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Instruction Manual

Model 4580

VW Pressure Transducer and Barometer

(Doc Rev S.1, 01/22/2024)

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GEOKON warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by GEOKON, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of GEOKON's control. Components which wear or which are damaged by misuse are not warranted. This includes fuses and batteries.

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1. THEORY OF OPERATION

The Model 4580 Vibrating Wire Pressure Transducer is designed primarily for the measurement of very small changes in pressure such as in weirs, streams, etc. A sealed version is also available which can be used for accurate measurement of barometric pressure. However, the Model 4580-1 Barometer (Figure 1) is specially designed for this purpose. A protective enclosure, Model 4580-1-ENCL, is also available (Figure 1).

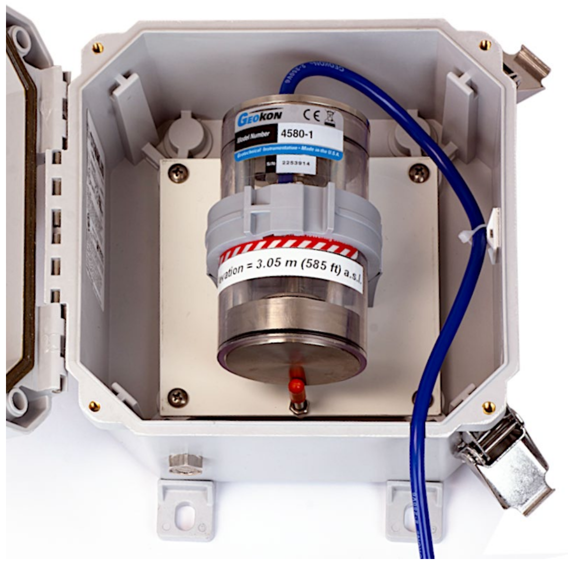

Figure 1 - Model 4850-1 Barometer Installed in Model 4580-1-ENC-L

The transducer consists of a double diaphragm capsule secured in a pressure chamber and connected to a vibrating wire strain gauge. Vented capsules are used where barometric effects need to be eliminated, such as in the weir and stream level measurements. In the case where the sensor is used as a barometer, the capsule is evacuated. The vibrating wire is attached to the capsule on one end and to the rigid housing on the other.

External pressure applied to the capsule causes it to compress and exert a force on the vibrating wire gauge 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.

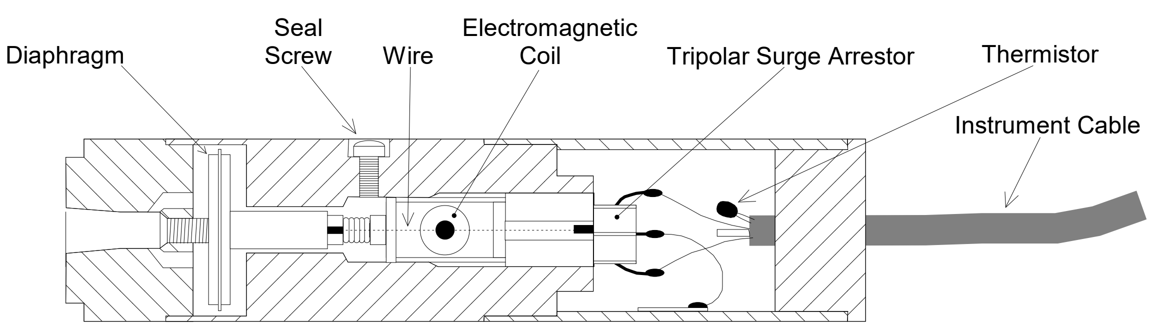

Figure 2 - Model 4580-2 Vibrating Wire Pressure Transducer

2. INSTALLATION

2.1 Preliminary Tests

Upon receipt of the pressure transducer the zero reading should be checked and noted (see Sections 3 for readout instructions). A thermistor is included inside the body of the sensor (as shown in Figure 2) for the measurement of temperature (see Section 3.4 for measurement instructions).

Calibration data are supplied with each gauge and 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 ft. Before March 21, 1995, factory barometric pressure readings were corrected to sea level; readings after this date represent absolute pressure. (Barometric pressure changes with elevation at a rate of ≈½ psi per 1,000 ft.) See Appendix D for a sample calibration report. Note that the calibrations were performed with the sensor vertical, cable end up.

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. 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, particularly the very low-pressure versions. 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 out by monitoring the sensor for a few days at a constant temperature, if possible.

2.2 Barometer Installation

The barometric sensors 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 and is calibrated in the vertical position.)

Transducers of this type have very high sensitivities and are usually somewhat susceptible to shocks of the type that can occur during shipping. It is therefore advisable to obtain concurrent readings with an accurate, local barometer following installation to be sure of obtaining a proper onsite starting point for all measurements.

2.2.1 4580-ENC Installation

To install the 4580-1 Barometer into the enclosure, complete the following:

1. Place the barometer in the clamp. Make sure the barometer is centered between the threaded rods, as shown in Figure 3.

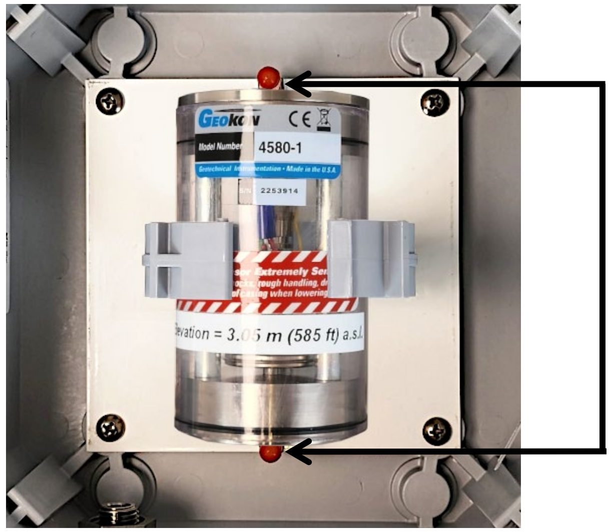

Figure 3 – Guidepost Alignment

2. Press down firmly on the barometer until the clamp comes together and latches (Figure 4).

3. Attach the cable to the side of the enclosure using the provided zip tie (Figure 4).

Figure 4 – Steps 2, and 3 Completed

4. Seat the cable in the recessed groove in the bottom of the enclosure.

5. Close and latch the enclosure lid.

To remove the barometer, pry open the clamp using a screwdriver (or similar tool), as shown in Figure 5.

Figure 5 – Barometer Removal

2.3 Piezometer

When used as a piezometer or weir monitor, the vented version is usually chosen. In this case, 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 transducer 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 transducers 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.)

With vented units, 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 ft length of blue cable is spliced at the end of the tubing, this allows for a standard connection to a readout or datalogger as needed. The <u>vent trap</u> <u>screw must be removed during the measurement period</u> 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 6 – Vented Barometer

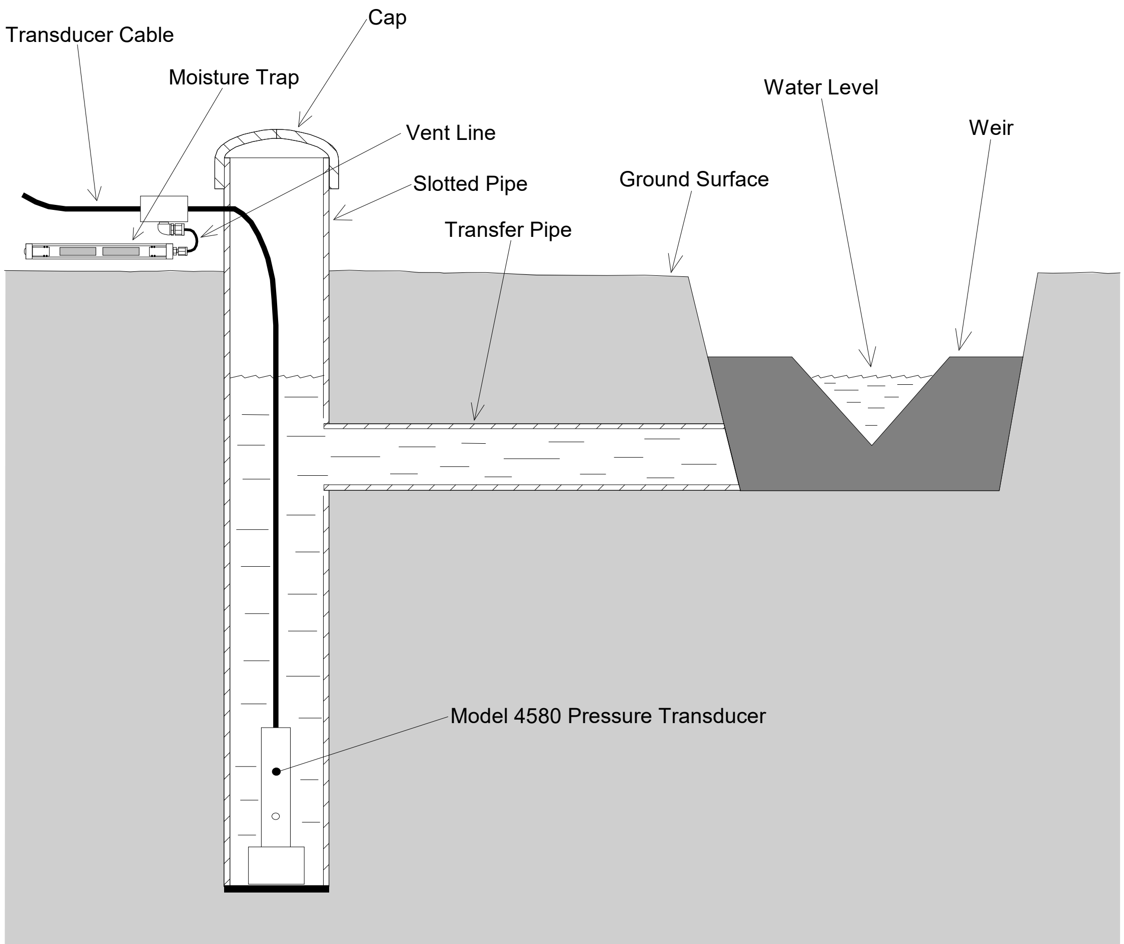

Figure 7 - Model 4580 Weir Monitor Installation

2.4 Pressure Transducer

The transducer has 1/4" NPT female thread on the front end allowing for connection to various types of fittings. Both vented and unvented transducers are used in this version and the choice depends upon the application and whether barometric changes must be automatically eliminated from the readings.

The wrench flats on the transducer should be used when tightening fittings into the transducer.

Prior to use, flush the transducer with water to remove all air from inside the sensor. This can be done by removing the seal screw and pumping water through the sensor. Replace the seal screw when bubbles no longer appear.

2.5 Splicing and Junction Boxes

Because the vibrating wire output signal is a frequency rather than a current or voltage, variations in cable resistance have little effect on gauge readings. Therefore, splicing of cables has no effect, and in some cases, can in fact be beneficial. For example, if multiple transducers are installed in a borehole, and the distance from the borehole to the terminal box or datalogger is great, a splice (or junction box) could be made to connect the individual cables to a single multi-conductor cable. This multi-conductor cable would then be run to the readout station. For these types of installations, it is recommended that the transducer be supplied with enough cable to reach the installation depth, plus extra cable to pass through drilling equipment (rods, casing, etc.).

Cable used for making splices should be a high-quality twisted pair type, with 100% shielding and an integral shield drain wire. **When splicing, it is very important that the shield drain wires be spliced together.** Splice kits recommended by GEOKON incorporate casts that are placed around the splice and 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.

Junction boxes and terminal boxes are available from GEOKON for all types of applications. In addition, portable readouts and dataloggers are also available. Contact GEOKON for specific application information.

2.6 Electrical Noise

Care should be exercised when installing instrument cables to keep them 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 alongside AC power lines as they will pick up the noise from the power cable, which will likely cause unstable readings. Contact the factory concerning filtering options available for use with the GEOKON dataloggers and readouts.

2.7 Lightning Protection

In exposed locations, it is vital that the transducer be protected against lightning strikes. A tripolar plasma surge arrestor, which protects against voltage spikes across the input leads, is built into the body of the transducer. (See Figure 2.)

Additional lightning protection measures available include:

- Placing a Lightning Arrestor Board (Model 4999-12L), in line with the cable, as close as possible to the installed transducer. (See Figure 8.) These units utilize surge arrestors and transzorbs to further protect the transducer. This is the recommended method of lightning protection.

- Terminal boxes available from GEOKON can be ordered with lightning protection built in. The terminal board used to make the gauge 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.

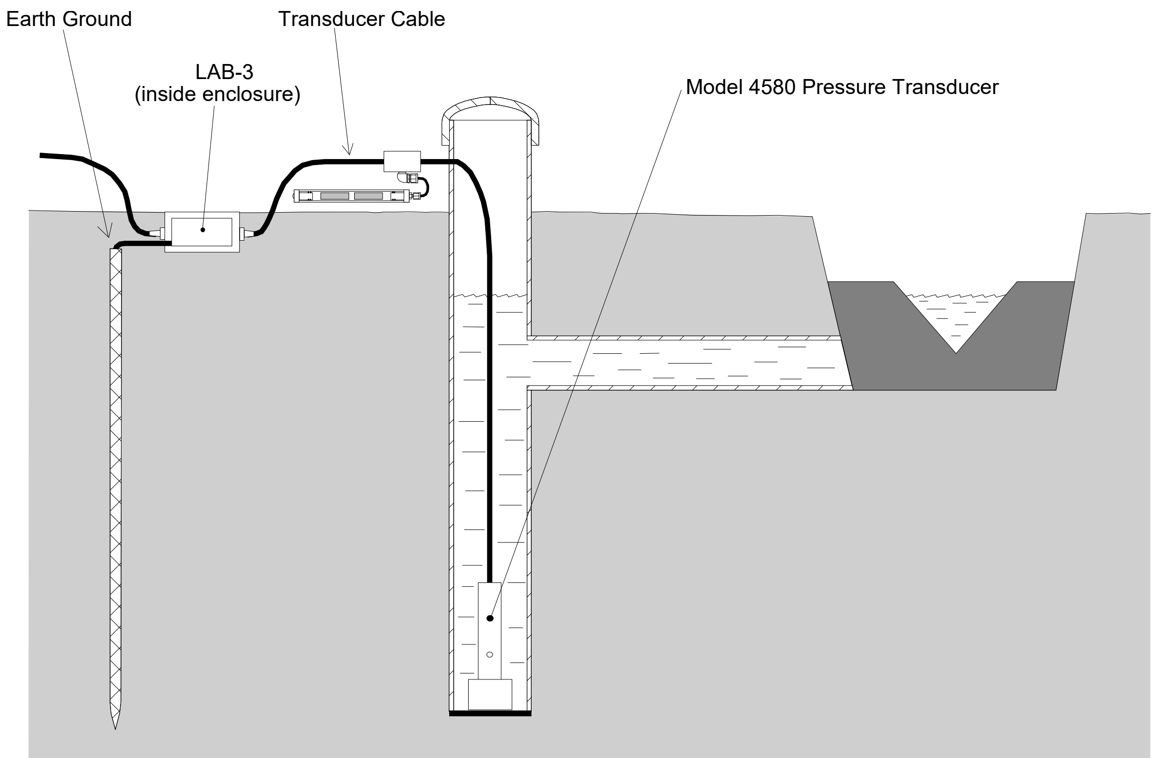

Figure 8 - Suggested Lightning Protection Scheme

3. TAKING READINGS

3.1 GK-404 Readout Box

The Model GK-404 Vibrating Wire Readout is a portable, low-power, handheld unit that can run continuously for more than 20 hours on two AA batteries. It is designed for the readout of all GEOKON vibrating wire gauges and transducers; and is capable of displaying the reading in either digits, frequency (Hz), period (μs), or microstrain (με). The GK-404 also displays the temperature of the transducer (embedded thermistor) with a resolution of 0.1 °C.

3.1.1 Operating the GK-404

Before use, attach the flying leads to the GK-404 by aligning the red circle on the silver Lemo connector of the flying leads with the red line on the top of the GK-404 (Figure 9). Insert the Lemo connector into the GK-404 until it locks into place.

Figure 9 - Lemo Connector to GK-404

Connect each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

To turn the GK-404 on, press the “ON/OFF” button on the front panel of the unit. The initial startup screen will be displayed. After approximately one second, the GK-404 will start taking readings and display them based on the settings of the POS and MODE buttons.

The unit display (from left to right) is as follows:

- The current Position: Set by the **POS** button. Displayed as a letter A through F.
- The current Reading: Set by the **MODE** button. Displayed as a numeric value followed by the unit of measure.
- Temperature reading of the attached gauge in degrees Celsius.

Use the **POS** button to select position **B** and the **MODE** button to select **Dg** (digits). (Other functions can be selected as described in the GK-404 Manual.)

The GK-404 will continue to take measurements and display readings until the unit is turned off, either manually, or if enabled, by the Auto-Off timer.

If no reading displays or the reading is unstable, see Section 6 for troubleshooting. For further information, consult the GK-404 manual.

3.2 GK-405 Readout Box

The GK-405 Vibrating Wire Readout is made up of two components: The Readout Unit, consisting of a Windows Mobile handheld PC running the GK-405 Vibrating Wire Readout Application; and the GK-405 Remote Module, which is housed in a weatherproof enclosure and connects to the vibrating wire gauge to be measured. The two components communicate wirelessly. The Readout Unit can operate from the cradle of the Remote Module, or, if more convenient, can be removed and operated up to 20 meters from the Remote Module.

3.2.1 Connecting Sensors with a 10-pin Bulkhead

Align the grooves on the sensor connector (male), with the appropriate connector on the readout (female connector labeled senor or load cell). Push the connector into place, and then twist the outer ring of the male connector until it locks into place.

3.2.2 Connecting Sensors with Bare Leads

Attach the GK-403-2 flying leads to the bare leads of a GEOKON vibrating wire sensor by connecting each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

3.2.3 Operating the GK-405

Press the button labeled “POWER ON”. A blue light will begin blinking, signifying that the Remote Module is waiting to connect to the handheld unit.
Launch the GK-405 VWRA program on the handheld PC by tapping on “Start”, then “Programs”, then the GK-405 VWRA icon. After a few seconds, the blue light on the Remote Module should stop flashing and remain lit, indicating that the remote module has successfully paired with the handheld PC. The Live Readings Window will be displayed on the handheld PC. Figure 10 shows a typical vibrating wire output in digits and thermistor output in degrees Celsius.

If the no reading displays or the reading is unstable, see Section 6 for troubleshooting suggestions. For further information, consult the GK-405 Instruction Manual.

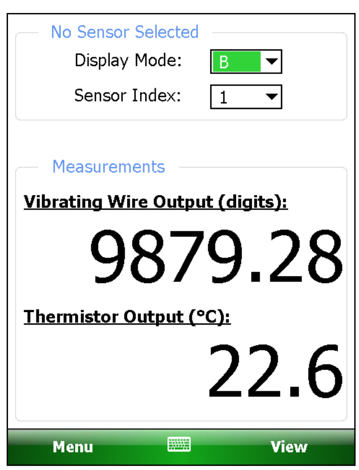

Figure 10 - Live Readings – Raw Readings

3.3 GK-403 Readout Box (Obsolete Model)

The GK-403 can store gauge readings as well as apply calibration factors to convert readings to engineering units. The following instructions explain taking gauge measurements using Modes "B" and "F".

3.3.1 Connecting Sensors with a 10-pin Bulkhead

Align the grooves on the sensor connector (male), with the appropriate connector on the readout (female connector labeled senor or load cell). Push the connector into place, and then twist the outer ring of the male connector until it locks into place.

3.3.2 Connecting Sensors with Bare Leads

Attach the GK-403-2 flying leads to the bare leads of a GEOKON vibrating wire sensor by connecting each of the clips on the leads to the matching colors of the sensor conductors, with blue representing the shield (bare).

3.3.3 Operating the GK-403

1) Turn the display selector to position "B" (or "F").
2) Turn the unit on.
3) The readout will display the vibrating wire output in digits (refer to Equation 1 in Section 4). The last digit may change one or two digits while reading.
4) The thermistor reading will be displayed above the gauge reading in degrees centigrade.
5) Press the "Store" button to record the value displayed.

If the no reading displays or the reading is unstable, see Section 6 for troubleshooting suggestions. The unit will automatically turn off after approximately two minutes to conserve power. Consult the GK-403 Instruction Manual for additional information.

3.4 Measuring Temperatures

All vibrating wire transducers are equipped with a thermistor, which gives a varying resistance output as the temperature changes. The white and green leads of the instrument cable are normally connected to the internal thermistor. GEOKON readout boxes will read the thermistor and display the temperature in degrees C. (High temperature versions use a different thermistor, which must be read using an ohmmeter.)

To read temperatures using an ohmmeter:

✓ Connect an ohmmeter to the green and white thermistor leads coming from the instrument. 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 14.7 Ω per one thousand feet (48.5Ω per km). Multiply this factor by two to account for both directions.

✓ Look up the temperature for the measured resistance in Appendix B, Table 3.

4. DATA REDUCTION

4.1 Pressure Calculation

The basic units utilized by GEOKON for measurement and reduction of data from vibrating wire pressure transducers are the “digits” displayed on the GK-404 or GK-405 reading box. Calculation of digits is based on the following equation:

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

Equation 1 - Digits Calculation

For example, a transducer reading 9000 digits on channel B of the GK-404 or GK-405 readout corresponds to a period of 333.3 μs and a frequency of 3000 Hz. Digits are directly proportional to wire tension and applied pressure.

To convert digits to pressure using a linear calibration coefficient the following equation applies: (See Appendix C for use of second order polynomial)

$$P_{\text{uncorrected}} = (R_1 - R_0) \times G \times F_1$$

Equation 2 - Convert Digits to Pressure

Where:
R_0 represents the initial reading taken at installation (usually the zero reading).
R_1 represents the current reading.
G is the calibration factor required to convert from “digits” to the engineering units given on the calibration report. (See Appendix D for a sample calibration report.)
F_1 is an optional multiplier to convert to any other required engineering units (see Table 1).

For example:
If;
The initial reading on channel B (R_0) = 2509,
The current reading (R_1) = 7023
The calibration factor (G) = -0.0001954 psi/digit.

Then;
Pressure = (7023 - 2509) × -0.0001954 = 0.882 psi

The calibration report gives the pressure in certain engineering units. These can be converted to other engineering units using the multiplication factors shown in Table 1.

From → To ↓	**psi**	**"H_2O**	**'H_2O**	**mm H_20**	**m H_20**	**"HG**	**mm HG**	**atm**	**mbar**	**bar**	**kPa**	**MPa**
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_20	704.32	25.399	304.788	1	1000	345.32	13.595	10332	10.197	10197	101.97	101970
m H_20	.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 Multiplication Factors

(Note: Due to changes in specific gravity with temperature, the factors for mercury and water in the above table are approximate.)

In the special case where the Model 4580 is being used as a Barometer it is necessary to add the atmospheric pressure at the time of the initial reading. This pressure would best be obtained locally as an absolute value not corrected for height above sea level. If a local measurement cannot be obtained then it is permissible to use the barometric pressure recorded on the calibration report, see Appendix D.

For example:
Suppose the Linear gauge factor is 0.004586 kPa/digit, and the initial reading is 4908 at a barometric pressure of 990.3 mbar which, converted to kPa equals 99.03 kPa. A subsequent reading of the barometer equals 5024.

The new barometric pressure = 99.03 + (5024 - 4908) x (0.004586) = 99.56 kPa or 995.6 mbar.

However, where the barometer is being used as a means of correcting for barometric pressure changes on nearby unvented vibrating wire piezometers then only the change of barometric pressure is required which in the above case is + 0.53 kPa. This value must be subtracted to correct for the barometric pressure change

Correction for Barometric pressure changes on unvented piezometers and pressure transducers is explained in Section 4.3.

4.2 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. Consult the supplied calibration report (see Appendix D for a sample calibration report) to obtain the coefficient for a given sensor.

Since piezometers 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. See Section 3.4 for instructions regarding obtaining the sensor temperature.

The temperature correction equation is as follows:

$$P_{temperature} = (T_1 - T_0) \times K \times F_1$$

Equation 3 - Temperature Correction

Where;
T_1 represents the current temperature.
T_0 represents the initial temperature.
K is the thermal coefficient from the supplied calibration report.
F_1 is an optional multiplier to convert to engineering units (see Table 1).

The calculated correction would then be **added** to the Pressure calculated using Equation 2. If the engineering units were converted remember to apply the same conversion to the calculated temperature correction!

4.3 Barometric Correction

Since the unvented pressure transducer is hermetically sealed, it responds not only to water pressure changes but also to changes in atmospheric pressure. That being the case, corrections may be necessary. For example, ignoring a barometric pressure change from 29 to 31 inches of mercury would result in ≈1 psi of error (or ≈2.3 feet if monitoring water level in a well).

The barometric correction equation is as follows:

$$P_{barometric} = (S_1 - S_0) \times F_2$$

Equation 4 - Barometric Correction

Where;
S_1 represents the current barometric pressure.
S_0 represents the initial barometric pressure.
F_2 is a multiplier to convert the barometric pressure units (see Table 1) to the required units.

The calculated correction is **subtracted** from the pressure calculated using Equation 2. If the engineering units were converted remember to apply the same conversion to the calculated barometric correction!

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.

An alternative to measuring the barometric pressure and making barometric correction is to use pressure transducers that are vented to the atmosphere. (as described in Section 4.3.1.) With vented transducers, barometric pressure finds its way to both the inside and the outside of the pressure capsule and is thus automatically canceled.

Equation 5 describes the pressure calculation with both temperature and barometric corrections applied.

$$P_{corrected} = (R_1 - R_0) \times G + (T_1 - T_0) \times K - (S_1 - S_0) \times F_2$$

Equation 5 - Corrected Pressure Calculation

For example, using the typical calibration report shown in Appendix D, showing a 7 kPa Pressure Transducer (vented) used to measure changes of water level, ΔL mm:

R_0 = 8168 digits
R_1 =9660 digits
T_0 = 15.1° C
T_1 = 23.8° C
S_0 = 29.3" Hg.
S_1 = 30.8" Hg.
G = 0.001875 kPa/digit
K = -0.0007823 kPa/°C
F_1 = 101.95 (to convert kPa to mm H_2O)
F_2 = 345.44 (convert "Hg. to mm H_20)
$P_{uncorrected} = (9660 - 8168) \times 0.001875 = 2.798$ *kPa*
$P_{temperature} = (23.8 - 15.1) \times -0.0007823 = -0.0068$ *kPa*
$P_{barometric} = 0$ *[this is a vented transducer]*
$P_{corrected} = P_{uncorrected} + P_{temperature} - P_{barometric}$
$P_{corrected} = 2.798 - 0.0068 - 0 = 2.791$ *kPa*
ΔL = +284.5 mm of water

4.3.1 Vented Transducers

Vented transducers are designed to eliminate barometric effects. The space inside the transducer is not hermetically sealed and evacuated (see Figure 2) but is connected via a tube (integral with the cable) to the atmosphere. A chamber containing desiccant capsules is attached to the end of the tube to prevent moisture from entered the transducer cavity. As supplied, the outer end of the desiccant chamber is closed by means of a seal screw to keep the desiccant fresh during storage and transportation. **THE SEAL SCREW MUST BE REMOVED BEFORE THE TRANSDUCER IS PUT INTO SERVICE!** The desiccant capsules are blue when fresh, they will gradually turn pink as they absorb moisture. When they have turned light pink in color they should be replaced. Contact GEOKON for replacement capsules.

4.4 Environmental Factors

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

5. MAINTENANCE

Vented transducers 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 of vibrating wire pressure transducers is confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves are sealed and are not user serviceable. **Gauges should not be opened in the field.**

Should difficulties arise, consult the following list of problems and possible solutions. For additional troubleshooting and support, contact GEOKON.

Symptom: Transducer fails to give a reading

- ✓ Is the cable cut or crushed? This can be checked with an ohmmeter. Nominal resistance between the two gauge leads (usually red and black leads) is 180Ω, ±20Ω. For long cables a correction can be applied, equal to approximately 14.7 Ω per one thousand feet (48.5Ω per km). Multiply this factor by two to account for both directions.
- ✓ . If the resistance reads infinite, or very high (megohms), a cut wire must be suspected. If the resistance reads very low (<100Ω) a short in the cable is likely.
- ✓ Does the readout or datalogger work with another transducer? If not, the readout or datalogger may be malfunctioning. Consult the readout or datalogger manual for further direction.
- ✓ Has the transducer been overranged or shocked? Contact the factory for further direction.

Symptom: Transducer reading unstable

- ✓ Is the readout box position set correctly? If using a datalogger to record readings automatically are the swept frequency excitation settings correct? Try reading the transducer on a different readout position. For instance, channel A of the GK-404 and GK-405 might be able to read the sensor. To convert the Channel A period display to digits, use Equation 1 in Section 4.1.
- ✓ Is there a source of electrical noise nearby? Most probable sources of electrical noise are motors, generators, transformers, arc welders and antennas. Make sure the shield drain wire is connected to ground whether using a portable readout or datalogger. If using the GK-404 or GK-405 readout box connect the clip with the blue boot to the shield drain wire.
- ✓ Does the readout work with another transducer? If not, the readout may have a low battery or be malfunctioning. Consult the appropriate readout manual for charging or troubleshooting directions.
- ✓ Has the transducer been dropped or otherwise shocked? If so, it may experience a large zero shift or be damaged.
- ✓ Has the pressure chamber been de-aired? See Section 2.3 for instructions.
- ✓ <u>Has the moisture trap seal screw been removed?</u>

Symptom: Thermistor resistance is too high

- ✓ Is there an open circuit? Check all connections, terminals and plugs. If a cut is located in the cable, splice according to instructions in Section 2.5.

Symptom: Thermistor resistance is too low.

- ✓ Is there a short? Check all connections, terminals and plugs. If a short is located in the cable, splice according to instructions in Section 2.5.
- ✓ Water may have penetrated the interior of the transducer. There is no remedial action.

APPENDIX A. MODEL 4580 SPECIFICATIONS

A.1 Model 4580 Pressure Transducer

Model:	**4580-1**	**4580-2/2V**	**4580-3V**
Available Ranges:[1]	200 mbar	4580-2: 35 kPa 4580-2V: 17, 35 kPa	7 kPa
Resolution:	0.02% FSR		
Accuracy:[2]	0.1% FSR		
Linearity:[3]	±0.5% FSR		
Over-Range:	2 × FSR		
Thermal Coefficient:	<0.02% FSR/°C		
Temperature Range:	-30 to +80° C		
Frequency Range	1400-3500 Hz		
Diameter:	63 mm 2.5"	38 mm 1.5"	63 mm 2.5"
Length:	110 mm 4.33"	172 mm 6.75"	172 mm 6.75"
Weight:	1.3 kg. 2.8 lbs.	1.5 kg. 3.3 lbs.	2.0 kg. 4.4 lbs.

Table 2 - Model 4580 Pressure Transducer Specifications

Notes:
[1] Other ranges available upon request.
[2] The accuracy of the calibration equipment.
[3] 0.1% FS linearity available upon request. Also 0.1% accuracy can be achieved by using a second order polynomial instead of a linear calibration factor. If the second order polynomial is used the pressure is calculated from the readings using the equation:
$AR^2 + BR + C = \text{Pressure}$.

A.2 Thermistor
(see Appendix B also)

Range: -80 to +150 °C
Accuracy: ±0.5 °C

APPENDIX B. THERMISTOR TEMPERATURE DERIVATION

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3
Resistance to Temperature Equation:

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

Equation 6 - Resistance to Temperature

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

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

Table 3 - Thermistor Resistance Versus Temperature

APPENDIX C. USE OF SECOND ORDER POLYNOMIAL TO IMPROVE ACCURACY

Most calibrations use linear coefficient to calculate pressure, loads strains etc. from measured readout “digits”. If the output of the sensor is not truly linear then there will be some inaccuracy introduced into the calculated value. Thus, even though the calibration accuracy may be 0.1% FS (because this is the accuracy of the calibration apparatus) yet the linearity may only be 0.5% F.S. so that the calculated value may differ from the true value by this larger amount.

To recapture the 0.1% FS accuracy inherent in the calibration data it makes sense to use a second order polynomial to fit the calculated values to the actual calibration curve. The second order polynomial has the following characteristics. Calculated value = $AR^2 + BR + C$ where R is the observed reading on the readout box and A, B, C, are the three coefficients shown on the calibration report. Note that, unlike the linear method, this equation does not contain the item ($R_1 – R_0$) and thus requires a different treatment for establishing zero conditions. The coefficients shown on the calibration report are those developed under the conditions of temperature and barometric pressure experienced at the time of the calibration and which are shown on the calibration report. Theoretically, these could be used as is, but it is always good practice to establish and use zero conditions at the site since the zero may have shifted slightly due to rough handling during shipment and/or installation; and hence a slight adjustment of the “C” coefficient may be called for. Therefor <u>it is recommended that the value of C be determined at the site for the conditions of temperature and barometric pressure experienced at that time</u>.

For example, using the data from the sample calibration report shown in Appendix D:
At the site, at a temperature of T_0 = 30°C and a barometric pressure of 1000 mbar, the observed zero pressure reading on a GK-404 readout (channel B) is R_1 =7420. Using the polynomial coefficient to calculate a new value of C.

$(7420)^2 \times 3.303E\text{-}09 + (7420) \times 0.001813 + C = O$
gives C = -13.634

Note that the transducer shown is of a vented type, and hence no barometric correction is required. However, it is <u>essential</u> for vented types, that the moisture trap seal screw be removed before taking the zero reading (or any reading) so that the vent line is open to the atmosphere.

APPENDIX D. TYPICAL CALIBRATION REPORT

GEOKON 48 Spencer St. Lebanon, N.H. 03766 USA

Vibrating Wire Pressure Transducer Calibration Report

Type: 4580-3V-7 kPa

Serial Number: 1125849

Pressure Range: 7 kPa

Date of Calibration: October 14, 2011

Temperature: 23.9 °C

Barometric Pressure: 981.4 mbar

Calibration Instruction: VW Pressure Transducers

Technician: KLBellavance

Applied Pressure (kPa)	Gage Reading 1st Cycle	Gage Reading 2nd Cycle	Average Gage Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	7413	7413	7413	-0.009	-0.13	-0.003	-0.04
1.4	8168	8168	8168	1.406	0.09	1.405	0.07
2.8	8915	8914	8915	2.806	0.08	2.802	0.02
4.2	9660	9660	9660	4.203	0.04	4.198	-0.03
5.6	10404	10404	10404	5.598	-0.03	5.597	-0.05
7.0	11151	11149	11150	6.996	-0.05	7.004	0.06

(kPa) Linear Gage Factor (G): 0.001875 (kPa/ digit) **Regression Zero: 7418**

Polynomial Gage Factors: A: 3.303E-09 B: 0.001813 C: ________

Thermal Factor (K): -0.0007823 (kPa/ °C)

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

(psi) Linear Gage Factor (G): 0.0002719 (psi/ digit)

Polynomial Gage Factors: A: 4.79042E-10 B: 0.0002630 C: ________

Thermal Factor (K): -0.0001135 (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.

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 11 - Sample Model 4580 Calibration Report