Model 4580

Vibrating Wire Barometer and Pressure Transducers

Instruction Manual

GEOKON®

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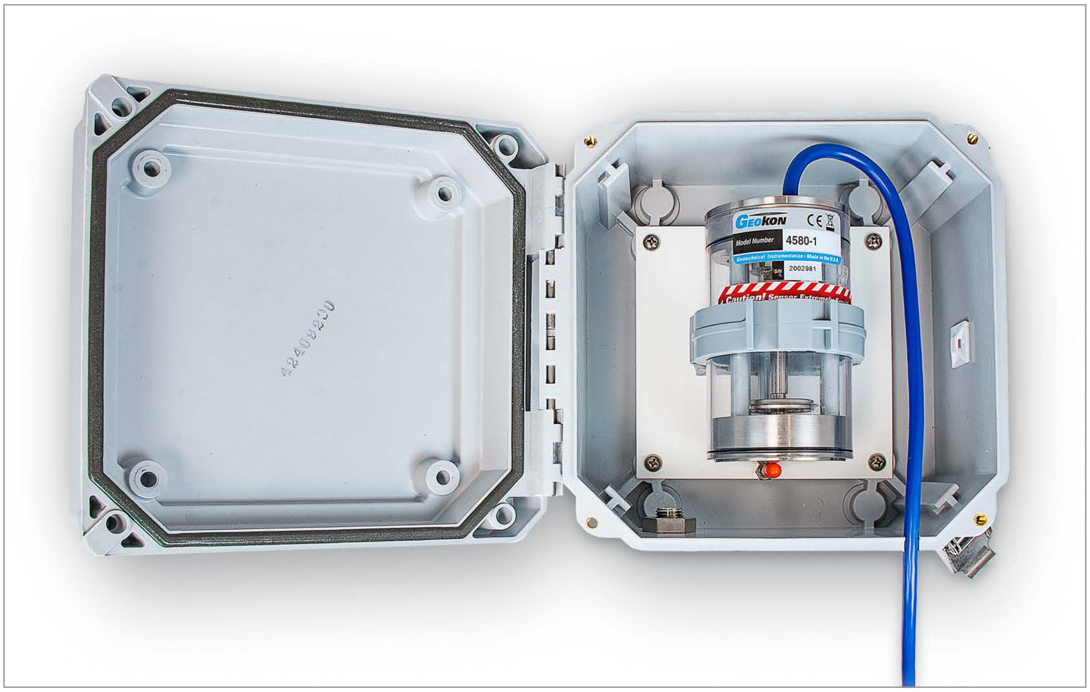
1. INTRODUCTION

The GEOKON Model 4580-1 Vibrating Wire Barometer is used to measure atmospheric pressure changes. The barometric sensors are calibrated at the factory and referenced to an absolute barometric reading in millibars. A protective enclosure, Model 4580-1-ENCL, is also available.



Model 4580-1 Vibrating Wire Barometer Installed in 4580-1-ENC-L

The GEOKON Models 4580-2V and 4580-3V Vibrating Wire Pressure Transducers are another version that are designed primarily for the measurement of very small changes in pressure such as in groundwater elevation in wells, water levels in streams, weirs, flumes, etc. Changes in water levels of as little as 0.2 mm can be measured.

FIGURE 2: *Model 4580-2V Vibrating Wire Pressure Transducer*

***FIGURE 3:** Model 4580-3V Vibrating Wire Pressure Transducer*

1.1 CONSTRUCTION

The instrument consists of a double diaphragm capsule connected to a vibrating wire sensor and secured inside a pressure chamber. In the case of the Model 4580-1 Barometer, the pressure chamber is evacuated.

External pressure applied to the capsule causes it to compress and exert a force on the vibrating wire sensor and this produces a change in wire tension and frequency of vibration. The change in tension is proportional to the pressure and, through calibration, the pressure can be very accurately determined.

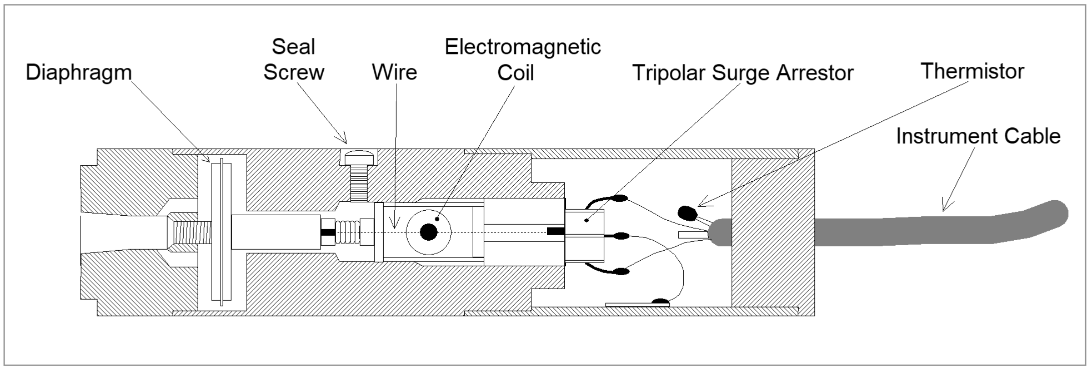


***FIGURE 4:** Construction of a Model 4580-2V Vibrating Wire Pressure Transducer*

2. INSTALLATION

2.1 PRELIMINARY TESTS

GEOKON recommends that each sensor is function tested before installing in the field. To perform this preliminary check complete the following steps:

1. Connect the sensor to a readout. This could be a portable, handheld readout or the system that will be used in the final installation.
2. The sensor should have a strong, stable signal. The temperature reading should match the ambient temperature. A calibration report is supplied with each sensor and displays a zero reading at a specific temperature and barometric pressure. Zero readings at the site should coincide with the factory readings within 20 digits after barometric and temperature corrections are made. The factory elevation is +580’ (Barometric pressure changes with elevation at a rate of ≈ 1/2 psi per 1,000’)

   The sensor is very sensitive, and it will be observed that the readings change depending on the position of the sensor. A 30 to 50 digit change between the sensor being vertically up and vertically down is normal (Factory calibrations were performed with the sensor vertical, cable end up). This phenomenon will not be a problem if the sensor remains stationary or is in the same orientation during use. Additionally, these sensors are sensitive to shock. A shift in the zero reading can occur during shipping or rough handling. Normally this will not affect the operation of the sensor, but a shift of more than 100 units should be checked by monitoring the sensor for a few days at a constant temperature, if possible.

Note: Before March 21, 1995, factory barometric pressure readings were corrected to sea level; readings after this date represent absolute pressure.

3. Check electrical continuity using an ohmmeter. Resistance between the gauge leads (usually red and black) should be approximately 180 ohms. Remember to add cable resistance, which is approximately 48.5 Ω per km (14.7 Ω per 1000’) of 22 AWG stranded copper leads at 20 °C. Multiply this factor by two to account for both directions. Resistance between thermistor leads (usually green and white) will vary based on temperature (see Appendix B). Resistance between any conductor and the shield should exceed two megaohms.

Should any of these preliminary tests fail, see Section 6 for troubleshooting tips.

2.2 INSTALLATION PROCESS

2.2.1 MODEL 4580-1 BAROMETER AND 4850-1-ENCL ENCLOSURE INSTALLATION

Barometers are calibrated at the factory and referenced to an absolute barometric reading in millibars. Installation at the site is usually carried out by installing the sensor in a vented enclosure (Model 4580-1-ENCL) with the sensor in a vertical position with the cable exiting from the top of the sensor. (The sensor is position sensitive.)

1. Mount the Model 4580-1-ENCL Enclosure, vent side down, using the mounting tabs on the enclosure.
2. Open the enclosure lid. Place the Model 4580-1 Barometer in the clamp. Make sure the barometer is centered between the threaded rods, as shown in Figure 5.

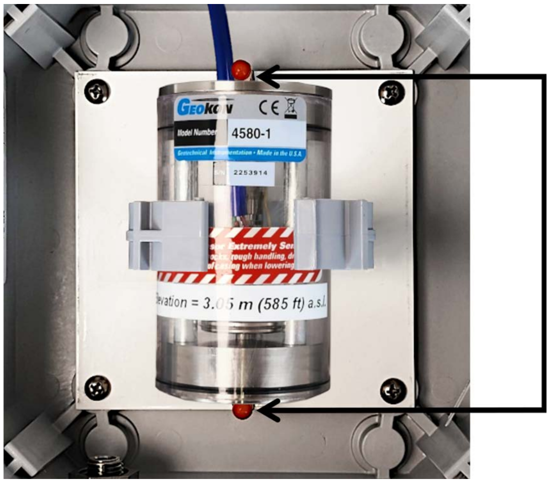


FIGURE 5: *Guidepost Alignment*

3. Press down firmly on the barometer until the clamp comes together and latches.
4. Attach the cable to the side of the enclosure using the provided zip tie.

FIGURE 6: *Sensor and Sensor Cable Secured*

5. Seat the cable in the recessed groove in the bottom of the enclosure.
6. Close and latch the enclosure lid.

FIGURE 7: *Enclosure Closed*

7. It is advisable to obtain concurrent readings with an accurate, local barometer following installation to be sure of obtaining a proper on-site starting point for all measurements.

Note: To remove the barometer, pry open the clamp using a screwdriver (or similar tool), as shown in Figure 8.

FIGURE 8: *Barometer Removal*

2.2.2 PRESSURE TRANSDUCER INSTALLATION

Care must be taken to be sure the entire pressure cavity surrounding the capsule is filled with water. A hole with a seal screw is provided on the body of the sensor to allow water to flow through the pressure chamber. Flush water through the body of the sensor with the water entering at the tip of the sensor and exiting through the seal screw. Agitate the body of the sensor until no bubbles are seen exiting the seal screw port. The screw should be replaced with the sensor held under water to prevent air from reentering the sensor. (Air trapped in the chamber can cause inaccurate and/or unstable pressure readings in changing temperature environments.)

The sensor has 1/4" NPT female thread on the front end allowing for connection to various types of fittings. The wrench flats on the sensor should be used when tightening fittings into the thread.

The outer end of the vent tube is connected to a desiccant chamber to prevent moisture from entering the inside of the sensor capsule. A 2.5′ length of blue cable is spliced at the end of the tubing, this allows for a standard connection to a readout or data logger as needed. **The vent trap screw must be removed during the measurement period** to equalize the changes in barometric pressure both inside and outside the pressure capsule. (When the desiccant turns from blue to pink it should be replaced.)

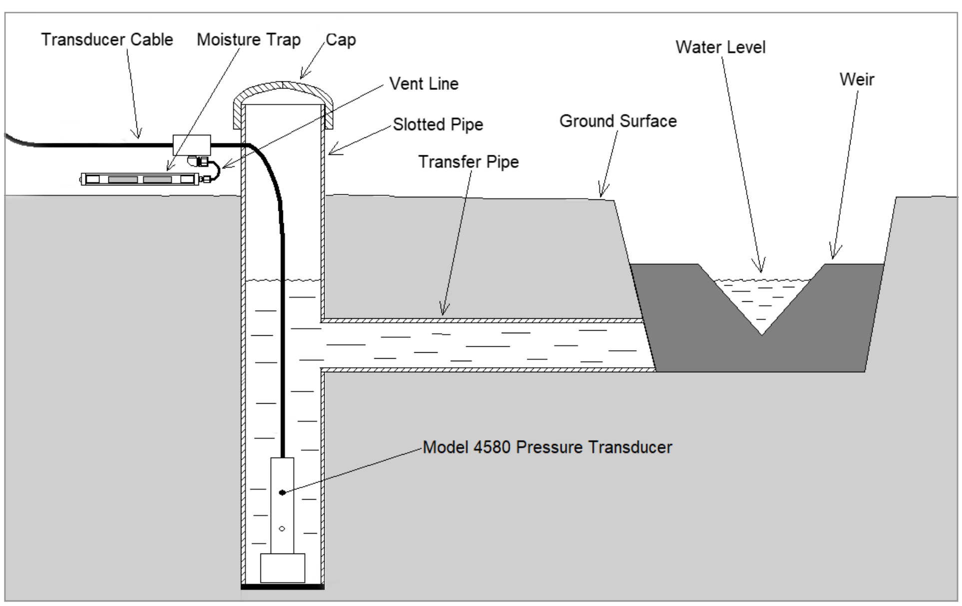


FIGURE 9: *Example of a Model 4580 Weir Monitor Installation*

2.3 CABLE AND CONNECTOR PROTECTION

The cable should be protected from accidental damage caused by moving equipment or debris. This is best accomplished by routing the cable through flexible conduit (available from GEOKON).

Because the vibrating wire output signal is a frequency rather than a current or voltage, cable splicing has no ill effects. The cable used for making splices should be a high-quality twisted pair type, with 100% shielding and an integral shield drain wire. **It is very important that the shield drain wires be spliced together.** Always maintain polarity when possible by connecting color to color.

Splice kits recommended by GEOKON incorporate casts that are placed around the splice and are then filled with epoxy to waterproof the connections. When properly made, this type of splice is equal or superior to the cable in strength and electrical properties. Contact GEOKON for splicing materials and additional cable splicing instructions.

Install instrument cables as far away as possible from sources of electrical interference such as power lines, generators, motors, transformers, arc welders, etc. Cables should never be buried or run with AC power lines. Doing so will cause the instrument cables to pick up the frequency noise from the power cable, and this will likely make obtaining a stable reading difficult.

2.4 LIGHTNING PROTECTION

In settings where lightning strikes are a concern, GEOKON offers the Model 4999-12L/LE Surge Protection Module:

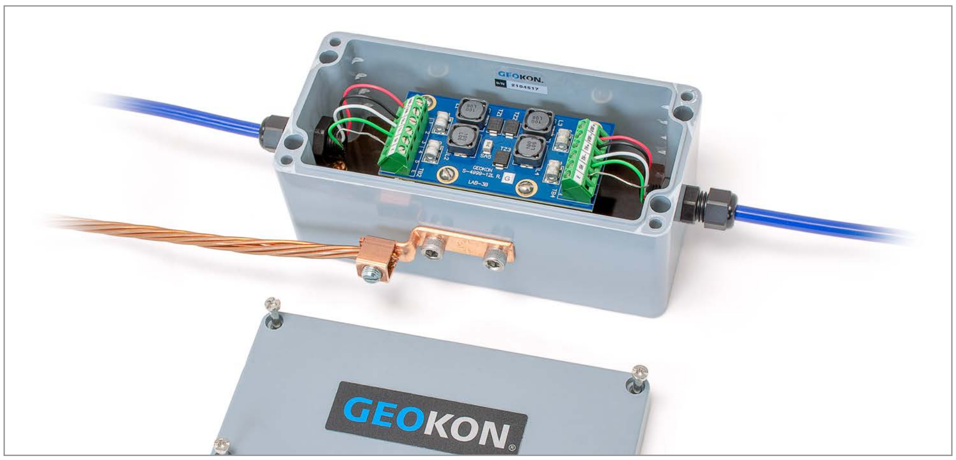


FIGURE 10: *Model 4999-12L/LE*

The module features surge protection circuitry that can be replaced in the event that it is damaged by a lightning strike. The Module is installed between a sensor and the data logger or terminal box it is connected to (see Figure 11). Consult the Model 4999-12L/LE Instruction Manual (geokon.com/4999-12L/E) for additional information.

Additional lightning protection measures available include:

- Terminal boxes available from GEOKON can be ordered with lightning protection built in. The terminal board used to make the sensor connections has provision for the installation of plasma surge arrestors. Lightning Arrestor Boards (Model 4999-12L) can also be incorporated into the terminal box. The terminal box must be connected to an earth ground for these levels of protection to be effective.
- If the instruments will be read manually with a portable readout (no terminal box), a simple way to help protect against lightning damage is to connect the cable leads to a good earth ground when not in use. This will help shunt transients induced in the cable to ground, away from the instrument.

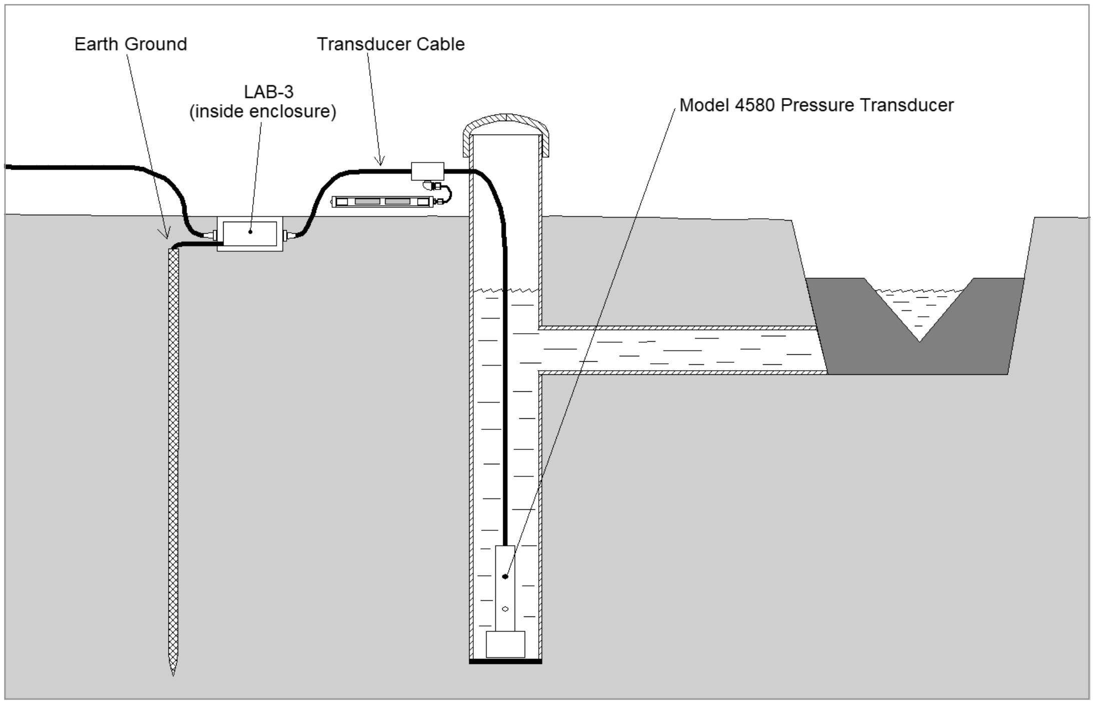


FIGURE 11: *Recommended Lightning Protection Scheme*

3. TAKING READINGS

3.1 COMPATIBLE READOUTS AND DATA LOGGERS

GEOKON can provide several readout and data logger options. Devices compatible with this product are listed below. For further details and instruction consult the corresponding Manual(s) at geokon.com/Readouts and geokon.com/Dataloggers.

DIGITAL READOUTS:

- **GK-404**

  The Model GK-404 VW Readout is a portable, low-power, hand-held unit capable of running for more than 20 hours continuously on two AA batteries. It is designed for the readout of all GEOKON Vibrating Wire (VW) instruments, and can display the reading in digits, frequency (Hz), period (µs), or microstrain (µε). The GK-404 displays the temperature of the sensor (embedded thermistor) with a resolution of 0.1 °C.

- **GK-406**

  The Model GK-406 is a field-ready device able to quickly measure a sensor, save data, and communicate results with custom PDF reports and spreadsheet output. Measurements are geo-located with the integrated GPS allowing the GK-406 to verify locations and lead the user to the sensor locations. The large color display and VSPECT™ technology produce the best measurement possible both in the field and in the office.

DATA LOGGERS:

- **GeoNet Series**

  The GeoNet Data Logger series is designed to collect and transfer data from vibrating wire, RS-485, and analog instruments. GeoNet offers a wide range of telemetry options, including LoRa, cellular, Wi-fi, satellite, and local. Data loggers can work together to operate in a network configuration, or be used separately as standalone units. GeoNet devices arrive from the factory ready for deployment and may commence with data acquisition in minutes.

  Data is transferred to a secure cloud-based storage platform where it can be accessed through the GEOKON OpenAPI. Industry leading data visualization software, such as the free GEOKON Agent Software, can be used with the OpenAPI for data viewing and reporting. Data loggers without network capabilities are also available.

- **8600 Series**

  The Model 8600 Series Data Logger is designed to support the reading of a large number of GEOKON instruments for various unattended data collection applications using GEOKON Model 8032 Multiplexers. Weatherproof packaging allows the unit to be installed in field environments where inhospitable conditions prevail. The Nema 4X enclosure also has a provision for locking to limit access to responsible field personnel.

3.2 MODEL 4999 TERMINAL BOXES

Terminal boxes with sealed cable entries are available from GEOKON. These allow many gauges to be terminated at one location with complete protection of the lead wires. The interior panel of the terminal box can have built-in jacks or a single connection with a rotary position selector switch.

Terminal Boxes make it easy to manually connect a Readout Box (GK-404 or GK-406). The rotary switch is used to select which “channel” or sensor is being read by the Readout Box.

For further details and instruction consult the Model 4999 Instruction Manual (geokon.com/4999).

3.3 MEASURING TEMPERATURES

All GEOKON vibrating wire sensors are equipped with a thermistor for reading temperature. The thermistor gives a varying resistance output as the temperature changes. The white and green leads of the sensor cable are normally connected to the internal thermistor.

The GK-404 and GK-406 readouts will read the thermistor and display the temperature in degrees Celsius.

USING AN OHMMETER TO READ TEMPERATURES:

Connect an ohmmeter to the green and white thermistor leads coming from the sensor. Since the resistance changes with temperature are large, the effect of cable resistance is usually insignificant. For long cables a correction can be applied equal to approximately 48.5 Ω per km (14.7 Ω per 1000') at 20 °C. Multiply these factors by two to account for both directions.

Look up the temperature for the measured resistance in Appendix B.

4. DATA REDUCTION

4.1 DATA CALCULATION

The basic units utilized by GEOKON for measurement and reduction of data from this sensor are digits. The calculation of digits is based on the following equation:

$$\text{digits} = \frac{Hz^2}{1000} \quad \text{or} \quad \text{digits} = \left(\frac{1}{\text{Period}}\right)^2 \times 10^{-3}$$

EQUATION 1: *Digits Calculation*

In typical installations the linear calculation is more than sufficient. However, if utmost accuracy is desired, the polynomial calculation can be used. Refer to the applicable section below.

4.1.1 LINEAR CALCULATION

To convert digits to pressure the following equation applies:

$$P = G(R_1 - R_0)$$

EQUATION 2: *Linear Pressure Calculation*

Where:
G = The gauge factor found on the calibration report, usually in terms of kPa, MPa, or psi per digit.

R_1 = The current readings in digits.
R_0 = The initial field zero reading in digits.

EXAMPLE:

The initial reading (R_0) at installation is 4966 digits. The current reading (R_1) is 5988 digits. The calibration factor (G) is 0.006718 kPa/digit. The pressure change is:

$$P = 0.006718(5988 - 4966)$$

$$P = 6.87 \text{ kPa}$$

4.1.2 POLYNOMIAL CALCULATION

To convert digits to pressure using the polynomial expression the following equation applies:

$$P = AR_1^2 + BR_1 + C$$

EQUATION 3: *Polynomial Pressure Calculation*

Where:
R_1 = The current reading in digits.
A, B = The polynomial gauge factors found on the calibration report.
C = The polynomial gauge factor that needs to be calculated (see below).

To perform the polynomial calculation, gauge factor "C" must be calculated first. This is done by using the equation above, but replacing "P" with a value of zero, and "R_1" with the value of "R_0".

$$0 = AR_0^2 + BR_0 + C$$

EQUATION 4: *Calculation for Polynomial Gauge Factor "C"*

Where:
R_0 = The initial field zero reading in digits.
A, B = The polynomial gauge factors found on the calibration report.

The calculated "C" can then be used in Equation 3 to find the precise value of pressure (P).

EXAMPLE:

The given polynomial gauge factors on the calibration are:

A = 3.912E-08

B = 0.006231

The initial reading (R_0) at installation of a sensor is 4966 digits. The current reading (R_1) is 5988 digits.

First, the gauge factor "C" must be calculated:

$$0 = AR_0^2 + BR_0 + C$$

$$0 = 3.912 \times 10^{-8} \times 4966^2 + 0.006231 \times 4966 + C$$

$$0 = 31.91\ C$$

$$C = -31.91$$

The pressure change is:

$$P = AR_1^2 + BR_1 + C$$

$$P = 3.912 \times 10^{-8} \times 5988^2 + 0.006231 \times 5988 + (-31.91)$$

$$P = 6.80\ \text{kPa}$$

4.2 ADDITIONAL CALCULATIONS

4.2.1 TEMPERATURE CORRECTION

Careful selection of materials is made in constructing the vibrating wire pressure transducer to minimize thermal effects, however, most units still have a slight temperature coefficient.

Since sensors are normally installed in a tranquil temperature environment, corrections are not normally required. If that is not the case for a selected installation, corrections can be made using the internal thermistor for temperature measurement.

The following thermal correction equation is calculated, then afterwards is added to the pressure calculation (Equation 2 or Equation 3):

$$T_{Correction} = K(T_1 - T_0)$$

EQUATION 5: *Thermal Correction for Pressure*

Where:
K = The thermal factor found on the calibration report, usually in terms of kPa, MPa, or psi per digit.

T_1 = The current temperature reading in °C.
T_0 = The initial field temperature reading in °C.

4.2.2 BAROMETRIC CORRECTION

Corrections for the Model 4580-1 Barometer may be necessary. For example, ignoring a barometric pressure change from 29 to 31" of mercury would result in ≈1 psi of error (or ≈2.3' if monitoring water level in a well).

It is necessary to record the barometric pressure at the time of each reading.

Note: An alternative to measuring the barometric pressure and making barometric correction is to use Model 4580-2V or 4580-3V, which are vented to the atmosphere. With vented transducers, barometric pressure finds its way to both the inside and the outside of the pressure capsule and is thus automatically canceled.

The following barometric correction equation is calculated, then afterwards is subtracted from the pressure calculation (Equation 2 or Equation 3):

$$S_{Correction} = (S_1 - S_0) \times F$$

EQUATION 6: *Barometric Correction with Conversion Factor*

Where:
S_1 = The current barometer.
S_0 = The initial field zero barometer.
F = The conversion factor, see below for more detail.

Barometric pressure must be converted to the same engineering unit as the sensor pressure range (kPa or MPa). Barometric pressure is usually recorded in inches of mercury. The conversion factor (F) for inches of mercury to kPa is 3.3863 and from inches of mercury to MPa is 0.003386. Table 1 in Section 4.2.3 lists other common conversion factors.

The user should be aware that this correction scheme assumes ideal conditions. In reality, conditions are rarely ideal. For example, if a well is sealed and not connected hydraulically to the atmosphere, barometric effects on the water pressure can be attenuated. This will result in an error due to applying an unnecessary or excessive correction. GEOKON recommends, in these cases, to independently record barometric pressure changes and correlate these with observed pressure changes to arrive at a correction factor.

4.2.3 ENGINEERING UNITS CONVERSION

To convert to a different engineering unit, take the result from data calculation (after other optional calculations have been completed, if applicable) and multiply it by the appropriate conversion multiplier from Table 1.

		Convert From											
		psi	**"H_2O**	**'H_2O**	**mm H_2O**	**m H_2O**	**"HG**	**mm HG**	**atm**	**mbar**	**bar**	**kPa**	**MPa**
Convert To	**psi**	1	.036127	.43275	.0014223	1.4223	.49116	.019337	14.696	.014503	14.5039	.14503	145.03
	"H_2O	27.730	1	12	.039372	39.372	13.596	.53525	406.78	.40147	401.47	4.0147	4016.1
	'H_2O	2.3108	.08333	1	.003281	3.281	1.133	.044604	33.8983	.033456	33.4558	.3346	334.6
	mm H_2O	704.32	25.399	304.788	1	1000	345.32	13.595	10332	10.197	10197	101.97	101970
	m H_2O	.70432	.025399	.304788	.001	1	.34532	.013595	10.332	.010197	10.197	.10197	101.97
	"HG	2.036	.073552	.882624	.0028959	2.8959	1	.03937	29.920	.029529	29.529	.2953	295.3
	mm HG	51.706	1.8683	22.4196	.073558	73.558	25.4	1	760	.75008	750.08	7.5008	7500.8
	atm	.06805	.002458	.029499	.0000968	.0968	.03342	.001315	1	.000986	.98692	.009869	9.869
	mbar	68.947	2.4908	29.8896	.098068	98.068	33.863	1.3332	1013.2	1	1000	10	10000
	bar	.068947	.002490	.029889	.0000981	.098068	.033863	.001333	1.0132	.001	1	.01	10
	kPa	6.8947	.24908	2.98896	.0098068	9.8068	3.3863	.13332	101.320	.1	100	1	1000
	MPa	.006895	.000249	.002988	.0000098	.009807	.003386	.000133	.101320	.0001	.1	.001	1

TABLE 1: *Engineering Units Conversion Multipliers*

4.3 ENVIRONMENTAL FACTORS

Since the purpose of the sensor installation is to monitor site conditions, factors that can affect these conditions should always be observed and recorded. Seemingly minor affects may have a real influence on the behavior of the structure being monitored and may give an early indication of potential problems. Some of these factors include, but are not limited to, blasting, rainfall, tidal levels, traffic, temperature and barometric changes, weather conditions, changes in personnel, nearby construction activities, excavation and fill level sequences, seasonal changes, etc.

5. MAINTENANCE

Vented sensors require periodic replacement of the desiccant capsules in the moisture trap. Replace capsules when they change from blue to pink.

If the sensor is installed in water with high concentrations of silts etc. it may require cleaning from time to time. This can be accomplished by gently flushing water through the transducer; first through the P-1 port and then back through the seal screw hole. Repeat this several times until the water passing through is clear. Remember not to apply excess pressure to the sensor.

6. TROUBLESHOOTING

Maintenance and troubleshooting is confined to periodic checks of cable connections and maintenance of terminals. The sensors themselves are sealed and are not user serviceable.

Should difficulties arise, consult the following list of problems and possible solutions. For additional troubleshooting and support visit geokon.com/Technical-Support.

SYMPTOM: THERMISTOR RESISTANCE IS TOO HIGH

- ☐ Check for an open circuit. Check all connections, terminals, and plugs. If a cut is in the cable, splice according to instructions in Section 2.3.

SYMPTOM: THERMISTOR RESISTANCE IS TOO LOW

- ☐ Check for a short circuit. Check all connections, terminals, and plugs. If a short is in the cable, splice according to instructions in Section 2.3.
- ☐ Water may have penetrated the interior of the sensor. There is no remedial action.

SYMPTOM: SENSOR READING UNSTABLE

- ☐ Make sure the shield drain wire is connected to the blue clip on the flying leads.
- ☐ Isolate the readout from the ground by placing it on a piece of wood or another insulator.
- ☐ Check for sources of nearby electrical noise such as motors, generators, antennas, or electrical cables. Move the sensor cable away from these sources if possible. Contact the factory for available filtering and shielding equipment.
- ☐ The sensor may have been damaged by over-ranging or shock. Inspect for damage.
- ☐ The body of the sensor may be shorted to the shield. Check the resistance between the shield drain wire and the sensor housing. If the resistance is very low, the gauge conductors may be shorted.
- ☐ Is the readout box position set correctly? If using a data logger to record readings automatically, are the swept frequency excitation settings correct?
- ☐ Check the readout with another sensor to ensure it is functioning properly.

SYMPTOM: SENSOR FAILS TO GIVE A READING

- ☐ Check the readout with another sensor to ensure it is functioning properly.
- ☐ The sensor may have been damaged by over-ranging or shock. Inspect for damage.
- ☐ Check the resistance of the cable by connecting an ohmmeter to the sensor leads. Cable resistance is about 48.5 Ω per km (14.7 Ω per 1000'). If the resistance is very high or infinite, the cable is probably broken. If the resistance is very low, the gauge conductors may be shorted. If a break or a short is present, splice according to the instructions in Section 2.3. Refer to the expected resistance for the various wire combinations below.

  Vibrating Wire Sensor Lead Resistance Levels

  Red/Black Coil Resistance: ≅180 Ω

  Green/White 3000 Ω at 25 °C

  Any other wire combination will result in a measurement of infinite resistance.

Note: Tests should be performed with a quality multimeter to accurately show possibilities of shorts. Sensors should be disconnected from other equipment while performing resistance tests, this includes surge modules, terminals, multiplexers and data loggers. Fingers cannot be touching the multimeter leads or sensor wires while testing.

Table 2 shows the expected resistance for the various wire combinations.

Table 3 is provided for the customer to fill in the actual resistance found.

Vibrating Wire Sensor Lead Grid - SAMPLE VALUES					
	Red	**Black**	**White**	**Green**	**Shield**
Red					
Black	**≅180 Ω**				
White	Infinite	Infinite			
Green	Infinite	Infinite	**3000 Ω at 25°C**		
Shield	Infinite	Infinite	Infinite	Infinite	

TABLE 2: *Sample Resistance*

Vibrating Wire Sensor Lead Grid - SENSOR NAME/##					
	Red	**Black**	**White**	**Green**	**Shield**
Red					
Black					
White					
Green					
Shield					

TABLE 3: *Resistance Worksheet*

APPENDIX A. SPECIFICATIONS

A.1 MODEL 4580 PRESSURE TRANSDUCER SPECIFICATIONS

Model	4580	4580-2V	4580-3V
Range[1]	200 mbar	17, 35 kPa	7 kPa
Resolution[2]	0.025% F.S.		
Linearity	±0.5% F.S.		
Accuracy[3]	0.5% F.S. (0.1% F.S. with a polynomial expression)		
Overrange	1.5x F.S.		
Thermal Zero Shift	<0.01% F.S./°C		
Temperature Range	-20 to +80 °C		
Frequency Range	1400 - 3500 Hz		
Coil Resistance	180 Ω, ±10 Ω		
Dimensions (L x D)	110 x 63 mm (4.33 x 2.5”)	165 x 38 mm (6.5 x 1.5")	165 x 63.5 mm (6.5 x 2.5”)
Weight	1.18 kg (2.6 lbs)	0.86 kg (1.9 lbs)	1.72 kg (3.8 lbs)

TABLE 4: *Model 4580 Pressure Transducer Specifications*

Note:

[1] Other ranges available upon request.

[2] Depends on readout system.

[3] Accuracy established under laboratory conditions.

A.2 THERMISTOR

See Appendix B for more information.

Range: -80 to +150 °C

Accuracy: ±0.5 °C

APPENDIX B. THERMISTOR TEMPERATURE DERIVATION

B.1 3KΩ THERMISTOR RESISTANCE

Thermistor Types include YSI 44005, Dale #1C3001–B3, Alpha #13A3001–B3, and Honeywell 192–302LET–A01.

Resistance to Temperature Equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.15$$

EQUATION 7: *3KΩ Thermistor Resistance*

Where:
T = Temperature in °C
LnR = Natural Log of Thermistor Resistance
A = 1.4051×10^{-3}
B = 2.369×10^{-4}
C = 1.019×10^{-7}
Note: Coefficients calculated over the –50 to +150 °C span.

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	15.72K	-9	2221	32	474.7	73	137.2	114
187.3K	-49	14.90K	-8	2130	33	459.0	74	133.6	115
174.5K	-48	14.12K	-7	2042	34	444.0	75	130.0	116
162.7K	-47	13.39K	-6	1959	35	429.5	76	126.5	117
151.7K	-46	12.70K	-5	1880	36	415.6	77	123.2	118
141.6K	-45	12.05K	-4	1805	37	402.2	78	119.9	119
132.2K	-44	11.44K	-3	1733	38	389.3	79	116.8	120
123.5K	-43	10.86K	-2	1664	39	376.9	80	113.8	121
115.4K	-42	10.31K	-1	1598	40	364.9	81	110.8	122
107.9K	-41	9796	0	1535	41	353.4	82	107.9	123
101.0K	-40	9310	1	1475	42	342.2	83	105.2	124
94.48K	-39	8851	2	1418	43	331.5	84	102.5	125
88.46K	-38	8417	3	1363	44	321.2	85	99.9	126
82.87K	-37	8006	4	1310	45	311.3	86	97.3	127
77.66K	-36	7618	5	1260	46	301.7	87	94.9	128
72.81K	-35	7252	6	1212	47	292.4	88	92.5	129
68.30K	-34	6905	7	1167	48	283.5	89	90.2	130
64.09K	-33	6576	8	1123	49	274.9	90	87.9	131
60.17K	-32	6265	9	1081	50	266.6	91	85.7	132
56.51K	-31	5971	10	1040	51	258.6	92	83.6	133
53.10K	-30	5692	11	1002	52	250.9	93	81.6	134
49.91K	-29	5427	12	965.0	53	243.4	94	79.6	135
46.94K	-28	5177	13	929.6	54	236.2	95	77.6	136
44.16K	-27	4939	14	895.8	55	229.3	96	75.8	137
41.56K	-26	4714	15	863.3	56	222.6	97	73.9	138
39.13K	-25	4500	16	832.2	57	216.1	98	72.2	139
36.86K	-24	4297	17	802.3	58	209.8	99	70.4	140
34.73K	-23	4105	18	773.7	59	203.8	100	68.8	141
32.74K	-22	3922	19	746.3	60	197.9	101	67.1	142
30.87K	-21	3748	20	719.9	61	192.2	102	65.5	143
29.13K	-20	3583	21	694.7	62	186.8	103	64.0	144
27.49K	-19	3426	22	670.4	63	181.5	104	62.5	145
25.95K	-18	3277	23	647.1	64	176.4	105	61.1	146
24.51K	-17	3135	24	624.7	65	171.4	106	59.6	147
23.16K	-16	3000	25	603.3	66	166.7	107	58.3	148
21.89K	-15	2872	26	582.6	67	162.0	108	56.8	149
20.70K	-14	2750	27	562.8	68	157.6	109	55.6	150
19.58K	-13	2633	28	543.7	69	153.2	110		
18.52K	-12	2523	29	525.4	70	149.0	111		
17.53K	-11	2417	30	507.8	71	145.0	112		
16.60K	-10	2317	31	490.9	72	141.1	113		

TABLE 5: *3KΩ Thermistor Resistance*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4580-1

Date of Calibration: June 13, 2025

This calibration has been verified/validated as of 07/09/2025

Serial Number: 2535543

Temperature: 21.20 °C

Calibration Instruction: CI-Pressure Transducer (7 kPa~3.5 MPa)

Barometric Pressure: 1000.9 mbar

Cable Length: 10 feet

Technician:

Applied Pressure (kPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	4966	4962	4964	-0.034	-0.20	0.000	0.00
3.4	5478	5474	5476	3.406	0.04	3.399	0.00
6.8	5988	5983	5986	6.829	0.17	6.802	0.01
10.2	6493	6489	6491	10.23	0.15	10.20	-0.01
13.6	6995	6993	6994	13.60	0.03	13.60	-0.01
17.0	7495	7494	7495	16.97	-0.19	17.00	0.01

(kPa) Linear Gauge Factor (G): 0.006718 (kPa/ digit)

Polynomial Gauge factors: A: 3.912E-08 B: 0.006231 C: ______

Thermal Factor (K): -0.001937 (kPa/ °C)

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): 0.0009744 (psi/ digit)

Polynomial Gauge Factors: A: 5.673E-09 B: 0.0009038 C: ______

Thermal Factor (K): -0.0002809 (psi/ °C)

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0) + K(T_1 - T_0) - (S_1 - S_0)^*$

Polynomial, $P = AR_1^2 + BR_1 + C + K(T_1 - T_0) - (S_1 - S_0)^*$

*Barometric pressures expressed in kPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: 4862 Temperature: 22.2 °C Barometer: 993.6 mbar

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 12: Typical Calibration Report

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