Vented
VW Pressure Transducer

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Introduction

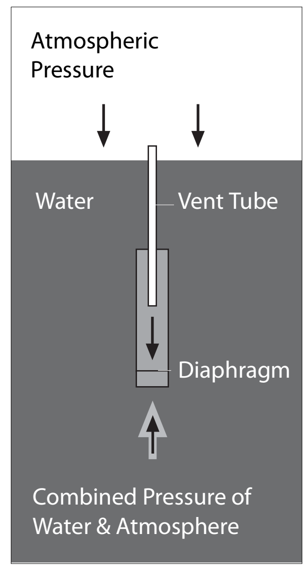
Applications

The vented pressure transducer is designed to monitor changes in water levels. Typical applications include:

- Monitoring water levels in wells and standpipes.
- Monitoring water levels in stilling basins installed in reservoirs.

Theory of Operation

The VW pressure transducer converts water pressure to a frequency signal via a diaphragm and a tensioned steel wire. The pressure transducer is designed so that a change in pressure on the diaphragm causes a change in tension of the wire.



A vent tube communicates atmospheric pressure to the backside of the diaphragm, eliminating the need to compensated the reading for changes in barometric pressure.

When excited by a magnetic coil, the wire vibrates at its natural frequency. The vibration of the wire in the proximity of the magnetic coil generates a frequency signal that is transmitted to the readout device. The readout device processes the signal and displays a reading.

Calibration factors, which establish a relationship between pressure applied to the diaphragm and the frequency signal returned to the readout device, are used to convert data to the engineering unit required.

Components

Overview

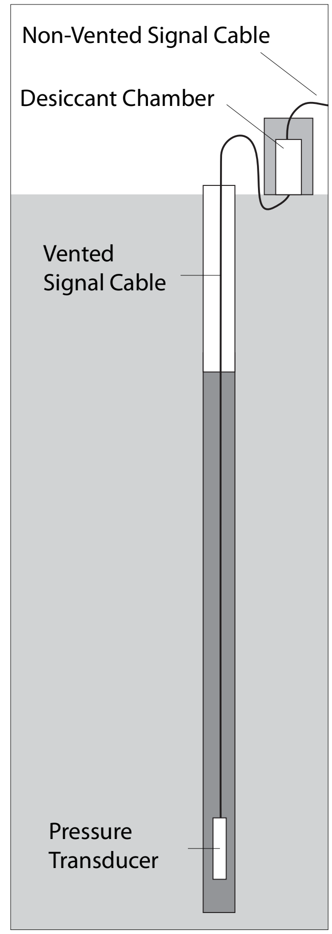
The vented pressure transducer system has four main components.

Non-Vented Signal Cable runs from the desiccant chamber to the readout station or data logger. The connection between non-vented cable and vented cable is protected inside desiccant chamber.

Desiccant Chamber keeps air in vent tube dry, protecting the transducer from condensation. Desiccant chamber should be protected from weather in a vented enclosure.

Vented Signal Cable is connected to non-vented cable inside the desiccant chamber and runs from the desiccant chamber down to the transducer. To keep the vent tube open, you must avoid making tight loops with this cable.

VW Pressure Transducer must be installed upright (vertical) with its filter end down. The pressure transducer is quite sensitive, so take care when you handle it.



Installation

Installation Tips

Read these tips to help ensure a successful installation:

Transducer

- Install the transducer in an upright (vertical) position, with its filter end down. Non-vertical installation may cause an offset in the data.
- Handle the pressure transducer with care. Dropping the transducer is likely to cause damage.
- Electrical noise from a pump in the same well may interfere with operation of the transducer. Either shut off the pump when you take readings or install the transducer in a different well.

Cable

- Terminate the vented signal cable inside the desiccant chamber. Splice conductors from the vented cable to the non-vented cable, which exits the desiccant chamber and runs to the readout station.
- Maintain a radius of at least 4 inches on any bends in the vented signal cable. Tighter bends can pinch the vent tubing and prevent proper operation.
- Protect the ends of signal cables so that water cannot enter the cable jacket. Cables should be terminated above ground level.

Desiccant Chamber

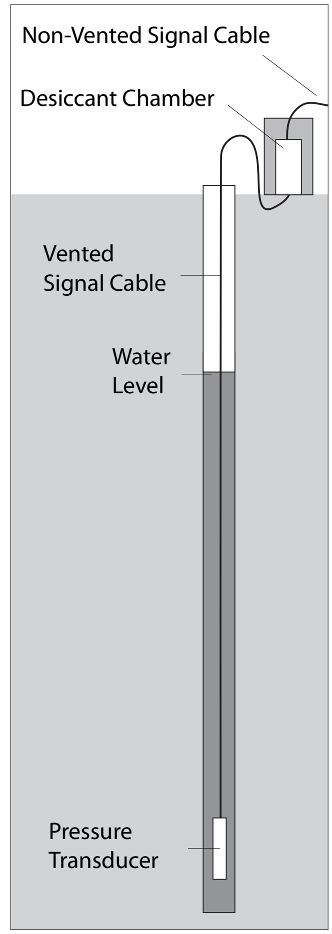
- Desiccant chamber should be protected from the elements. If you install the chamber in a box, be sure to put holes in the box so that the chamber can "breath."
- An indicator in the desiccant changes color when it is saturated. Replace it with fresh desiccant as soon as possible. The life of the desiccant depends on the environment.
- Renew desiccant in an oven. Spread out in a single layer on baking sheet. Bake at 210°C or 425°F, for 1 hour, then seal in a glass container while it is still hot.

  If you use another type of desiccant, be sure to check the manufacturer's instructions. Some types of desiccant cannot be recharged. Others may catch fire.

Installing in a Monitoring Well

1. Remove filter from end of transducer. Fill cavity with water. Replace filter.
2. Lower the transducer into the well. Position it at the specified depth or just below the depth of maximum drawdown.

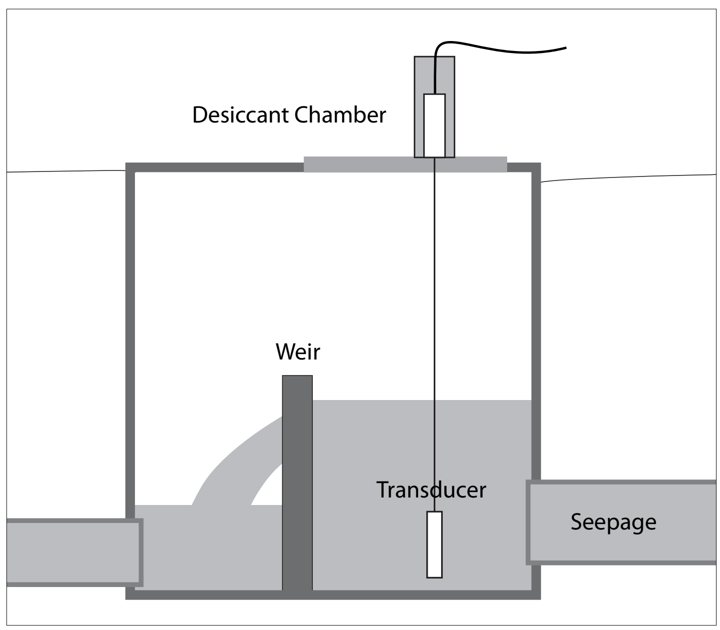
   If turbulence is expected, devise a centralizer to keep the transducer stable.
3. Terminate vented cable inside desiccant chamber. Choose a protected location for the chamber, ideally outside the humid environment of the well casing. Any enclosure should be vented and easily accessed for inspections.
4. Terminate signal cable in a dry, protected location.



Installing in a Stilling Basin or Seepage Weir

The transducer is not suitable for environments in which the temperature changes rapidly. However, it can be used in weirs and ponds where water temperature is fairly stable.

1. Remove the filter. Fill the cavity with water, then replace filter.
2. Position the transducer away from turbulent areas, such as inlet from pipe and outlet through the V-notch. Install the transducer in an upright position, with its filter end down. Anchor the transducer so that it cannot move.
3. Terminate vented cable inside desiccant chamber. Choose a protected location for the chamber. Ideally, the chamber should be positioned in a less humid environment. Any enclosure should be vented and accessible for inspections.
4. Run non-vented cable from the desiccant chamber to readout station or data logger.
5. Establish a relationship (an offset) between the water level (head of water) reported by the transducer and the actual level of water at the weir.



Taking Readings

Introduction

The Vented VW Pressure Transducer provides pressure and temperature data. Be sure to record both if you want to correct readings for temperature effects.

Reading with the VW Data Recorder

1. Connect signal cable from the sensor to the data recorder:

Binding Posts	Wire Colors	
VW	Orange	Red
VW	White & Orange	Black
TEMP	Blue	White
TEMP	White & Blue	Green
SHIELD	Shield	Shield

2. Choose Hz + RTD or Hz + Thermistor.
3. Select the 800-2000 Hz range.
4. The recorder displays a VW reading in Hz and a temperature reading in degrees C.

Instructions for reading vented VW settlement cells with data loggers and retired readouts can be found on our website:

Data Loggers

- Campbell Scientific Loggers:

http://www.slopeindicator.com/support/dataloggers/faq-cr10.html

- VW Minilogger:

http://www.slopeindicator.com/pdf/manuals/vw-minilogger-ti-2012_52613399.pdf

- VW Quattro Logger:

http://www.slopeindicator.com/pdf/manuals/vw-quattro-logger-manual.pdf

Retired Readouts

- VWP Indicator:

http://www.slopeindicator.com/pdf/manuals/vwp-indicator.pdf

- DataMate MP:

http://www.slopeindicator.com/pdf/manuals/datamate-mp.pdf

Data Reduction

Overview

Readings from a Vented VW Pressure Transducer are typically in Hz, rather than in units of pressure. To convert the Hz reading to units of pressure, you must apply calibration factors listed on the sensor calibration record.

If you record temperature readings from the built-in temperature sensor, we recommend that you apply the TI factors on the sensor calibration record to correct for temperature effects.

Depending on your application, you may also want to correct for barometric pressure or elevation. We list these corrections- later in this chapter.

Sensor Calibration Record

Each Vented VW Pressure Transducer has a serial number and a unique calibration. Use the sensor serial number to match the sensor with its calibration record.

Serial Number

The serial number is found near the top of the page. You can also find range, cable length, and date of calibration there.

Calibration Factors

ABC Factors: These factors are used to convert Hz readings to units of pressure, such as kPa or psi.

TI Factors: These "temperature integrated" factors are used to convert Hz readings to units of pressure. The resulting pressure values are automatically corrected for temperature effects.

TI factors were introduced in August, 2007. Older calibration records do not have TI factors.

Summary of Results

This table of recorded values shows the pressure applied by the calibration device, the frequency output of the sensor, and the pressure calculated by applying the calibration factors. It also shows error, the difference between the applied pressure and the calculated pressure, as a percent of the full range of the sensor.

Calculating Pressure

Apply ABC or TI factors to readings in Hz as shown below.

Using ABC Factors

1. Choose the factors for kPa or psi.
2. Apply the factors as follows:

$$\text{Pressure} = (A \times Hz^2) + (B \times Hz) + C$$

Where:

Hz is the frequency reading in Hertz, and A, B, and C are ABC factors on the sensor calibration record.

Using TI Factors

1. Choose the factors for kPa or psi.
2. Apply the factors as follows:

$$\text{Pressure} = C0 + (C1 \times Hz) + (C2 \times T) + (C3 \times Hz^2) + (C4 \times Hz \times T) + (C5 \times T^2)$$

Where:

Hz is the frequency reading in Hertz, T is the temperature in degrees C from the built-in temperature sensor, and C0 through C5 are TI factors on the sensor calibration record.

Calculating Changes in Pressure

Subtract the initial reading from the current reading. A positive value indicates increased pressure. A negative reading indicates decreased pressure.

$$\Delta\text{Pressure} = \text{Pressure}_{\text{current}} - \text{Pressure}_{\text{initial}}$$

Calculating Change in Water Level

Convert the pressure value above to head of water using a multiplier below. Values assume a water temperature of 15.5 °C.

Head of Water = Pressure Reading x Multiplier

Starting Unit	Multiplier	Resulting Unit
psi	27.707	inch
	2.3089	feet
	703.77	mm
	0.70377	m
kPa	4.01	inch
	0.335	feet
	102	mm
	0.102	m

Correcting for Density of Water (Optional)

This correction is not usually necessary. It is given here for completeness.

Density varies with the temperature and chemistry of the water and affects the pressure reported by the transducer. The table at right shows density changes for pure water. Find the temperature of the water, then divide the head of water by the specific gravity listed for that temperature. For example, at 4°C, 1 psi = 2.3066 feet of water (or 0.70305 meters of water).

°C	Specific Gravity	°C	Specific Gravity
0	0.99987	26	0.99681
2	0.99997	28	0.99626
4	1.00000	30	0.99567
6	0.099997	32	0.99505
8	0.99988	34	0.99440
10	0.99973	36	0.99371
12	0.99952	38	0.99299
14	0.99927	40	0.99224
16	0.99897	42	0.99147
18	0.99862	44	0.99066
20	0.99823	46	0.98982
22	0.99780	48	0.98896
24	0.99732	50	0.98807

Suppose the measured temperature is 16°C. To correct the head of water value, we would divide 2.3066 ft of water by 0.99897 to obtain a corrected head of 2.3089 feet of water (or 0.70377 meters of water).

Acceptance Tests

Introduction

The main purpose of an acceptance test is to provide reasonable assurance that a sensor is functioning properly. Unless you have access to sophisticated test facilities and calibration equipment, acceptance tests should not be expected to achieve the accuracy and precision of the calibration data provided on the sensor calibration record.

In-Water Pressure Check

This test is conducted in a water-filled borehole or well. There are many variables that can degrade the accuracy of the test, including positioning errors, the specific gravity of water at each depth, temperature of the transducer at each depth, etc. You can correct for these, but the real purpose of the test is to verify that the transducer gives you roughly the reading that you would expect.

1. Mark signal cable at two places, one at a shallow depth and the other at a deeper depth. Measure the distance between the two marks.
2. Pull the filter off, fill the cavity with clean water, and replace the filter.
3. Place the pressure transducer into the water, making sure that water has not drained out of the filter cavity. Lower the transducer to the shallow mark on the signal cable. Clamp the cable in position and wait at least 30 minutes for the transducer to adjust to the temperature of the water.
4. Connect the signal cable to the readout device. Make sure that the vent tube is open to atmosphere. Record the frequency reading and the temperature reading at the shallow depth.
5. Lower the transducer to the deeper mark. Again, clamp the cable and allow the transducer to adjust to temperature at that depth. Record the frequency reading and the temperature reading.
6. Convert the frequency readings to units of pressure by applying calibration factors. Calculate temperature corrections, if temperatures are different at the two depths.
7. Subtract the shallow reading from the deep reading and convert the pressure to feet or meters of liquid head. This should be equivalent to the distance between the two marks.

Diagnostics

Introduction

Perform the tests below to check the sensor and cable.

No Reading

Set your handheld multimeter to a low-ohm range (5k ohm).

- Measure the resistance between the two VW wires (orange and white-and-orange). A normal reading should be about 300 ohms. If the reading is very high or infinite, the coil is damaged (or the cable is severed). If the reading is very low, the cable may have been crushed and a short has developed.
- Measure the resistance between the temperature sensor wires (blue and white). Thermistors should read about 3000 ohms. RTDs should read about 2000 ohms. If the reading is very high or infinite, the temperature device is damaged (or the cable is severed). If the reading is very low, the cable may have been crushed and a short has developed.

Unstable Reading

Set your handheld multimeter to a high range (10 or 20 M ohm).

- Measure the resistance between a VW wire and a Temp wire. The reading should be infinite or out of range.
- Measure the resistance between any of the colored wires and the drain (shield) wire. The reading should be infinite or out of range.
- Measure the resistance between the shield wires of two installed VW sensors. Wires must be disconnected from data logger or terminal box to make this test. The reading should be very high or infinite. A lower reading indicates the presence of a ground loop.
- Other sources of unstable readings are electrical noise from nearby power lines, radio transmitters, or motors. Also, over ranged or shocked instruments can exhibit this problem.

Splicing Vented Signal Cable

Introduction

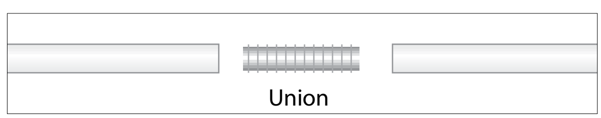
If you have a choice, consider splicing the non-vented signal cable rather than the vented cable. If you must splice the vented cable, you should have splice kit #50614415, a soldering iron, solder, and a heated blower.

Prepare Wires

Strip back 3 or more inches of cable jacket and cut conductors different lengths to minimize the overall diameter of the splice. Strip about 0.3 inches of insulation from each conductor.

Splice Wires and Tubing

1. Slide large cold-shrink insulator onto cable.
2. Cut short lengths of heat shrink tubing to cover each splice and slide onto wires.
3. Solder wires using rosin-core solder. Hold wires with clamps or a soldering jig. Solder drain wires, too. Crimp connectors may be supplied in the kit. You may use these if you cannot solder.
4. Apply oxidation inhibitor to wires, if specified.
5. Slide heat shrink tubing over soldered wires and apply heat.
6. Push tubing ends onto brass union.



7. Wrap mastic pad around splices. It is important to make the diameter of the wrap as small and even as possible. Wrap rubber tape over spliced areas from cable jacket to cable jacket.

Release Cold Shrink Insulator

1. Coat wrapped area with grease.
2. Center cold-shrink insulator over wrapped area.
3. Hold cold shrink insulator in position and pull on the release tab to unwind the supporting core of the insulator. You must pull and unwind (counter clockwise) at the same time.
4. The cold shrink insulator collapses onto the spliced area to complete the splice.

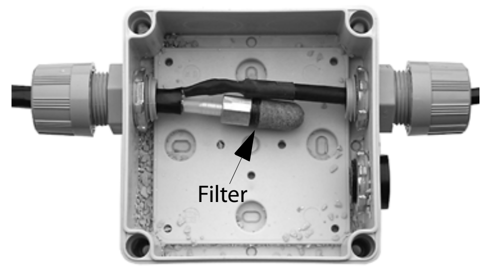
Terminating Vented Signal Cable

Overview

Vented signal cable runs between the transducer and the dessicant chamber. The vent tube must be terminated inside the dessicant chamber to prevent the entry of moisture. The signal conductors of the vented cable are connected to non-vented cable which then exits the dessicant chamber and runs to the readout station or data logger.

Open Desiccant Chamber

1. Remove the lid by unscrewing the four retaining screws. Pour desiccant into airtight container.
2. Loosen gland seals and push out of the way.



3. Cut out old splice and remove filter from vent tube.
4. Loosen cable glands and pull cable out of chamber.

Prepare Cable Ends

1. Cut vented cable to the proper length. Strip the jacket back about two inches to expose conductors and vent tube. Strip about 0.5 inch of insulation from each conductor.
2. Cut off the exposed vent tube so about 1 inch remains.
3. Strip 1.5-inches of the jacket on the non-vented cable. Strip about 0.5 inch of insulation from each conductor.
4. Slide cables through cable glands and into dessicant chamber. You may need to slide components of cable glands onto cables first. Some lubrication may be required.

Splice Cables

1. Insert small filter into the vent tube. You may have to soften the vent tube with a little heat.
2. Identify matching conductors and twist ends together. Secure with wire nuts or solder.
3. Wrap spliced cables with electrical tape.

Assemble Chamber

4. Fill the chamber with dessicant and screw the lid.