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*Instruction Manual*  
**Model 4580**  
VW Pressure Transducer



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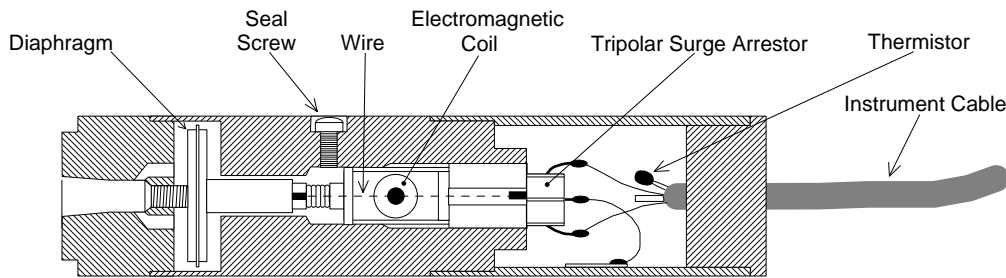


**1. THEORY OF OPERATION**

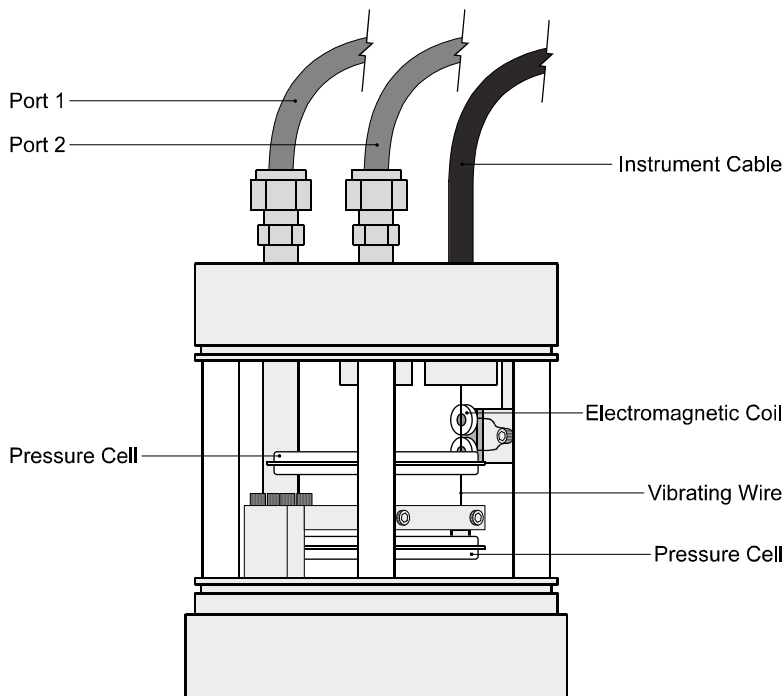
The Model 4580 Vibrating Wire Pressure Transducer is designed primarily for the measurement of very small changes in pressure such as in weirs, streams, etc. A sealed version is also available which can be used for accurate measurement of barometric pressure.

The transducer consists of a double diaphragm capsule secured in a pressure chamber and connected to a vibrating wire strain gage. 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 gage 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 1 - Model 4580-2 Vibrating Wire Pressure Transducer**



**Figure 2 - Model 4580-4 Differential Pressure Transducer**

The differential sensor is designed to measure the differential pressure between two input ports. The pressure rating is the maximum allowable difference in these two pressures. The maximum line pressure for the 4580-4 is 15 psi (100 kPa) for the 1 and 2 psi (15 and 30 kPa), 22.5 psi (150 kPa) for the 5 and 10 psi (35 and 70 kPa) and 45 psi (310 kPa) for the 25 psi (170 kPa). The sensor will not survive a differential pressure greater than 2-3 times it's range.

When used as a water level sensor the P-2 port needs to be vented to the atmosphere using a swagelok fitting in the port and a length of polyethylene tubing leading to a dry area. The tubing should be terminated in such a way that moisture can not enter it. The P-1 port is left open and under the surface of the water to communicate the pressure to the sensor. Filters are available to prevent particles from entering the sensor. The P1 port is usually purged of air at the factory and filled with propylene glycol, a non-toxic, potable fluid used to prevent freezing. The sensor should be installed in a upright position with the cable coming out of the top.

## **2. INSTALLATION**

### **2.1. Preliminary Tests**

Upon receipt of the pressure transducer the zero reading should be checked and noted (see Sections 3.1 to 3.3 for readout instructions). A thermistor is included inside the body of the sensor (Figures 1 & 2) for the measurement of temperature (see Section 3.4 for measurement instructions).

Calibration data are supplied with each gage 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  $\approx 1/2$  psi per 1,000 ft.) See Figure 2-1 for a sample calibration sheet. 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 so long as 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 may 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. Model 4580 Installation

### 2.2.1. Barometer

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 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 on site starting point for all measurements.

### 2.2.2. 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.)

The vented versions incorporate a moisture trap on the end of the vent line. Desiccant inside the moisture trap prevents moisture from entering the inside of the sensor capsule. 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.)

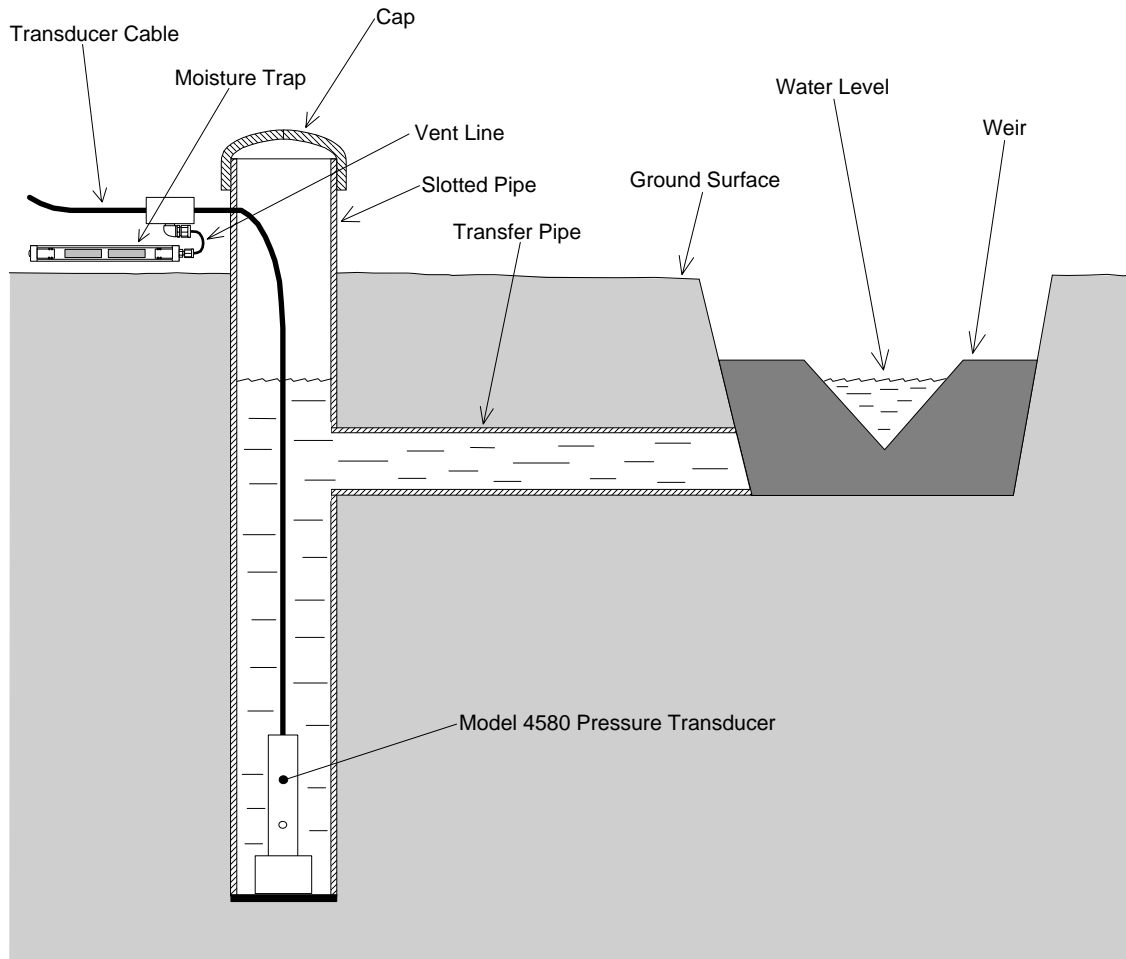


Figure 3 - Model 4580 Weir Monitor Installation

### 2.2.3. Pressure Transducer

The transducer has  $\frac{1}{4}$ " NPT female thread on the front end allowing for connection to various types of fittings. Both vented and non-vented transducers are used in this version and the choice depends upon the application and whether or not barometric changes must be automatically eliminated from the readings.

The wrench flats on the transducer (see Figure 1) 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.

### 2.3. Splicing and Junction Boxes

Because the vibrating wire output signal is a frequency rather than current or voltage, variations in cable resistance have little effect on gage readings and, therefore, splicing of cables has no effect on the readings.

The cable used for making splices should be a high quality twisted pair type with 100% shielding (with integral shield drain wire). When splicing, it is very important that the shield drain wires be spliced together! Splice kits recommended by Geokon (i.e., 3M Scotchcast™, model 82-A1, available from the factory) incorporate casts placed around the splice then filled with epoxy to waterproof the connections. When properly made, this type of splice is equal or superior to the cable itself 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 readout equipment and datalogging hardware are available. Contact Geokon for specific application information.

### 2.4. 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 with AC power lines. The instrument cables will pick up the 50 or 60 Hz (or other frequency) noise from the power cable and this will likely cause a problem obtaining a stable reading. Contact the factory concerning filtering options available for use with the Geokon dataloggers and readouts should difficulties arise.

### 2.5. Lightning Protection

In exposed locations it is vital that the transducer be protected against lightning strikes.

A tripolar plasma surge arrester (Figures 1&2) is built into the body of the transducer and protects against voltage spikes across the input leads. Following are additional lightning protection measures available;

1. 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 thereby protecting the instrument.
2. Terminal boxes available from Geokon can be ordered with lightning protection built in. There are two levels of protection;
  - The terminal board used to make the gage connections has provision for installation of plasma surge arrestors (similar to the device inside the transducer).

- Lightning Arrestor Boards (LAB-3) can be incorporated into the terminal box. These units utilize surge arrestors and transzorbis to further protect the transducer.

In the above cases the terminal box would be connected to an earth ground.

3. Improved protection using the LAB-3 can be had by placing the board in line with the cable as close as possible to the installed transducer (see Figure 4). This is the recommended method of lightning protection.

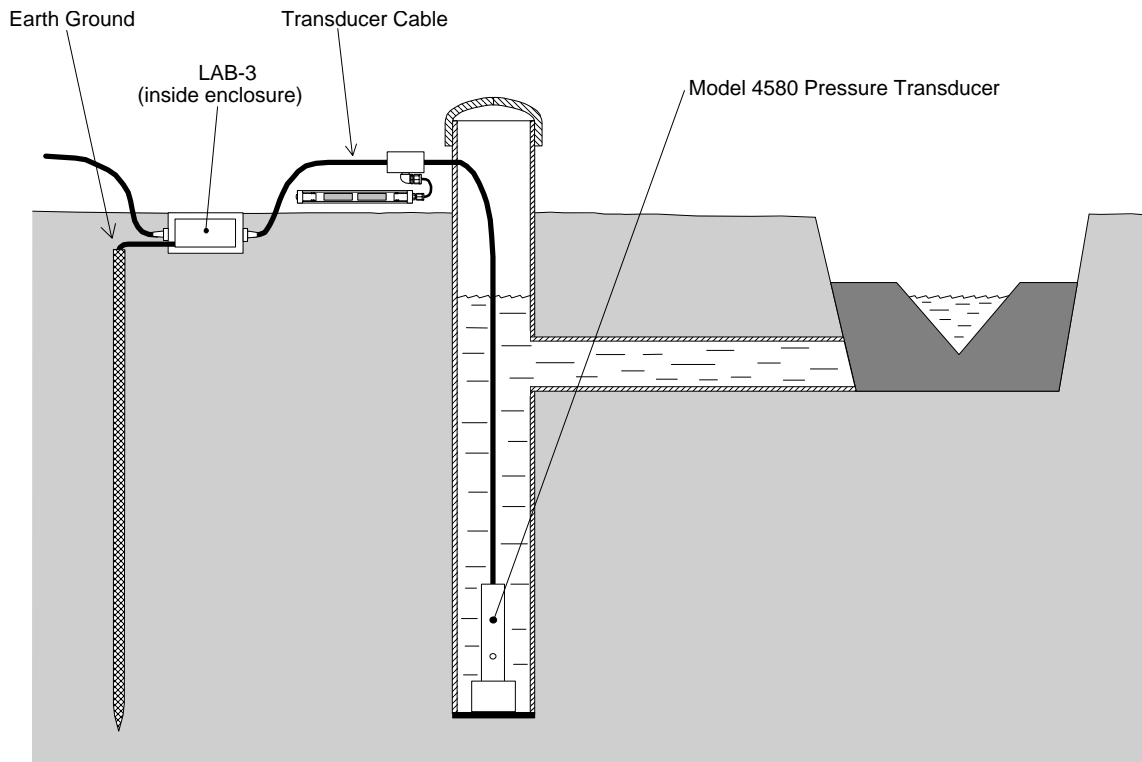


Figure 4 - Suggested Lightning Protection Scheme

### **3. TAKING READINGS**

#### **3.1. Operation of the GK-401 Readout Box**

The GK-401 is a basic readout for all vibrating wire gages.

Connect the Readout using the flying leads or in the case of a terminal station, with a connector. The red and black clips are for the vibrating wire gage, the green lead for the shield drain wire. The GK-401 cannot read the thermistor (see Section 3.4).

1. Turn the display selector to position "B" (or "F"). Readout is in digits (Equation 1).
2. Turn the unit on and a reading will appear in the front display window. The last digit may change one or two digits while reading. Record the value displayed. If zeros are displayed or the reading is unstable see section 5 for troubleshooting suggestions.
3. The unit will automatically turn itself off after approximately 4 minutes to conserve power.

#### **3.2. Operation of the GK-403 Readout Box**

The GK-403 can store gage readings and also apply calibration factors to convert readings to engineering units. Consult the GK-403 Instruction Manual for additional information on Mode "G" of the Readout. The following instructions will explain taking gage measurements using Modes "B" and "F" (similar to the GK-401 switch positions "B" and "F").

Connect the Readout using the flying leads or in the case of a terminal station, with a connector. The red and black clips are for the vibrating wire gage, the white and green leads are for the thermistor and the blue for the shield drain wire.

1. Turn the display selector to position "B" (or "F"). Readout is in digits (Equation 1).
2. Turn the unit on and a reading will appear in the front display window. The last digit may change one or two digits while reading. Press the "Store" button to record the value displayed. If the no reading displays or the reading is unstable see section 5 for troubleshooting suggestions. The thermistor will be read and output directly in degrees centigrade.
3. The unit will automatically turn itself off after approximately 2 minutes to conserve power.

#### **3.3 Operation of the GK-404 Readout Box**

The GK-404 is a palm sized readout box which displays the Vibrating wire value and the temperature in degrees centigrade.

The GK-404 Vibrating Wire Readout arrives with a patch cord for connecting to the vibrating wire gages. One end will consist of a 5-pin plug for connecting to the respective socket on the bottom of the GK-404 enclosure. The other end will consist of 5 leads terminated with alligator clips. Note the colors of the alligator clips are red, black, green, white and blue. The colors

represent the positive vibrating wire gage lead (red), negative vibrating wire gage lead (black), positive thermistor lead (green), negative thermistor lead (white) and transducer cable drain wire (blue). The clips should be connected to their respectively colored leads from the vibrating wire gage cable.

Use the **POS** (Position) button to select position **B** and the **MODE** button to select **Dg** (digits). Other functions can be selected as described in the GK404 Manual.

The GK-404 will continue to take measurements and display the readings until the **OFF** button is pushed, or if enabled, when the automatic Power-Off timer shuts the GK-404 off.

The GK-404 continuously monitors the status of the (2) 1.5V AA cells, and when their combined voltage drops to 2V, the message **Batteries Low** is displayed on the screen. A fresh set of 1.5V AA batteries should be installed at this point

### 3.4. Measuring Temperatures

Each vibrating wire pressure transducer is equipped with a thermistor for reading temperature. The thermistor gives a varying resistance output as the temperature changes. Usually the white and green leads are connected to the internal thermistor. The GK-401 Readout Box does not read temperatures – a digital ohmmeter is required.

1. Connect the ohmmeter to the two thermistor leads coming from the transducer. (Since the resistance changes with temperature are so large, the effect of cable resistance is usually insignificant.)
2. Look up the temperature for the measured resistance in Table B-1. Alternately the temperature could be calculated using Equation B-1.

Note: The GK-403 and GK-404 readout boxes will read the thermistor and display temperature in °C automatically.

## 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-401 or GK-403 reading box. Calculation of digits is based on the following equation;

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

Equation 1 - Digits Calculation

For example, a transducer reading 9000 digits on channel B of the GK-401 or GK-403 readout corresponds to a period of 333.3 $\mu$ s 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)

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

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 (Figure 5) required to convert from "digits" to the engineering units given on the calibration sheet.

$F_1$  is an optional multiplier to convert to any other required engineering units (see Table 1).

For example, assume, on channel B an initial reading,  $R_0$ , of 2509, a current reading,  $R_1$ , of 7023, and a calibration factor, C, of -0.0001954 psi/digit.

$$\text{Pressure} = (2509 - 7023) \times -0.0001954 = 0.882036 \text{ psi}$$

From → To ↓	psi	"H <sub>2</sub> O	'H <sub>2</sub> O	mm H <sub>2</sub> O	m H <sub>2</sub> O	"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 <sub>2</sub> O	27.730	1	12	.039372	39.372	13.596	.53525	406.78	.40147	401.47	4.0147	4016.1
'H <sub>2</sub> O	2.3108	.08333	1	.003281	3.281	1.133	.044604	33.8983	.033456	33.4558	.3346	334.6
mm H <sub>2</sub> O	704.32	25.399	304.788	1	1000	345.32	13.595	10332	10.197	10197	101.97	101970
m H <sub>2</sub> O	.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	.0024583	.0294996	.0000968	.0968	.03342	.0013158	1	.0009869	.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	.0024908	.0298896	.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	.00000981	.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 approximations!

**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 sheet, see Figure 5.

As an example:

Suppose the Linear gage factor is  $-0.004586$  kPa/digit, and the initial reading is 4908 at a barometric pressure of 990.3mbar which, converted to kPa equals 99.03 kPa.

A subsequent reading of the barometer equals 5024 so the new barometric pressure is

$$99.03 + (4908-5024) \times (-0.004586) = 99.56 \text{ kPa or } 995.6\text{mbar.}$$

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  $+0.53\text{kPa}$ . This value must be subtracted to correct for the barometric pressure change.

Correction for Barometric pressure changes on unvented piezometers and pressure transducers is dealt with 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 sheet (see Figure 4) 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 (Figures 1&2) for temperature measurement. See Section 3.4 for instructions regarding obtaining the sensor temperature.

The temperature correction equation is as follows;

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

### 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 sheet.

$F_1$  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  $\approx 1$  psi of error (or  $\approx 2.3$  feet if monitoring water level in a well!).

The barometric correction equation is as follows;

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

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 4. 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 may be attenuated. This will result in an error due to applying an unnecessary or excessive correction. We recommend, 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. ( Note 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.

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

Equation 5 - Corrected Pressure Calculation

For example, assume a model 4580-1-2.5 Pressure Transducer (unvented) used to measure water level;

$$R_0 = 2800 \text{ digits}$$

$$R_1 = 7023 \text{ digits}$$

$$T_0 = 15.1^\circ \text{ C}$$

$$T_1 = 23.8^\circ \text{ C}$$

$$S_0 = 29.3'' \text{ Hg.}$$

$$S_1 = 30.8'' \text{ Hg.}$$

$$G = -0.0006693 \text{ psi/digit}$$

$$K = -0.0004192 \text{ psi/}^\circ\text{C}$$

$$F_1 = 2.3108 \text{ (to convert psi to feet H}_2\text{O)}$$

$$F_2 = 1.113 \text{ (convert ''Hg. to feet H}_2\text{O)}$$

$$P_{\text{uncorrected}} = (2800 - 7023) \times -0.0006693 \times 2.3108 = 6.5314 \text{ feet of water}$$

$$P_{\text{temperature}} = (23.8 - 15.1) \times -0.0004192 \times 2.3108 = -0.00843 \text{ feet of water}$$

$$P_{\text{barometric}} = (30.8 - 29.3) \times 1.113 = 1.6695 \text{ feet of water}$$

$$P_{\text{corrected}} = P_{\text{uncorrected}} + P_{\text{temperature}} - P_{\text{barometric}}$$

$$P_{\text{corrected}} = 6.5314 + (-0.00843) - 1.6695$$

$$P_{\text{corrected}} = +4.853 \text{ feet of water}$$

#### 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 1), 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 which may affect these conditions should always be observed and recorded. Seemingly minor effects may have a real influence on the behavior of the structure being monitored and may 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**

Following are typical problems and suggested remedial action:

### ***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 gage leads (usually red and black leads) is  $180\Omega, \pm 20\Omega$ . Remember to add cable resistance when checking (22 AWG stranded copper leads are approximately  $14.7\Omega / 1000'$  or  $48.5\Omega/\text{km}$ , multiply by 2 for both directions). If the resistance reads infinite, or very high (megohms), a cut wire must be suspected. If the resistance reads very low ( $<100\Omega$ ) 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 over-ranged 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-401 and GK-403 might be able to read the sensor. To convert the Channel A period display to digits use Equation 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-401 Readout connect the clip with the green boot to the bare shield drain wire of the transducer cable. If using the GK-403 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 be damaged.(may have large zero shift)
- ✓ Has the pressure chamber been de-aired? See section 2.2.3 for instructions.
- ✓ Has the moisture trap seal screw been removed?

***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 2.3.

***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 2.3.
- ✓ 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**

<b>Model:</b>	<b>4580-1</b>	<b>4580-2</b>	<b>4580-3</b>	<b>4580-4</b>
Available Ranges: <sup>1</sup>	0-2.5 psi, 0-15 kPa 0-5 psi, 0-40 kPa 0-10 psi, 0-80 kPa			
Resolution:	0.02% FSR			
Accuracy: <sup>2</sup>	0.1% FSR			
Linearity: <sup>3</sup>	±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:	38 mm 1.5"	38 mm 1.5"	63 mm 2.5"	100 mm 4.0"
Length:	172 mm 6.75"	172 mm 6.75"	172 mm 6.75"	112 mm 4.5"
Weight:	1.5 kg. 3.3 lbs.	1.5 kg. 3.3 lbs.	2.0 kg. 4.4 lbs.	4.0 kg. 9.0 lbs.

Table A-1 Model 4580 Pressure Transducer Specifications

Notes:

<sup>1</sup> Other ranges available upon request.

<sup>2</sup> The accuracy of the calibration equipment.

<sup>3</sup> 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:**

$$T = \frac{1}{A + B(\ln R) + C(\ln R)^3} - 273.2$$

Equation B-1 Convert Thermistor Resistance to Temperature

Where: T = Temperature in °C.

LnR = Natural Log of Thermistor Resistance

A = 1.4051 × 10<sup>-3</sup> (coefficients calculated over the -50 to +150° C. span)

B = 2.369 × 10<sup>-4</sup>

C = 1.019 × 10<sup>-7</sup>

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	<b>3000</b>	<b>25</b>	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 B-1 Thermistor Resistance versus Temperature

## **APPENDIX C- THE USE OF A SECOND ORDER POLYNOMIAL TO IMPROVE THE ACCURACY OF THE CALCULATED PARAMETER**

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 sheet. Note that, unlike the linear method, this equation does not contain the item  $(R_0 - R_1)$  and thus requires a different treatment for establishing zero conditions. The coefficients shown on the calibration sheet 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 sheet. 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. Therefore 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. For example using the data from figure 5. At the site, at a temperature of 30°C and a barometric pressure of 1000 mbar, the observed zero pressure reading on a GK-403 readout box (channel B) is 2832. Using the polynomial coefficient to calculate a new value of C.

$$(2832)^2 A + (2832) B + C = 0$$

Substituting for A and B gives

$$C = - 0.5399$$

Note that the transducer shown is of a vented type, and hence no barometric correction is required. However, it is essential, 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.