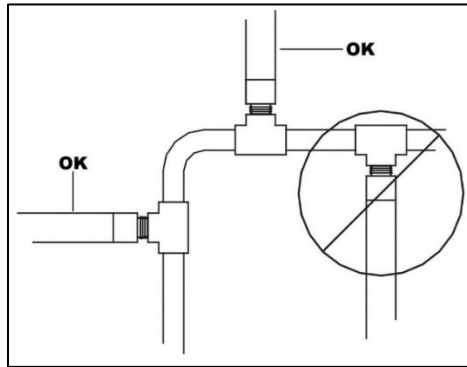


Figure 2-3: Gas Sensor Orientation

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.

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 as length increases, because moisture can collect in the vented tube and atmospheric changes in pressure over long distances are noticeable. For these reasons, the maximum cable length for vented (gauge) sensors is 750' (228.6 m). For installations that require more than 750' (228.6 m) of vented cable, consider deploying a Geotech junction box inline. Consult with a Geotech sales associate to discuss your application and sensor options.

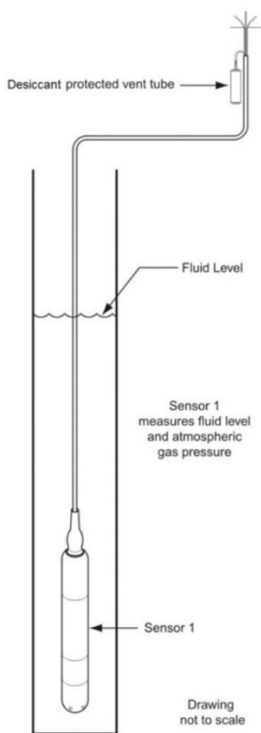


Figure 3-1: Well Schematic with Vented Gauge Sensor

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.

A desiccant or bellows must be used with vented cables to avoid moisture from entering the vented line. New unsaturated desiccant material will be blue in color (see Figure 3-2). As moisture saturates the desiccant beads, the color will change to pink or white. The desiccant material or desiccant pack must be replaced when signs of saturation appear.

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 3-2: Example of New Desiccant Pack Installed on Vented Transducer Cable

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

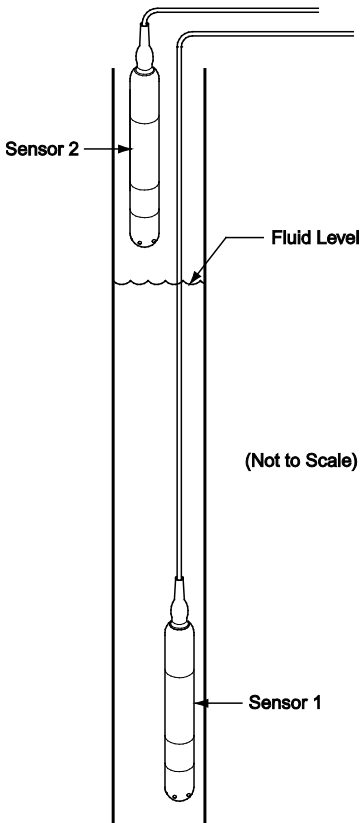


Figure 3-3: Example of Maintenance-Free Bellows Installed on Vented Transducer Cable

The bellows 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 30 PSI (2 bar) absolute and above. Because absolute sensors use non-vented cable, they are not subject to vent-tube moisture or atmospheric variation over distance; the maximum cable length for non-vented cable and absolute sensors is 5000' (1524 m). 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: Pressure Conversion Chart*)

Figure 3-4: 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:

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

System Components



Figure 3-5: Transducer (without Surge Suppressor)

Modbus (RS-485 Serial Interface)

The Geotech Pressure Transducer uses a Modbus RTU serial interface. This standard supports a "bus" architecture, allowing a single client (PLC, PC, or data logger) to communicate with one or more sensors.

MODBUS Communication Basics

Mode:	RTU (ASCII not supported), half-duplex (two-wire)
Coding System:	8-bit binary, hexadecimal 0–9, A–F Two hexadecimal characters (bytes) contained in each 8-bit field of the message.
Bits per Byte:	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 bits (programmable)
Error Check Field:	2 byte Cyclical Redundancy Check (CRC16)
Baud Rate:	9,600 bps (default) or 115,200 bps (programmable)
Response Times:	Time between receipt of inquiry and start of response: 9,600 baud: typ. 3.5ms to 10.0ms max. 100ms 115,200 baud: typ. 1.8ms to 10.0ms max. 100ms Time to ready-to-receive state for the servant: 9,600 baud: min 0.5ms 115,200 baud: min 0.5ms

Data Interchange

Message Structure

- All data interchange messages will typically follow the structure of
 - Client sends request
 - Servant sends response
- The client and servant request/response format will depend on the **function code** used.
- Every data interchange is initiated by the client. This means that a device may only transmit data if requested to do so by the client.

Explanation of Message Elements

DevAddr (Device Address):

- This is the **unique** address of the (servant) device connected to the bus.
 - Address 0 is reserved for broadcasting (0x00)
 - Addresses 1 (default) ...249 can be used for bus mode (0x01-0xF9)
 - Address 250 is transparent and reserved for non-bus mode. Every device can be contacted and written to (excluding baud rate) with this address (0xFA) but no device will respond.
 - Addresses 251...255 are reserved for subsequent developments (0xFB-0xFF)
- Appears in both the client and servant messages.
- An address may only be allocated to **one** device connected to the bus. If two devices on the bus have the same address, a conflict occurs.
- Devices from factory are addressed as 0x01 (1) unless specified at the time of order.

Function Code:

- Determines the function executed by the device.
- Appears in both the client and servant messages.
- For the response message, the most significant bit in the function code will display 0 for success and **1 for an Exception Error.** (see *Section 5: System Troubleshooting*)

Starting Address High/Low:

- Starting address of a specific register.
- Appears in both the client and servant messages.
- Registers are represented as different data types and units, some data types require sequential registers, see Table 3-1 & Table 3-2.
- Always represented by two bytes, high and low, in that order.
 - For example, the two bytes 0x00 and 0x02 (high and low) would appear as 0x0002 in Table 3-2. (0xHiLo)

Number of Registers High/Low:

- This specifies how many consecutive registers is requested, by the client corresponding to the starting register data type.
 - **Each register contains two bytes (16 bits);** therefore, data types that contain four bytes (32 bits) must use two registers to deliver their full data, see Table 3-1.

Number of Data Bytes:

- The number of bytes of data responded by the servant.
- This value is determined by the starting address and number of registers.

Data High/Low:

- The requested data in bytes, ordered high to low repeatedly.

CRC16 High/Low:

- 16-bit checksum, which serves to verify the integrity of the received data. **If an error is established, the entire message will be discarded.**

- Appears in both the client and servant messages with different values at the end of the messages.

Register Addresses & Data Types

- As stated previously, each register contains different values corresponding to different data types.
- Below are the types of data the registers can appear, as well as the most useful starting addresses.

Table 3-1: Possible Data Types in Holding Registers

Data Types	# of Bits	# of Bytes	# of Words	# of Registers	Smallest Value	Largest Value
Signed Integer	16	2	1	1	-32,768	+32,767
Unsigned Integer	16	2	1	1	0	+65,535
Signed Integer	32	4	2	2	-2,147,483,648	+2,147,483,647
IEEE754 Float	32	4	2	2	-3.4028 x 10 ³⁸	3.4028 x 10 ³⁸

Table 3-2: Modbus Read Only Register Map (Function Code 3)

Register Address (0xHiLo)	Channel	Bytes	Data Type	Unit	Description
0x0002 (2 dec)	P1	4	IEEE754 Float	bar	Pressure of Sensor 1
0x0008 (8 dec)	T1	4	IEEE754 Float	°C	Temperature of Sensor 1
0x0011 (17 dec)	P1	2	16-bit signed Integer	1/100 bar	Pressure of Sensor 1 x 100
0x0014 (20 dec)	T1	2	16-bit signed Integer	1/100 °C	Temperature of Sensor 1 x 100
0x0022 (34 dec)	P1	4	32-bit signed Integer	pascals (10 ⁻⁵ bar)	Pressure of Sensor 1
0x0028 (40 dec)	T1	4	32-bit signed Integer	°C	Temperature of Sensor 1
0x0100 (256 dec)	P1	4	IEEE754 Float	bar	Pressure of Sensor 1
0x0102 (258 dec)	T1	4	IEEE754 Float	°C	Temperature of Sensor 1

Table 3-3: Modbus Read/Write Register Map (Function Codes 3 & 6)

Register Starting Address (0xHiLo) (& decimal)	Register Name	Data Type & Number of Bytes	Default Value	Description
0x0200 (512 dec)	UART Setting	Two 8-bit unsigned integer 2 bytes	High Word: 0x00 Low Word: 0x00 9,600 8N1	Bits 0...3: Baud Rate 0: 9,600 bps (default) 1: 115,200 bps Bit 4: Parity 0: No Parity (default) 1: Parity enable Bit 5: Parity Mode 0: Odd Parity (default) 1: Even Parity Bit 6: Stop Bit 0: 1 Stop Bit (default) 1: 2 Stop Bits
0x020D (525 dec)	Device Address	Two 8-bit unsigned integer 2 bytes	High Word: 0x00 Low Word: 0x01 (default 1)	Range 1...249 0 is used for broadcast (no response) 250 is transparent (stand-alone only) 251...255 are reserved

Function Code 3 (0x03) MODBUS Register Read

- Function Code 3 is the **MODBUS Register Read (Sequential)**.
- Each register contains two bytes; therefore, the total byte count in the response should always be an even number.
- Reading float values always requires two registers since its data is typically four bytes.
- This code is the primarily for data gathering from servants.
- A maximum of 120 registers can be read in a single read cycle.
- See Table 3-2 and Table 3-3 for what registers can be read.

The format of messages follows:

Client Request:

DevAddr (Servant Address)	Function Code (0x03)	Starting Address High	Starting Address Low	# Registers High	# Registers Low	CRC16_ Low	CRC16_ High
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Servant Response:

DevAddr (Servant Address)	Function Code (0x03)	# of Data Bytes	Data High	Data Low	(Data cont.) ...	Data Low	CRC16_ Low	CRC16_ High
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Error:

DevAddr (Servant Address)	0x83	Error	CRC16_ Low	CRC16_ High
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Error codes:

- 2** Illegal data address:
 - Wrong starting-address or wrong number of registers
 - Start-address not defined; register exceeding defined rangereturn 0x0000

- 3** Illegal data value:
 - Quantity of requested registers out of bound
 - Must be ≤ 120 for devices

Function Code 3 Example

Given below request and response:

Message	Interchange	Response value
Client	0x01 0x03 0x00 0x02 0x00 0x00 0x65 0xCB	
Servant	0x01 0x03 0x04 0x3F 0x75 0xF0 0x7B 0xE3 0xDE	0.960701

Notice this follows the format:

Client Request:

DevAddr (0x01) (1)	Function Code (0x03) (3)	Starting Address High (0x00)	Starting Address Low (0x02)	# Registers High (0x00) (0)	# Registers Low (0x02) (2)	CRC16_ Low (0x65)	CRC16_ High (0xCB)
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(Note that combined 0xHiLo turns the starting address into 0x0002)

Servant Response:

DevAddr (0x01) (1)	Function Code (0x03) (3)	# of Data Bytes (0x04) (4)	Data High (0x3F)	Data Low (0x75)	(Data cont.) ...	Data Low (0x7B)	CRC16_ Low (0xE3)	CRC16_ High (0xDE)
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The request register 0x0002 contains four bytes of IEEE754 Float data; therefore, it requires data from two registers (each register contains two bytes), causing the servant to respond with four bytes as well.

The received value is then found by converting from the IEEE754 float hex data (pressure of sensor) into decimal, producing 0.960701 bar.

Function Code 6 (0x06) MODBUS Register Write

- Function Code 6 is the **MODBUS Single Register Write**.
- This allows the user to write settings to specific registers one at a time.
- As previously stated, a register contains two bytes.
- See Table 3-3 for what registers can be edited.

The format of messages follows:

Client Request:

DevAddr (Servant Address)	Function Code (0x06)	Starting Address High	Starting Address Low	Data High	Data Low	CRC16_ Low	CRC16_ High
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Servant Response:

DevAddr (Servant Address)	Function Code (0x06)	Starting Address High	Starting Address Low	Data High	Data Low	CRC16_ Low	CRC16_ High
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Error:

DevAddr (Servant Address)	0x86	Error	CRC16_ Low	CRC16_ High
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Error codes:

- 2** Illegal data address
 - Address not accessible by function 6
 - Start-address not defined (for writing)
- 3** Illegal data value
 - frame length incorrect
- 4** Servant Device Failure
 - Attempted to write into a protected register
 - The data written is outside the defined data range

Function Code 6 (0x06) Example:

Given

Message	Interchange
Client	0x01 0x06 0x02 0x00 0x00 0x01 0x49 0xB2
Servant	0x01 0x06 0x02 0x00 0x00 0x01 0x49 0xB2

Notice this follows the format:

Client Request:

DevAddr (0x01)	Function Code	Starting Address	Starting Address	Data High	Data Low	CRC16_ Low	CRC16_ High
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(1)	(0x06) (6)	High (0x02)	Low (0x00)	(0x00)	(0x01)	(0x49)	(0xB2)
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(Note that combined 0xHiLo turns the starting address into 0x0200)

Servant Response:

DevAddr (0x01) (1)	Function Code (0x06) (6)	Starting Address High (0x02)	Starting Address Low (0x00)	Data High (0x00)	Data Low (0x01)	CRC16_ Low (0x09)	CRC16_ High (0xB3)
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The request address is 0x0200 which writes UART Settings. The data sent is 0x00 0x01 which corresponds to changing the low bits 0...3 corresponding to baud rate. The value of 0x00 0x01 changes the low bit to 1, therefore changing the baud rate from the default 9,600bps to 115,200bps.

Function Code 8 (0x08) MODBUS Echo Test

- Function Code 8 is the **MODBUS Echo Test**.
- This function may be used to perform a quick line check. It simply returns the data received.
- Data may be any two-byte value.

The format of messages follows:

Client Request:

DevAddr (Servant Address)	Function Code (0x08)	0x00	0x00	Data High	Data Low	CRC16_ Low	CRC16_ High
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Servant Response:

DevAddr (Servant Address)	Function Code (0x08)	0x00	0x00	Data High	Data Low	CRC16_ Low	CRC16_ High
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Error:

DevAddr (Servant Address)	0x88	Error	CRC16_ Low	CRC16_ High
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Error codes:

- 1** Illegal subfunction code:
- The subfunction code is not supported (it is not (0x00, 0x00))
- 3** Illegal data value
- The data following the function code was not the fixed data (0x00, 0x00)

Function Code 8 (0x08) Example

Given

Message	Interchange
Client	0x01 0x08 0x00 0x00 0x04 0xF5 0x22 0x8C
Servant	0x01 0x08 0x00 0x00 0x04 0xF5 0x22 0x8C

Notice this follows the format:

Client Request:

DevAddr (0x01) (1)	Function Code (0x08)	0x00	0x00	Data High (0x04)	Data Low (0xF5)	CRC16_ Low (0x22)	CRC16_ High (0x8C)
--------------------------	----------------------------	------	------	------------------------	-----------------------	-------------------------	--------------------------

Servant Response:

DevAddr (0x01) (1)	Function Code (0x08)	0x00	0x00	Data High (0x04)	Data Low (0xF5)	CRC16_ Low (0x22)	CRC16_ High (0x8C)
--------------------------	----------------------------	------	------	------------------------	-----------------------	-------------------------	--------------------------

Echoes back the data 0x04, 0xF5

Analog (4-20mA) Set-Up

The Geotech series pressure transmitters can operate on a standard two-wire, 4-20 mA current loop.

Calculating the Linear Equation ($y = mx + b$)

To convert the current signal (mA) back into meaningful pressure or depth units, data loggers use a linear equation. You must calculate the multiplier (m) and the offset (b).

1. Calculating the multiplier (m)

The multiplier is determined by dividing the sensor's total measurement range by the 16-mA spread (the difference between 20 mA and 4 mA).

$$m = \text{Total Measurement Range} / 16$$

2. Calculating the offset (b)

The offset ensures that the 4 mA "floor" equals zero in your units.

$$b = m \times 4 \times (-1)$$

Calculation Example: 0–30 PSI Sensor

If you are using a transmitter rated for a maximum of 30 psi, here is how you would configure your data logger:

Calculation Example 0-30 PSI Sensor

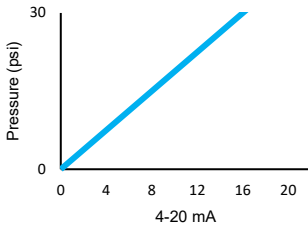


Figure 3-6

Calculation Example 0-30 PSI Sensor

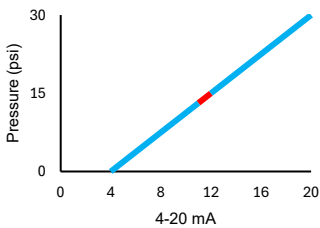


Figure 3-7

Step 1: Find the multiplier (m)

$$m = 30 / 16 = 1.875$$

Step 2: Find the offset (b)

$$b = 1.875 \times 4 \times (-1) = -7.5$$

Step 3: The Final Conversion Formula

If your data logger reads a current of 12 mA, you can find the pressure (y) using:

$$y = (1.875 \times 12) - 7.5$$

$$y = 22.5 - 7.5 = 15 \text{ psi}$$

In this scenario, a 12 mA reading (which is exactly halfway between 4 and 20 mA) correctly correlates to 15 psi (which is exactly halfway between 0 and 30 psi).

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, 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

While the transducer cable contains wires for both Modbus (Digital) and 4-20mA (Analog), they should not be used simultaneously to provide data to two different inputs.



Using both protocols can cause the internal power regulator to overheat or create "ground loops" that result in significant measurement errors.

Exception Errors

An exception error occurs when the message is physically received without corruption, but the instruction itself is unusable. This happens if the function code or the associated parameters are invalid for the device.

System Response

Unless the message was sent via "Broadcasting Mode," the servant will actively send an error response to the client. This notification confirms the message was received but explains why the request could not be executed.

The message transmitted as a response by the servant has the following format:

DevAddr	"1" Function Code	Exception Code	CRC16_Low	CRC16_High
---------	-------------------	----------------	-----------	------------

Table 5-1: Exception Errors

Exception Code	Error Type	Description
1	Illegal Function	The request function is not implemented or supported
2	Illegal Data Address	The memory address accessed is invalid or out of range
3	Illegal Data Value	The memory address accessed is invalid or out of range
4	Servant Device Failure	An unrecoverable error occurred while the servant was processing the action
32	Initialization Error	(bus only) occurs if the device was power-cycled and has not yet been initialized



Note that Code 32 will be encountered every time the device's power supply is interrupted. It serves as a notification that the unit has restarted and requires a fresh initialization sequence before it can resume normal operations.

Transmission Errors

In the event of a transmission error, the servant will not respond. It ignores all incoming data and reverts to listening mode. The client will experience a timeout and must re-initiate the request.

Signal Range Limits

Measurement capabilities are restricted by defined upper and lower thresholds. For the P1 channel, these limits are determined by the factory-compensated pressure range.

- **Effective Monitoring Range:** The transducer remains operational from 10% below the minimum pressure rating to 10% above the maximum pressure rating.

Out-of-Range Handling (Status-Byte)

If a reading for P1 or T1 exceeds these defined boundaries, the measured value is no longer valid when the Status-Bit is set. It is set to +Inf or -Inf.

- **Output Value:** To prevent downstream calculation errors, the output value will default to positive infinity (+Inf) or negative infinity (-Inf) until the signal returns to the valid range.

Table 5-2: Limit Errors

Indicator	Meaning	Trigger Condition
NaN (Not a Number)	Dependency Error	Occurs if the required source channel is inactive or reporting an error
+Inf (overflow)	Value Too High	ADC hardware limit exceeded or Temperature > 300°C
-Inf (underflow)	Value Too Low	ADC hardware limit reached or Temperatures < - 70°C
0.000	Sqrt: (P >Pcutoff)	When pressure falls below a defined cutoff point. (P<Pcutoff)

The sensor will display the status-bit and also an error in the value itself. The format follows special indications according to floating point arithmetic: NaN, +Inf over value limit (ovl), -Inf under value limit (uvl).

Table 5-3: Range Errors

	CH0	P1	T
NaN	Dependency error (P1 = NaN or +/- Inf)	+/- in compensating T-channel	-
+Inf	-	ADC value out of range (overflow)	ADC value out of range or T > 300°C
-Inf	-	ADC value out of range (underflow)	ADC value out of range or T < - 70°C
0.000	Sqrt: (p > Pcutoff)	-	-

The values NaN, +Inf and -Inf are defined in the IEEE754 standard. NaN is also shown when the channel is not active.

Table 5-4: Special Integer Values

	32bit signed integer	16bit signed integer
NaN, +Inf	2147483674 (0x7FFFFFFF)	32767 (0x7FFF)
-Inf	-2147483648 (0x80000000)	-32768 (0x8000)

Analogue Output

The graph below shows the error state transfer function between pressure (in this example the analogue output is a function of pressure). The sig-error is independent of any scaling function and represents an internal error state (source has NaN, see Table 5-4 above).

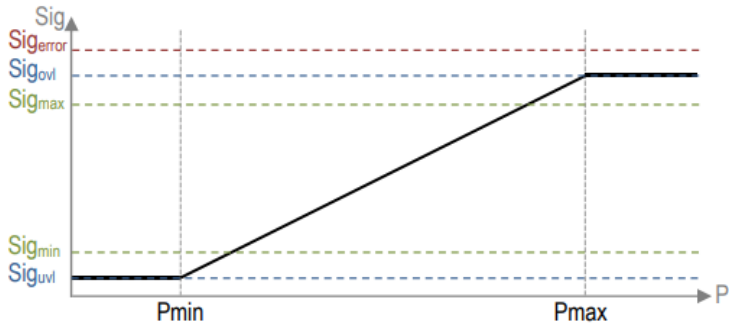


Figure 5-1: Sig-Error vs Pressure Example Graph

Table 5-5: Analog Values to Digital Output Response

	0-10V	0-2.5	4-20mA	Digital Output
Sig error	11.6V	2.9v	22.5mA	NaN
Sig ovl	11V	2.75V	21.8mA	+Inf
Sig max	10V	2.5V	20mA	Value
Sig min	0V	0V	4mA	Value
Sig uvl	-1V	-0.3V	3.3mA	-Inf

Scenarios

The Data Values are $\pm\text{Inf}$ or NaN

Problem: The device is communicating, but the pressure or temperature values show "Infinity" or "Not a Number" instead of real measurements.

Potential Causes (System/Channel Errors):

- Range Overflow: The pressure is 10% higher or lower than the sensor's rated compensated range, triggering a "Status-Bit."
- Hardware Limits: The temperature has exceeded 300°C $+\text{Inf}$ or dropped below -70 °C $-\text{Inf}$

The Servant Responds with an Error Code

Problem: The communication is technically successful (no transmission error), but the servant sends back an "Exception Response" instead of data. See Table 5-1 for potential causes and Exception Codes.

Solution & Recovery:

1. Check Register Maps: Verify the Modbus address and function codes in your client software against the device manual.

2. **Power Cycle Recovery:** If you receive Code 32, perform a fresh initialization sequence. This is required every time the power supply is interrupted.
3. **Checksum Check:** If using MODBUS specific protocols, ensure the High/Low byte order of your CRC16 is correct for that specific bus.

The Servant Device is Not Responding (Silent)

Problem: The client sends a request, but the servant does not reply, eventually causing a "Client Timeout."

Potential Causes (Transmission Errors):

- **Physical Line Faults:** Wiring issues or interference causing signal degradation.
- **Timing Gaps:** Excessive delays between bytes within a frame make the message appear incomplete.
- **Buffer Overflow:** The request sent is larger than the servant's internal memory can handle.
- **Formatting/Checksum Mismatch:** The CRC16 checksum fails, or the word length is uninterpretable, suggesting corrupted data.

Solution & Recovery:

1. Check for loose terminals, frayed wires, or incorrect polarity (A/B lines swapped).
2. Re-terminate connections and power-cycle the servant device to reset the physical interface.
3. In Modbus RTU, a gap of more than 3.5 characters signals the end of a frame.
4. Synchronize the baud rate settings across all devices to ensure timing remains consistent.

Section 6: System Specifications

Maximum ratings

Supply Voltage	12-36 VDC	
Supply Current	25 mA	
Maximum Pressure	As specified	PSI absolute or gauge
Analog mA Signal Output	4-20 mA	
Analog Voltage Output	1-5 VDC	
Probe is protected from reverse polarity supply connection.		

Table 6-1: System Specifications

Mode	RTU Mode (ASCII is not supported)
Error Check Field	2 Byte Cyclical Redundancy Check (CRC)
Baudrate	Factory 9,600 or 115,200, 8N1
Bus Address	Factory Configurable – 1 default
Encoding	32-bit, IEEE Floats, Big Endian

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



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

<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.

**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 gases compatible with 316 stainless steel

Cable

Polyurethane Cable

Max Cable Length	Vented (gauge): 750' (228.6 m) Non-vented (absolute): 5000' (1524 m)
Section Weight	0.064 lbs/ft (0.095 kg/m)
Jacket	Yellow Polyurethane
Diameter	.335" to .360" (8.5 mm to 9.14 mm)
Conductors	HDPE 4-24AWG 7/32 Tinned Copper Nom. OD .045" (1.143 mm) White, Red, Blue, Orange
Drain	Unjacketed 24 AWG 7/32 Tinned Copper
Filler	0.065/8500 White Polypropylene
Vent Tube	Nylon 6/6 Vent Tube
Inner Shield	Aluminum/Polyester Tape Wrap
Binder	Polyester Tape Wrap
Outer Shield	36 AWG Tinned Copper, Braided, 95% coverage
Separator	Tissue Paper Tape
Conductors	TPC FEP 4-24AWG 7/32 Tinned Copper Nom. OD .048" (1.219 mm) White, Red, Blue, Orange
Drain	Unjacketed 24 AWG 7/32 Tinned Copper
Filler	0.065/8500 White Polypropylene
Insulation	TPC FEP .012" Nom. Wall (.3 mm)
Vent Tube	Nylon 6/6 Vent Tube
Inner Shield	Aluminum/Polyester Tape Wrap
Binder	Polyester Tape Wrap
Outer Shield	36 AWG Tinned Copper, Braided, 95% coverage
Separator	Tissue Paper Tape

Parts and Accessories

Part Description	Part Number
CAP, DELRIN, BOTTOM, TRANSDUCER	22050018
DESICCANT KIT, TRANSDUCERS	82050128
BELLOWS KIT, TRANSDUCERS	82050129
J-BOX, PRESSURE TRANS, VENTED W/ DESICCANT KIT	82051006
J-BOX, PRESSURE TRANS, VENTED W/ BELLOWS KIT	82051004
SURGE SUPPRESSOR,PRES TRANS,UW UPWELL	82050113
RESISTOR, 250 OHM, 1/4W, .01% WW	12050745
SPOOL, SMALL, PLASTIC, 350FT MAX CABLE	22050011
SPOOL, MEDIUM, PLASTIC, 800FT MAX CABLE	22050010
SPOOL, LARGE, PLASTIC, 2500FT MAX CABLE	22050009
MANUAL, PRESSURE TRANSDUCER	12050178

Contact Geotech for specific pressure ranges and cable lengths.

Appendix A: Pressure Conversion Chart

	PSI	Inches of Water (in. H ₂ O) 4°C	Feet of Water (ft. H ₂ O) 4°C	Bar (bar)	Atmosphere (atm)
1 PSI	1	27.68	2.31	68.95×10^{-3}	68.05×10^{-3}
1 Inches of Water (in. H₂O) 4°C	27.68	1	1/12	2.49×10^{-3}	2.46×10^{-3}
1 Feet of Water (ft. H₂O) 4°C	.434	12	1	29.9×10^{-3}	29.5×10^{-3}
1 Bar (bar)	14.50	401.46	33.46	1	.987
1 Atmosphere (atm)	14.696	406.8	33.90	1.01325	1

Revision History		
Project #	Description	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
M2000	Removed vent tube from section 6, minor style changes, SR	11/22/2016
1538	Removed Probe PAL, StellaR	1/25/2017
1559	Corrected specification call outs - StellaR	5/24/2017
M2000	Removed Blue Polyurethane cable from specs, added MODBUS – StellaR	5/28/2020
M2000	Added MODBUS Communication Basics and Bus Addressing – StellaR	6/8/2020
M2100	Removed Conductivity addressing, option not available. – StellaR	2/3/2021
M2100	Updated figure 2-3 – StellaR	4/6/2021
M2178	Updated figures 2-1, 2-2, 2-3 to include 5 conductor cable. Updated all cable specs, updated specifications (reduced Modbus details), – StellaR/GR	4/26/2022
M2467	Removed PVC and Tefzel Options – AH	5/21/2025
M2579	Captioned figures and tables. Reworked Section 4 MODBUS to increase clarity. Adjusted formatting. Added graphed examples to Section 5. Updated figures. – AL	7/15/2026
M2579	Added “Geotech” back on cover. Reformatted to match template including standardizing sections. Removed sealed gauged transducers. Added spools and j-boxes to Replacement Parts List. - GR	8/6/2026
M2279	Updated maximum cable lengths for both absolute and gauged sensors.-AL	9/10/2026

Notes

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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.

Geotech Environmental Equipment, Inc.

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