GE
Sensing

Druck

PRESSURE-LEVEL SENSOR APPLICATION HANDBOOK

(Revision J4)

- **Application Notes**
- **Installation guidelines**
- **Detailed Specifications**

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1. **Jan Matthews:** He passed away June 2012 and who was the original author of the first edition of the Pressure-Level Application Handbook..

2. **Steve Drussell**, Hydrogeologist, Reliable GEO LLC

Contribution of application data and technical review

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1. INTRODUCTION

For many years, the only method of measurement of level in wells, tanks, rivers, reservoirs and open channels was the use of floats with a visual readout. In deep wells, manual logging of the wells, using a graduated drop-line, was the only effective method of determining recovery rates. In more recent years, other technologies have been developed which have improved the accuracy and reliability of depth and level measurement.

In today's agro-industrial market, the demand for large amounts of potable water is critical. Settlement of geographical areas formerly considered uninhabitable have, with the availability of water, become productive agricultural areas.

Management of our water and wastewater resources has placed a responsibility on government and private agencies to provide adequate methods of distribution of these resources. Increasing population densities, changes in global climatic conditions and an awareness of toxic disposal problems have increased demands on water supplies.

It is with these considerations in mind, that GE Sensing has produced this Depth/Level Handbook to assist the people responsible for funding, engineering, specifying, installing, maintaining, and using level measurement equipment.

NOTE: The authors acknowledge that there are a number of suppliers of these devices in the marketplace, but since GE Sensing is sponsoring this handbook, a liberal use of its products and specifications, including data sheets, are used in this manual. Every attempt has been made to present the information in an unbiased format and direct references to the GE Sensing devices are transparent.

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2. COMMON TECHNIQUES FOR MEASURING DEPTH/LEVEL

The following methods of measuring liquid level are some of the most commonly used in the industry today. This chapter will discuss some of the advantages and disadvantages of each method.

2.1. Manual Logging: Graduated Stick

Liquid level can be determined by using a graduated line or pole, weighted at the end, which is dropped into the well. The line/pole is then retrieved and the level is noted where the wet/dry interface occurs. Its main advantage is its low cost. It also can be improvised from common materials. The disadvantages are that it is a manual system, with local indication, relying entirely upon the user for accuracy and measurement recording.

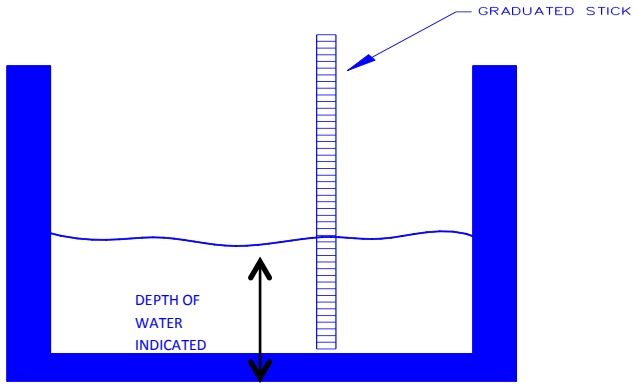

FIGURE 2.1: Manual Logging – Graduated Stick

2.2. Manual Logging: Dip Meter

A variation is the use of a dip meter that uses a graduated cable and is normally wound on a spool. When the end of the cable (equipped with electrodes) touches the water, the circuit is completed and a galvanometer registers continuity. Some diameters have an audio tone that beeps when the circuit is completed at the surface of the water.

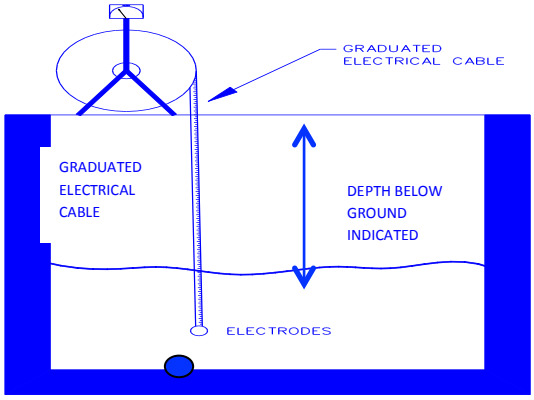

FIGURE 2.2: Manual Logging – Dip Meter

2.3. Visual Sight Gauges

A graduated column of liquid may be used to determine liquid level and are typically located outside of the tank. The level is visually checked and recorded. Some of these devices are quite inexpensive and no more reliable than the person taking the reading. In some circumstances, the marking becomes faded or the sight glass becomes clouded, making it difficult to read the level. It is also a local indication. The use of fiber optics allows remote readings to be made, but increases the cost dramatically.

2.4. Floats and Switches

A major step forward from the manual and visual systems. It is possible to set up alarms actuated by switches. This enables the system to turn pumps on or off or actuate alarm annunciators. Normally they are used as backup "last ditch" methods if all else fails. The major advantage is low cost. **Problems**: Sometimes the floats hang-up or freeze-up and will not actuate. It is impossible to test it without elevating the level, thus making it difficult to determine if it is working properly. It also does not provide suitable resolution to determine rate of change in level.

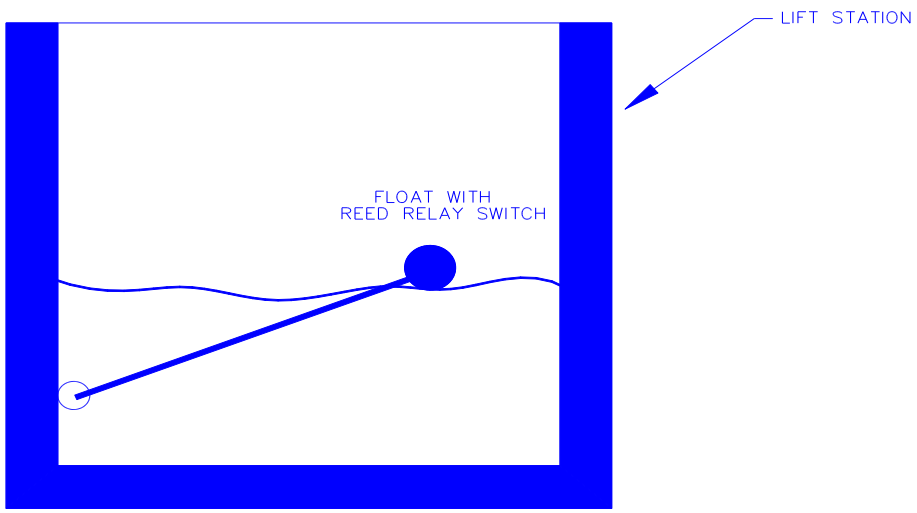

FIGURE 2.3: Float with Reed Relay Switch

2.5. Magnetostrictive Float

This method is quite reliable and is effective in tank level applications. The float contains a magnet, which slides along the outside of a transducer containing a resonated wire. The magnet's location along the probe provides a reflection point that can be measured and related to displacement of the float. The major advantage is reliability. Disadvantages include cost, limited displacement, and difficulty of installation. Also in freezing or dirty environments, the float can become stuck.

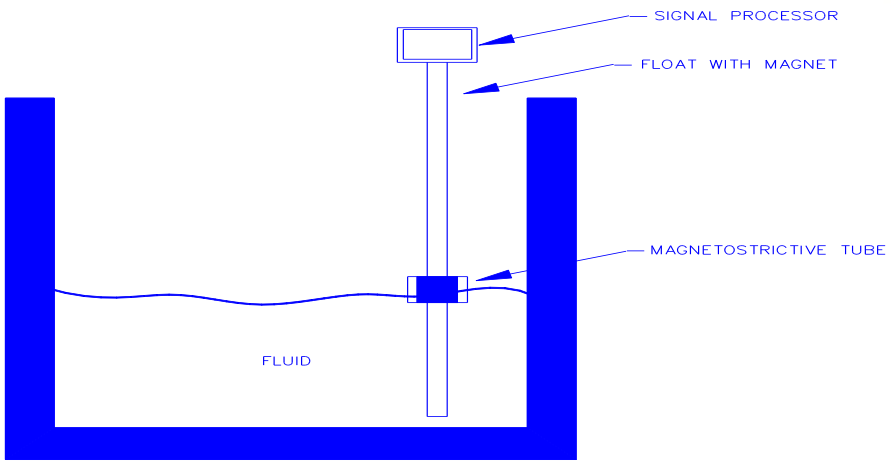

FIGURE 2.4: Magnetostrictive Float System

2.6. Ultrasonic transducer

A high frequency RF signal is generated and directed at the surface of the liquid. The time for the reflected signal to return is measured and related to the distance. Major advantages are accuracy and the fact that it does not contact the liquid, thus reducing corrosion effects. It also can be used on highly viscous slurries, where conventional methods of level measurement are not practical. Disadvantages include high cost, possible errors due to foaming liquids, and inability to penetrate ice layers.

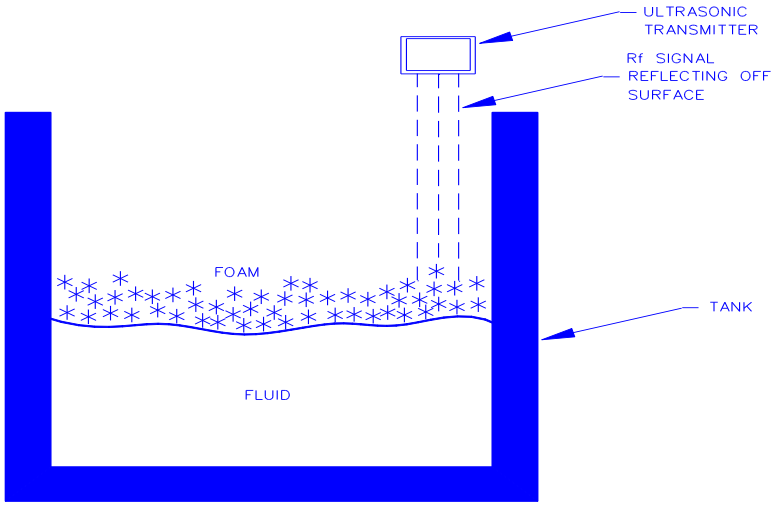

FIGURE 2.5: Ultrasonic Transmitter

2.7. Tank Weighing Systems

These are only effective where load cells can be placed underneath the tank. The tank plus its contents are weighed, subtracting the weight of the tank, leaving the weight of the liquid. By knowing the density of the tank plus the shape/volume, liquid level may be determined. These systems are relatively expensive, hard to install, and not suitable for applications other than tanks.

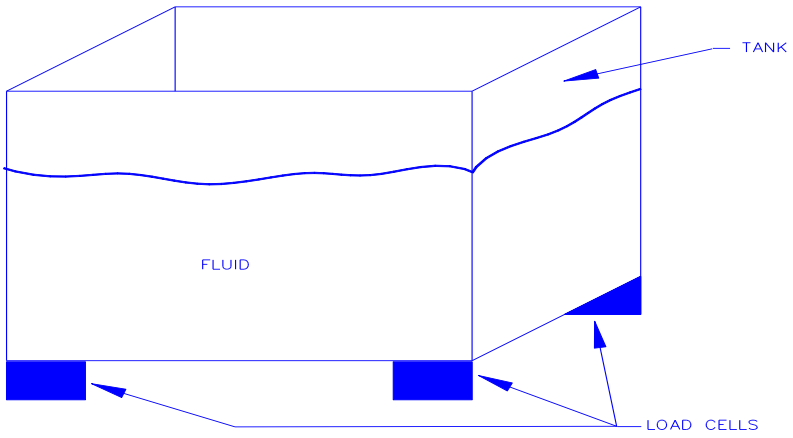

FIGURE 2.6: Tank Weighing System

2.8. Pressure Transmitters

There are several ways to use pressure sensing to measure liquid level; measurement of hydrostatic head using bubble-tube (bubbler) systems or submersible pressure transducers and transmitters.

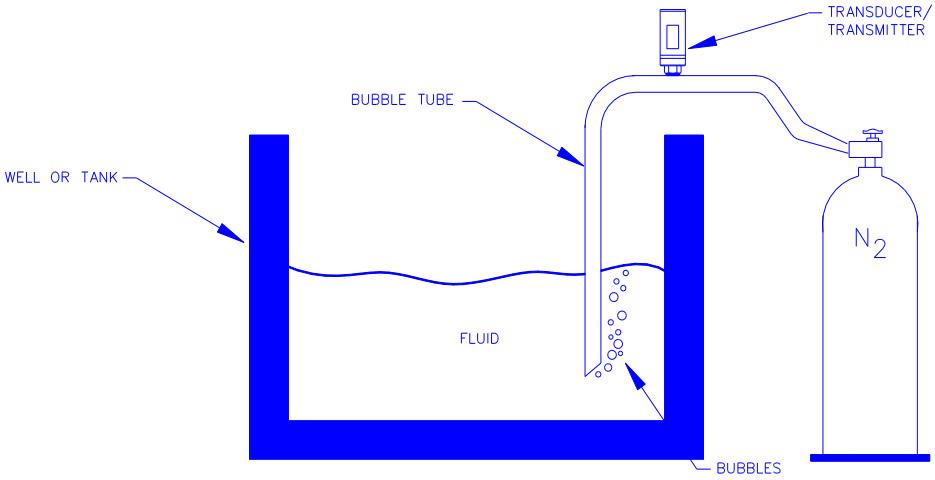

FIGURE 2.7: Bubbler System

2.8.1. Bubblers

By using a hollow tube and blowing dry nitrogen into it, measuring the back pressure generated by the depth within the liquid, a reasonable measurement of liquid level may be made. The major advantage of this method is that in extremely harsh environments, the tube, which is less expensive than the pressure sensor, is sacrificed to corrosion. The tube may also be immersed in high temperature liquids with application of the right materials. The acquisition cost is higher than a submersible sensor due to the addition of the Nitrogen or Dry Air source, plus installation and maintenance. Routine

maintenance is required in order to maintain reliability. The accuracy is not quite as good as the directly submerged sensor.

This method is also used, as shown in Figure 2.8, in open channel flow measurements where hydrostatic head is measured in flumes and weirs.

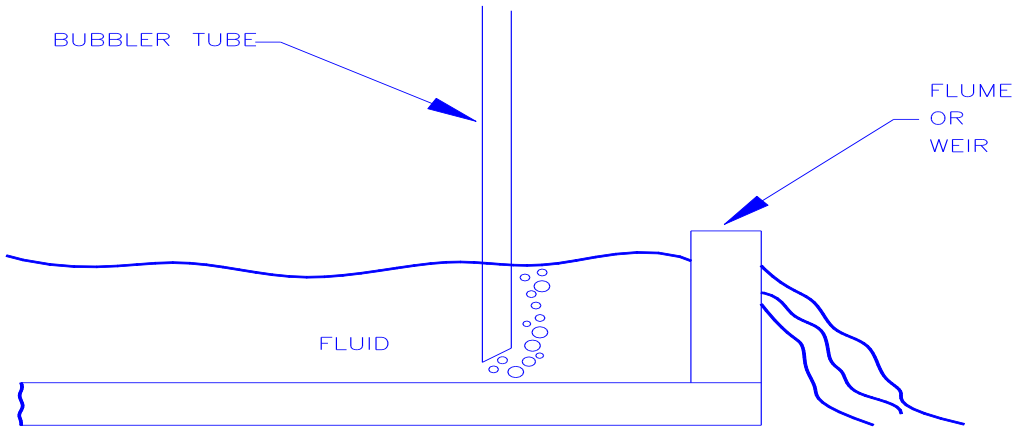

FIGURE 2.8: Open Channel Flow Using Bubbler System

2.8.2. GE Sensing offers a range of pressure sensors suitable for use with bubbler systems including the UNIK 5000 Series, the RTX1000 Series Smart Transmitters with HART® protocol, and TERPS Series high accuracy pressure sensors.

2.9. Submersible Pressure Sensors

This method is an accurate, cost-effective method of liquid-level measurement in most applications. A sensor with or without a gauge referenced breather vent in the cable is submerged in the liquid. Given the density of the liquid, the output is directly proportional to hydrostatic head.

2.9.1. Cable Venting Considerations

2.9.1.1. In shallow level (below 600 mH_2O [1,969 feet H_2O]) applications such as open tanks, open channels, rivers, lakes, canals, unpressurised wells, etc., a vented sensor or non-vented sensor may be used. To avoid the maintenance cost of using a Sensor Termination Enclosure (STE), one could use an absolute pressure sensor along with a barometer, where the barometric pressure is subtracted from the absolute pressure level reading to give gauge pressure. Otherwise if a vented sensor is used (gauge pressure) than an STE box is recommended by GE Druck to keep the vent tube dry.

FIGURE 4.1: RPT-410V Barometer, Submersible Pressure Sensors, STE Box

2.9.1.2. In deep level (above 600 mH_2O [1,969 feet H_2O]) applications such as oceanographic surveying a non-vented (absolute) sensor may be used. In closed, pressurized applications, a differential pressure measurement must be made to allow for the pressure on top of the liquid.

This method allows accurate measurement in foaming liquids, in freezing conditions, in harsh environments, and is cost-competitive with most other methods. Major disadvantages are that many suppliers offer materials and designs unsuitable for the application. Corrosion is one of the major causes of premature failure. Leaking O-rings also are a major problem. However, GE Sensing's submersible pressure sensors solve these problems by using all-welded titanium or 316 stainless steel metal parts.

GE Sensing's small diameter and in some cases, short length, allows installation in the typical well without pulling the existing pump. In the design and specification section, these issues will be discussed in more detail.

3. THE PHYSICS OF DEPTH/LEVEL MEASUREMENT USING PRESSURE

In order to use pressure as a means of determining the level in a vented tank or any column of liquid vented to atmosphere, the following formula must be applied:-

$$H = \frac{P * C}{S_g}$$

where H = Height (in meters); P = Pressure in bar; C_f = Conversion Factor of Pressure in bar to meters; S_g = Specific Gravity of the Fluid Being Measured

Level may be calculated in inches, feet, meters, or any other units of linear measurement as long as the proper conversion factor is applied. Appendix A contains many of the most common conversion factors. In the case of water, using Appendix B takes into account the specific gravity changes due to temperature of pure water. If dissolved minerals are present, it is probable that the Specific Gravity is increased and this should be accounted for in the calculations.

Most manufacturers will calibrate their pressure sensors in whatever units the customer wishes. You must give them the proper conversion factors for whatever the units. If none are given, normally mH_2O is used.

Specify the level pressure sensor ranged as close to the requirement as is possible in order to achieve the best accuracy possible.

In many applications, absolute accuracy is not critical. In those instances, it is an acceptable procedure to ignore variations in Specific Gravity.

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4. SPECIFICATIONS AND DESIGN CONSIDERATIONS

Unfortunately, oftentimes pressure sensor specifications are written by people with poor background knowledge of what the important sensor characteristics should be, and what is critical in their specific application. In many cases, the purchasing departments determine which sensor is purchased based on price. The specifying engineer must be very careful to consider all issues before approving a design for the application. Once a specification is written and incorporated into the purchasing documents, the buyers assume that the devices will meet the demands.

If the specification is too general, unsuitable equipment may be supplied, resulting in re-specification and re-purchasing of devices, with the engineering firm losing professional esteem in the process. The small initial cost savings results in huge losses due to the system not being available for use. In addition to the downtime expense, there is extra cost for the removal and replacement of the sensors.

Conversely, if the specification is too tight, especially if non-critical specifications are imposed, competition is seriously diminished and purchasing costs increase excessively.

In order to ensure that the proper specification is applied, it is important to understand the critical parameters of the application.

4.1. Introduction

This section will discuss pressure sensors as used for liquid level measurement, their characteristics and differentiation between critical and non-critical specifications. Cost of ownership will be the underlying theme. Remember, the customer has the responsibility of maintaining his systems in operating condition at all times. Chronic failures and excessive downtime results in added costs and lower efficiency. This ultimately affects the user, the funder (taxpayer), the supplier, and ultimately the specifier.

4.2 DEPTH/LEVEL SENSOR TECHNOLOGIES

4.2.1 Silicon Strain Gauge: Wheatstone Bridge

Is the subject of the bulk of this section, starting in section 4.3. Outputs are analog in nature (mV, mA and amplified voltage outputs).

4.2.2 TERPS: Trench-Etched-Resonating-Pressure-Sensor

TERPS is a new technology. The output is either a frequency waveform with a temperature output, or a serial output (RS232 or RS485). The accuracies and long-term stabilities are typically an order of magnitude greater than the silicon Wheatstone bridge type sensors. However, the discussion in this handbook will focus mostly on the wheatstone bridge type sensing technology.

4.3 Pressure Sensor Specifications

The following specifications are discussed in detail and marked as critical and non-critical. While every specification is important, there are some that are essential for safe, reliable operation of the measurement and/or control system.

4.3.1. Pressure Range

The effective measuring range must be determined, including any possible overpressure. The density of the liquid is important to take into consideration, e.g., if the specific gravity of the fluid is 2, then it will require twice the range of a transducer measuring water at a specific gravity of 1 or 1.05

Formula: Range (psi) = $C_f * Sg * H$

C_f = Pressure /ft of water @ 40^0F

S_g = Specific Gravity @ operating temperature

H = Depth of water in feet

Range = 0.43352 * 1.04 * 10 = 4.51 psi

A complete set of conversion factors plus specific gravity tables of some of the most common liquids are found in the addendum section of the handbook.

4.3.2. Overpressure

It is impossible to cover every eventuality, so the overpressure specification becomes an important part of your specification. Keep in mind; overpressure is an occasional event, not regularly encountered. Occasional excursions to this over pressure should cause no permanent change in zero or span. At the lower ranges, this becomes more critical, e.g., an application using a 1.5 mH_2O is more apt to be over-pressured than a 150 mH_2O when measuring liquid level.

In the case of a river application, what is the highest possible level at flood stage? In a well, what is the highest level possible, etc? It is important to get these figures from your customer so that proper overpressure ratings can be evaluated.

Flash floods are fairly routine in mountainous areas where narrow valleys and ravines are prevalent. Here it is very important to specify a large overpressure capability.

High-pressure spikes called water hammer can damage submersible pressure sensors. Dropping a transducer a long distance in free-fall may cause this. As the sensing end impacts the water, a large pressure spike may be generated. Also in closed systems with valves, such as municipal

water systems, rapid closure of a valve, especially in fast flowing systems, may cause water hammer. GE Sensing protects its submersible sensors by incorporating a filter in the nose-cone (see Figure 4.1). The small holes on the periphery of the front end are designed to allow any trapped air to escape as the unit is submerged.

4.3.3. **Pressure containment**

If the mechanical integrity is important, i.e., if the transducer leaks and that leakage could cause damage or an unsafe condition, this specification is important.

4.3.4. **Media compatibility**

This is one of the most critical and important specifications since it is a major cause of premature failure in submersible pressure sensors.

Often, the customer is not aware of corrosive chemicals present in his application, such as H_2S, Salt (NaCl), or other mild or severe acids or caustics. Their "water" contains naturally occurring, aggressive chemicals that are removed during water treatment, but are present in the wells.

The following materials are used by the majority of sensor manufacturers: 316L stainless steel/ Hastelloy C276 and titanium. Of these materials, only titanium is impervious to virtually all corrosive elements normally found in ground water and wastewater applications.

Many water applications include installation in sea/brackish water. It is recommended that 316 stainless steel **not** be used in sea/brackish water applications. Titanium is ideal for those applications where sea/brackish water is anticipated.

4.3.5. **Construction**

An all-welded design provides hermetic sealing, thus preventing leaks in the body of the pressure sensor. It also eliminates a potential problem with material compatibility of O-rings.

If O-rings are used in the device, they must be considered in the media compatibility. The best design is the all-welded construction, where no leak path can form. O-ring designs are repairable because it is highly likely they will leak and need to be repaired. By the time you realize that it needs to be repaired, major damage may have occurred. The major expense is not the repaired or replaced sensor, but the installation and downtime. Watertight integrity is essential in maintaining reliability of the submersible transducer.

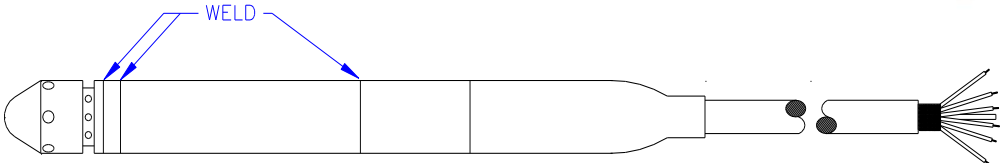

FIGURE 4.1: Submersible Pressure Sensor

4.3.6. Cable

The cable used is also an important consideration. Most standard cables are polyurethane with a nylon vent tube. In some instances, especially when hydrocarbon solvents are present, Hytrel™ cable can be specified. Although it is stiffer and harder to install and use, it is chemically compatible with most media and has good abrasion resistance.

Molded cable assemblies normally provide the best reliability.

4.3.7. Excitation Voltage

In many applications, battery power or solar (rechargeable battery) power is used, especially in remote locations using Remote Transmission Units (RTU's). GE Sensing can supply a wide range of low voltage/current/mV devices.

Where power is available, normally 2-wire 4 to 20 mA is used for its good noise immunity. Do not specify too wide an excitation value. Most systems work on 24 Vdc nominal power, e.g., one supplier likes to get 9 to 40 Vdc written into the specification to lock out all of the companies with only 9 to 32 Vdc specifications. 10 to 30 Vdc should be perfectly adequate for most applications.

Low-level mV sensors are normally used when the diameter must be very small and when the sensor length must be short and if battery power is critical (GE Sensing PDCR 1830).

Low-level mV pulse power sensors are normally used when linking into low power data-logger applications.

4.3.8. EMI Considerations

It is important to know how far the signal will be transmitted before being signal conditioned. Also are there any EMI (Electromagnetic Interference) noise problems in the local area such as may be generated by large pump motors. If it is a short run, less than 20 meters a mV output sensor can be used. If the longer runs are used, the 2-wire, 4 to 20 mA device is better. It provides excellent EMI immunity.

4.3.9. Combined Non-Linearity, Hysteresis and Non-Repeatability

This is measured at a constant temperature and does not include the temperature drift. Once the transducer has reached thermal equilibrium, this is the specification that determines how accurate any changes in level are. This specification is important if the customer wishes to control or indicate level accurately. It is important to specify how accurate the level is to be measured. On a 10 mH_2O measurement, ±0.1% F.S. is a 10 mm error, while ±0.5% is a 50 mm error.

If the application is to prevent a sump from running dry, accuracy is not very important. But, in determination of a reservoir level, it is a critical parameter.

NOTE: Some suppliers specify non-linearity, hysteresis, and non-repeatability as separate parameters. When writing a specification, it is important to have all respondents combine all three errors into one as static accuracy. This will make the evaluation of test data much easier because of the complexity of sorting the different errors.

4.3.10. Zero Offset and Span Setting

In order to maintain a hermetic seal, access to zero and span potentiometers is not available on most submersible sensors. It is important on high level (4 to 20 mA) devices to have a zero/span setting in order to obtain the best possible resolution. On the bridge-level mV/V devices, it is not as critical since most external signal conditioning has electronic zero and span adjustments.

NOTE: In setting up submersible pressure sensors, the system must be zeroed and the span setting properly installed in the signal processor. Normally the sensor manufacturer provides zero and span of the sensor within ±3% or better. GE Sensing sets its PTX 1830 to ±0.25% FS.

4.3.11. Long-Term Stability

This is one of the best ways to evaluate the design and quality of submersible pressure. Most manufacturers do not publish a specification on this parameter because they do not have a good control of their manufacturing processes and design.

If the level measurement is a long-term measurement such as reservoir level or if evaporation or recovery rates are being compared from one test to another, then this parameter is extremely important. Some customers wish to look at trends that occur seasonally. The reliability of this trend data is dependent upon how accurate and how stable the measurement is. If future projects are dependent upon this data, it is important that the trend be an actual occurrence rather than the results of an unstable sensor.

4.3.12. **Operating Temperature Range**

This range defines the maximum range the sensor, e.g., if the level being measured is above the operating temperature range, the transducer may become damaged.

4.3.13. **Compensated Temperature Range**

This is the range within which the manufacturer guarantees his temperature accuracy specifications. In the case of groundwater applications, it is normally a small range. In the case of a geothermal well, it may be necessary to increase the compensated temperature range.

4.3.14. **Temperature Effects**

This specification may be stated in several ways as follows:

±0.3% F.S. TEB for range 3.5 mH_2O over -2 to 30°C

where F.S = Full Scale Pressure Range and TEB is Thermal Error Band as a percentage of Full Scale Pressure Range

or

±0.093% F.S./°C Zero Error
±0.093% F.S./°C Span Error

In the first case, TEB makes it easy to calculate what the maximum temperature error might be, worst case. In the other case, maximum temperature error of the combined effects of zero and span is difficult to calculate because the thermal error is normally not guaranteed to be linear over the entire range. This requires averaging the thermal error over the defined temperature span. However, the temperature is specified, it is important that all respondents use the same format.

4.3.15. **Pressure Port**

In GE Sensing's case, normally, included in the nose cone is a device that reduces the likelihood of damage due to water hammer effect. This effect is discussed in detail in the chapter on avoiding the most common causes of failure.

4.3.16. Electrical Connection/Cable

Normally on a submersible sensor, the cable is molded to the back of the sensor and is equipped with a vent tube that allows the gauge pressure device to reference to atmospheric pressure.

Some manufacturers use a cable-gland that consists of a rubber grommet and a plastic or metal collet which clamps onto the cable. This technique is less expensive than the molded method, but has serious limitations when used on pressure ranges above 50 mH_2O. Also, care must be taken not to tighten the gland too much for fear of collapsing the vent tube in the cable.

The use of a large vent tube is important, especially in low-pressure applications with long cable runs, where large atmospheric pressure changes can occur. During a weather-front passing, atmospheric pressure may change as much as 0.7 mH_2O (2.3 Feet of H_2O or 1 psig). If the full-scale pressure range is 0.7 mH_2O, that is a 100% error in pressure. Use of a large vent tube will ensure rapid response to atmospheric pressure changes. With a small restrictive tube, this equalization may take days in long cable runs.

Some submersible sensors have no vent tube, but “breathe through the cable”. This is a very slow way to equalize the effects of atmospheric pressure changes, especially in long cable runs. The main advantage is that the cable is considerably less expensive.

Standard cable insulation is normally polyurethane with Hytrel™ as the preferred alternate. Some manufacturers also use polyethylene insulation, but it is more difficult to seal properly.

There also should be a Kevlar fiber used for added strength and virtual elimination of elongation due to creepage of the cable when the transducer is suspended in the liquid. Some manufacturers do not use Kevlar and choose to provide an external hook so that the user is required to use a wire of some sort. Almost everything available for external connection will stretch, especially stainless steel wires.

4.3.17. Sealing (Ingress Protection)

(IP68) Submersible, watertight, dust-tight, sleet/ice resistant, indoor and outdoor.

In the GE Sensing design, special care is taken to provide internal sealing between the sensor and cable molding. The vent tube is connected directly to the back of the sensing element that is impervious to the fluid. Even if moisture does ingress into the vent tube, it will not damage the sensor. It may be heated and the moisture driven out if moisture should ever enter.

An injection molding technique is used which bonds directly to the case material and the vented

polyurethane cable, providing an excellent barrier to ingress of water.

4.3.18. **Insulation Resistance**

Greater than 100 MOhm at 500 Vdc.

4.3.19. **Voltage Spike Protection**

This is important in applications where the transducer will be in close proximity to a submersible pump. It is possible that large voltage spikes may be induced long cable runs. Large static electricity charges can build up and cause damage to amplifiers, which are most likely not designed to withstand these voltage spikes.

GE Sensing pressure transmitters are designed to withstand a 600 V voltage spike in accordance with ENV 50142 without damage when applied between all excitation lines and case.

4.3.20. **Safety**

In some applications, intrinsic safety is required. If it is required in the USA or Canada, one or more of the following agencies approvals may be required:

Underwriters Laboratories (UL)
Factory Mutual Approval (FM)
Canadian Standards Association (CSA)
cUL (Combined CSA and UL approval)
Class I, Div I, Groups C & D should be sufficient for most submersible applications

or in Europe

ATEX IS Approval	
Certification	CE Marked
EMC Emissions	EN50081-1
EMC Immunity	EN50082-2

4.3.21. **Dimensions**

Several diameters have emerged as standard, including 25 mm (1 inch) for well casings of 32 mm and up and 17.5 mm (0.69 inch) for the 19 mm and above well casing. The GE Sensing sensors all

use molded backends and tapered front ends, which reduce the likelihood of the sensor hanging up on obstructions in the well casing. The streamlined molded backend design is ideal when extracting the sensor.

Smaller diameters make installation easier, especially if many wires are bundled together or if an existing conduit is used with limited free space.

In applications where sharp bends in the well casing or stilling tube are encountered, use of the shorter length PDCR 1830 may be advisable.

4.2. Cable and Vent Tube -Moisture Ingress Protection

It is important to ensure the cable and vent tube is not subject to condensation. In the daytime on a hot, humid day, the air has a high water vapor content. The submerged sensor is likely to be at a much lower temperature. At some point down the cable, both in the vent tube and the cable structure, the moist air will reach its dew point and condense. In most cases small amounts of moisture will cause no damage to a GE Sensing sensor. Water in the vent tube will not cause failure in a GE Sensing sensor but will inevitably cause a small zero offset. GE Sensing sensors have three barriers to water in the cable but a long period of exposure to quantities of water will eventually affect the sensors operation.

In order to avoid all such moisture effects the air around the electrical termination should be kept dry to a dew point below the temperature of the sensor. In many sites the heat from other devices will maintain this condition. If this is not possible then 2 methods are recommend:

4.3.22 Desiccant Box:

The use of a termination box that contains a drying agent and is vented through a filter is recommended. A visual indicator is useful to warn when the desiccant is no longer active. Most desiccant modules can be heated either in an oven, or if made from plastic in a microwave, to drive collected moisture from them on a regular basis. The frequency of the drying period will depend upon the humidity and temperature variation encountered. Reducing the variations in temperature that the termination box is exposed to will extend the life of the desiccant modules so avoiding sites in direct sunlight is recommended.

e.g., GE Sensing's Model STE (Sensor Termination Enclosure) is shown in Figure 4.2

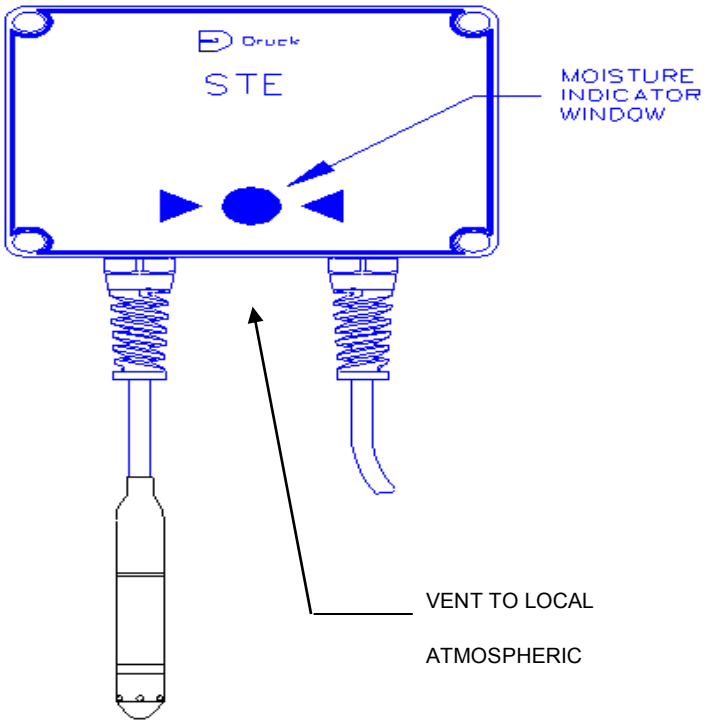

FIGURE 4.2: Sensor Termination Enclosure (STE)

4.3.23 The Use of a Barometric Sensor (in place of an STE Box)

As an alternate to the use of a desiccant box lie the STE box, an absolute pressure/level submersible sensor along with a barometer is can be used. By subtracting the barometric pressure from the submersible pressure sensor's absolute pressure, the equivalent gauge pressure is calculated. This achieves the same result as using a desiccant box (STE) along with a vented gauge pressure submersible sensor. A common barometer used for this purpose is the RPT-410V shown in figure 4.3.

Figure 4.3: GE Druck Model RPT410V

5. AVOIDING THE MOST COMMON CAUSES OF PREMATURE FAILURE

In every method of measuring depth/level, there are many common-sense rules for avoiding premature failure or degradation of performance. In this section, the following common problems and their prevention will be discussed: Installation problems, overpressure, corrosion, ingress of moisture, and lightning.

5.1. Installation Problems

5.1.1 Many times adequate instructions are provided with submersible pressure sensor for safe, professional installation. The problem often is that the installer fails to read these instructions.

5.1.2 In the case of GE Sensing, a cap is provided on the end of the vented cable. This prevents water or water vapor from entering the vent during transit and storage. LEAVE THE CAP ON until termination time.

5.1.3 Do not drive over the vented cable. It is possible to damage the cable, causing tears in the jacket. If the jacket is damaged, it will be necessary to return the device to the manufacturer to have a new cable installed. This may be costly as well as time consuming.

5.1.4 If the cable is to be pulled into a conduit, it is important to lubricate it to reduce friction, thus reducing the tensile load on the cable. **CAUTION:** Leave the cap in place while pulling the cable; do not allow the lubricant to enter the vent tube.

5.2 Overpressure

5.2.1 In many applications, the specifier chooses the lowest measuring range possible to make his measurement, not considering the possibility of a flood or high water condition. In a storm sewer, with a diameter of 3 meters, it is easy to make this mistake, considering that the maximum height in the sewer can be no more than 3 meters. However, if a flood condition exists on the surface, it will add the hydrostatic head of the floodwater. GE Sensing's low range submersible sensors have minimum overpressure of between 4 and 8 times specified range.

5.2.2 When using the lower ranged sensor of 5 psi (11.5 feet H_2O) and lower, it is important to ensure that they have a minimum overpressure of 4 times. In the case of GE Sensing, the overpressure is generally 8X for the ranges below 5 psig (11.5 Feet of Water), 6X for ranges over 5 psig, and 4X for the ranges from 5 psi up to a maximum 995 psi (2,300 Feet H_2O).

5.3 Corrosion

5.3.1 Appendix D is a corrosion table of common fluids and their compatibility with various materials. It is important to understand the different corrosion effects that can occur in a submersible pressure sensor application.

5.3.2 Materials such as 316 and 316L stainless steel are alloys of iron, which are relatively good with corrosive chemicals. However, when the 316 stainless steel is welded, weld contaminants are created. Unfortunately, more of the iron is exposed to the surface without the high chromium content, making the weld susceptible to corrosion in aggressive (saline) water media.

For this reason, GE Sensing offers an alternative electron-beam welded titanium sensor. Titanium is far more corrosion resistant, including its welds, than 316 stainless steel in saline ground and surface water applications. Many GE Sensing units are used in oceanographic applications because of their extreme corrosion resistance.

5.3.3 Grounding of the sensor can also cause corrosion failures. It is important to ground the transducer to earth ground. Many instrumentation manuals suggest that the sensor ground be attached to the instrument ground. In this application, DON'T DO IT. There can be substantial differences in potential between instrument ground and earth ground, causing current to flow. If a current is allowed to flow between the transducer case and ground, the sensor may become a sacrificial anode, regardless of the material used or the condition of the water. If this occurs, the welds will disappear, regardless of the material used.

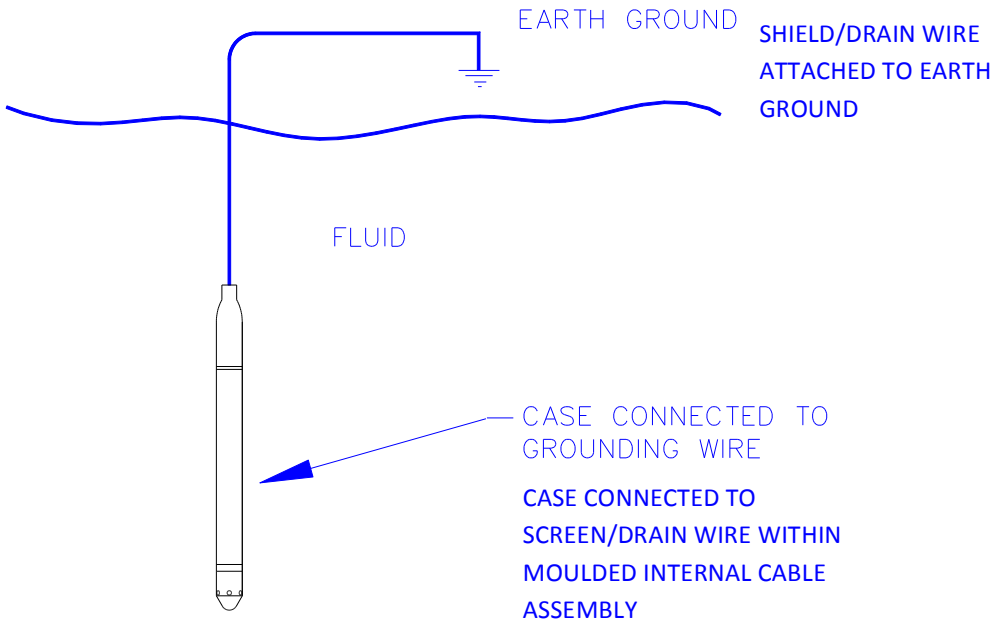

FIGURE 5.1: Grounding Submersible Pressure Sensors

5.4 Ingress of Moisture

5.4.1 On most open well or water applications, the level is measured using a submersible sensor with a gauge reference to atmospheric pressure. In order to accomplish this, a vent tube is attached to the back of the sensing diaphragm. Some manufacturers have a design that will allow damage to occur to the sensor if moisture migrates into the vent tube. All of GE Sensing's vented sensors are designed so that if moisture does enter the tube, no damage will occur to the unit.

5.4.2 The moisture is a result of moist air entering the vent tube at one temperature and when the temperature is reduced. For example, when the sun goes down, the water vapor condenses, filling the vent with water. As this water migrates down the vent, the sensor accuracy can be affected because the vent tube becomes plugged with water.

5.4.3 **Aneroid Bellows & In-Line Desiccant Pack:** Some companies offer a small in-line desiccant pack that attaches directly to the cable vent tube. Others offer an aneroid bellows attached to the vent tube, claiming that this eliminates the necessity for using desiccant. However, in both methods moisture can also ingress along the conductors if they are not properly desiccated and damage the sensor causing it to fail. In addition to this the aneroid bellows method also can introduce errors that become especially pronounced in the very low-pressure level ranges of 1.5 mH_2O (5 Feet H_2O) and below. This is because of its lack of sensitivity to its own pressure characteristics arising from the barometric pressure changes.

For the above fore mentioned reasons, we do not recommend the use of aneroid bellows or in line desiccant packs. Instead, the SENSOR TERMINATION ENCLOSURE (STE) is recommended; please see Chapter 8 in the Installation Instructions.

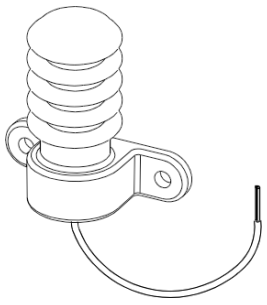

Figure 4.4 (Aneroid Bellows)

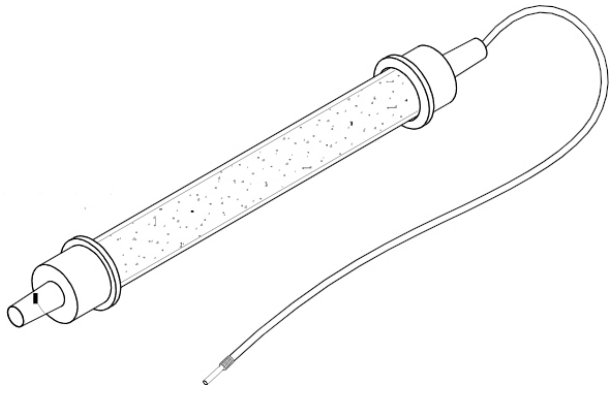

Figure 4.5 (In-Line Desiccant Pack)

Not recommended **for protecting submersible pressure / level sensors from moisture ingress**

5.5 Lightning

Refer to Section 6 for specific information on the proper installation of the pressure sensor with lightning arrester. It is inexpensive insurance to add a lightning arrester on any application where lightning is even a remote possibility.

GE Sensing offers an internal lightning arrester in the PTX 1835 (Option A in the PTX-1840) that will provide protection equal to that of an external lightning arrester. For best protection, the combination of both external and internal arresters is recommended.

6. LIGHTNING

6.1 INTRODUCTION:

This section discusses the ways by which high voltages produced by lightning discharges, affect electronic instrumentation and control devices. It is estimated that 85% of all lightning is cloud-to-cloud, producing mainly static RFI as its most serious consequence. The remaining 15% of strikes are cloud-to-ground, which are discussed in this section.

It is estimated that the cloud-to-ground potential is 10 to 100 million volts, causing ionization of the air molecules and creating a conduction path to the ground. The magnitude of the strike can be 10,000 to 200,000 amps with a rise time of between 0.1 and 10 microseconds.

Normally a visible lightning strike observed from the ground is actually a series of as many as 40 discharges, occurring so rapidly that they appear to be a single strike. They tend to discharge into high objects, close to the clouds. That is why flagpoles, radio towers, and mountains all seem to have a larger number of strikes. On very flat land masses, such as is found on a golf course, many times a person is the highest object and thus attracts the lightning strike.

As the energy discharges into the earth, the potential changes dramatically, plunging earth ground to more than 10,000 volts above or below normal ground. Since most insulation on cables is rated at 600 volts, it is important to protect sensitive instrumentation and control components against over-voltage and over-current.

The same phenomenon can occur over lakes, rivers, or reservoirs in the form of a direct water strike. The energy discharges through the water to the earth below and beside the water. Any devices within the water are susceptible to large voltage potentials that, if not protected against, can cause catastrophic damage.

Direct lightning strikes to buildings and structures can normally be prevented by the use of devices such as lightning rods that protrude above normal structures and installations. As the energy is drained to ground via the lightning rods and cabling, the local earth ground potential is elevated. This is the most common way that lightning can damage sensitive instrumentation located within a certain range of the building.

Another problem is that large energy fields can be induced in cables, propagating large surges that will damage unprotected electronic systems.

Since lightning strikes are of large magnitude but very short duration, the energy flows in the outer skin of the conductors, thus requiring only minimal cross-sectional areas in the conductors. Flat tape or copper lined cylinders are as effective as large, solid conductors since surface area is the important factor. This is an important factor when considering cost and aesthetics in designing protective systems.

Lightning attracters must be of very low impedance in order to present a better path to earth than surrounding structures and devices. Lightning will take the "path of least resistance" when seeking earth ground. Most standard down conductors have inductances of the order of 1.5 microhenries per meter and negligible resistance (less than 0.01W/meter). It is important in buildings to bond all metal components, such as reinforcing bars in the concrete as well as any metalwork outside or attached to the inside of the walls, to the lightning conductors. In this manner, all points of the structure are at the same potential, thus preventing damage at hot spots.

A significant source of instrumentation damage is caused by this shift in local earth potential versus the far earth potential. This potential may cause a breakdown in insulation of conductors or printed circuit boards to case, allowing surge currents to flow. Transient generation in nearby instrumentation systems may be induced via magnetic or capacitive coupling, as well as RFI. For most instrumentation circuits, the RFI is insignificant due to its high frequency and is normally screened out through shielding of cables. Use of twisted pairs may also reduce some of the inductive coupling, reducing surge voltages between lines to levels which will not cause measurement errors. The most significant problem is the high common mode voltages, which may result in component damage in microcircuits. Modern communications and instrumentation systems have reduced power requirements, increased component densities, and reduced circuit board separation between conductors, while at the same time increasing susceptibility to transient voltage damage.

6.2 Transient Specification

In order to provide adequate protection against transients due to lightning, it is important to understand the nature of the problem. Unfortunately, lightning effects are so varied that it is impossible to guarantee that one can protect against all occurrences, no matter how large. Statistically, however, it is possible to predict maximum levels in better than 99% of the occurrences. Few lightning strikes exceed 200,000 amps and 200KA/microsecond rate of rise. To protect against direct strikes to levels above 200KA would be prohibitively expensive. Therefore, most instrumentation protection systems are designed to prevent damage due to near strikes. The most important specification is the "let-through" voltage during the transient. Instrumentation systems must be able to withstand these voltages without damage.

6.3 Protection

In order to protect against damage due to lightning effects, it is important to look at the entire installation. While lightning arresters can protect against line surges, there are other design characteristics, which can protect against the immense shifts in ground potentials.

6.3.1 Shielding

In the case of a lightning strike on the water where a depth/level sensor is installed, a simple change in the stilling-well design gives a high level of protection against induced voltage transients in the cable and case. By using a conductive pipe or applying a conductive copper tape around a PVC pipe and attaching it to local earth ground, the transducer can be protected.

NOTE: Shield/drain wire to connect to same earth ground as lightning arrester.

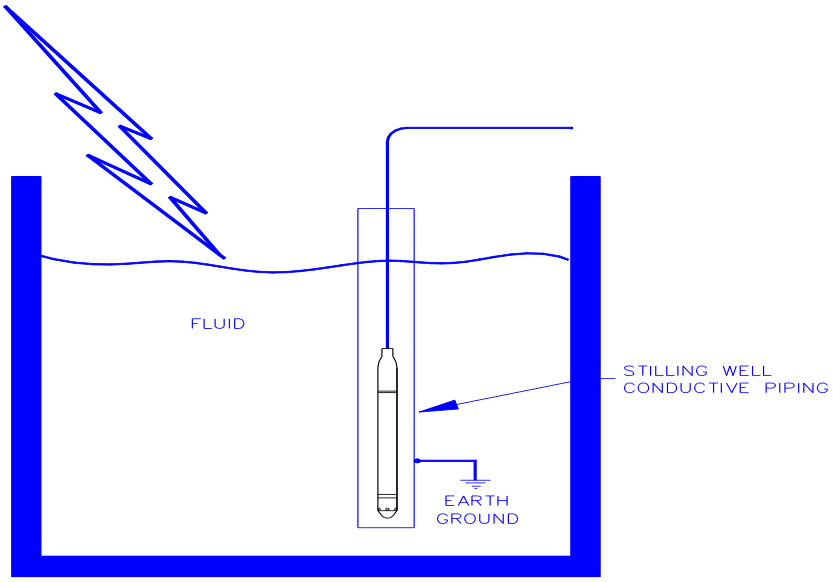

FIGURE 6.1: Protecting Submersible Pressure Sensor for Lightning Strikes

6.3.2 Conduit:

Enclosing all cabling in conduit will also reduce induced transients on long cable runs.

6.3.3 **Lightning Arresters** incorporate several transient surge protection devices which divert the transients to earth ground while isolating sensitive electronic instruments from damage, the more sophisticated of these being completely automatic. While a number of different technologies are available, GE Sensing recommends lightning arresters, which incorporate both Zener Diodes and Gas Discharge Tubes.

A Zener (Clamping) Diode is used to rapidly (faster than 5 nanoseconds) begin shunting the transient voltage spike, while a gas discharge tube is used to absorb the high energy. There are normally multiple tubes installed, depending upon the number of wires being protected. The Zener limits the maximum voltage and is rated according to "let-through" voltage values, but has a conduction voltage sufficiently above the maximum system power supply voltage so that on a 2-wire system, current does not leak via the Zener during normal operation.

7. DATALOGGERS

In wells and level applications where short or long-term information is desired, the use of a data-logger is normally specified. While there are a number of manufacturers of such devices, not all data-loggers are alike. They vary as to capacity, accuracy, battery-operated vs. non-battery operated, speed of data acquisition, physical size, materials of construction, submersible vs. non-submersible, etc.

7.1 Before ordering a data-logger, it is important to understand the scope of the data that is to be recorded. If one reading per hour for 1 year is desired, it will require enough data storage plus enough battery power. If it is submersible, the diameter must be small enough to allow it to be lowered in the well casing, e.g., if logging slug tests, it must acquire data fast enough to make the desired measurement.

7.2 Some manufacturers use bridge-level sensors to reduce cost of the sensor. Others like the standardization offered by the 2-wire 4 to 20mA devices.

7.3 It is recommended that the data-logger be calibrated together with the sensor to ensure compatibility and that the proper engineering units are being used. It is important to specify the pressure sensor desired to ensure that corrosion resistance and/or accuracy are achieved.

7.4 Note: All Depth/Level Pressure Sensors are not alike. Have the data-logger manufacturer specify the overall system performance with the sensor included, for all environmental and electrical parameters. In order to reduce power consumption it is common for Data-loggers to power up collect a reading and then power down the simple analogue circuitry used in hydrostatic sensors make it possible for this time to be very short. GE Sensing products typically give a stable reading after less than 50 ms.

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8. INSTALLATION INSTRUCTIONS

8.1 PRE-INSTALLATION: Before installing a Depth/Level pressure sensor, it is advisable to review certain criteria to ensure success. Please review the following pre-installation guidelines:

8.1.1 PRESSURE RANGE: Check to see that the proper range has been specified. Refer to Appendix A for conversion factors relating pressure range to actual depth units. For example, if you want a sensor ranged to 100 feet of water (43.3528 psig), you can specify the exact range with the GE Sensing PTX 1830. With other suppliers you may have to settle for a standard range which is the closest available but not 100 feet, like 50 psig (115.3329 feet of water). As most sensor parameters are specified as %FS characteristics, for best accuracy it is important that the optimum full scale be specified.

8.1.2 CABLE LENGTH: Make sure that sufficient cable has been specified and provided to achieve the required depth. Normal practice recommends that the length of cable is equal to the depth below the measuring point at which the sensor will be located, plus any lengths of cable necessary to reach the termination point. Because vented cable is relatively expensive, a terminal box is normally located close to the wellhead. This allows a less expensive cable without a vent tube to be used for the distance from the wellhead to the monitoring and control instrumentation.

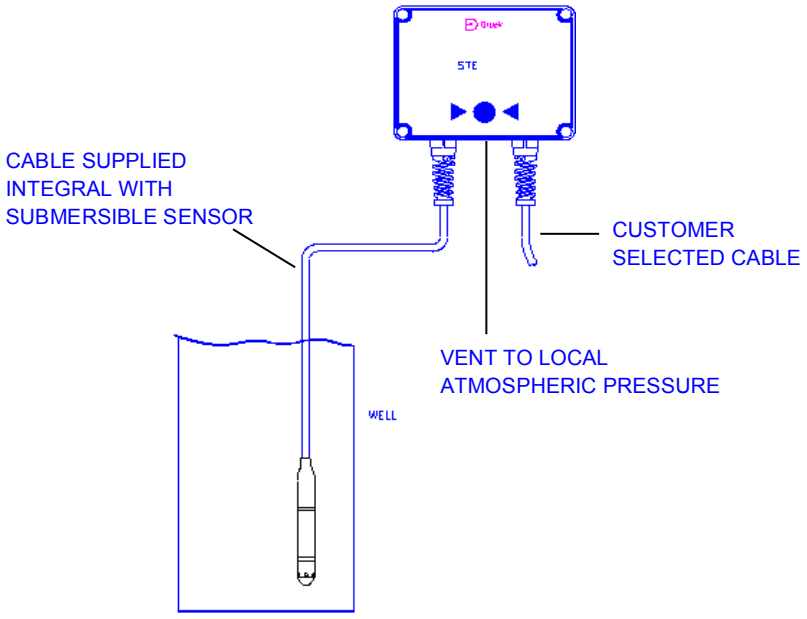

FIGURE 8.1: Submersible Pressure Level Sensor with STE Box

8.1.3 **ESTABLISHING WELL HEAD REFERENCE:** If the installation is in a well, it is important to specify a range that covers the distance from the location of the pump (normally slightly above the bottom) to the measuring point. This is especially true in wells located in areas that may be susceptible to flooding. There are two commonly used methods; using a calibrated cable or using a dip-meter to determine the distance to the water level.

8.1.3.1 In the first case, it is necessary to calibrate and mark the cable of the submersible sensor so that a proper reference can be established. Before installing the depth/level sensor, determine the actual point on the sensor where the sensing diaphragm is located. Measure from this datum when marking the cable. An accurate measurement must be made when determining the length of cable being extended into the liquid being measured. Using a marker or waterproof tape, mark the cable wherever desired. Normally, the first mark should be at 1 meter. This mark will be determined by measuring from the diaphragm datum. Accuracy is very important when placing these markers. The accuracy of the depth measurement is critically dependent on setting the sensing element in the level transducer at a known distance from the measuring point.

8.1.3.2 In the second method, a dip-meter is used to determine the distance from the wellhead to the surface of the water. The dip-meter is an electrical apparatus that conducts current from one electrode to the other when immersed in water. The electrical cable is marked with indicators so that when the electrode touches the water, the distance can be determined. This method is especially useful when numerous installations are to be made. In this method, an accurate calibration of the pressure sensor is required. Once the sensor is lowered to the desired depth, the system can then be calibrated. The number of feet of water can be read from the sensor, which indicates how much water is above the sensor. However, in many applications, the distance from the datum to the surface of the water is desired. In order to accurately make this measurement, it is necessary to determine the distance of the sensor from the datum. The following calculations will determine this distance:

D_S = Depth of pressure sensor below the water surface
L_D = Distance from the water surface to the datum (using dip meter)
T_D = Distance of sensor from datum

$$T_D = D_S + L_D$$

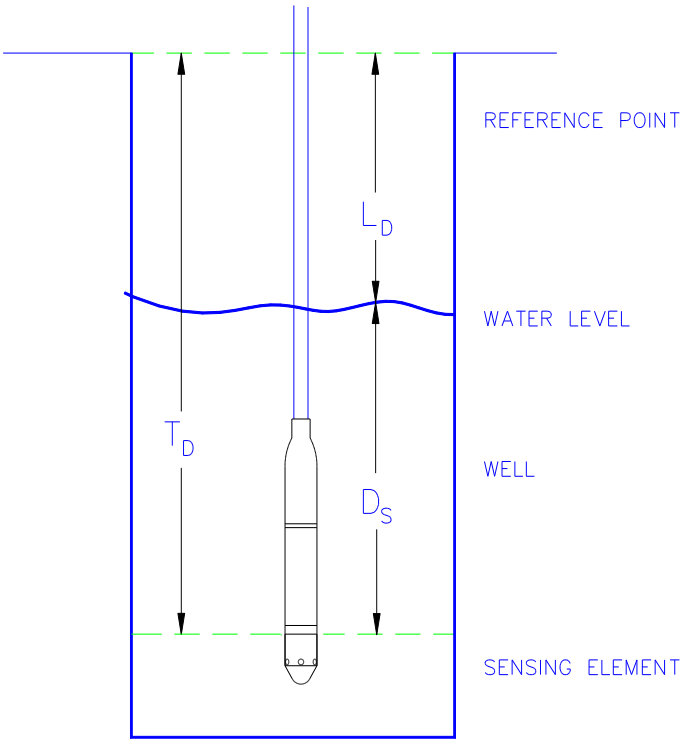

FIGURE 8.2: Establishing a Well Head Reference

Once this distance of the sensor from datum is determined, it should not change. Then the measurement becomes the following:-

$L_D = T_D + D_S$

Since the distance of the pressure sensor does not change, the only variable is the output of the pressure sensor, which is proportional to the hydrostatic head of water above the sensor.

8.1.4 **STILLING WELLS:** It is recommended that a stilling well be used. In a well, the casing or the pump-cable conduit is normally used as the stilling well. In a surface water application for reservoir, river, canal, etc., a pipe of some sort is normally used. This prevents any turbulence or current from disturbing the depth/level pressure sensor, e.g., in a river with a 3 knot current. If a stilling well is not used, the current will cause the sensor to physically drift downstream, causing the depth to decrease relative to the cable length. The stilling well also protects the sensor and cable from debris damaging the cable, and if made of metal, can help provide lightning protection, but most often, a PVC pipe is used. Refer to Appendix E for more information about still tube construction for GE Druck Submersible Pressure Sensors.

8.1.5 **CALIBRATION CONSIDERATIONS:** If a calibrator is available, it is recommended to calibrate the sensor together with the monitor or controller prior to installation to ensure proper set-up. This will allow accurate level to be measured from the start. If a calibrator is not available, the calibration certificate must be used to set up the system. A regular calibration check is essential to meet local or national quality practices. This requires a level sensor to have a known pressure applied and the output measured. In the field, a portable calibrator can be used with one of the new calibration adaptors to carry out a calibration check.

Note: the zero and span figures are normally not precise, allowing for the manufacturer's tolerances for setting, e.g., if the manufacturer specifies a zero tolerance of ±1% and a span tolerance of ±1%, then the precision could be off by those amounts if not properly calibrated to the instrument. GE Sensing has a range of self-contained portable calibrators (See Section 10) which can be used to eliminate these potential errors.

FIGURE 8.3

Portable Pressure Calibrators and Pressure Fittings to Adapt to Submersible Sensors
(GE Sensing DPI 610 Pressure Calibrator or the DPI-620 can simultaneously power, apply a calibrated pressure to the Depth Sensor, and measure the sensor output.)

8.1.6 **VENT TUBE CONSIDERATIONS:** It is mandatory that a desiccant be used to prevent moisture from condensing and entering through the cable or vent tube. It is important to dry the air that can contain water vapor before allowing it to breathe into the sensor. The cable vent, as well as conductors, is a source of moisture ingress. The GE Sensing STE box removes moisture from the air that enters the sensor assembly.

8.1.6.1 ***Sensor Termination Enclosure:*** GE Sensing recommends the use of its STE Sensor Termination Enclosure, which includes filter and desiccant in order to prevent the moist air from entering the vent tube. The desiccant has a sight glass that can be seen through the window in the STE box. When the color is blue, the desiccant is OK; when it is red, it is time to be replaced. Under normal conditions, the desiccant should be changed every 6 to 12 months. The desiccant pack can be dried out by baking it in the oven at 135°C for about 3 hours, or with the new plastic pack by heating in a microwave oven. Every STE box is supplied with sealed desiccant pack. The STE box is designed to work in damp environments and uses a small Teflon breather port that does not allow water to enter, but will pass air for barometric breathing.

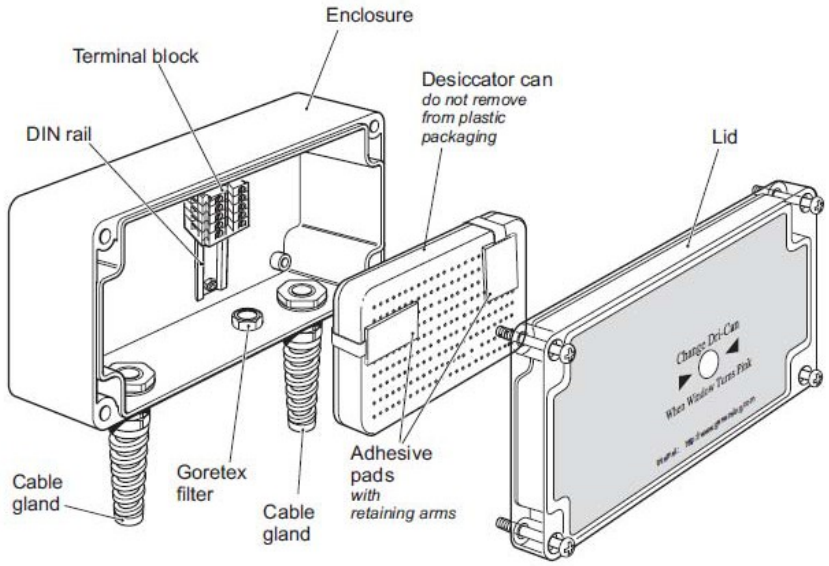

FIGURE 5.2: Sensor Termination Enclosure (P/N: 202-034-03)

8.1.6.2 ***Use of Barometers (instead of desiccant boxes):*** As an alternate to the use of a desiccant box like the STE box, an absolute pressure/level submersible sensor along with a barometer is can be used. By subtracting the barometric pressure from the submersible pressure sensor's absolute pressure, the equivalent gauge pressure is calculated. This achieves the same result as using a desiccant box (STE) along with a vented gauge pressure submersible sensor. A common barometer used for this purpose is the RPT-410V shown in figure 4.3.

Figure 4.3: GE Druck Model RPT410V

8.1.7 **LIGHTENING CONSIDERATIONS:** If the installation is located in a potential lightning area, it is recommended that a lightning arrestor be installed to protect against both common-mode and differential-mode transients.

8.2 INSTALLATION:

With the pre-installation details attended to, installation may now commence:

8.2.1 **READ THE INSTALLATION INSTRUCTIONS!** (e.g. PTX-1830 shown next 2 pages). Note any warnings or cautions. The most common cause of transducer failure is not heeding them.

8.2.2 **CABLE:** In a well, in order to determine the level of the water below the measuring point, the length of cable must be precisely set, referenced to this measurement point.

8.2.2.1 For example, if a sensor is ranged at 3 mH_2O and has 30 meters of cable below the ground datum, and is submerged in 3 mH_2O of water, the range between the level and the datum point is -27 mH_2O. As the water level is pumped lower by 1 mH_2O, the new range is -28 mH_2O. In groundwater hydrology, this negative is a common measurement. The hydrologist tries to determine the distance from his measuring datum and the surface of the water, (depth below ground surface).

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PTX 1830 Series, Installation Instructions (K268 ISSUE NO. 3)

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8.2.2.2 With the GE Sensing cable, there is a Kevlar fiber which prevents stretching of the cable during normal installation. For premium set up of the ground datum cable length, readjust after 2 weeks.

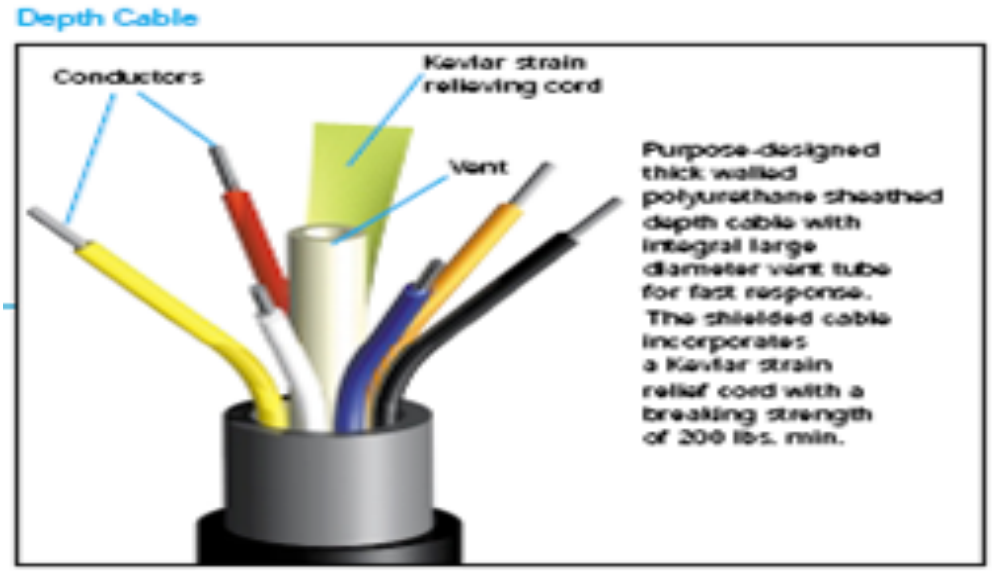


FIGURE 8.4: Vented Depth/Level Cable with Kevlar Strain Relief Fiber

FIGURE 8.5: Accessories for Submersible Pressure / Level Sensors

8.2.3 **ACCESSORIES:** A range of special accessories to complement both past and present submersible sensors are available. The accessories provide a complete system solution, easing problems in installation and maintenance. These new accessories are compatible with the following submersible sensors.

Submersible Level Sensors

Model	Sensor Type
PTX 1290	30 mm (1.2 inch) diameter – titanium sensor
PDCR 1830	17.5 mm (0.69 inch) diameter- titanium sensor
PTX 1730	17.5 mm (0.69 inch) diameter- stainless steel sensor
PTX 1830	17.5 mm (0.69 inch) diameter- titanium sensor
UNIK 5000	25 mm (1 inch) diameter – stainless steel sensor
TERPS (RPS/DPS 8000)	25 mm (1 inch) diameter – stainless steel sensor

8.2.3.1 ***CABLE CLAMP:*** (Cable Clamp P/N: 192-373-01) In many surface and ground water applications there has been no easy or cost-effective way to hold a sensor cable at the water exit point, until now. This clamp secures a sensor cable and prevents the vent tube in the sensor cable from becoming constricted. The slide mechanism of the cable clamp makes installation an easy task.

8.2.3.2 ***SINK WEIGHTS:*** Many submerged sensor applications require additional weight to prevent incorrect datum reference due to 'cable snake'. The old solution of strapping lead weights to the cable boot can damage the sensor cable.

GE's solution attaches sink weights directly to the sensor. These sink weights match the diameter of the sensor and screw into the front of the sensor. Radial holes around the sensing diaphragm area provide accurate measurement with continuous water circulation, maintaining cleanliness.

Part Number	Description
DA2608-1-01	Slimline Sink Weight 17.5 mm – 1830/UNIK 5000 (*PJ)
222-116-01	Slimline Sink Weight 17.5 mm – 1730/UNIK 5000 (*PA, PW)
DA4068-1-01	Short Sink Weight 25.4 mm – 1830/UNIK 5000 (*PJ)
222-117-01	Short Sink Weight 25.4 mm – 1730/UNIK 5000 (*PA, PW)

**Compatible UNIK 5000 Pressure connector options (PA, PJ, PW)*

8.2.3.3 ***SENSOR TERMINATION ENCLOSURE -STE:*** (P/N: 202-034-03) Terminate the cable using a desiccated terminal enclosure such as the GE Sensing STE box. This enclosure has a replaceable desiccant pack that is reusable after drying out. This sealed 'junction box' receives the special 'vented' type sensor cable from a GE sensor and connects to a less expensive, non-vented, proprietary sourced instrument cable. It allows barometric reference pressure to enter the enclosure while providing a block to water/humidity entering and condensing in the assembly. A desiccant pack is included which keeps the junction box' dry.

8.2.3.3.1 DESICCANT: (P/N: 410-A001) Spare desiccant for the STE boxes.

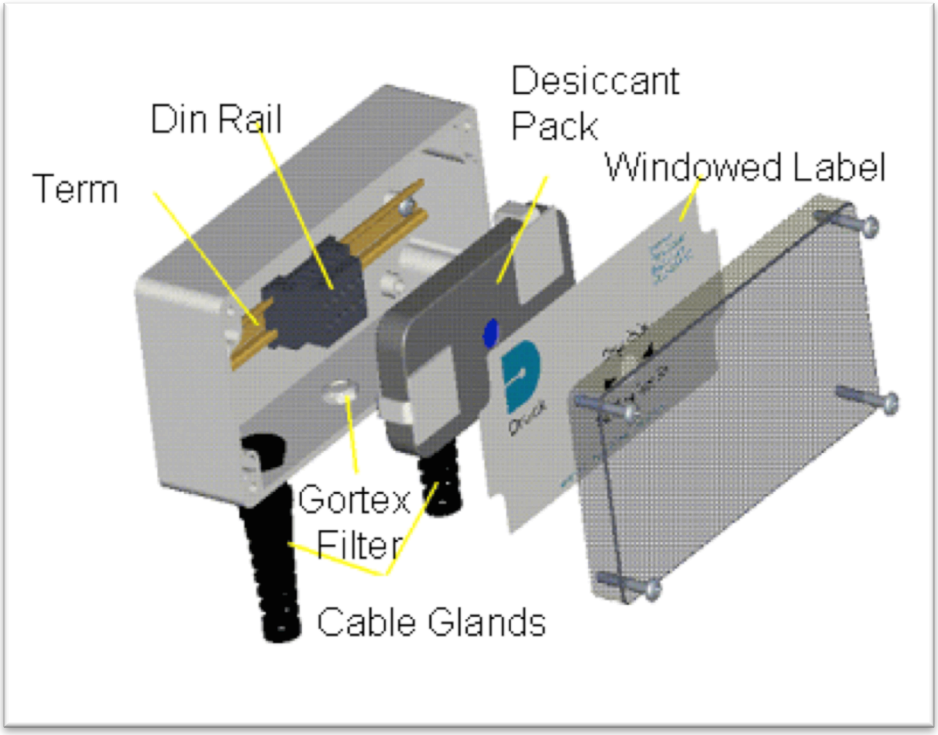


Figure 8.6: Sensor Termination Enclosure Dissected

8.2.3.4 ***CALIBRATION ADAPTORS:*** Used for adapting from the nose cone of the pressure sensor to a calibrator fitting and come in various sizes.

Part Number	Description
DA2537-1-01	G1/8 Pressure adaptor– 1830 to DPI620
DA2536-1-01	G1/8 Pressure adaptor– 1730 to DPI620
222-127-01	1830 Nose Cone
222-112-01	1730 Nose Cone

8.2.3.5 ***CLEANING KIT:*** Call factory.

8.2.3.6 ***ANCHOR ASSEMBLY:*** (P/N: TAS-A157) It is used with the PTX-1290 Waste Water Submersible Pressure Level Transmitter. Easy to insert and remove from lift station, 8-pound marine anchor, 316SS wire rope, 3/16" diameter, Nylon clamp to hold PTX 1290.

PTX-1290 Waste Water Submersible Pressure Transmitter

PTX-1290 Anchor Assembly (P/N: TAS-A157)

8.2.3.7 ***PRESSURE-LEVEL APPLICATION HANDBOOK:*** Available upon request.

8.2.3.8 ***CSI SPECIFICATIONS:*** Available on request for Engineering Design Personnel.

Figure 8.7: From left to right in picture are: Cable Clamp, Sink Weights, Senor Termination Enclosure (STE Box), and below right are calibration adaptors.

ACCESSORIES PARTS LIST: When ordering, please refer to this Accessories Parts List, and specify the part number required.

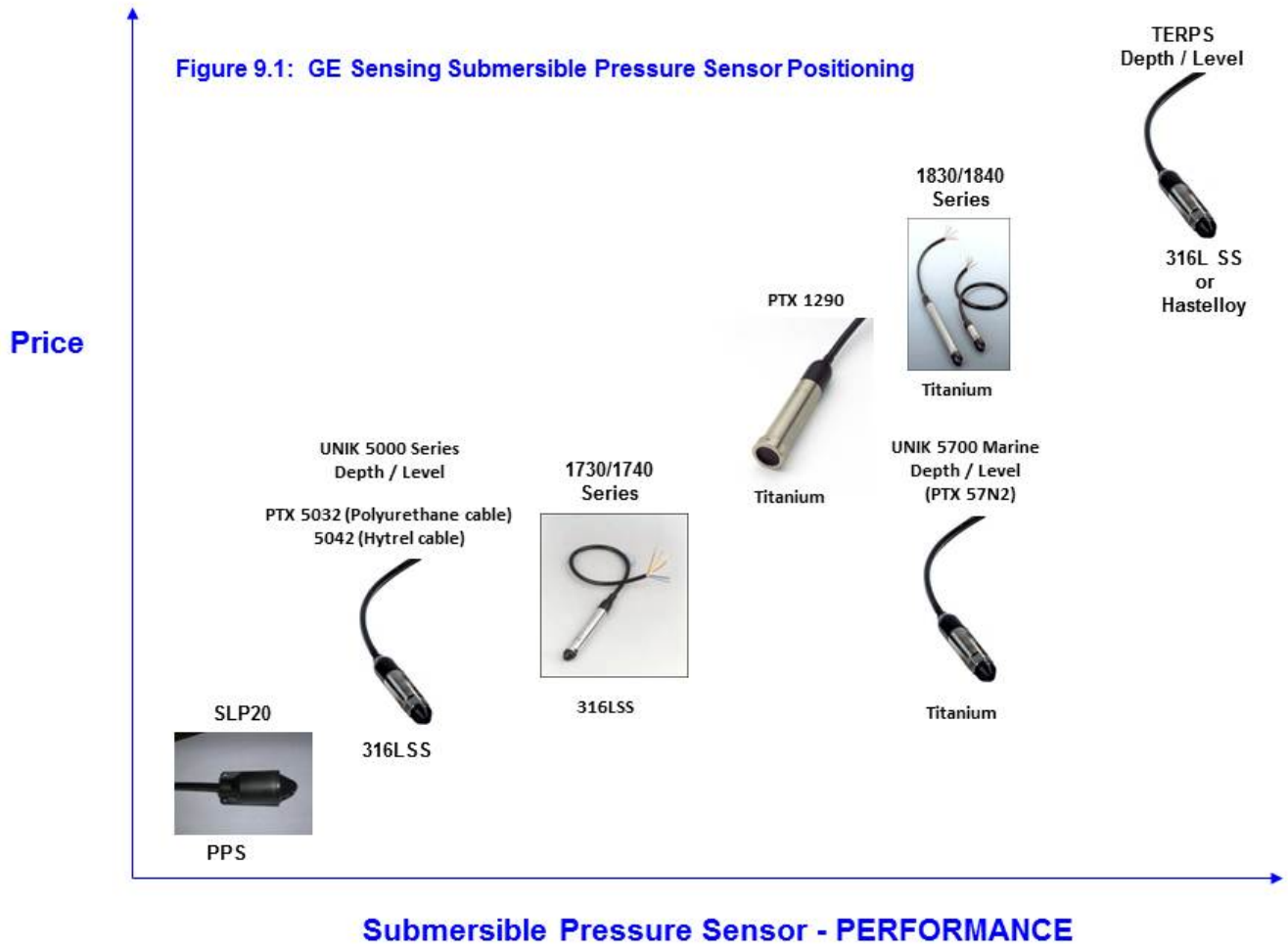
Part Number	Description
202-034-03	STE Sensor Termination Enclosure
600-914	STE Desiccant Silica Gel pack
410-A001 (US only)	STE Desiccant Silica Gel pack
DA2608-1-01	Slimline Sink Weight 17.5 mm – 1830/UNIK 5000 (*PJ)
222-116-01	Slimline Sink Weight 17.5 mm – 1730/UNIK 5000 (*PA, PW)
DA4068-1-01	Short Sink Weight 25.4 mm – 1830/UNIK 5000 (*PJ)
222-117-01	Short Sink Weight 25.4 mm – 1730/UNIK 5000 (*PA, PW)
192-373-01	Cable Clamp System
DA2537-1-01	Economical G1/8 Pressure adaptor– 1830 to DPI620
DA2536-1-01	Economical G1/8 Pressure adaptor– 1730 to DPI620
222-127-01	1830 Nose Cone
222-112-01	1730 Nose Cone
TAS-A157	Anchor and Cable Assembly for PTX 1290

**Compatible UNIK 5000 Pressure connector options (PA, PJ, PW)*

9. SUBMERSIBLE DEPTH/LEVEL PRODUCT SELECTION GUIDE

9.1 GE Sensing Submersible Pressure Sensor Positioning Graph

(Please reference Figure 9.1)



9.2 Depth Level Sensor EZ Guide

(Please reference Figure 9.2) This is a complete list of all model numbers available from GE Druck. Please refer to the individual data sheets listed in section 9.4 for details.

Depth Level Sensor EZ Guide

Depth level Sensors		Output	Hydrocarbon resistant	Construction	Lightning/Surge Protection	IS available	Range	Diameter	Accuracy	Corrosion waranty	Supply Voltage	Max Cable length
PTX1830		4-20ma	no	titanium	no	FM, CSA	1 to 900psiG 5 to 900psiA	0.69"	±0.10%FS BSL - standard ±0.06%FS BSL - optional	5yr	9-30V non-IS 9-28V IS	1600ft
PDCR1830		mV Optional temperature sensor thermistor, 100Ω, 0.385Ω/°C	no	titanium	no	CSA/UL, FM	1 to 900psiG/A (discrete values)	0.69"	±0.10%FS BSL - standard ±0.06%FS BSL - optional	5yr	2.5 -12V	1600ft
PTX1835		4-20ma	no	titanium	yes	FM, CSA	same as PTX1830	0.69"	±0.10%FS BSL - standard ±0.06%FS BSL - optional	5yr	see PTX1830	1600ft
PTX1840		4-20ma	yes	titanium	yes, opt A	option B - ATEX	0.75 to 600mH2O G	0.69"	±0.10%FS BSL - standard	5yr	see PTX1830	1600ft
PDCR1840		mV	yes	titanium	no	option B - ATEX	0.75 to 600mH2O A	0.69"	±0.06%FS BSL - optional	5yr	see PDCR1830	1600ft
PTX1730		4-20ma	no	stainless steel	no	no	5-900psiG - discrete ranges	0.69"	±0.25%FS BSL	1yr	9-30V	1900ft
PDCR1730		mV	no	stainless steel	no	no	5-900psiG - discrete ranges	0.69"	±0.25%FS BSL	1yr	2.5-12V	1900ft
UNIK5000	PDCR50Y0	mV		stainless steel	no	FM/CSA	G, A, SG	1.0"	A1 , A2	1yr	2.5-12V	
	PDCR50Y1	mV linearized		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	7-12V	
	PTX50Y2	4-20ma		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	7-32V non-IS,7- 28V IS	
	PMP50Y3	0-5V 4-wire		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	7-32V non-IS,7-16V IS	
	PMP50Y4	0-5V 3-wire		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	7-32V non-IS,7-16V IS	
	PMP50Y5	1-6V 3-wire		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	7-32V non-IS,7-16V IS	
	PMP50Y6	0-10V 4-wire		"	no	FM/CSA	G, A, SG	1.0"	A1, A2, A3	1yr	12-32V non-IS,12-16V IS	
	PMP50Y7	0.5-4.5V 3-wire		"	no	no	G, A, SG	1.0"	A1, A2, A3	1yr	5.0 ± 0.5V	
	PMP50Y8	configurable 3or4-wire		"	no	no	G, A, SG	1.0"	A1, A2, A3	1yr	7-36V	
	PMP50Y9	configurable 3-wire		"	no	no	G, A, SG	1.0"	A1, A2, A3	1yr	7-36V	
							G = 1 to 1000psi Gauge		A1 = ±0.20%FS BSL			
	Y=3	Polyurethane cable	no				A = 1.5 to 10,000psi Absolute		A2 = ±0.10%FS BSL			570ft
	Y=4	Hytrel cable	yes				SG = 145 to 10,000psi Sealed Gauge		A3 = ±0.04%FS BSL			570ft
							(max subersible depth of 692Ft H2O)					
SLP	SLP20-H	mV	yes - Riteflex	PPS & Stainless	no	ATEX, IECEx	2.5-200psi	0.94"	±0.5%FS BSL	1yr	2.5-15V	330ft
	SLP20-T		yes - Tefzel			FM-US & Canada	G or A					
		Optional temperatue voltage output - nom 10mV/°C, 2.98V @ 25°C					discrete ranges				2.98V @ 25°C	
PTX1290		4-20ma	no	titanium	no	ATEX	1.75 to 15mH2O G	1.20"	±0.25%FS BSL	5yr	9-28V	984ft
TERPS	RPS803X	Digital - frequency temperature diode	no	Stainless	no	no	2barG to 70barG	1.0"	0.02% and 0.01%	1yr	6 -28V	984ft
	DPS803X	Digital - Serial	no	Stainless	no	no	2barG to 70barG	1.0"	0.02% and 0.01%	1yr	11-28V	984ft

Depth Level Sensor Accessories

Part number	Description	Compatible Sensors
DA2608-1-01	Sink weight, M14x1.5-female 0.69" diameter	PTX/PDCR18XX
DA4068-1-01	Sink weight, M14x1.5-female 1.0" diameter	PTX/PDCR18XX
222-116-01	Sink weight, G1/4-Male 0.69" diameter	PTX/PDCR1730
TAS-A157	Anchor kit	PTX1290
222-127-01	Depth cone	PTX/PDCR18XX
202-034-03	STE - Sensor Termination Enclosure	all gauge sensors
410-A001	Dri-Can dessicant	STE-110
192-373-01	Cable Clamp	all

Part number	Description	Compatible Sensors
DA2537-2-01	Calibation adapter - M14x1.5 to 1/8NPT w/seal	PTX/PDCR18XX
DA4112-2-01	Calibration adapter - M14x1.5 to 1/8NPT w/seal, quick connect	PTX/PDCR18XX
227-A018	Calibraton adapter - M14x1.5 to 1/NPT male	PTX/PDCR18XX
DA4112-1-01	Calibration adapter - M14x1.5 to G1/8 male w/seal, quick connect	PTX/PDCR18XX
DA4112-3-01	Calibration adapter - G1/4 male to G1/8 male w/seals, quick conect	PTX/PDCR1730
DA2537-1-01	Calibration adapter - M14x1.5 to G1/8 male w/seals	PTX/PDCR18XX
201-A013	Sensor Tagging option	all

9.3 HOW TO ORDER

What to include when ordering Submersible Pressure Sensors from GE Druck:

9.3.1 State Model Number: Select the model number of the particular sensor you wish to get (e.g. PTX-1830, PTX-1290, etc.)

9.3.2 State Pressure Range and Units:

Pressure Range: e.g. 0 to 10 psi, -5 to + 5 psi

Pressure Units: (psi, feet of water, meters of water, bar etc.)

9.3.3 State Pressure Reference: (gauge, absolute, differential, etc.)

9.3.4 State Cable Lengths and Units: Integer values only. All submersibles come with 3 feet of cable (1 meter) as standard. Extra cable must be specified beyond 3 feet. Maximum cable lengths vary by sensor, refer to individual data sheets.

9.3.5 Options: Higher Accuracies are available on certain depth level sensors (e.g. 1830 Series standard accuracy is 0.1% FS optional accuracy 0.06% FS, for PTX-1290 standard accuracy is 0.25%, optional higher accuracy is 0.1% FS and etc.)

9.3.6 Sales/Technical Support/Pricing Information, QUOTES:

9.3.6.1 California call: 1-888-470-7222

9.3.6.2 Outside California call: 1-800-833-9438

9.4 DATA SHEETS

This section contains the product brochures and individual data sheets for the GE Druck Submersible Pressure Sensor product line.

9.4.1 Depth/Level Druck Submersible Pressure Sensors Product Guide (Brochure)

(Please reference following 8 Pages)

GE
Measurement & Control

Depth/Level
Druck Submersible Pressure Sensors Product Guide

Features

- High accuracy
- Excellent reliability
- Robust construction
- Harsh media compatible
- High stability
- Low power/pulsed power operation

Applications

- Bore hole monitoring
- River level
- Tank level
- Tide and wave height
- Pump control
- Sand filter differential
- Marine

Ground and Surface Water

One of the most efficient methods of measuring water level in wells, streams, rivers, canals and reservoirs is the submersible pressure sensor. It uses very little energy and provides an accurate long term measuring system solution.

There are many thousands of submersible GE pressure sensors installed worldwide in a variety of applications where the high stability and reliability of the devices have clearly delivered the lowest "cost-of-ownership" of any method available.

PDCR/PTX 1830
High specification, robust submersible pressure sensor

- Ranges from 0.75 to 600 mH_2O (1 to 900 psi)
- Millivolt or milliamp output
- Accuracy to ±0.06% FS
- Body diameter 17.5 mm (0.69 in)
- All-welded titanium construction
- Vented polyurethane cable with Kevlar® anti-stretch construction
- Hazardous area approvals
- Lightning protection
- Five-year anti-corrosion warranty

UNIK 5000
Low cost submersible pressure sensor

- Range 0.7 to 200 mH_2O (1 to 300 psi)
- Voltage, milliamp, millivolt output
- Accuracy to ±0.04%
- Body diameter 25 mm (1 in)
- All-welded 316L stainless steel with Hastelloy® C276 diaphragm
- Vented polyurethane cable with Kevlar® anti-stretch construction
- Supply current <3 mA (at no load)
- Gauge, absolute, differential versions

PTX 1730
Submersible pressure sensor

- Ranges from 3.5 to 600 mH_2O (5 to 900 psi)
- Milliamp output
- Accuracy ±0.25%
- Body diameter 17.5 mm (0.69 in)
- All welded 316L stainless steel construction
- Vented polyurethane cable with Kevlar® anti-stretch construction

UNIK 5000 Differential
Submersible differential pressure transmitter

- Ranges from 1 to 350 mH_2O (1.5 to 500 psi)
- Voltage, milliamp, millivolt output
- Accuracy ±0.04% FS
- All-welded 316L stainless steel with Hastelloy C276 diaphragm
- Moulded polyurethane cable

Wastewater and Remediation

One of the most difficult applications in level measurement is sewage. Most methods suffer from clogging, high-humidity interface from foaming or require line of sight.

GE has developed the PTX1290 with its flush elastometric diaphragm and titanium body in order to provide an inexpensive way to ensure highly reliable level measurement in this harsh environment.

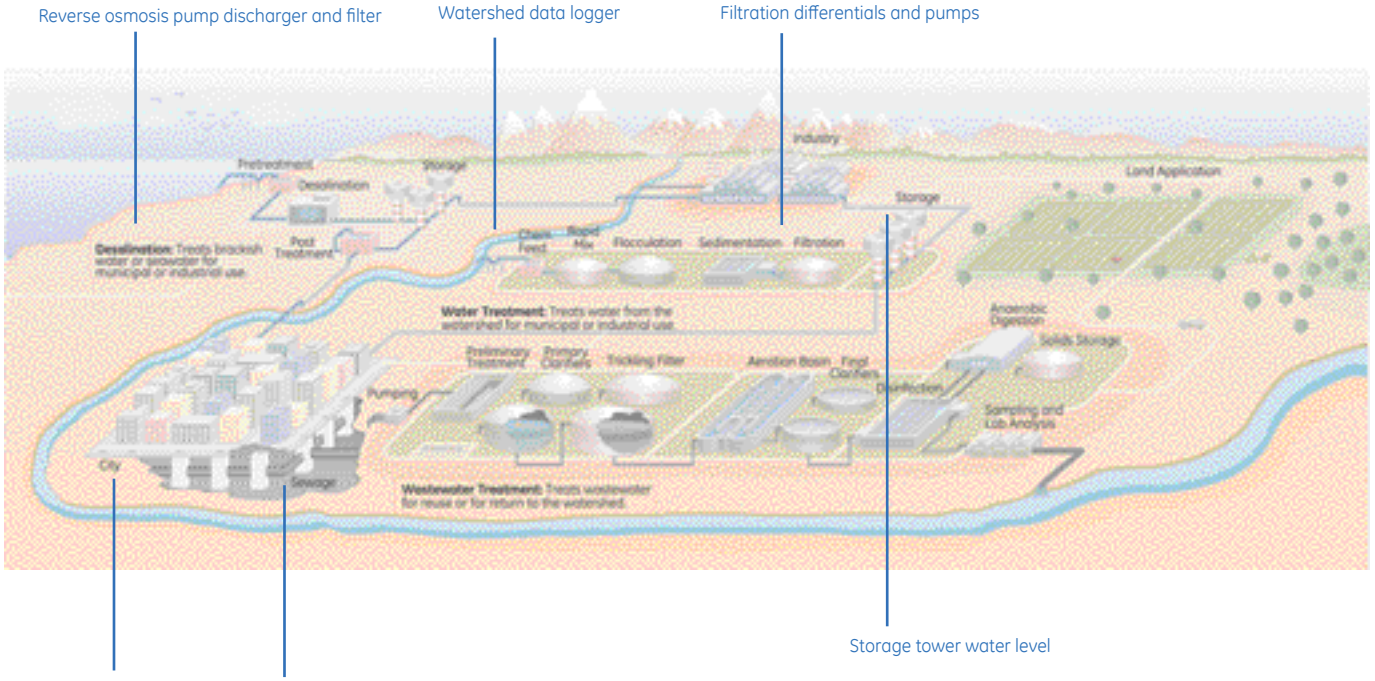
In groundwater remediation applications, undocumented chemicals may be encountered that could cause corrosion in stainless steel devices. All-welded titanium construction and robust Hytrel® cable is insurance against premature failure.

PTX 1290 (US Only)
Wastewater submersible pressure transmitter/ transducer

- Ranges from 1.75 to 15 mH_2O (2.5 to 22.5 psi)
- Current output
- Accuracy ±0.25% FS
- Body diameter 30 mm (1.2 in)
- All-welded titanium construction
- Polytetrafluoroethylene-coated elastometric flush diaphragm
- Hazardous area approvals (US only)
- Five-year anti-corrosion warranty

PDCR/PTX 1840
High specification robust submersible pressure sensor

- Ranges from 0.7 to 600 mH_2O (1 to 900 psi)
- Millivolt or milliamp output
- Accuracy to ±0.06% FS
- Body diameter 17.5 mm (0.69 in)
- All-welded titanium construction
- Chemically resistant cable with Kevlar® anti-stretch construction
- Hazardous area approvals
- Lightning protection
- Five-year anti-corrosion warranty



Tank level, marine and pipe pressure

A choice of metal and cable materials make it possible to select a sensor capable of withstanding most aggressive media. This allows simple installation into the tank by direct immersion.

Features such as IP68 cable connections and snubbers enable the correct sensor to be selected from GE's standard industrial transmitters to enable robust stable and reliable measurement of pump and pipeline pressures. DNV certifications are available for products designed for applications on board ship.

UNIK 5000
Robust OEM industrial level transmitter

- Ranges from 70 mbar to 700 bar (1 to 10,000 psi)
- Millivolt, milliamp, voltage output
- Accuracy to ±0.04% FS
- Body diameter 25 mm (1 in)
- All-welded 316L stainless steel with Hastelloy C276 diaphragm
- Vented polyurethane or Hytrel® cable with Kevlar® anti-stretch construction
- Selection of high IP rated electrical connections

PTX 1730
Low cost submersible pressure sensor

- Ranges from 2 to 900 psi
- Milliamp output
- Accuracy ±0.25%
- Body diameter 17.5 mm (0.69 in)
- All welded 316L stainless steel construction
- Vented polyurethane cable with Kevlar® anti-stretch construction

PDCR/PTX 1840
High specification, robust submersible pressure sensor

- Ranges from 0.7 to 600 mH_2O (1 to 900 psi)
- Millivolt or milliamp output
- Accuracy to ±0.06% FS
- Body diameter 17.5 mm (0.69 in)
- All-welded titanium construction
- Chemically resistant cable with Kevlar® anti-stretch construction
- Hazardous area approvals
- Lightning protection
- Five-year anti-corrosion warranty

RTX 1000
Process pressure transmitter

- Ranges from 1.5 to 20,000 psi
- HART® compatible
- Milliamp output
- Accuracy to ±0.075% FS
- 316L stainless steel, Hastelloy®, Inconel® wetted parts
- Conduit connections
- Hazardous area approvals

UNIK 5600/5700
DNV marine certified pressure transmitter

- Ranges from 70 mbar to 700 bar (1 to 10,000 psi)
- Milliamp output
- Accuracy to ±0.04% FS
- Body diameter 25 mm (1in)
- All-welded 316L stainless steel or titanium construction
- Hazardous area approvals
- DIN 43650 or fully submersible electrical connectors

SLP
Robust OEM level transducer

- Ranges from 2.5 to 100 psi
- Millivolt output
- Accuracy ±0.5% FS
- Polymer construction
- Hazardous area approvals

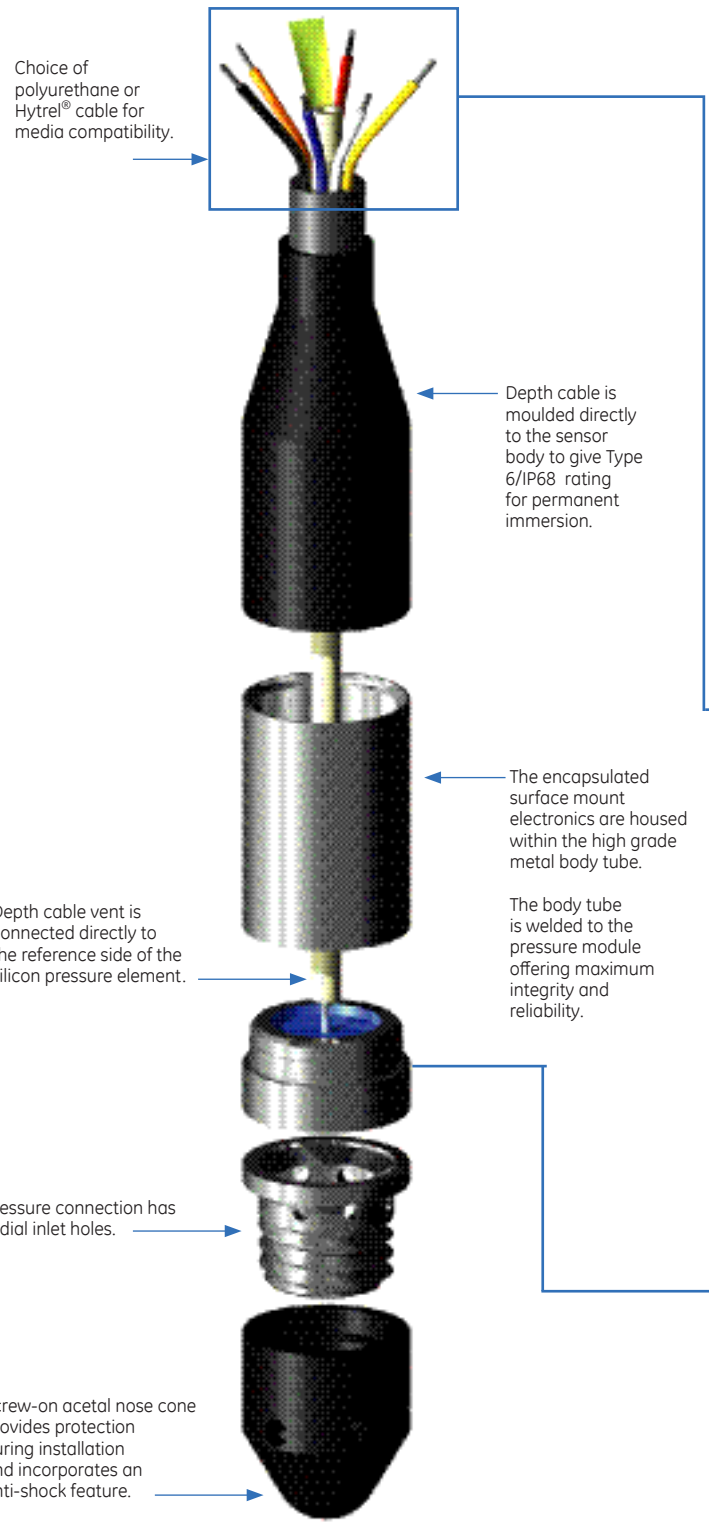
The Latest Technology for Submersible Sensors

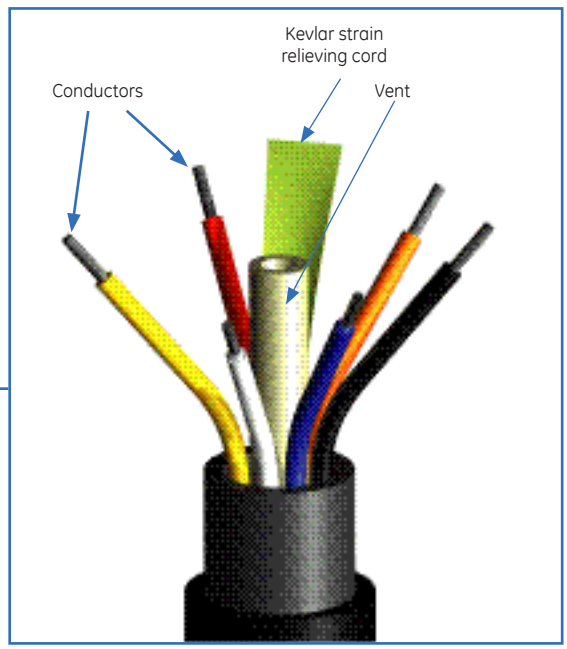
GE offers the latest generation of fully submersible sensors that incorporate the most recent technological advances in depth and level measurement.

At the heart of these sensors is a high stability pressure element manufactured from micro-machined silicon developed within GE's own processing facility. The silicon sensing element is fully isolated from the media by an isolation diaphragm.

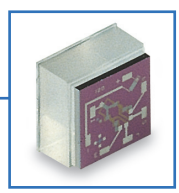
Surface mount electronics within the body tube minimize sensor size and improve reliability. The purpose-designed vented electrical cable results in level sensors with the highest integrity and the lowest cost of ownership.

With a choice of millivolt, voltage or current outputs, small physical size and wide range of pressures, the sensors can be used in a variety of applications from the smallest diameter bore holes to canals, rivers and reservoirs. They are ideally suited for depth/level application in the oceanographic and remediation industries.





Depth cable



Pressure module assembly

Accessories

A full range of accessories is available to enhance installation, operation and maintenance of the Druck submersible pressure sensors:

STE Moisture-Proof Sensor Termination Enclosure

STE Desiccant Silica Gel Can

Cable Clamp Assembly

Short Sink Weight

Slim Line Sink Weight

Economical Direct Calibration Adaptor

Related Products

GE manufactures a wide range of pressure transducers, transmitters, associated digital indicators, barometers and a complete range of precision process calibrators and controllers for the field, workshop and laboratory. A selection of these is shown below:

RPT 410
Low cost, high accuracy surface mount barometer

- 600 to 1100 mbar absolute
- High accuracy
- High stability 100 ppm
- Voltage or frequency outputs

Druck DPI 620 Series
Portable pressure/temperature/electrical/ multi-function, battery-powered calibrators

- Available in standard or intrinsically safe formats
- Compact, rugged, ergonomically-designed universal tools
- Digital interface

UPS III
Rugged, compact/pocket size loop calibrator

- Measure and source 0 to 24 mA
- Accuracy 0.01% of reading
- Dual mA and % readout, linear or flow
- Step, span check, value check, ramp
- 60 Vdc measurement and continuity

TransPort® PT878
Portable flowmeter

- Portable verification of installation
- Retrofit permanent meter
- No routine maintenance

DF868
Fixed-installation ultrasonic liquid flowmeter

- Low installation cost
- Wide variation in pipe size or material
- Low ownership cost
- Industry certification

PACE Series
Pneumatic pressure controllers

- High accuracy
- High speed pressure control
- Flexible modular construction
- Intuitive icon task driven menu structure

PACE Series
Precision pressure indicator

- Up to 3 pressures displayed simultaneously
- Datalogging as standard
- RS232, IEEE connectivity, Ethernet and USB as standard
- Selectable graphical display

RPS 8000
Ultra high accuracy sensors

- 0.01% Precision
- 0.01% Stability
- Pressure ranges to 70 bar
- Barometric options

Level Sensor Accessories

For many years, GE Measurement & Control has supplied high quality submersible sensors for applications in the worldwide water industry. GE has a range of special accessories to complement both past and present submersible sensors. The accessories provide a complete system solution, easing problems in installation and maintenance. These new accessories are compatible with the following submersible sensors.

Submersible Level Sensors

Model	Sensor Type
PTX 1290	- 30 mm titanium sensor
PDCR 1830	- 17.5 mm titanium sensor
PTX 1730	- 17.5 mm stainless steel sensor
PTX 1830	- 17.5 mm titanium sensor
UNIK 5000	- 25 mm stainless steel sensor

STE Sensor Termination Enclosure

This sealed 'junction box' receives the special 'vented' type sensor cable from a GE sensor and connects to a less expensive, non-vented, proprietary sourced instrument cable. It allows barometric reference pressure to enter the enclosure while providing a block to water/humidity entering and condensing in the assembly. A desiccant pack is included which keeps the 'junction box' dry.

Cable Clamp

In many surface and ground water applications there has been no easy or cost-effective way to hold a sensor cable at the water exit point, until now. This clamp secures a sensor cable and prevents the vent tube in the sensor cable from becoming constricted. The slide mechanism of the cable clamp makes installation an easy task.

Calibration Adaptors

A regular calibration check is essential to meet local or national quality practices. This requires a level sensor to have a known pressure applied and the output measured. In the field, a portable calibrator can be used with one of the new calibration adaptors to carry out a calibration check.

Sink Weights

Many submerged sensor applications require additional weight to prevent incorrect datum reference due to 'cable snake'. The old solution of strapping lead weights to the cable boot can damage the sensor cable.

GE's solution attaches sink weights directly to the sensor. These sink weights match the diameter of the sensor and screw into the front of the sensor. Radial holes around the sensing diaphragm area provide accurate measurement with continuous water circulation, maintaining cleanliness.

Parts List

When ordering, please refer to this Accessories Parts List, and specify the part number required.

Part Number	Description
202-034-03	STE Sensor Termination Enclosure
600-914	STE Desiccant Silica Gel pack
410-A001 (US only)	STE Desiccant Silica Gel pack
DA2608-1-01	Slimline Sink Weight 17.5 mm – 1830/UNIK 5000 (*PJ)
222-116-01	Slimline Sink Weight 17.5 mm – 1730/UNIK 5000 (*PA, PW)
DA4068-1-01	Short Sink Weight 25.4 mm – 1830/UNIK 5000 (*PJ)
222-117-01	Short Sink Weight 25.4 mm – 1730/UNIK 5000 (*PA, PW)
192-373-01	Cable Clamp System
DA2537-1-01	Economical G1/8 Pressure adaptor– 1830 to DPI620
DA2536-1-01	Economical G1/8 Pressure adaptor– 1730 to DPI620
222-127-01	1830 Nose Cone
222-112-01	1730 Nose Cone

**Compatible UNIK 5000 Pressure connector options (PA, PJ, PW)*

www.ge-mcs.com

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9.4.2 1830/1840 Series – Druck High Performance Level Pressure Sensors

(4 pages)

GE
Sensing

Features

- Ranges from 0.75 mH_2O to 600 mH_2O
- Accuracy ±0.06% full scale (FS) best straight line (BSL)
- Fully welded 17.5 mm titanium construction
- Integral lightning surge arrestor
- Polyurethane and hydrocarbon resistant cables
- Full range of installation accessories
- 5 year anti corrosion warranty

The PDCR 1830/1840 transducer (mV output) and PTX 1830/1840 transmitter (4 to 20 mA output) are the latest generation of fully submersible titanium high performance sensors for measurement of hydrostatic liquid levels.

1830/1840 Series

Druck High Performance Level Pressure Sensors

1830/1840 is a Druck product. Druck has joined other GE high-technology sensing businesses under a new name—GE Sensing.

GE
Sensing

Applications

The PDCR/PTX 1830/1840 Series incorporates many enhanced features gained from experience in supplying thousands of sensors for small and large scale installations worldwide. Example applications include:

- Potable water

From ground water borehole to surface water level measurements in rivers, canals and reservoirs.

- Waste water and remediation

Monitoring of secondary and outflow sewage levels within certified hazardous areas and contaminated ground water levels in land fill sites.

- Tank Level

From land based liquid storage vessels to on-board ship ballast tank monitoring within safe and certified hazardous areas, using potable water approved (1830) cable and hydrocarbon resistant (1840) cable.

- Sea Water

Marine environmental applications including tide gauging, coastal flood protection and wave profiling amongst others.

Reliability and Data Quality

The combination of a high technology sensor, together with advanced signal conditioning and packaging techniques, provides an ideal long term solution for reliable, accurate and economical level measurements.

The Druck micromachined silicon element is sealed within an all-titanium pressure module assembly, fully isolated from the pressure media. This is contained in a slimline, welded titanium body, terminated in an injection moulded cable assembly. The cable features a Kevlar® strain cord and is IP68 rated for indefinite immersion in 700 mH_2O, with a selection of cable material to meet the application.

Lightning Surge Protection

An optional integral lightning surge arrestor is available, qualified to the highest standard IEC 61000-4-5 (level 4). This protects the sensor from raised earth potentials caused by lightning strikes, which often occur in surface water applications.

Ease of Use

A simple datum marked cable system is provided for ease of installation. Incremental 1 m datum points are clearly marked for quick and accurate cable alignment below ground level. In addition, a full range of related accessories simplifies installation, operation and maintenance.

- Quick-release cable clamp assembly
- Slimline and short profile sink weights
- Moistureproof Sensor Termination Enclosure
- Pressure test/calibration adaptors

GE
Sensing

1830/1840 Specifications

Pressure Measurement

Operating Pressure Ranges

PDCR 1830/1840 (mV)

0.75, 1.5 mH_2O gauge, 3.5, 7, 10, 15, 20, 35, 50, 70, 100, 150, 200, 350, 600 mH_2O gauge and absolute

PTX 1830/1840 (mA)

Any zero based FS from 0.75 to 600 mH_2O gauge and 3.5 to 600 mH_2O absolute.

Elevated zero, compound and reversed output ranges available. Refer to GE Sensing for further information. Other units may be specified e.g. ftH_2O, inH_2O, bar, mbar, kpa, kg/cm^2

Overpressure

The operating FS pressure range may be exceeded by the following multiples with negligible effect on calibration:

- 8 x for ranges up to 1.5 mH_2O
- 6 x for ranges above 1.5 to 3.5 mH_2O
- 4 x for ranges above 3.5 mH_2O (1400 mH_2O maximum)

Pressure Containment

- 10 x for ranges up to 3.5 mH_2O gauge
- 6 x for ranges above 3.5 mH_2O gauge (1400 mH_2O maximum)
- 200 bar for absolute ranges.

Media Compatibility

Fluids compatible with titanium (body), acetyl (nose cone) and polyurethane or Hytrel® 6108 (cable assembly).

Excitation Voltage

PDCR 1830/1840 (mV)

10 V at 5 mA nominal

Output is fully ratiometric to supply within 2.5 V to 12 V limits.

PTX 1830/1840 (mA)

9 to 30 V

9 to 28 V for Intrinsically Safe version.

The minimum supply voltage (V_{MIN}) which must appear across the pressure transmitter terminals is 9 V and is given by the following equation:

$V_{MIN} = V_{SUP} - (0.02 \times R_{LOOP})$

Where V_{SUP} is supply voltage in Volts, R_{LOOP} is total loop resistance in Ohms

Pulse Power Excitation

Recommended power-on time before output sample

PDCR 1830/1840: 10 ms

PTX 1830/1840: 30 ms

For pulse power operation refer to technical note.

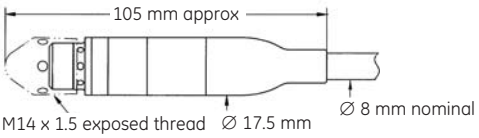
Output Signal

PDCR 1830/1840

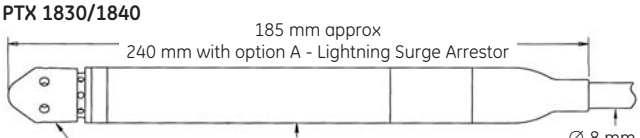
- 25 mV for 0.75 mH_2O range
- 50 mV for 1.5 and 3.5 mH_2O ranges
- 100 mV for ranges 7 mH_2O and above

PTX 1830/1840

PDCR 1830/1840



PTX 1830/1840



Installation drawing

Electrical Connections

PDCR 1830 - Polyurethane cable
PDCR 1840 - Hytrel® 6108 cable

Red:	Supply positive
White:	Supply negative
Yellow:	Output positive
Blue:	Output negative

Screen wire connected to case
(IS version - screen not connected)
Remaining cores not connected

PTX 1830 - Polyurethane cable
PTX 1840 - Hytrel 6108 cable

Red:	Supply positive
Blue:	Supply negative

Screen wire connected to case
(IS version - screen not connected)
Remaining cores not connected

4 to 20 mA proportional, for zero to FS pressure.

Common Mode Voltage - PDCR 1830/1840

Typically +3.5 V to +9 V with respect to the negative supply.

Output Impedance - PDCR 1830/1840

2 kΩ nominal.

Performance Specification

Accuracy

Combined effects of Non-linearity, Hysteresis and Repeatability:

- Standard: ±0.1% FS BSL maximum
- Option D: ±0.06% FS BSL maximum (±0.08% FS BSL maximum for 1 mH_2O and below).

Zero Offset and Span Setting

PDCR 1830/1840

- Typical: ±1.5 mV
- Maximum: ±3 mV

PTX 1830/1840

Maximum: ±0.05 mA

Long-Term Stability

±0.1% FS typically per annum.

Operating Temperature Range

-20 to 60°C (-4 to 140°F)

Compensated Temperature Range

-2 to 30°C.

Temperature Effects

- ±0.3% FS Temperature Error Band (TEB) for 3.5 mH_2O range and above
- ±0.6% FS TEB for ranges below 3.5 mH_2O.

Shock and Vibration

MIL-STD-810E, method 514.4. Category 10 min. Figure 514.4-16

Product will withstand 20 g peak shock half sine wave 9 ms duration in all axes, also 2000 g peak shock 0.5 ms duration in all axes.

GE
Sensing

Insulation
Standard: >100 MΩ at 500 Vdc
Intrinsically Safe version: <5 mA at 500 Vac

Intrinsic Safety (Option B)
PDCR 1830/1840: ATEX: Certified (BAS 02 ATEX 1250X) for use with IS barrier systems to EEx ia IIC T4 (80°C ambient) for cable lengths up to 29 metres
PTX 1830/1840: ATEX: Certified (BAS 01 ATEX 1018X) for use with IS barrier systems to EEx ia IIC T4 (-40°C <= Tamb <= 80°C) for cable lengths up to 300 metres maximum

Physical Specification

Pressure Connection (Option C)
Standard: Radial holed M14 x 1.5 mm male thread fitted with protective acetyl nose cone.
Option C: Screw on welded male pressure connection available
G1/8B (60° Int cone)
G1/4B (60° Int cone or flat end)
1/4 NPT
7/16 UNF to M533656-4

Electrical Connection
1830: Vented polyurethane cable with integral Kevlar® strain relief cord rated to 54 kg load. Water ingress protection IP68 to 700 mH_2O.
1840: Vented Hytrel® 6108 cable (hydrocarbon resistant) with integral Kevlar® strain relief cord rated to 54 kg load. Water ingress protection IP68 to 700 mH_2O.

Cable Lengths
To be specified as required in 1 metre increments up to 500 metres.
For longer lengths refer to GE Sensing.

CE marking
CE marked for electromagnetic compatibility, pressure equipment directive and, for ATEX version only, use in potentially explosive atmospheres.

Documentation
Detailed user instructions are provided with specific calibration data. Supplied in English, French, German, Italian, Spanish or Portuguese. Language selected on order.

Accessories

A full range of accessories is available to enhance installation, operation and maintenance of the 1830/1840 Series as listed below:
- STE moistureproof sensor termination enclosure (202-034-01)
- Slimline sink weight ∅17.5 mm (DA2608-1-01)
- Short sink weight ∅25 mm (DA4068-1-01)
- Cable clamp system (192-373-01)
- 360° Rotatable calibration adaptor to:
  G1/8 (DA4112-1-01) 1/8 NPT (DA4112-2-01)
- Economical direct calibration adaptor to:
  G1/8 (DA2537-1-01) 1/8 NPT (DA2537-2-01)
- Accessory pack contains (S01830E)
  STE box Slimline sink weight
  Cable clamp Direct calibration adaptor

Options

(A) Lightning Surge Arrestor (PTX 1830/1840 only)
Integral lightning protection assembly certified to standard IEC 61000-4-5 (level 4).
(B) Intrinsically Safe Version
(C) Alternative Pressure Connection
In place of the standard acetyl nose cone, a welded male pressure connection can be supplied.
(D) Improved Accuracy
An improved accuracy of ±0.06% FS BSL is available (±0.08% FS BSL for ranges below 1 mH_2O (1.5 psi))

Ordering Information

Please state the following:
(1) Select model number
(2) Pressure range and scale units
(3) Options (if required)
(4) Cable length required
(5) Accessories (order as separate items).
(6) Supporting Services (order as separate items)

Code	Model
PDCR18	mV output
PTX 18	mA output

Code	Cable type
3	Polyurethane
4	Hytrel® 6108

Code	Not used
0	

____ - __ - __

Supporting Services

Our highly trained staff can support you, no matter where you are in the world. We can provide training, nationally accredited calibration - both initially and at periodic intervals - extended warrantee terms and even rental of portable or laboratory calibrators. Further details can be found in www.gesensing.com/productservices/service.htm

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9.4.3 1730 Series – Druck Stainless Steel Level Pressure Sensors

(4 pages)

GE
Sensing

Features

- Ranges from 5 to 900 psi
- Accuracy ±0.25% full scale (FS) best straight line (BSL)
- Fully welded 0.69 in 316 stainless steel construction
- Pulse power operation
- Polyurethane cable
- Full range of installation accessories

The PDCR 1730 transducer (mV output) and PTX 1730 transmitter (4 to 20 mA output) are the latest generation of fully submersible, 316 stainless steel, high performance sensors for measurement of hydrostatic liquid levels.

Application specific features include a Kevlar® strain relieved vented cable, internal condensation protection and an IP68 injection moulded cable assembly, which ensures sensor operation over an extended lifetime.

1730 Series

Druck Stainless Steel Level Pressure Sensors

1730 is a Druck product. Druck has joined other GE high-technology sensing businesses under a new name—GE Sensing.

GE
Sensing

1730 Specifications

Pressure Measurement

Operating Pressure Ranges
PDCR 1730 (mV)/PTX 1730 (mA)
5, 10, 15, 20, 30, 50, 75, 100, 150, 300, 500, 900 psi gauge

Overpressure
The operating FS pressure range can be exceeded by the following multiples with negligible effect on calibration.
- 4 x for 5 psi range
- 2 x for ranges 10 to 900 psi

Pressure Containment
- 10 x for 5 psi range
- 4 x for ranges up to 900 psi (2000 psi maximum)

Media Compatibility
Fluids compatible with 316 stainless steel, polyurethane (cable) and EPDM (nose cone).

Excitation Voltage
PDCR 1730 (mV)
10 V at 1 mA nominal
Output is fully ratiometric to supply within 2.5 V to 12 V limits.
PTX1730 (mA)
9 to 30 VDC across terminals

For pulse power operation refer to technical note.

The minimum supply voltage (V_{MIN}) which must appear across the pressure transmitter terminals is 9 V and is given by the following equation:
$V_{MIN} = V_{SUP} - (0.02 \times R_{LOOP})$
Where V_{SUP} is supply voltage in Volts, R_{LOOP} is total loop resistance in Ohms

Output Signal
PDCR 1730
- 50 mV for 5 psi range
- 100 mV for ranges 10 psi and above

PTX 1730
4 to 20 mA proportional for zero to FS pressure

Common Mode Voltage - PDCR 1730
Nominally 50% of excitation voltage

Output Impedance - PDCR 1730
5 kΩ nominal

Performance Specification

Accuracy
Combined effects of Non-linearity, Hysteresis and Repeatability: ±0.25% FS BSL max

Zero Offset & Span Setting
PDCR 1730
Typical: ±1.5 mV
Maximum: ±3 mV
PTX 1730
Maximum: ±0.1 mA

Long-Term Stability
±0.2% FS typical per annum

Operating Temperature Range
-4 to 140°F (-20 to 60°C)

Compensated Temperature Range
30 to 85°F (-1 to 30°C)

Temperature Effects
±0.5% FS Temperature Error Band (TEB)

Shock and Vibration
MIL-STD-810E, method 514.4. Category 10 min. integrity. Figure 514.4-16
Product will withstand 20 g peak shock half sine wave ms duration in all axes,

Insulation
Greater than 100 MΩ at 500 VDC

GE
Sensing

1730 Specifications

Physical Specification

Pressure Connection
G1/4 (female) with recessed open face diaphragm, fitted with protective EPDM nose cone.

Electrical Connection
Vented polyurethane cable with integral Kevlar® strain relief cord rated to 200 lb load. Water ingress protection IP68 to 1000 psi.

Cable Lengths
Variable cable lengths available from 3 to 1900 ft.

CE marking
CE marked for electromagnetic compatibility and pressure equipment directive.

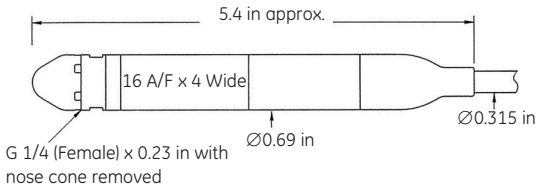
Documentation
Statement of conformity and installation notes supplied as standard.

Accessories

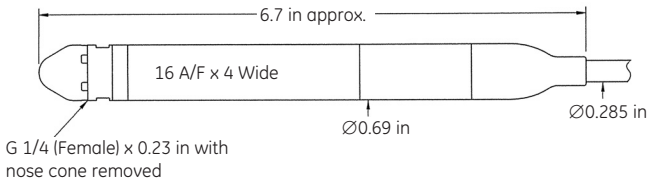
A full range of accessories is available to enhance installation, operation and maintenance of the 1730 Series as listed below:

- STE moistureproof sensor termination enclosure (202-034-01)
- Slimline sink weight Ø0.69 in (222-116-01)
- Short sink weight Ø1 in (222-117-01)
- Cable clamp system (192-373-01)
- 360° rotatable calibration adaptor to:
  - G1/8 (DA4112-3-01)
  - 1/8 NPT (DA4112-4-01)
- Economical direct calibration adaptor to:
  - G1/8 (DA2536-1-01)
  - 1/8 NPT (DA2536-2-01)

PDCR 1730



PTX 1730



Electrical Connections

PDCR 1730 - Polyurethane cable

Red:	Supply positive
White:	Supply negative
Yellow:	Output positive
Blue:	Output negative

Screen wire connected to case
Remaining cores not connected

PTX 1730 - Polyurethane cable

Red:	Supply positive
Black:	Supply negative

Screen wire connected to case
Remaining cores not connected

Ordering Information

Please state the following:
(1) Model PDCR 1730 (mV) or PTX 1730 (mA)
(2) Pressure range and scale units
(3) Cable length required
(4) Accessories (order as separate items).
(5) Supporting Services (order as separate items)

Supporting Services

Our highly trained staff can support you, no matter where you are in the world. We can provide training, nationally accredited calibration - both initially and at periodic intervals - extended warranty terms and even rental of portable or laboratory calibrators. Further details can be found in www.gesensing.com/productservices/service.htm

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PTX-1290 Series – Druck Wastewater Submersible Pressure Transmitters

Page 2 of 2

GE
Sensing

Features

- Flush, PTFE-coated elastometric diaphragm
- All-titanium construction
- Accuracy: ±0.25% full scale (FS) best straight line (BSL)
- Intrinsically safe approval
- Outputs: 4 to 20 mA
- Submersible with vented polyurethane cable

The PTX 1290 Series submersible/depth pressure transmitter is specifically designed for wastewater and pump/lift station applications. The all-titanium construction assures excellent life in the most hostile environments, including corrosive and hazardous chemical applications.

The PTX 1290 Series pressure transmitter technology is based on Druck's field proven submersible sensors with the exception of the pressure port which is equipped with a flush PTFE-coated elastometric diaphragm that reduces the likelihood of grease or biosolids buildup.

An advanced micro-machined silicon piezoresistive pressure sensor provides excellent performance and resistance to shock and vibration. A tough, polyurethane cable is moulded to the transducer body, providing a high integrity, waterproof assembly. The cable is strengthened with Kevlar® so that there is no measurable elongation when the cable is lowered into deep wells.

The fully isolated, all-titanium design ensures long term reliable measurements in water and wastewater management, industrial, process and marine applications.

PTX 1290 Series

Druck Wastewater Submersible Pressure Transmitter

PTX 1290 Series is a Druck product. Druck has joined other GE high–technology sensing businesses under a new name—GE Industrial, Sensing.

GE
Sensing

PTX1290 Specifications

Pressure Measurement

Operating Ranges
Any range from 1.75 mH_2O to 15 mH_2O

Overpressure
The operating pressure range may be exceeded with negligible effect on calibration by
4x FS for ranges ≤ 7 mH_2O
2x FS for ranges > 7 mH_2O (28 mH_2O Maximum)

Pressure Media
Fluids compatible with Titanium, PTFE-coated nitrile rubber and Polyurethane

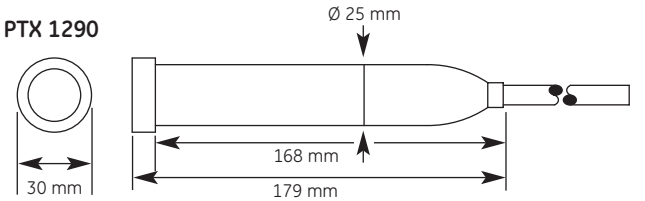
Excitation Voltage
9 to 28 Vd.c.

The minimum supply voltage (V_{MIN}) which must appear across the pressure transmitter is 9V and is given by the following equation:-
$V_{MIN} = V_{SUP} - (0.02 \times R_{LOOP})$

Output Signal
4 to 20 mA

Performance

Accuracy
Combined effects of non-linearity, hysteresis and repeatability ±0.25% FS BSL



Electrical Connection
Red__Positive supply
Blue__Negative supply
Shield__Not connected to case

Installation Drawings

Zero offset and Span Setting
Maximum ±0.1 mA

Long Term Stability
Maximum 0.2% FS per annum

Operating Temperature Range
-20 to 60 ºC

Compensated Temperature Range
-2 to 30 ºC

Temperature Effects
±1.5% FS for ranges above 7 mH_2O increasing prorata for ranges below 7 mH_2O

Insulation
500 Va.c. ≤ 5 mA tested for 1 minute

Intrinsically Safe
Certified (BAS 01ATEX1018X) for use with IS barrier systems to EEx ia IIC T4 (-40 ≤ T_{amb} ≤ 80ºC) for cable lengths to 300m maximum

CE Marking
CE marked for electromagnetic compatibility, pressure equipment directive and potentially explosive atmospheres

Physical

Electrical Connection
Vented Polyurethane cable with integral Kevlar strain relief cord rated to 54 kg load. Water Ingress protection IP68 to 700 mH_2O

Cable Lengths
To be specified as required in 1 m increments

Weight
140 g nominal (excluding cable)

Caution
Do not remove the retaining ring that holds the elastometric diaphragm in place. This will void the calibration and could result in loss of the silicone pressure transfer compound.

Ordering Information

1) Model number
2) Pressure range
3) Cable length

Please order accessories as separate items

920-104C

CE

www.ge.com/sensing

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9.4.5 UNIK5000 Pressure Sensing Platform (5032 Models are Submersibles)

(8 pages)

GE
Measurement & Control

UNIK 5000

Pressure Sensing Platform

The new UNIK 5000 is a high performance configurable solution to pressure measurement. The use of Druck silicon technology and analogue circuitry enables best in class performance for stability, low power and frequency response. The new platform enables you to easily build up your own sensor to match your own precise needs. This high performance, configurable solution to pressure measurement employs modular design and lean manufacturing techniques to offer:

High Quality

With 35 years of pressure measurement experience, our field-proven Druck silicon technology is at the heart of the new platform, resulting in a range of high quality, high stability pressure sensors.

Bespoke as Standard

Custom-built from standard components, manufacturing sensors to your requirement is fast and simple; each UNIK 5000 is a "bespoke" pressure sensing solution, but with the short lead times and competitive pricing you would expect from standard products.

Expertise

We have the people and the knowledge to support your needs for accurate and reliable product performance; our team of experts can help you make the right sensor selection, guiding you and providing the help and tools you need. It is important to ensure that the sensor material and performance selected are suitable for your application.

Features

- Ranges from 70 mbar (1 psi) to 700 bar (10,000 psi)
- Accuracy to ±0.04% Full Scale (FS) Best Straight Line (BSL)
- Stainless Steel construction
- Frequency response to 3.5 kHz
- High over pressure capability
- Hazardous Area certifications
- mV, mA, voltage and configurable voltage outputs
- Multiple electrical & pressure connector options
- Operating temperature ranges from –55 to 125°C (-67 to 257°F)

5000 Specifications

Measurement

Operating Pressure Ranges

Gauge ranges

Any zero based range between 70 mbar and 70 bar (1 to 1,000 psi) (values in psi are approximate)

Sealed Gauge Ranges

Any zero based range between 10 and 700 bar (145 to 10,000 psi)

Absolute Ranges

Any zero based range between 100 mbar and 700 bar (1.5 to 10,000 psi)

Differential Ranges

Wet/Dry

Uni-directional or bi-directional 70 mbar to 35 bar (1 to 500 psi)

Wet/Wet

Uni-directional or bi-directional 350 mbar to 35 bar (5 to 500 psi)

Line pressure: 70 bar max (1000 psi)

Barometric Ranges

Barometric ranges are available with a minimum span of 350 mbar (5.1 psi)

Non Zero Based Ranges

Non zero based ranges are available. Please contact GE Sensing to discuss your requirements

Over Pressure

- 10 × FS for ranges up to 150 mbar (2 psi)
- 6 × FS for ranges up to 700 mbar (10 psi)
- 2 × FS for barometric ranges
- 4 × FS for all other ranges (up to 200 bar for ranges ≤70 bar and up to 1200 bar for ranges >70 bar)

For differential versions the negative side must not exceed the positive side by more than:

- 6 × FS for ranges up to 150 mbar (2 psi)
- 4 × FS for ranges up to 700 mbar (10 psi)
- 2 × FS for all other ranges up to a maximum of 15 bar (200 psi)

Containment Pressure

Ranges up to 150 mbar (2 psi) gauge 10 x FS
Ranges up to 70 bar (1000 psi) gauge 6 x FS
(200 bar (2900 psi) max)
Ranges up to 70 bar (1000 psi) absolute
200 bar (2900 psi)
Ranges above 70 bar (1000 psi)
1200 bar (17400 psi)

Differential (-ve port) must not exceed positive port by more than 6 × FS (15 bar (200 psi) maximum)

Supply and Outputs

Electronics Option	Description	Supply voltage (V)	Output	Current Consumption (mA)
0	mV Passive	2.5 to 12	10 mV/V^	<2 at 10 V
1	mV Linearised	7 to 12	10 mV/V^	<3
2	mA	7 to 28**	4-20 mA	<30
3	0 to 5 V 4-wire	7 to 16**	0 to 5 V	<3
4	0 to 5 V 3-wire	7 to 16**	0 to 5 V*	<3
5	1 to 6 V 3-wire	7 to 16**	1 to 6 V	<3
6	0 to 10 V 4-wire	12 to 16**	0 to 10 V	<3
7	0.5 to 4.5 V Ratiometric	5.0 ± 0.5	0.5 to 4.5 V	<3
8	Isolated/Configurable (4 wire)	7 to 36	See below	See below
9	Configurable (3 wire)	7 to 36	See below	See below

^ with a 10 volt supply mV output sensors give 100 mV over the full scale pressure.
- Output is ratiometric to the supply voltage
- Output reduces pro-rata for pressure ranges below 350 mbar (5 psi)

*0 to 5 V 3-wire output is non true zero. At pressures below 1% of span the output will be fixed at approximately 50 mV
**7 to 32 V in non-hazardous area operation

Isolated/Configurable (Option 8) or Configurable (Option 9)

Any pressure signal output configurations will be available, subject to the following limitations:

- Minimum span: 2 V
- Maximum span: 20 V
- Output limits: ±10 V
- Maximum zero offset: ± span
- Output voltage range can be specified to a resolution of 0.1 V

Reverse output response to pressure is available.
The output will continue to respond to 110% FS. i.e. if a 0 to 10 V output is specified, the output will continue to increase proportionally to applied pressure until at least 11 V.
Current consumption is <20 mA @ 7 Vdc supply, reducing to <5 mA @ 32 Vdc supply. On startup <100 mA drawn for 10 ms typically.
Shunt calibration: not available with reverse output.
Note: Restricted to 80°C (176°F) for these options.

Examples

Allowed	Not Allowed
-10 to 0 V	0 to 12 V (outside ±10 V limits)
0 to 5 V	6 to 10 V (offset too big)
-5 to +5 V	0 to 0.5 V (span too small)
-2 to 10 V	
1 to 6 V	
10 to 0 V	

Power-Up Time

- mV, Voltage and current versions: 10 ms
- Isolated/configurable version: 500 ms

Insulation

- 500 Vdc: 100 MΩ
- 500 Vac: ≤ 5 mA leakage current (mV and mA versions only).

Shunt Calibration

Shunt Calibration provides a customer accessible connection which, when applied, causes a shift in output of 80% FS in order to simulate applied pressure.
It is fitted to the mV and Isolated/Configurable versions as standard. It is not available with DIN or M12 x 1 electrical connectors. (options 7, D and G)

Shunt calibration is activated in different ways depending on the electrical connector and version:

- mV versions: connect Shunt Cal to -ve Supply or, where available, connect both Shunt Cal connections together.
- Isolated/Configurable version: connect Shunt Cal to -ve Output or, where available, connect both Shunt Cal connections together.

Note: Not available with reverse output.

Performance Specifications

There are three grades of performance specification: Industrial, Improved and Premium

Accuracy

Voltage, Current and mV Linearised

Combined effects of non-linearity, hysteresis and repeatability:

Industrial:	±0.2% FS BSL
Improved:	±0.1% FS BSL
Premium:	±0.04% FS BSL

mV Passive

≤ 70 bar

Industrial/Improved:	±0.2% FS BSL
Premium not available	

> 70 bar

Industrial/Improved:	±0.5% FS BSL
Premium not available	

Note: For the barometric pressure range, accuracy is of span, not full scale.

Zero Offset and Span Setting

Demountable electrical connector options allow access to potentiometers that give at least ±5% FS adjustment (see Electrical Connector section)

Factory set to:

Product Description	Industrial	Improved and Premium
Current and Voltage Versions (Demountable Electrical Connections and Cable Gland)	±0.5% FS	±0.2% FS
Current and Voltage Versions (All Other Electrical Connections)	±1.0% FS	±1.0% FS
mV Versions	±3.0 mV	±3.0 mV

Long Term Stability

±0.05% FS typical (±0.1% FS maximum) per year increasing pro-rata for pressure ranges below 350 mbar

General Certifications

RoHS 2002/95/EC
CRN Certified 0F13650.513467890YTN for pressure ranges up to and including 350 bar (5000 psi)

CE Conformity

Pressure Equipment Directive 97/23/EC
ATEX 94/9/EC (Optional)
EMC Directive 2004/108/EC

BS EN 61000-6-1: 2007	Susceptibility - Light Industrial
BS EN 61000-6-2: 2005	Susceptibility - Heavy Industrial (except mV versions)
BS EN 61000-6-3: 2007	Emissions - Light Industrial
BS EN 61000-6-4: 2007	Emissions - Heavy Industrial
BS EN 61326-1: 2006	Electrical Equipment for Measurement, Control and Laboratory Use
BS EN 61326-2-3: 2006	Particular requirements for pressure transducers

Hazardous Area Approvals (optional)

General applications	• IECEx/ATEX Intrinsically Safe 'ia' Group IIC • FM Approved (Canada & US) Intrinsically Safe Exia Class I, Division 1, Groups A, B, C & D and Class I, Zone 0 AEx/Ex ia Group IIC; Single Seal
Mining applications	• IECEx/ATEX Intrinsically Safe 'ia' Group I

For full certification details, refer to the type-examination certificates (or approval listings) and Hazardous Area Installation Instructions.

Temperature Effects

Four compensated temperature ranges can be chosen.
Industrial Accuracy performance:

-10 to +50 °C (14 to +122 °F):	±0.75% FS Temperature error band (TEB)
-20 to +80 °C (-4 to 176 °F):	±1.5% FS TEB
-40 to +80 °C (-40 to 176 °F):	±2.25% FS TEB
-40 to +125 °C (-40 to 257 °F):	±2.25% FS TEB

Improved and Premium Accuracy performance:

-10 to +50 °C (14 to +122 °F):	±0.5% FS TEB
-20 to +80 °C (-4 to 176 °F):	±1.0% FS TEB
-40 to +80 °C (-40 to 176 °F):	±1.5% FS TEB
-40 to +125 °C (-40 to 257 °F):	±1.5% FS TEB

Temperature effects increase pro-rata for pressure ranges below 350 mbar (5 psi) and are doubled for barometric ranges.

Line Pressure Effects (Differential Version Only)

Zero shift: <±0.03% span/bar of line pressure
Span shift: <±0.03% span/bar of line pressure
Effects increase pro-rata for differential pressure ranges below 700 mbar (10 psi).

Physical Specifications

Environmental Protection

- See Electrical Connector section
- Hyperbaric Pressure: 20 bar (300 psi) maximum

Operating Temperature Range

See Electrical Connector section

Pressure Media

Fluids compatible with Stainless Steel 316L and Hastelloy C276.
For the wet/dry differential version, negative pressure port: fluid compatible with stainless steel 316L, stainless steel 304, pyrex, silicon and structural adhesive.

Enclosure Materials

Stainless steel (body), nitrile- or silicone-rubber (o-rings, gaskets), EPDM (gaskets, depth cone), PTFE (vent filter), Nickel plated brass (lock rings), glass filled nylon (electrical connector assemblies), delrin (depth cone). Cable sheaths as specified (see Electrical Connector).

Pressure Connector

Available options are

- G1/4 Female*
- G1/4 Male Flat
- G1/4 Male 60° Internal Cone
- G1/4 Male Flat Long
- G1/4 Male Flat with Snubber
- G1/4 Male Flat with Cross Bore Protection
- G1/4 Quick Connect
- G1/8 Male 60° Internal Cone
- G1/2 Male via Adaptor*
- 1/4 NPT Female*
- 1/4 NPT Male
- 1/8 NPT Male
- 1/2 NPT Male via Adaptor
- 7/16-20 UNF Female
- 7/16-20 UNF Male Short Flat
- 7/16 UNF Long 37° Flare Tip
- 7/16-20 UNJF Male 74° External Cone
- 3/8-24 UNJF
- 1/4 Swagelok Bulkhead
- M10 X 1 80° Internal Cone
- M12 X 1 60° Internal Cone
- M14 X 1.5 60° Internal Cone
- M20 X 1.5 Male
- Depth Cone (G1/4 Female Open Face)
- M12 x 1.0 74° External Cone
- Quick Release Male
- VCR Female
- VCR Male

Choose connectors marked * for pressure ranges over 70 bar. Other pressure connectors may be available, contact GE to discuss your requirement.

Electrical Connector

Various electrical connector options are available offering different features:

Code Number	Description	Max Operating temp range °C	Max Operating temp range °F	IP rating	Zero span Adjust
0	No Connector	-55 to +125	-67 to +257	-	Y
1	Cable Gland	-40 to +80	-40 to +176	65	N
2	Raychem Cable	-55 to +125	-67 to +257	65	N
3	Polyurethane Depth	-40 to +80	-40 to +176	68	N
4	Hytrel Depth	-40 to +80	-40 to +176	68	N
6/E	Bayonet MIL-C-26482	-55 to +125	-67 to +257	67	N
7	DIN 43650 Form A Demountable	-40 to +80	-40 to +176	65	Y
A/F	Bayonet MIL-C-26482 Demountable	-55 to +125	-67 to +257	65	Y
C	1/2 NPT Conduit	-40 to +80	-40 to +176	65	N
D	Micro DIN (9.4 mm pitch)	-40 to +80	-40 to +176	65	N
G	M12x1 4pin	-55 to +125	-67 to +257	67	N
K	Zero Halogen Cable Demountable	-40 to +80	-40 to +176	65	Y
M	Tajimi R03-R6F	-25 to +85	-13 to +185	65	N

Note: Electronics output options 8 and 9 are restricted to a maximum operating temperature of 80°C (176°F).
Note: Hazardous area approved versions are restricted to a maximum operating temperature range of -40°C to 80°C (-40°F to 176°F).

Electrical Connector

Connector Type	Option code		Electronics Option					
			4 to 20 mA	Voltage (3-wire)	Voltage (4-wire)	Isolated/ Configurable	Configurable (3-wire)	mV
Molex	0	1 Red	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		2 Yellow	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		3 Green	-	-	-ve Output	-ve Output	0V common	-ve Output
		4 Blue	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		5 Orange	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		6 Black	Case	Case	Case	Case	Case	-
Cable (Not Raychem)	1, 3, 4, C	Red	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		Yellow	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		Blue	-	-	-ve Output	-ve Output	0V common	-ve Output
		White	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		Orange	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		Black	-	-	-	-	-	-
		Screen	-	-	-	-	-	-
Raychem Cable	2	Red	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		White	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		Green	-	-	-ve Output	-ve Output	0V common	-ve Output
		Blue	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		Black	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		Screen	-	-	-	-	-	-
Bayonet	6, A	A	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		B	-ve Supply	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		C	-	-	-ve Output	-ve Output	0V common	-ve Output
		D	-	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		E	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		F	-	-	-	-	-	Shunt Cal
DIN A Micro DIN	7 D	1	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		2	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		3	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		E	Case	Case	-ve Output	-ve Output	0V common	-ve Output
Bayonet Alternative Wiring Options	E, F	A	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		B	-	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		C	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		D	-ve Supply	-	-ve Output	-ve Output	0V common	-ve Output
		E	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		F	-	-	-	Shunt Cal	Shunt Cal	-
M12 X 1 4-Pin	G	1	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		2		+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		3	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		4	Case	Case	-ve Output	-ve Output	0V common	-ve Output
Zero Halogen Cable (Demountable)	K	Pink	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		White	-	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		Green	-	-	-ve Output	-ve Output	0V common	-ve Output
		Blue	-ve Supply	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		Grey	-	-	-	Shunt Cal	Shunt Cal	Shunt Cal
		Brown	-	-	-	-	-	-
		Yellow	-	-	-	-	-	-
		Screen	-	-	-	-	-	-
Tajimi R03-R6F	M	A	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply	+ve Supply
		B	-	0V common	-ve Supply	-ve Supply	0V common	-ve Supply
		C	-ve Supply	Case	Case	Case	Case	-
		D	-	-	-ve Output	-ve Output	0V common	-ve Output
		E	Case	+ve Output	+ve Output	+ve Output	+ve Output	+ve Output
		F	-	-	Shunt cal	Shunt cal	Shunt Cal	Shunt cal

Ordering Information

See the online configuration tool at www.unik5000.com

(1) Select model number

Main Product Variant

PMP Amplified Pressure Transducer
PDCR mV Pressure Transducer
PTX 4-20 mA Pressure Transmitter

Product Series

5 UNIK 5000

Diameter and Material

0 25mm Stainless Steel

Electrical Connector Note 6

0 No Electrical Connector **Note 7**
1 Cable Gland (Polyurethane Cable)
2 Raychem Cable
3 Polyurethane Cable (Depth)
4 Hytrel Cable (Depth)
6 MIL-C-26482 (6-pin Shell Size 10) (Mating connector not supplied)
7 DIN 43650 Form A Demountable (Mating connector supplied)
A Demountable MIL-C-26482 (6-pin Shell Size 10) (Mating connector not supplied)
C 1/2" NPT Conduit (Polyurethane cable)
D Micro DIN (9.4 mm Pitch) (Mating connector supplied)
E MIL-C-26482 (6 pin Shell Size 10) Alternative Wiring (Mating connector not supplied)
F Demountable MIL-C-26482 (6 pin Shell Size 10) Alternative Wiring (Mating connector not supplied)
G M12 x 1 4-pin male (Mating connector not supplied)
K Zero Halogen Cable Demountable
M Tajimi R03-R6F

Electronics Option

0 mV Passive 4-wire (PDCR) **Note 1**
1 mV Linearised 4-wire (PDCR)
2 4 to 20 mA 2-wire (PTX)
3 0 to 5 V 4-wire (PMP)
4 0 to 5 V 3-wire (PMP)
5 1 to 6 V 3-wire (PMP)
6 0 to 10 V 4-wire (PMP)
7 0.5 to 4.5 V Ratiometric 3-wire (PMP) **Note 5**
8 Isolated/Configurable 4-wire (PMP) **Note 4, 5**
9 Configurable 3-wire (PMP) **Note 4, 5**

Compensated Temperature Range

TA -10 to +50 °C (14 to +122 °F)
TB -20 to +80 °C (-4 to +176 °F
TC -40 to +80 °C (-40 to +176 °F)
TD -40 to +125 °C (-40 to +257 °F) **Note 2, 5**

Accuracy

A1 Industrial
A2 Improved
A3 Premium

Calibration

CA Zero/Span Data
CB Room Temperature
CC Full Thermal

Hazardous Area Approval Note 6

H0 None
H1 IECEx/ATEX Intrinsically Safe 'ia' Group IIC
H2 IECEx/ATEX Intrinsically Safe 'ia' Group I
H6 FM (C & US) Intrinsically Safe 'ia' Group IIC/ABCD
HA IECEx/ATEX Intrinsically Safe 'ia' Groups I/IIC [H1 + H2]
HS IECEx/ATEX/FM (C & US) Intrinsically Safe 'ia' Groups IIC/ABCD [H1 + H6]

Pressure Connector

PA G1/4 Female **Note 3**
PB G1/4 Male Flat
PC G1/4 Male 60° Internal Cone
PD G1/8 Male 60° Internal Cone
PE 1/4 NPT Female **Note 3**
PF 1/4 NPT Male
PG 1/8 NPT Male
PH M20x1.5
PJ M14x1.5 60° Internal Cone
PK M12x1 Internal Cone
PL 7/16-20 UNJF Male 74° External Cone
PN G1/2 Male via Adaptor **Note 3**
PQ G1/4 Quick Connect
PR 1/2 NPT Male via adaptor **Note 3**
PS 1/4 Swagelok Bulkhead
PT G1/4 Male Flat Long
PU 7/16-20 UNF Long 37° flare tip
PV 7/16-20 UNF Female
PW Depth Cone (G1/4 Female open face)
PX 7/16-20 UNF Male Short Flat
PY 3/8-24 UNJF
PZ M10 x 1 80° Internal Cone
RA VCR Female
RB G1/4 Male Flat with Snubber
RC G1/4 Male Flat with Cross Bore Protection
RD M12 x 1.0 74° External Cone
RE Quick Release Mount
RF VCR Male

PTX	**5**	**0**	**7**	**2**	**-**	**TA**	**-**	**A2**	**-**	**CB**	**-**	**H0**	**-**	**PA**	**Typical Model Number**

Ordering Notes

Note 1 Premium Accuracy is not available on this version
Note 2 Please ensure that the electrical connector selected is option 0, 2, 6, A, E, F or G.
Note 3 Select one of these pressure connectors for pressure ranges over 70 bar
Note 4 Max operating temperature is 80°C (176°F)
Note 5 Hazardous area certifications not available
Note 6 Hazardous area certifications are restricted by electrical connector options in line with the following table:

	Connector										
Approval	0	1	2	3	4	6/E	7	A/F	C	D	G
H1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
H2	Y	-	Y	Y	Y	Y	-	-	Y	-	Y
H6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
HA	Y	-	Y	Y	Y	Y	-	-	Y	-	Y
HS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note 7 Has component certification and must be incorporated into certified apparatus with an IP rated enclosure appropriate to the certification type supplied.

2) State pressure range and units: e.g. 0 to 10 bar, -5 to + 5 psi

Unit options are:

Symbol	Description
bar	bar
mbar	millibar
psi	pounds/sq. inch
Pa	Pascal
hPa	hectoPascal
kPa	kiloPascal
MPa	MegaPascal
mmH_2O	mm water
cmH_2O	cm water
mH_2O	metres water
inH_2O	inches water
ftH_2O	feet water
mmHg	mm mercury
inHg	inches mercury
kgf/cm^2	kg force/sq. cm
atm	atmosphere
Torr	torr

3) State Pressure reference: e.g. gauge

Reference options are:

- gauge
- absolute
- barometric
- sealed gauge
- wet/dry differential
- wet/wet differential

4) State cable lengths and units: Integer values only, e.g. 1m cable, 8 ft, minimum length 1 m (3 ft) cable (only required on certain electrical connectors), Maximum cable length 190 m (570 ft)

5) Output options 8 and 9: State voltage output at minimum and maximum pressure: e.g. output –1 to 9 V

Typical order examples:

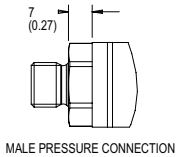
PTX5012-TB-A2-CA-H0-PA, 0 to 10 bar, gauge, 3 m cable
PMP5028-TD-A3-CC-H0-PE, -15 to 75 psi, gauge, 15ft cable, output voltage -1 to 5 volts
PDCR5071-TB-A1-CB-H0-PB, 0 to 100 bar, sealed gauge

Accessories

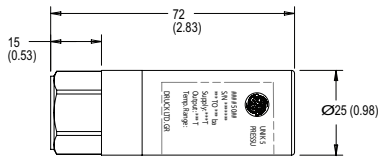
Mating connector for MIL-C-26482 (Electrical connector options 6, A, E and F) under part number S_163-009,

Note: Not considered suitable for use in hazardous areas due to light metals content and low ingress protection (IP) rating.

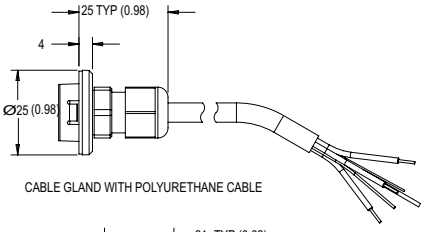
Mechanical Drawings



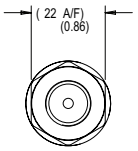
MALE PRESSURE CONNECTION

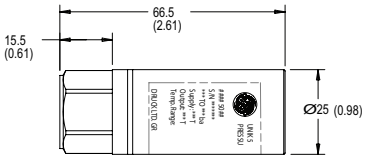


HIGH PRESSURE CONSTRUCTION

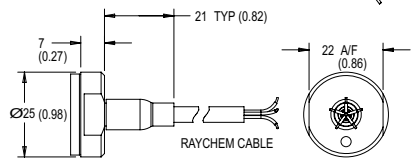


CABLE GLAND WITH POLYURETHANE CABLE

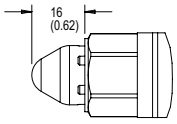




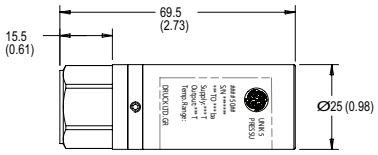
MEDIUM PRESSURE CONSTRUCTION



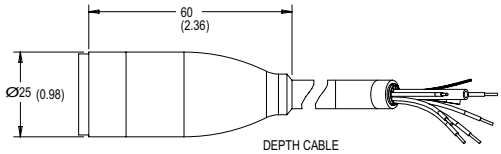
RAYCHEM CABLE



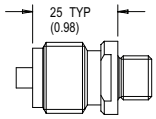
DEPTH CONE PRESSURE ADAPTOR



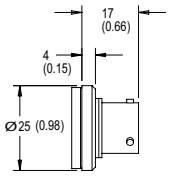
LOW/MEDIUM PRESSURE CONSTRUCTION



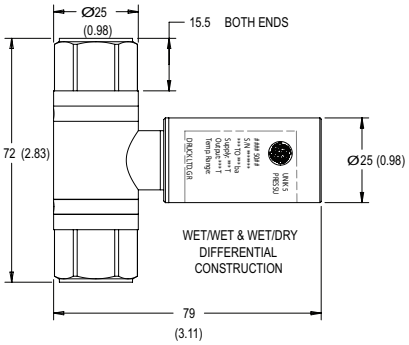
DEPTH CABLE



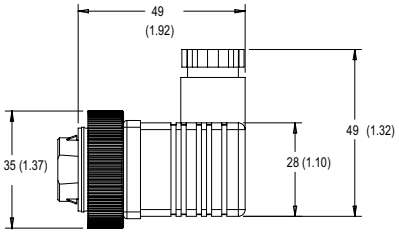
OPTIONAL PRESSURE ADAPTOR



BAYONET MIL-C-26482 NON-DEMOUNTABLE



WET/WET & WET/DRY DIFFERENTIAL CONSTRUCTION



DIN 43650 DEMOUNTABLE

NOTES:

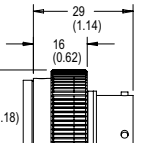
[1] DIMENSIONS SHOWN ARE FOR STANDARD LENGTH PRODUCTS WITH THE FOLLOWING ELECTRICAL OUTPUT OPTIONS:
- mV LINEARISED (PDCR)
- 4 TO 20 mA (PTX)
- STANDARD VOLTAGE OPTIONS (PMP)

FOR mV PASSIVE (PDCR) - SUBTRACT 10mm (0.39 in)
FOR ISOLATED/CONFIGURABLE (PMP) - ADD 15mm (0.59 in)

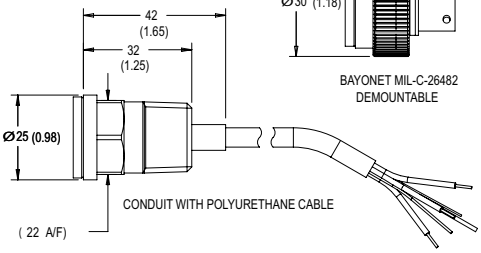
[2] REFER TO PAGE 4 FOR LIST OF PRESSURE CONNECTION OPTIONS (ORIENTATION NOT CRITICAL)

[3] ALL DIMENSIONS ARE IN MILLIMETRES (INCHES IN PARENTHESES)

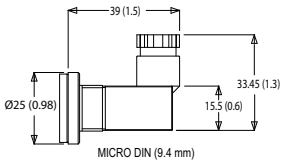
(4) **HIGH PRESSURE IS >70 BAR**
MEDIUM PRESSURE
INDUSTRIAL ACCURACY >1 BAR ≤ 50 BAR
IMPROVED/PREMIUM ACCURACY >2 BAR ≤ 70 BAR
LOW/MEDIUM PRESSURE
INDUSTRIAL ACCURACY ≤ 1 BAR, ≥ 50 BAR TO ≤ 70 BAR
IMPROVED/PREMIUM ACCURACY ≤ 2 BAR, ≥ 50 BAR TO ≤ 70 BAR



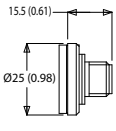
BAYONET MIL-C-26482 DEMOUNTABLE



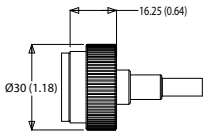
CONDUIT WITH POLYURETHANE CABLE



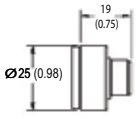
MICRO DIN (9.4 mm)



M12x1 4-PIN



ZERO HALOGEN CABLE DEMOUNTABLE



TAJIMI R03-R6F

www.ge-mcs.com

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9.4.6 UNIK 5600/5700 Marine Certified Pressure Sensing Platform

(8 pages)

GE
Measurement & Control

UNIK 5600/5700

Marine Certified
Pressure Sensing Platform

The new UNIK 5600/5700 carries marine certification for most zones on-board ship, as well as Intrinsically Safe certifications. Marine approval means UNIK 5000 complies with International standards, regulations and Marine Law. The use of Druck silicon technology and analogue circuitry enables best in class performance for stability, low power and high frequency response. The platform enables you to build up your own sensor to match your precise needs. This high performance, configurable solution to pressure measurement employs modular design and lean manufacturing techniques to offer:

High Quality

With 40 years of pressure measurement experience, our field-proven Druck silicon technology is at the heart of the new platform, resulting in a range of high quality, high stability pressure sensors.

Bespoke as Standard

Custom-built from standard components, manufacturing sensors to your requirement is fast and simple; each UNIK 5000 is a “bespoke” pressure sensing solution, but with the short lead times and competitive pricing you would expect from standard products.

Expertise

We have the people and the knowledge to support your needs for accurate and reliable product performance; our team of experts can help you make the right sensor selection, guiding you and providing the help and tools you need.

Features

- Ranges from 70 mbar (1 psi) to 700 bar (10,000 psi) (Depending on material option)
- Accuracy to ±0.04% Full Scale (FS) Best Straight Line (BSL)
- Stainless Steel 316L and Titanium construction options
- Frequency response to 3.5 kHz
- High over pressure capability
- Intrinsically Safe Hazardous Area certification
- mA output
- Multiple pressure connector options
- DIN 43650 electrical connection
- Operating temperature ranges from –25 to 70°C (-13 to

5600/5700 Specifications

Measurement

Operating Pressure Ranges

Gauge ranges
Any zero based range between 70 mbar and 70 bar (1 to 1,000 psi) (values in psi are approximate)

Sealed Gauge Ranges
Any zero based range between 10 and 700 bar (145 to 10,000 psi) (Titanium option limited to 70bar)

Absolute Ranges
Any zero based range between 100 mbar and 700 bar (1.5 to 10,000 psi)
(Titanium option limited to 70bar)

Differential Ranges (Stainless Steel option only)
Wet/Dry
Uni-directional or bi-directional 70 mbar to 35 bar (1 to 500 psi)
Wet/Wet
Uni-directional or bi-directional 350 mbar to 35 bar (5 to 500 psi)
Line pressure: 70 bar max (1000 psi)

Barometric Ranges
Barometric ranges are available with a minimum span of 350 mbar (5.1 psi)

Non Zero Based Ranges
Non zero based ranges are available. Please contact GE to discuss your requirements

Over Pressure
- 10 × FS for ranges up to 150 mbar (2 psi)
- 6 × FS for ranges up to 700 mbar (10 psi)
- 2 × FS for barometric ranges
- 4 × FS for all other ranges (up to 200 bar for ranges ≤70 bar and up to 1200 bar for ranges >70 bar)

For differential versions the negative side must not exceed the positive side by more than:
- 6 × FS for ranges up to 150 mbar (2 psi)
- 4 × FS for ranges up to 700 mbar (10 psi)
- 2 × FS for all other ranges up to a maximum of 15 bar (200 psi)

Containment Pressure
Ranges up to 150 mbar (2 psi) gauge 10 × FS
Ranges up to 70 bar (1000 psi) gauge 6 × FS (200 bar (3000 psi) max)
Ranges up to 70 bar (1000 psi) absolute 200 bar (3000 psi)
Ranges above 70 bar (1000 psi) 1200 bar (17500 psi)

Differential (-ve port) must not exceed positive port by more than 6 × FS (15 bar (200 psi) maximum)

Supply Voltage
7 to 32 Vdc (7 to 28 Vdc in hazardous area operation)

Output
4-20 mA

Power-Up Time
10 ms

Insulation
- 500 Vdc: 100 MΩ
- 500 Vac: ≤ 5 mA leakage current

Performance Specifications

There are two grades of performance specification: Improved and Premium

Accuracy
Voltage, Current and mV Linearised
Combined effects of non-linearity, hysteresis and repeatability:
Improved: ±0.1% FS BSL
Premium: ±0.04% FS BSL

Note: For the barometric pressure range, accuracy is of span, not full scale.

Zero Offset and Span Setting
Demountable electrical connector allows access to potentiometers that give at least ±5% FS adjustment

Factory set to:
±0.2% FS

Long Term Stability
±0.05% FS typical (±0.1% FS maximum) per year increasing pro-rata for pressure ranges below 350 mbar

Temperature Effects
-10 to +50 °C (14 to +122 °F): ±0.5% FS
Temperature error band (TEB)
-20 to +80 °C (-4 to 176 °F): ±1.0% FS TEB
-40 to +80 °C (-40 to 176 °F): ±1.5% FS TEB

Temperature effects increase pro-rata for pressure ranges below 350 mbar (5 psi) and are doubled for barometric ranges.

Line Pressure Effects (Differential Version Only)
Zero shift: <±0.03% span/bar of line pressure
Span shift: <±0.03% span/bar of line pressure
Effects increase pro-rata for differential pressure ranges below 700 mbar (10 psi).

Physical Specifications

Environmental Protection
- See Electrical Connector section
- Hyperbaric Pressure: 20 bar (300 psi) maximum

Operating Temperature Range
-40 to 80°C (-40 to 176°F)
DNV Approval Temperature Class
-25 to 70°C (-13 to 158°F)

Pressure Media
(Stainless Steel 316L Option)
Fluids compatible with Stainless Steel 316L and Hastelloy C276.
For the wet/dry differential version, negative pressure port: fluid compatible with stainless steel 316L, stainless steel 304, pyrex, silicon and structural adhesive.
(Titanium Option)
Fluids compatible with Grade 4 Titanium.

Enclosure Materials
Stainless steel / Titanium (body – material option), glass filled nylon (electrical connector assemblies) with rubber seals (nitrile o-rings & silicone gaskets.

Pressure Connector
Available options are
- G1/4 Female*
- G1/4 Male Flat
- G1/2 Male via Adaptor*
- 1/4 NPT Male
- 1/2 NPT Male via Adaptor*
- M20 X 1.5 Male

Choose connectors marked * for pressure ranges over 70 bar.
Other pressure connectors may be available.
Contact GE to discuss your requirement.

Electrical Connector

Code Number	Description	Max Operating temp range		IP rating	Zero span Adjust
		°C	°F		
7	DIN 43650 Form A Demountable	-25 to +70	-13 to +158	56	Y

Wiring Details

Connector Type	Option code		Electronics Option
DIN 43650 Form A	7	1	+ve Supply
		2	-ve Supply
		3	-
		E	Case

General Certifications
RoHS 2002/95/EC

CE Conformity
Pressure Equipment Directive 97/23/EC
ATEX 94/9/EC (Optional)
EMC Directive 2004/108/EC

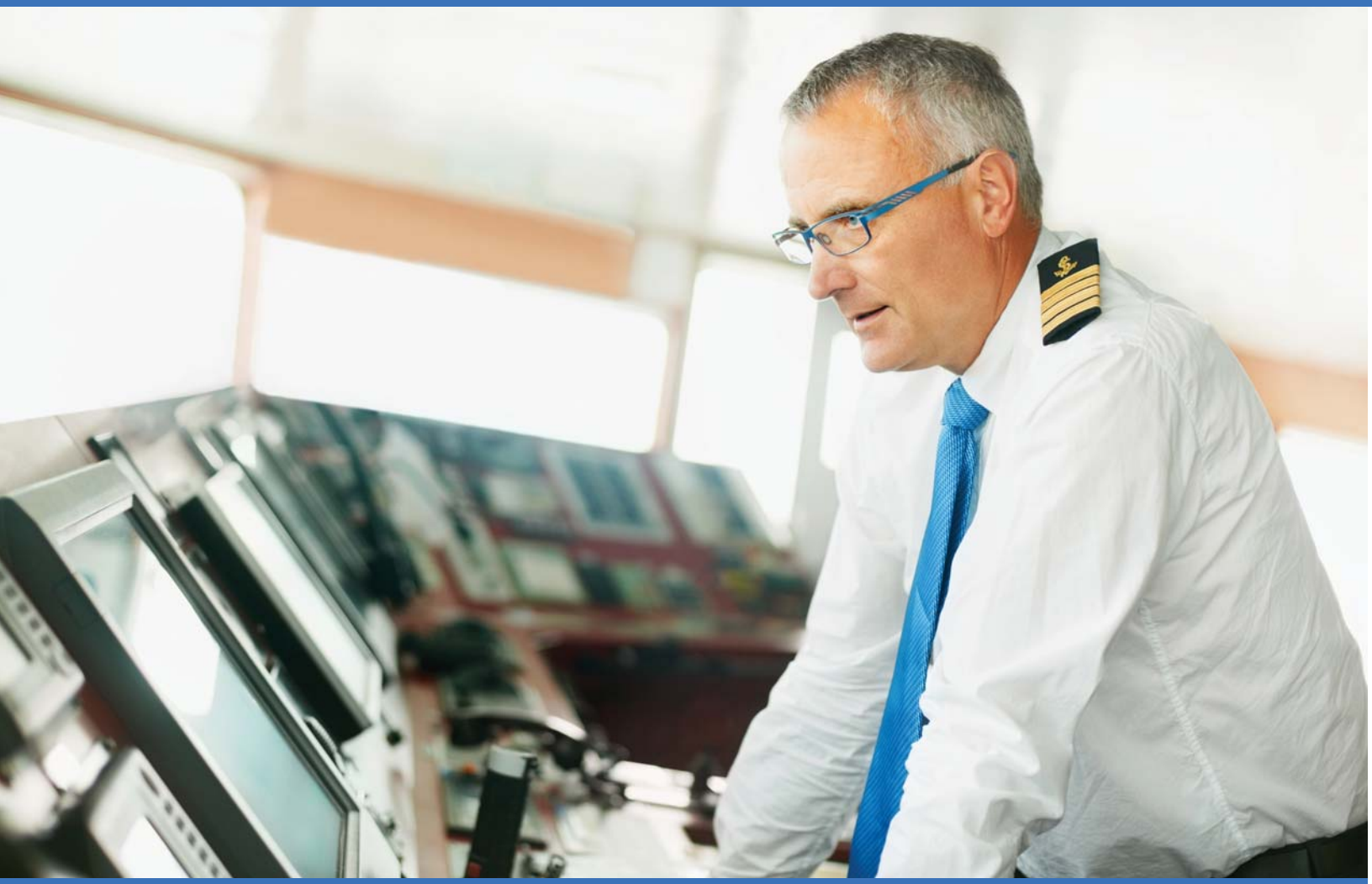
BS EN 50121-3-2:2006	Emission and Immunity - Railway Rolling Stock
BS EN 61000-6-1: 2007	Susceptibility - Light Industrial
BS EN 61000-6-2: 2005	Susceptibility - Heavy Industrial (except mV versions)
BS EN 61000-6-3: 2007	Emissions - Light Industrial
BS EN 61000-6-4: 2007	Emissions - Heavy Industrial
BS EN 61326-1: 2006	Electrical Equipment for Measurement, Control and Laboratory Use
BS EN 61326-2-3: 2006	Particular requirements for pressure transducers

Hazardous Area Approvals (optional)
IECEx/ATEX Intrinsically Safe 'ia' Group IIC
For full certification details, refer to the type-examination certificates (or approval listings) and Hazardous Area Installation Instructions.

Marine Approvals

Det Norske Veritas (DNV) Approvals

Location	Class
Temperature	D
Humidity	B
Vibration	B
EMC B	B
Enclosure (DIN Plug)	C
(Depth Cable)	D (IP68 - 60m)



Ordering Information

See the online configuration tool at www.unik5000.com

(1) Select model number

Main Product Variant

PTX 4-20 mA Pressure Transmitter

Product Series

5 UNIK 5000

Diameter and Material

6 25 mm Stainless Steel 316L Fluid-Isolated (Marine Approved)

7 25 mm Titanium Fluid-Isolated (Marine Approved)

Electrical Connector Note 6

7 DIN 43650 Form A Demountable (Mating connector supplied)

Electronics Option

2 4 to 20 mA 2-wire (PTX)

Compensated Temperature Range

TA -10 to +50 °C (14 to +122 °F)

TB -20 to +80 °C (-4 to +176 °F

TC -40 to +80 °C (-40 to +176 °F)

Accuracy

A2 Improved

A3 Premium

Calibration

CA Zero/Span Data

Hazardous Area Approval

H0 None

H1 IECEx/ATEX Intrinsically Safe 'ia' Group IIC **Note 1**

Pressure Connector

PA G1/4 Female **Note 2**

PB G1/4 Male Flat

PF 1/4 NPT Male

PH M20x1.5

PN G1/2 Male via Adaptor **Note 2**

PR 1/2 NPT Male via adaptor **Note 2**

PW Depth Cone (G1/4 Female open face)

PTX	**5**	**6**	**7**	**2**	**-**	**TA**	**-**	**A2**	**-**	**CA**	**-**	**H0**	**-**	**PA**	**Typical Model Number**

Ordering Notes:
Note 1: Pending
Note 2: Select one of these pressure connectors for pressure ranges over 70 bar.

2) State pressure range and units: e.g. 0 to 10 bar, -5 to + 5 psi

Unit options are:

Symbol	Description
bar	bar
mbar	millibar
psi	pounds/sq. inch
Pa	Pascal
hPa	hectoPascal
kPa	kiloPascal
MPa	MegaPascal
mmH_2O	mm water
cmH_2O	cm water
mH_2O	metres water
inH_2O	inches water
ftH_2O	feet water
mmHg	mm mercury
inHg	inches mercury
kgf/cm^2	kg force/sq. cm
atm	atmosphere
Torr	torr

3) State Pressure reference: e.g. gauge

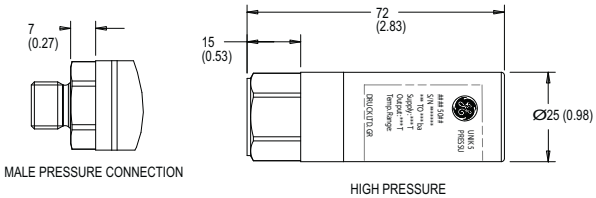
Reference options are:

gauge
absolute
barometric
sealed gauge
wet/dry differential
wet/wet differential

Typical order examples:

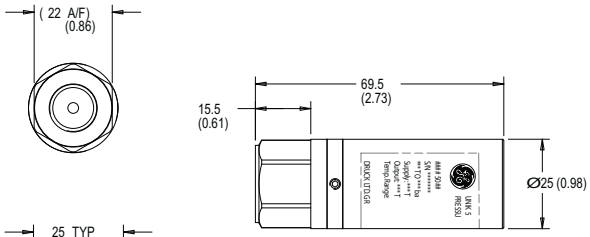
PTX5672-TA-A2-CA-H0-PA, 0 to 3500 psi, absolute

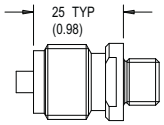
Mechanical Drawings



MALE PRESSURE CONNECTION

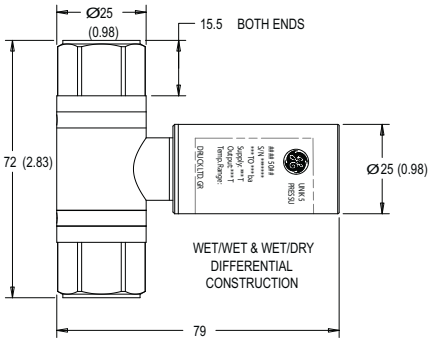
HIGH PRESSURE CONSTRUCTION



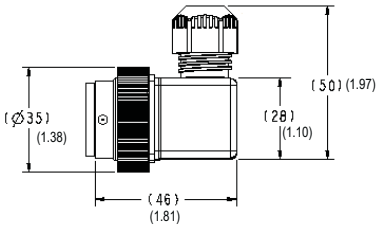


OPTIONAL PRESSURE ADAPTOR

LOW/MEDIUM PRESSURE CONSTRUCTION



WET/WET & WET/DRY DIFFERENTIAL CONSTRUCTION



MARINE DIN

NOTES:
[1] ALL DIMENSIONS ARE IN MILLIMETRES (INCHES IN PARENTHESES)

[2] HIGH PRESSURE IS >70 BAR

www.ge-mcs.com

920-597A

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9.4.7 RPS/DPS 8000 High Accuracy Resonant Pressure Sensor

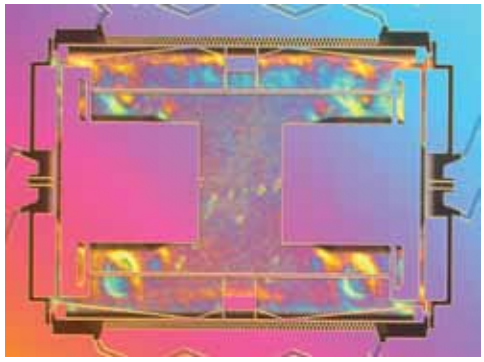
9.4.8 RPS/DPS 8200/8300 High Accuracy Resonant Pressure Sensor for Harsh Media

(8 Pages and 4 Pages)

GE
Measurement & Control

RPS/DPS 8000

High Accuracy Resonant Pressure Sensor



For over 40 years, Druck has manufactured precision pressure sensors with a capability to meet critical applications in industrial, aerospace, oil and gas, and research environments. Today, Druck is part of GE Measurement & Control and has continually worked to develop and improve on the performance of our pressure sensors to meet customer's requirements.

The RPS/DPS 8000 is the first product to incorporate the exciting new TERPS technology. TERPS is a resonant silicon pressure sensor technology platform that provides an order of magnitude greater accuracy and stability than current pressure measurement technologies available. The new TERPS technology also extends the pressure range capability to high pressures and by incorporating true pressure media isolation greatly improves its suitability for use in harsh environments.

In addition to providing the performance and packaging improvements available with TERPS, the RPS/DPS 8000 product line takes advantage of best practices to offer a wide range of pressure and electrical connections to enable a level of customization for your specific requirements never before available in the performance class of this sensor.

The combination of the power of the TERPS technology and the quality, reliability and flexibility of the RPS/DPS 8000 Series offer a truly unique solution for high accuracy and high stability pressure measurement requirements.

Features:

- High Precision, ±0.01% FS over compensated temperature range
- High Stability, ±100 ppm FS/year
- Wide temperature range, -40°C to +85°C (-40° to 185°F)
- Media isolated construction, suitable for use in harsh environments
- Multiple Output configurations, RS-232, RS-485, Frequency & Diode (TTL)
- Wide selection of pressure & electrical connections to suit specific requirements

GE imagination at work

Specifications

Measurement

Base Pressure Ranges

- 0 to 2 bar (0 to 30 psi) absolute
- 0 to 7 bar (0 to 100 psi) absolute
- 0 to 14 bar (0 to 200 psi) absolute
- 0 to 20 bar (0 to 300 psi) absolute
- 0 to 35 bar (0 to 500 psi) absolute
- 0 to 70 bar (0 to 1000 psi) absolute

(Values in psi are approximate.)

Calibration Ranges

- Any zero-based range between 1 and 70 bar (14.5 to 1000 psi) can be specified. (Performance will be of the full scale of the base pressure range selected.)

Barometric ranges are available in the RPS/DPS 8100 series. The lowest calibrated pressure is 35 mbar absolute.

Overpressure

1.5X FS

Sensor Failure Pressure

2.0X FS

Pressure Containment

- Ranges to 7 bar, (100 psi), 70 bar (1,000 psi)
- Ranges to 70 bar (1,000 psi), 200 bar (3,000 psi)

Supply and Output

Electronics Option	Supply Voltage (V)	Output	Current Consumption*** (mA)
0	6 to 28	Frequency^ & Diode^^ (Low Power)*	3.5
1	6 to 28	Frequency^ & Diode^^ (Low Noise)**	10
A	11 to 28	RS485	16.5 quiescent, 32 max
B	11 to 28	RS232	16.5 quiescent, 32 max

* Low Power has Jitter of <120 ns
** Low Noise has Jitter of <75 ns
*** At 25°C (77°F)
^ Square wave pressure signal, 25 kHz nominal, 4-10 kHz span
^^ Forward voltage diode, 0.5 to 0.7 V @ 25°C (77°F), typically –2 mV/°C nominal

Response Time

< 300 msec for pressure change from 10% to 90% FS

Supply Response

Frequency & Diode: Accurate to specification within 500 ms of supply switch on, over all operating temperatures
RS 232/485: First stable reading within 20 sec of supply switch on

Electrical Protection

Connecting V_{supply} and GND between any combinations of pins on the connector will not damage the unit

Insulation

500 V dc

Performance

There are two levels of performance specification: standard and Improved

Specifications include combined effects of non-linearity, hysteresis, repeatability and temperature errors over the compensated temperature range, and over the pressure range 35 mbar to the full scale pressure.

Accuracy Code	Precision
A1- Standard	0.02% FS
A2- Improved	0.01% FS

.

For Frequency & Diode output the above accuracies are achievable by using a polynomial curve fit algorithm and coefficient data supplied with sensor.
Sensors are calibrated against standards traceable to UKAS operating to better than 100 ppm.

Compensated Temperature Ranges:

There are two compensated temperature ranges available:
-10 to +50°C
-40 to +85°C

Temperature Effects

All temperature effects are included in the accuracy statement.

Long Term Stability

Standard: ±0.02% FS/annum
Improved: ±0.01% FS/annum

Note: Unless otherwise specified, specifications are at reference conditions: 25°C (77°F) ±5°C (±9°F).

Orientation (g) Sensitivity

Less than 0.2 mbar/g

Physical Specifications

Storage Temperature Range
As compensated temperature range.

Operating Temperature Range
As compensated temperature range

Pressure Media
Media compatible with 316L Stainless Steel and Hastelloy C276

Ingress Protection
See Electrical Connector Section

Vibration
DO-160E Curve W Sine sweeps 5 Hz to 2 kHz, levels to $20g_n$
<0.2 mbar/g_n (<0.003 psi/g_n) output change

Shock
DO-160E 9 (Figure 7.2) 20 g_n 11 ms terminal saw-tooth profile
Negligible calibration change

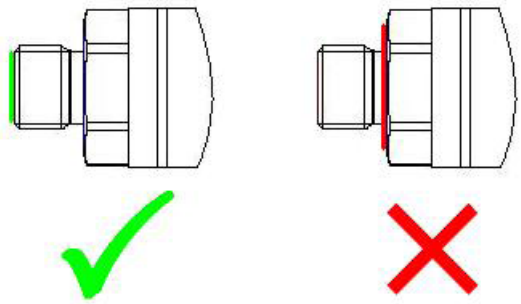
Humidity
MIL-STD-810D Method 507.2 Procedure III (Aggravated humidity environment, 65°C, 95% RH)

Pressure Connector
Available Options are

- G1/4 Female
- G1/4 Male Flat
- G1/4 Male 60 degree Cone
- G1/8 Male 60 degree Cone
- 1/4 NPT Female
- 1/4 NPT Male
- 1/8 NPT Male
- M20 x 1.5
- M14 x 1.5 60 degree Internal Cone
- M12 x 1 Internal Cone
- 7/16 UNF Male
- G1/2 Male
- G1/4 Quick Connect
- 1/2 NPT Male
- G1/4 Male Flat Long
- 7/16-20 UNF Female
- Depth Cone (G1/4 Female)
- 7/16-20 UNF Male Short Flat
- Other pressure connectors may be available. Contact GE to discuss your requirement.

Please ensure that only the intended sealing face is used when mounting the sensor. Failure to comply with this requirement may affect performance or calibration accuracy.

Male threaded pressure connectors must not be sealed or constrained against the face at the base of the thread. The forward cone or flat face should always be used, as indicated below.



Electrical Connector

Code Number	Description	Max Operating temp range		IP rating
		°C	°F	
0	No Connector	-55 to +125	-67 to +257	-
1	Cable Gland	-40 to +80	-40 to +176	65
2	Raychem Cable	-55 to +125	-67 to +257	65
3	Polyurethane Depth	-40 to +80	-40 to +176	68
4	Hytrel Depth	-40 to +80	-40 to +176	68
6	Bayonet MIL-C-26482	-55 to +125	-67 to +257	67
C	1/2 NPT Conduit	-40 to +80	-40 to +176	67
G	M12 X 1 5-pin	-55 to +125	-67 to +267	65
H	PTFE Cable (Orange)	-55 to +125	-67 to +267	54

Connection Details

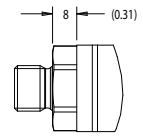
Option	Code	Connection	Function		
			Frequency & Diode	Digital- RS485	Digital - RS232
Flying Leads	0	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		YELLOW	FREQ	RS485 B	Rx
		GREEN	+VE TEMP	RS485 A	Tx
		BLUE	GROUND	GROUND	GROUND
		ORANGE	EEPROM	-	-
		BLACK	-VE TEMP	-	-
CABLE	1, 3, 4, C	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		YELLOW	FREQ	RS485 B	Rx
		BLUE	+VE TEMP	RS485 A	Tx
		WHITE	GROUND	GROUND	GROUND
		ORANGE	EEPROM	-	-
		BLACK	-VE TEMP	-	-
		SCREEN	-	-	-
			-		
RAYCHEM	2	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		WHITE	FREQ	RS485 B	Rx
		GREEN	+VE TEMP	RS485 A	Tx
		BLUE	GROUND	GROUND	GROUND
		BLACK	EEPROM	-	-
		SCREEN	-	-	-
MIL-C	6	A	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		B	FREQ	RS485 B	Rx
		C	+VE TEMP	RS485 A	Tx
		D	GROUND	GROUND	GROUND
		E	EEPROM	-	-
		F	-VE TEMP	-	-
M12	G	1	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		2	FREQ	RS485 B	Rx
		3	GROUND	GROUND	GROUND
		4	+VE TEMP	RS485 A	Tx
		5	EEPROM	-	-
PTFE	H	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		YELLOW	FREQ	RS485 B	Rx
		GREEN	+VE TEMP	RS485 A	Tx
		BLUE	GROUND	GROUND	GROUND
		BLACK	EEPROM	-	-
		WHITE	-VE TEMP	_	_
		SCREEN	-	_	_

Certification

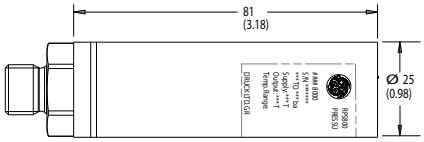
- CE Marked
- RoHS
- EMC Standards

BS EN 61000-6-1: 2007 Susceptibility - Light Industrial
BS EN 61000-6-2: 2005 Susceptibility - Heavy Industrial (except mV versions)
BS EN 61000-6-3: 2007 Emissions - Light Industrial
BS EN 61000-6-4: 2007 Emissions - Heavy Industrial
BS EN 61326-1: 2006 Electrical Equipment for Measurement, Control and Laboratory Use - EMC requirements
BS EN 61326-2-3:2006 Requirements for pressure transducers

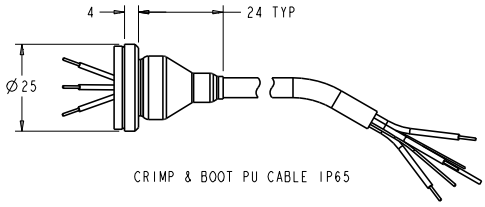
Mechanical Drawings

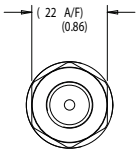


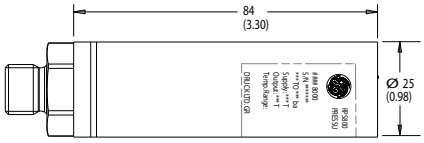
MALE PRESSURE CONNECTION



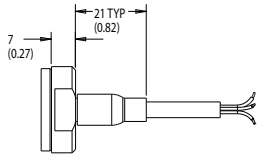
MEDIUM PRESSURE CONSTRUCTION



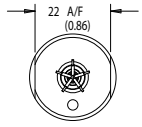


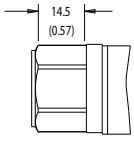


LOW PRESSURE CONSTRUCTION

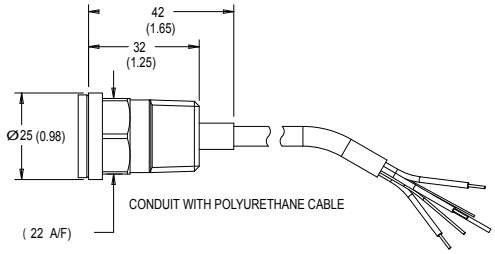


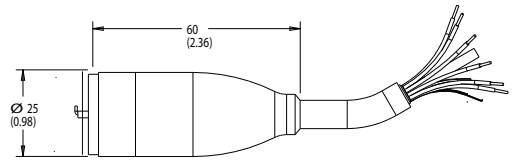
RAYCHEM CABLE



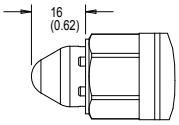


FEMALE PRESSURE CONNECTION

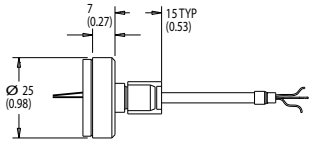




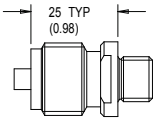
DEPTH CABLE



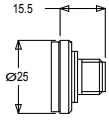
DEPTH CONE PRESSURE ADAPTOR



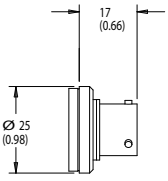
24 AWG 7/0.2 PTFE CABLE



OPTIONAL WELDED PRESSURE ADAPTOR



M12x1 5-PIN



BAYONET MIL-C-26482

Notes:

1. *All dimensions are nominal lengths and are subject to change.*
2. *All dimensions are in millimeters (inches).*
3. *Other pressure and electrical connectors may be available, please contact GE.*
4. *Low Pressure ≤ 7 bar (100 psi)*
5. *Medium Pressure >7 bar (100 psi) and ≤ 70 bar (1,000 psi)*

(1) Select model number

Main Product Variant

RPS Resonant Pressure Sensor - Frequency & Diode Output **(Note 1)**

DPS Digital Pressure Sensor - Digital Output **(Note 1)**

Product Series

8 RPS/DPS 8000 Series

Diameter, Material and Isolation

0 25mm Stainless Steel Oil isolated

Electrical Connector

0 No Electrical Connector (Flying leads)
1 Polyurethane Cable IP65
2 Raychem Cable
3 Polyurethane Cable (Depth) IP68
4 Hytrel Cable (Depth) IP68
6 MIL-C-26482 (6-pin Shell Size 10)
C 1/2" NPT Conduit with Polyurethane Cable (Non-Exd Only)
G M12x1 5-Pin
H Orange PTFE Cable

Output Option

0 Frequency & Diode (Low Power <3.5 mA)
1 Frequency & Diode (Low Jitter aprox 75 ns)
A RS485
B RS232

Compensated Temperature Range

TA -10 to +50 °C
TB -40 to +85 °C **(Note 2)**

Accuracy

A1 - Standard 0.02%
A2 - Improved 0.01%

Calibration

CC Full Thermal Calibration

Hazardous Area Approval

H0 None

Pressure Connector

PA G1/4 Female
PB G1/4 Male Flat
PC G1/4 Male 60 degree internal Cone
PD G1/8 Male 60 degree internal Cone
PE 1/4 NPT Female
PF 1/4 NPT Male
PG 1/8 NPT Male
PH M20x1.5
PJ M14x1.5 60° Internal Cone
PK M12x1 Internal Cone
PL 7/16-20 UNJF Male 74 degree external cone
PN G1/2 Male
PQ G1/4 Quick Connect
PR 1/2 NPT Male
PT G1/4 Male Flat Long
PV 7/16-20 UNF Female)
PW Depth Cone (G1/4 Female)
PX 7/16-20 UNF Male Flat

R	**8**	**0**	**4**	**1**	**-**	**TA**	**-**	**A2**	**-**	**CC**	**-**	**H0**	**-**	**PA**	**Typical Model Number**

Note 1: RPS variants require Output Option Code '0' or '1'. DPS variants require Output Option Code 'A' or 'B'.

Note 2: Pressure ranges 2 and 7 bar (30 and 100 psi) are not available at this temperature range.

2) State pressure range (2, 7, 14, 20, 35 or 70 bar or equivalents) and units: e.g. 0 to 20 bar, 0 to 100 psi
Unit options are:

Symbol	Description
bar	bar
mbar	millibar
psi	pounds/sq. inch
Pa	Pascal
hPa	hectoPascal
kPa	kiloPascal
MPa	megaPascal
mmH_2O	mm water
cmH_2O	cm water
mH_2O	metres water
inH_2O	inches water
ftH_2O	feet water
mmHg	mm mercury
inHg	inches mercury
kgf/cm^2	kg force/sq. cm
atm	atmosphere
Torr	torr

3) State cable lengths and units: e.g. 1 m cable, 3 ft cable (only required on certain electrical connectors)

Typical order examples:
RPS 8010-TA-A1-CC-H0-PA, 0-7 bara, 5 m cable
DPS 806A-TB-A2-CC-H0-PL, 0-1,000 psia

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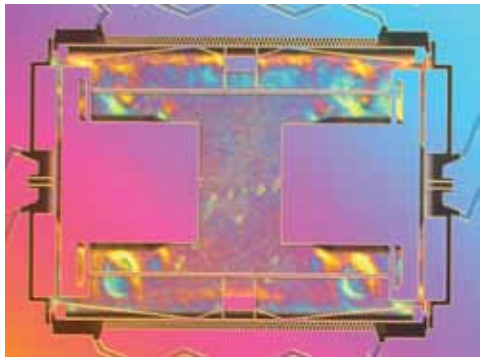
920-519E

GE
Measurement & Control

RPS/DPS 8200/8300

High Accuracy Resonant Pressure Sensor for Harsh Media



For over 40 years, Druck has manufactured precision pressure sensors with a capability to meet critical applications in industrial, aerospace, oil and gas, and research environments. Today, Druck is part of GE Measurement & Control and has continually worked to develop and improve on the performance of our pressure sensors to meet customer's requirements.

The RPS/DPS 8200/8300 moves the exciting new TERPS technology into harsh media environments. TERPS is a resonant silicon pressure sensor technology platform that provides an order of magnitude greater accuracy and stability than current pressure measurement technologies available. The new TERPS technology also extends the pressure range capability to high pressures and by incorporating true pressure media isolation greatly improves its suitability for use in harsh environments.

By packaging TERPS technology in Hastelloy C276, the RPS/DPS 8200/8300 allows for use in harsh corrosive media such as sea water, or sour gas.

The combination of the power of the TERPS technology and the quality, reliability and flexibility of the RPS/DPS 8000 Series offer a truly unique solution for high accuracy and high stability pressure measurement requirements.

Features:

- High Precision, ±0.01% FS over compensated temperature range
- High Stability, ±100 ppm FS/year
- Wide temperature range, -40°C to +125°C (-40°F to 257°F)
- Media isolated construction, suitable for use in harsh environments
- Multiple Output configurations, RS-232, RS-485, Frequency & Diode (TTL)
- Selection of pressure & electrical connections to suit specific requirements

GE imagination at work

Specifications

Measurement

Pressure Ranges
- 0 to 2 bar (0 to 30 psi) absolute
- 0 to 7 bar (0 to 100 psi) absolute
- 0 to 14 bar (0 to 200 psi) absolute
- 0 to 20 bar (0 to 300 psi) absolute
- 0 to 35 bar (0 to 500 psi) absolute
- 0 to 70 bar (0 to 1000 psi) absolute

(Values in psi are approximate.)
The lowest calibrated pressure is 35 mbar absolute.

Overpressure
1.5X FS

Sensor Failure Pressure
2.0X FS

Pressure Containment
- Ranges to 7 bar, (100 psi), 70 bar (1,000 psi)
- Ranges to 70 bar (1,000 psi), 200 bar (3,000 psi)

Supply and Output

Electronics Option	Supply Voltage (V)	Output	Current Consumption*** (mA)
0	6 to 28	Frequency^ & Diode^^ (Low Power)*	3.5
1	6 to 28	Frequency^ & Diode^^ (Low Noise)**	10
A	11 to 28	RS485	16.5 quiescent, 32 max
B	11 to 28	RS232	16.5 quiescent, 32 max

* Low Power has Jitter of <120 ns
** Low Noise has Jitter of <75 ns
*** At 25°C (77°F)
^ Square wave pressure signal, 25 kHz nominal, 4-10 kHz span
^^ Forward voltage diode, 0.5 to 0.7 V @ 25°C (77°F), typically –2 mV/°C nominal

Response Time
< 300 msec for pressure change from 10% to 90% FS

Supply Response
Frequency & Diode: Accurate to specification within 500 ms of supply switch on, over all operating temperatures
RS 232/485: First stable reading within 20 sec of supply switch on

Electrical Protection
Connecting V_{supply} and GND between any combinations of pins on the connector will not damage the unit

Insulation
500 V dc

Performance

There are two levels of performance specification: standard and Improved.

Specifications include combined effects of non-linearity, hysteresis, repeatability and temperature errors over the compensated temperature range, and over the pressure range 35 mbar to the full scale pressure.

Accuracy Code	Precision
A1- Standard	0.02% FS
A2- Improved	0.01% FS

.
For Frequency & Diode output the above accuracies are achievable by using a polynomial curve fit algorithm and coefficient data supplied with sensor.

Sensors are calibrated against standards traceable to UKAS operating to better than 100 ppm.

Compensated Temperature Ranges:

There are three compensated temperature ranges available:
-10 to +50°C
-40 to +85°C
-40 to +125°C

Temperature Effects
All temperature effects are included in the accuracy statement.

Long Term Stability
Standard: ±0.02% FS/annum
Improved: ±0.01% FS/annum
Note: Unless otherwise specified, specifications are at reference conditions: 25°C (77°F) ±5°C (±9°F).

Orientation (g) Sensitivity
Less than 0.2 mbar/g

Physical Specifications

Storage Temperature Range
As operating temperature range.

Operating Temperature Range
See electrical connector section

Pressure Media
Media compatible with Hastelloy C276

Ingress Protection
See Electrical Connector Section

Vibration

DO-160E Curve W Sine sweeps 5 Hz to 2 kHz, levels to $20g_n$
<0.2 mbar/g_n (<0.003 psi/g_n) output change

Shock

DO-160E 9 (Figure 7.2) 20 g_n 11 ms terminal saw-tooth profile
Negligible calibration change

Humidity

MIL-STD-810D Method 507.2 Procedure III (Aggravated humidity environment, 65°C, 95% RH)

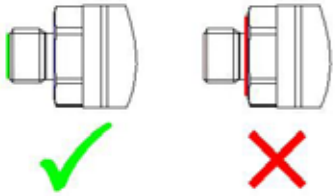
Pressure Connector

Available Options are

- G1/4 Female
- G1/4 Male Flat
- 1/4 NPT Female
- 1/4 NPT Male
- Depth Cone (G1/4 Female)

Please ensure that only the intended sealing face is used when mounting the sensor. Failure to comply with this requirement may affect performance or calibration accuracy.

Male threaded pressure connectors must not be sealed or constrained against the face at the base of the thread. The forward cone or flat face should always be used, as indicated below.



Electrical Connector

Code Number	Description	Max Operating temp range °C	°F	IP rating
0	No Connector	-55 to +125	-67 to +257	-
3	Polyurethane Depth	-40 to +80	-40 to +176	68
4	Hytrel Depth	-40 to +80	-40 to +176	68

Certification

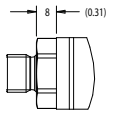
- CE Marked
- RoHS
- EMC Standards

BS EN 61000-6-1: 2007 Susceptibility - Light Industrial
BS EN 61000-6-2: 2005 Susceptibility - Heavy Industrial
BS EN 61000-6-3: 2007 Emissions - Light Industrial
BS EN 61000-6-4: 2007 Emissions - Heavy Industrial
BS EN 61326-1: 2006 Electrical Equipment for Measurement, Control and Laboratory Use - EMC requirements
BS EN 61326-2-3:2006 Requirements for pressure transducers

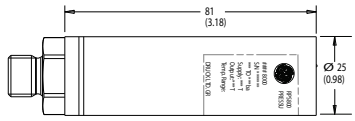
Connection Details

Option	Code	Connection	Function		
			Frequency & Diode	Digital-RS485	Digital - RS232
Flying Leads	0	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		YELLOW	FREQ	RS485 B	Rx
		GREEN	+VE TEMP	RS485 A	Tx
		BLUE	GROUND	GROUND	GROUND
		ORANGE	EEPROM	-	-
		BLACK	-VE TEMP	-	-
CABLE	3, 4,	RED	SUPPLY +VE	SUPPLY +VE	SUPPLY +VE
		YELLOW	FREQ	RS485 B	Rx
		BLUE	+VE TEMP	RS485 A	Tx
		WHITE	GROUND	GROUND	GROUND
		ORANGE	EEPROM	-	-
		BLACK	-VE TEMP	-	-
		SCREEN	-	-	-
			-		

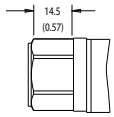
Mechanical Drawings



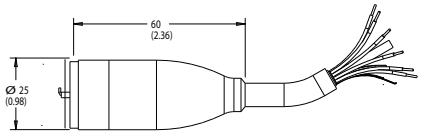
ALE PRESSURE CONNECTION



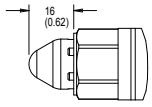
MEDIUM PRESSURE CONSTRUCTION



MALE PRESSURE CONNECTION



DEPTH CABLE



DEPTH CONE PRESSURE ADAPTOR

Notes:

1. *All dimensions are nominal lengths and are subject to change.*
2. *All dimensions are in millimeters (inches).*
3. *Other pressure and electrical connectors may be available, please contact GE.*

(1) Select model number

Main Product Variant

RPS Resonant Pressure Sensor - Frequency & Diode Output **(Note 1)**

DPS Digital Pressure Sensor - Digital Output **(Notes 1 and 2)**

Product Series

8 RPS/DPS 8000 Series

Diameter, Material and Isolation

2 25mm Oil isolated Hastelloy Wetted Parts

3 25 mm Oil isolated all Hastelloy

Electrical Connector

0 No Electrical Connector (Flying leads)

3 Polyurethane Cable (Depth) IP68 **(Note 2)**

4 Hytrel Cable (Depth) IP68 **(Note 2)**

Output Option

0 Frequency & Diode (Low Power <3.5 mA)

1 Frequency & Diode (Low Jitter aprox 75 ns)

A RS485 **(Note 2)**

B RS232 **(Note 2)**

Compensated Temperature Range

TA -10 to +50 °C

TB -40 to +85 °C

TC -40 to +125 °C

Accuracy

A1 - Standard 0.02%

A2 - Improved 0.01%

Calibration

CC Full Thermal Calibration

Hazardous Area Approval

H0 None

Pressure Connector

PA G1/4 Female

PB G1/4 Male Flat

PE 1/4 NPT Female

PF 1/4 NPT Male

PW Depth Cone (G1/4 Female)

R	**8**	**2**	**4**	**1**	**-**	**TA**	**-**	**A2**	**-**	**CC**	**-**	**H0**	**-**	**PA**	**Typical Model Number**

Note 1: RPS variants require Output Option Code '0' or '1'. DPS variants require Output Option Code 'A' or 'B'.

Note 2: Compensated temperature range -40 to +125°C (TC) is not available with this option.

2) State pressure range (2, 7, 14, 20, 35 or 70 bar or equivalents) and units: e.g., 0 to 20 bar, 0 to 100 psi

Unit options are:

Symbol	Description
bar	bar
mbar	millibar
psi	pounds/sq. inch
Pa	Pascal
hPa	hectoPascal
kPa	kiloPascal
MPa	megaPascal
mmH_2O	mm water
cmH_2O	cm water
mH_2O	metres water
inH_2O	inches water
ftH_2O	feet water
mmHg	mm mercury
inHg	inches mercury
kgf/cm^2	kg force/sq. cm
atm	atmosphere
Torr	torr

3) State cable lengths and units: e.g. 1 m cable, 3 ft cable (only required on certain electrical connectors)

Typical order examples:

RPS 8301-TC-A2-CC-H0-PA,70 bara

DPS 823A-TA-A1-CC-H0-PW, 2 bara, 10 m cable

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920-602A

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9.4.9 Submersible Level Probe (OEM Depth/Level Sensor)

(4 pages)

GE
Sensing & Inspection Technologies

Submersible Level Probe

Features

- A hermetically-sealed, submersible level sensor
- Manufactured from corrosion-resistant materials
- Instrinsically safe versions
- Pressure ranges from 2.5 to 100 psi (0.17 to 7 bar)
- Measures levels up to 70m H_2O (230 ft H_2O)
- Gauge and absolute versions
- Accurate to 0.5%
- Robust construction
- Low power requirement
- Economic design to allow multiple point measurements
- Extended warranty available

The SLP provides a range of economical level measurement devices in a mechanically and chemically robust polymer package.

Applications

The versatile and economic SLP sensor is suitable for a wide variety of applications, from single tanks to multiple point installations.

The robust design and corrosion resistance of the SLP allow it to be used in measuring levels in:

- The chemicals and petrochemicals industries, handling hydrocarbons and a wide range of corrosive fluids.
- The agricultural sector, monitoring levels of silages, pesticides and chemicals.
- The fuels industry, working in tank farms and petrol stations.
- Environmental monitoring, especially in the monitoring of water levels around industrial facilities and sites where there is potential for pollution.

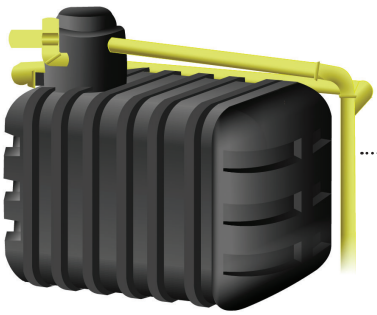
The SLP level sensor finds extensive application in inventory control and is used by data providers as an economic sensor, which can be connected to data loggers and to wireless systems, allowing the remote collection of level data.

SLP

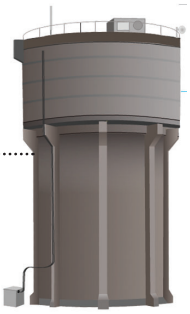
The SLP has been developed as a fully submersible level measurement solution and is especially suitable for applications requiring measurement at multiple points.

Its innovative design and use of moulded polymer materials ensure a complete hermetic seal, over an operating temperature range of -40°F to 175°F (-40°C to 80°C).

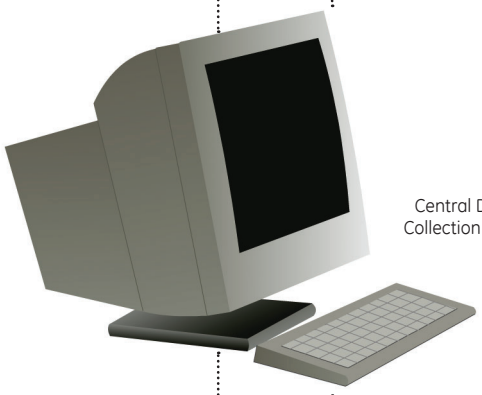
It measures level by measuring hydrostatic pressure, which is a simple, well-established technique. Pressure transmitters are located at the bottom of liquid-containment vessels and, being submerged, they are protected from vandalism and readings are unaffected by surface disruptions.



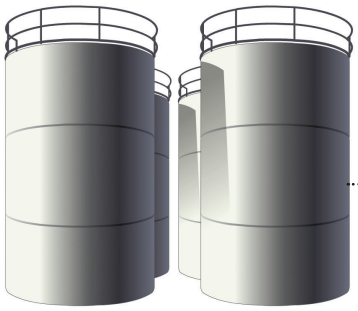
Domestic Tanks



Water Towers



Central Data Collection Point



Industrial Tanks

Fuel Tanks

Individual SLP sensors feeding a Central data collection point

SLP Specifications

Operating Pressure Ranges

- 2.5, 5, 15, 30, 50, and 100 psi (170, 350 mbar, 1, 2, 3, and 7 bar) gauge
- 20, 30, 50, and 100 psi (1.3, 2, 3 and 7 bar) absolute

Over Pressure
2x rated pressure to a maximum of 150 psi (10 bar)

Excitation Voltage
- 10 VDC at nominally 1 mA
- Supply limits of 2.5 to 15 VDC

Pulse Power Excitation
Recommended power on time before output samples
10ms

Output Voltage with 10 VDC supply
2.5 and 5 psi ranges 75 mV
All other ranges 100mV. (Output is ratiometric to supply)

Common Mode Voltage
Mid Rail (nominally)

Output Impedance
5 kΩ

Input Impedance
10 kΩ

Performance Specifications

Accuracy
Combined effects of Non-linearity Hysteresis and repeatability ±0.5% FS BSL

Zero Offset and Span Settings with 10 VDC supply

Zero Offset	Absolute ranges	±4 mV
	Gauge Ranges	±4 mV
Span Setting	2.5 psi range	±3 mV
	All other ranges	±1 mV

Long Term Stability
±0.1% per year Typical

Compensated Temperature Range
0°C to 70°C (32°F to 158°F)

Temperature Effects (Over Compensated Range)

Typically	±0.5% FS	
Maximum	2.5 psi (170 mbar) range	±2% FS
	5 psi (350 mbar) range	±1.5% FS
	Other ranges	±1% FS

Physical Specifications

Isolation
500 V RMS

Protection
IP68

Operating Temperature Range
-40°C to 80°C (-40°F to 175°F)

Pressure Media
Fluids compatible with Stainless Steel 316L (Sensor element), PolyPhenylene Sulphide (PPS) (body), Epoxy based resin (potting), Hytrel® or Tefzel® (cable), Polyolefin (label).

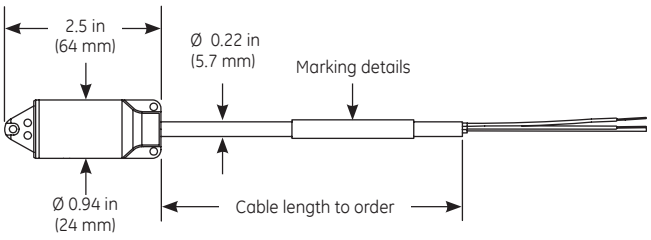
Pressure Connection
Depth Nose Cone

Electrical Connection
6 Core vented cable sheathed in either Hytrel or Tefzel
Length to be specified on order to a maximum of
100 m (330 ft).

Certification
CE Marked
Intrinsically safe:
- ATEX and IECEx - Certified (baseefa08ATEXX0232 and IECEx BAS 08.0076) For use with IS barrier systems in Zone 0 hazardous locations: Ga Ex ia IIC T4 (-40°C to 80°C ambient)
- FM Approved for U.S./Canada - Certified (FM 3033510) for use with IS barrier systems in hazardous locations: Class I, Zone 0, AEx Ex ia IIC: IS class I, Division 1, Groups A, B, C & D, T4 (-40°C to 80°C ambient)

Mass (Nominal)

Unit	30 g (1 oz)	
Cable	Hytrel	35 g/m (0.4 oz/ft)



Nominal Dimensions

Ordering Information

1) Select Model Number

SLP Model Number

Code Output
- 20 mV Output

Code Pressure Range

002	2.5 psi	Gauge Only
005	5 psi	Gauge Only
015	15 psi	Gauge Only
020	20 psi	Absolute only
030	30 psi	Gauge or Absolute
050	50 psi	Gauge or Absolute
100	100 psi	Gauge or Absolute

Code Pressure Units
- **P** psi

Code Reference
- **G** Gauge
- **A** Absolute

Code Temperature Option
- **N** No temperature output

Code Module Material
- **L** Stainless Steel

Code Pressure Connection
- **C** Nose Cone

Code Cable Type
- **H** Hytrel®
- **T** Tefzel®

□ - □ - □ - □ - □ - □ - □ - □ - □ - □ - □

1) Typical Model Number
SLP20-005-PGNLC-H

2) State Cable Length and Units
Maximum 330 ft (100 m)

3) State Options Required Intrinsic Safety
ATEX and IECEx (Option A)
FM Approved for U.S./Canada (Option B)
Combined Approvals (Option A & B)
None

Nominal Pressure/Depth Conversions

Pressure Conversion Table			Nominal Depth in Water	
psi	bar	kPa	ft H_2O	mH_2O
2.5 Gauge	0.175	17.5	5	1.75
5 Gauge	0.35	35	10	3.5
15 Gauge	1	100	30	10
30 Gauge	2	200	65	20
50 Gauge	3.5	350	100	35
100 Gauge	7	700	200	70
20 Absolute	1.4	140	10	3.5
30 Absolute	2	200	30	10
50 Absolute	3.5	350	100	25
100 Absolute	7	700	190	60

Supporting Services

Our highly trained staff can support you, no matter where you are in the world. We can provide training, extended warranty terms and rental of portable or laboratory calibrators. Further details can be found in www.gesensing.com/productservices/services.htm

www.gesensinginspection.com

920-432D
SDS 0005 Issue 1

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9.4.10 STE - Sensor Termination Enclosure (part number 202-034-03)

(2 pages)

STE - Sensor Termination Enclosure

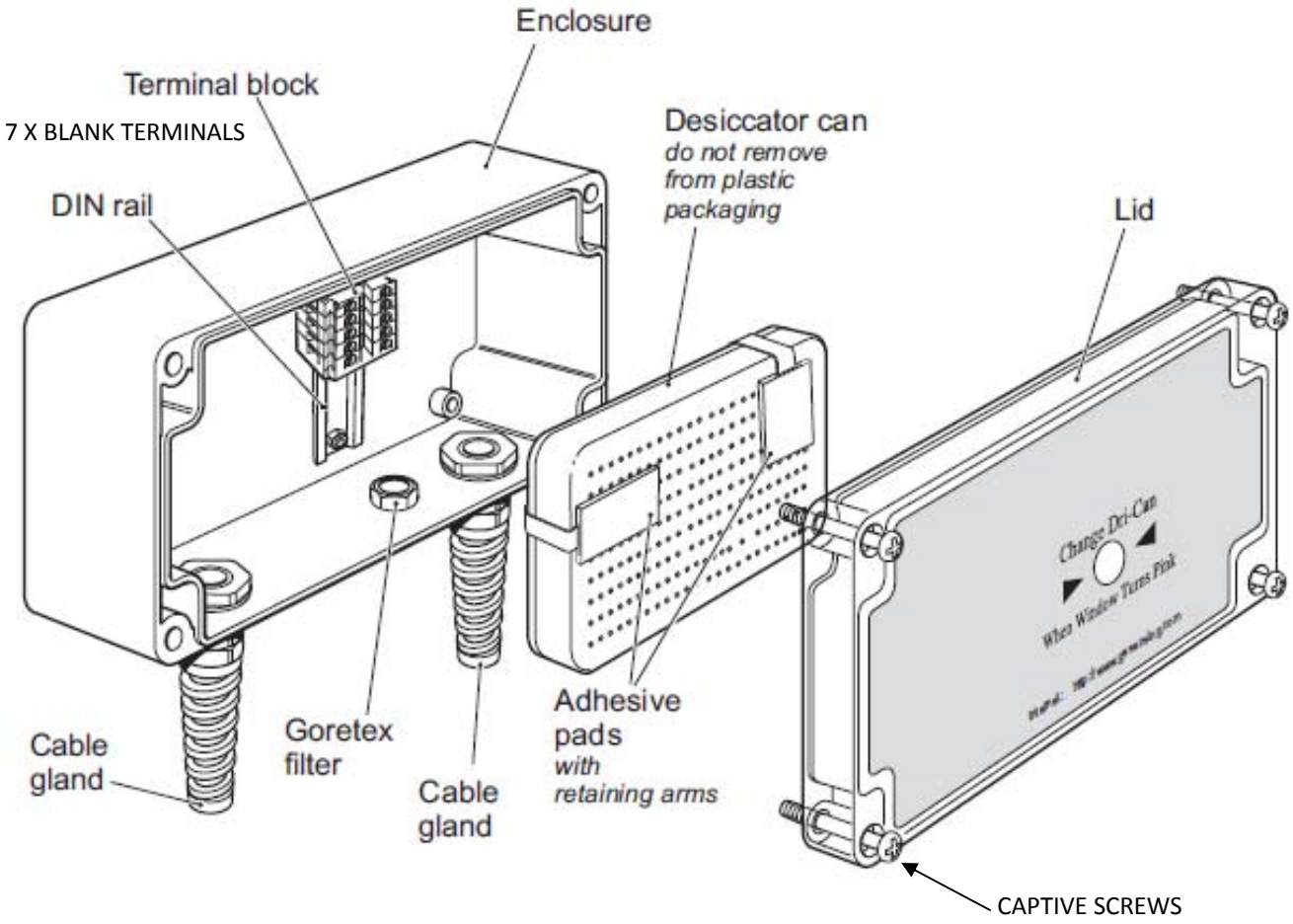
(part number 202-034-02)

Consists of the following Items:

FILTER BREATHER VENT TEFLON

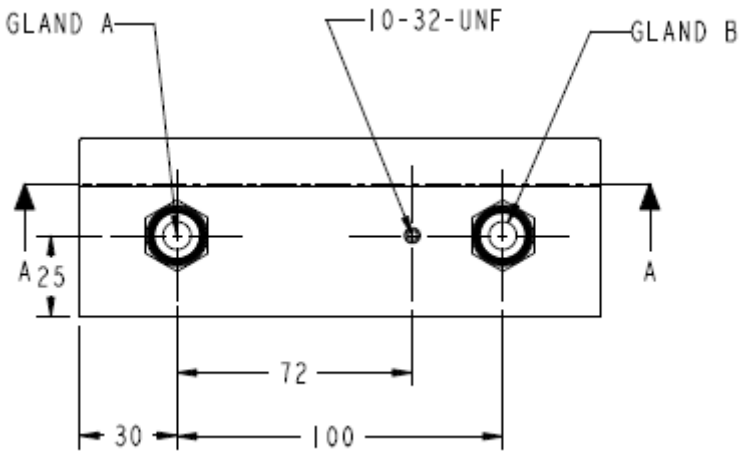
DESSICANT CAN SILICA GEL

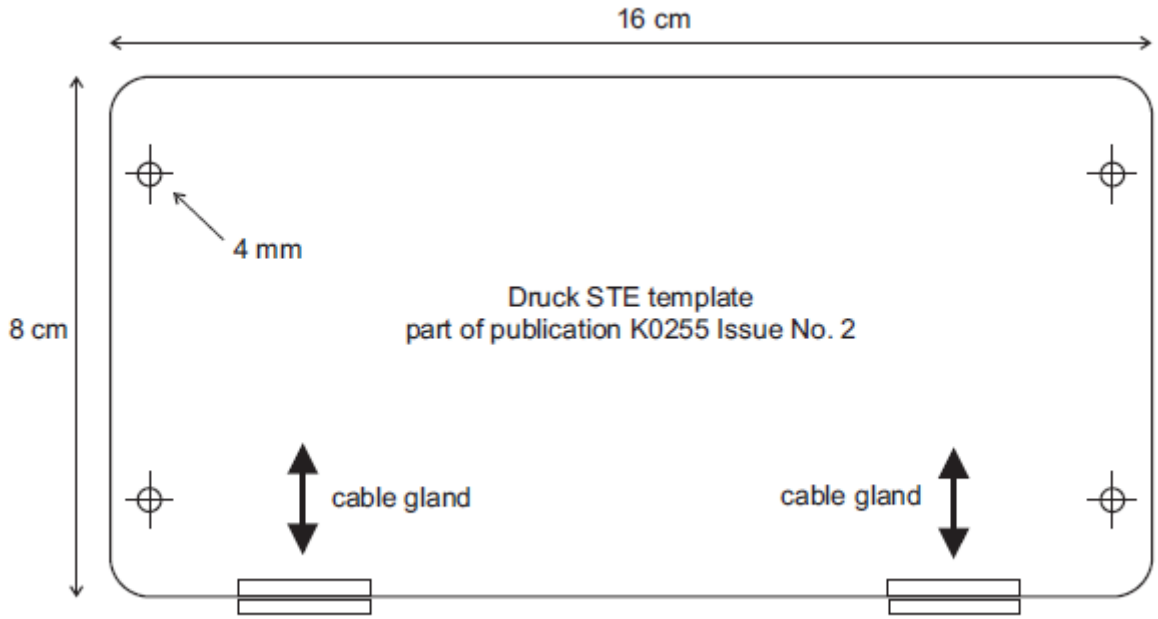
INSTALLATION NOTE K0255



STE - Sensor Termination Enclosure

(part number 202-034-02)





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9.4.11 RPT 410 Barometric Pressure Sensor

(2 pages)

RPT 410

RPT 410

Barometric Pressure Sensor

- High stability - 100ppm per annum
- Accuracy: better than ±0.015 inHg
- Voltage or frequency output
- Supply voltage 9.5 to 24 Vdc
- Current consumption less than 6mA
- On/Off control with external trigger

The RPT 410 Resonant Silicon Pressure Transducer (RPT) utilizes Druck's resonant silicon technology that has been field proven in many applications in air data flight and test, precision portable and bench calibrators, and high performance wind tunnels.

The multi layer sensor structure consists of a resonator and pressure sensitive diaphragm micro-machined from single-crystal silicon, thus achieving the highest level of performance stability.

The sensor is available with either a voltage or frequency output proportional to the barometric pressure range. Microprocessor based thermal error correction assures accurate performance over a wide temperature range. An external trigger feature allows the device to be "shut down", thus conserving power in remote battery operated installations.

Druck's RPT 410 is ideally suited for weather stations monitoring atmospheric trends, engine test cells, data buoys, ships ballast systems, as well as a highly stable barometric pressure reference transfer standard.

SPECIFICATION

Pressure Measurement

Operating Pressure Ranges
17.5 to 32.5 inHg
600 to 1100 mbar (hPa)
Other engineering units can be specified.

Overpressure
42 inHg (1.4 bar)

Pressure Containment
44 inHg (1.5 bar)

Excitation Voltage
9.5 to 24 Vdc at 6mA nominal

Supply Voltage Sensitivity
Less than 0.1 mbar effect over excitation voltage range

Frequency Output (RPT 410F)
TTL square wave 600 to 1100 Hz
(others available)

Voltage Output (RPT 410V)
0 to 2.5 Vdc (4-wire)
0 to 5 Vdc (4-wire)
Other output voltages available

Performance Specifications

Long Term Stability
±0.00295 inHg (0.1 mbar) (100 ppm) per year

Operating Temperature Range
-40° to 140°F

Settling Time
1 second to reach full accuracy after power up

Response Time (100% response)
300 ms

Resolution
RPT 410V - 0.00059 inHg (0.02 mbar)
RPT 410F - 0.000295 inHg (0.01 mbar)

Current Consumption
RPT 410V - <6mA
RPT 410F - <8mA
Less than 0.1 microamp in shutdown mode

Safety
CE marked
EMC emissions: BS EN50081-1
EMC immunity: BS EN61000-6-2

STANDARD ACCURACY		OPTION A ACCURACY		TEMPERATURE RANGE
inHg	mbar	inHg	mbar	
±0.015	±0.5	±0.015	±0.5	at 68°F
±0.030	±1.0	±0.015	±0.5	14° to 122°F
±0.059	±2.0	±0.030	±1.0	-4° to 140°F
±0.074	±2.5	±0.059	±2.0	-40° to 140°F

Physical Specification

Weight
4.5 ounces (125 grams)

Pressure Connection
10-32 UNF with barbed hose fitting

Electrical Connection
Terminal block connector

External Trigger On/Off voltage
On: 1 to 24 Vdc
Off: 0 Vdc

CALIBRATION STANDARDS

Pressure transducers manufactured by Druck are calibrated against precision pressure calibration equipment which is traceable to international standards.

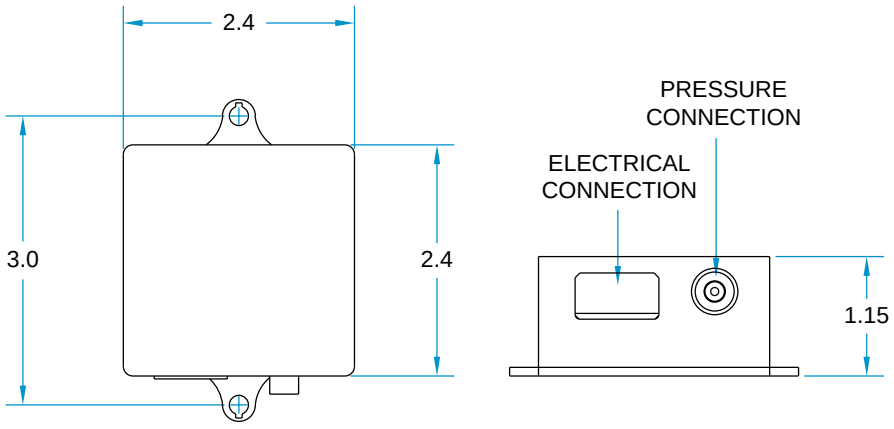
ORDERING INFORMATION

Please state the following:
(1) Model number RPT 410F or RPT 410V
(2) Pressure range and units
(3) Accuracy Option A (if required)
(4) Output voltage (RPT 410V only)

Continuing development sometimes necessitates specification changes without notice.

Druck is an ISO 9001 registered company.

INSTALLATION DRAWINGS: Dimension in inches



PIN No.	Frequency Version	Voltage Version
1	Frequency out	Positive output
2	Positive supply	Positive supply
3	Negative supply	Negative supply
4	-	Negative output
5	External trigger	External trigger

Druck Incorporated
4 Dunham Drive
New Fairfield, CT 06812
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http://www.pressure.com

Representative

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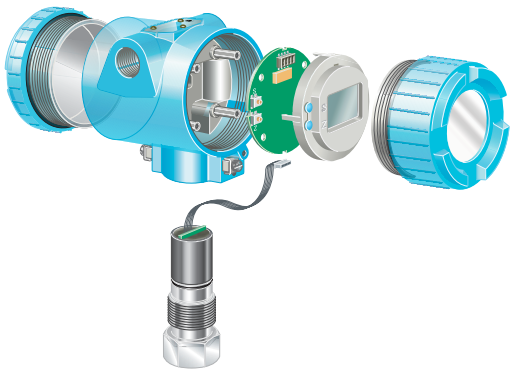
9.4.12 RTX1000 Series Rangeable Pressure HART® Transmitters

(8 Pages)

GE
Measurement & Control Solutions

RTX 1000 Series

Versatile Transmitters for a World of Pressure



GE Measurement & Control Solutions is renowned for the design and manufacture of compact and rugged high performance pressure sensors and related products for extremely accurate and reliable measurements.

To adjust span, the RTX 1000 uses a simple set-up routine using push buttons located on the electronics board. When calibration is complete, a switch locks the push buttons out of the main circuit, eliminating this potential source of drift to ensure optimum long term operational stability.

The RTX 1000H extends the range to include a fully rangeable transmitter utilizing the industry standard HART® protocol. This provides enhanced performance and digital two-way communication. In addition, any span can be set within a 1:1 to 100:1 ratio of the pressure module upper range limit (URL).

Features

- URL's from 10 psi to 20,000 psi (700 mbar to 1400 bar)
- Up to 100:1 rangeability
- 'Best in class' performance
- Hastelloy C diaphragm supplied as standard
- Aluminum or stainless electronics housing
- NAMUR compliant alarm outputs

Proven Technologies

GE has its own comprehensive and technologically advanced silicon processing facility. Silicon has excellent performance characteristics and is readily adapted for many applications, from process and subsea to race car and aerospace.

RTX 1000 Flexibility

The RTX 1000 series provides a choice of user rangeable pressure transmitters with HART® digital signal superimposed (RTX 1000 H). Offering turndowns up to 100:1 and ranging from 0.3 psi to 20,000 psi, the RTX 1000 covers the widest range of gauge and absolute pressure applications available on the market.

High Performance

The RTX 1000 provides accuracy up to 0.075% including non-linearity, hysteresis and repeatability effects. This helps the user to achieve optimum process efficiency and ultimate product quality.

Ease of Use

Zero/span push buttons and a simple configuration routine reduce user set-up and calibration time. A separate terminal on the terminal block allows a meter to be connected to check calibration without breaking into the 4-20mA loop.

Low Cost of Ownership

The RTX 1000 offers high value performance and reliable long term service. For example, 5 year stability is better than 0.2%, keeping recalibration checks and process downtime to a minimum.

Media Compatibility

A Hastelloy C276 diaphragm and 316L stainless steel pressure port are supplied as standard for compatibility with a wide range of hostile media. For severe or hygienic process conditions, an all Hastelloy C276 or all Inconel 625 pressure port can be supplied..

Harsh Environments

The optional stainless steel electronics housing is cost-effective for applications such as offshore oil and gas or in hygienic environments such as food and beverage or pharmaceutical facilities.

Sensing Excellence

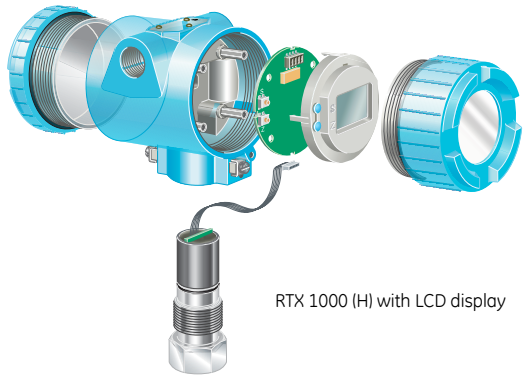
At the heart of the instrument is a micro-machined silicon sensing element. Micro-machining defines the thickness and area of the silicon which forms the pressure sensitive diaphragm and a fully active four-arm strain gauge bridge is diffused into the appropriate regions. Silicon has excellent mechanical properties being perfectly elastic and free from hysteresis, and the 'atomically' diffused gauges provide high output signals and high overload capabilities.

The basic sensor is housed within a high integrity glass to metal seal, providing both electrical and physical isolation from the pressure media. The Hastelloy isolation diaphragm is electron beam welded to this seal and transmits applied pressure to the sensor via a silicone fluid filling.

Intelligent Electronics

The electronics assembly utilizes microprocessor technology to create a compact circuit with the minimum of components while producing an extremely stable signal unaffected by shifts in ambient temperature. User selectable switches provide direct access to damping adjustment, high or low failure alarm and write protection to inhibit any unauthorized change of instrument configuration.

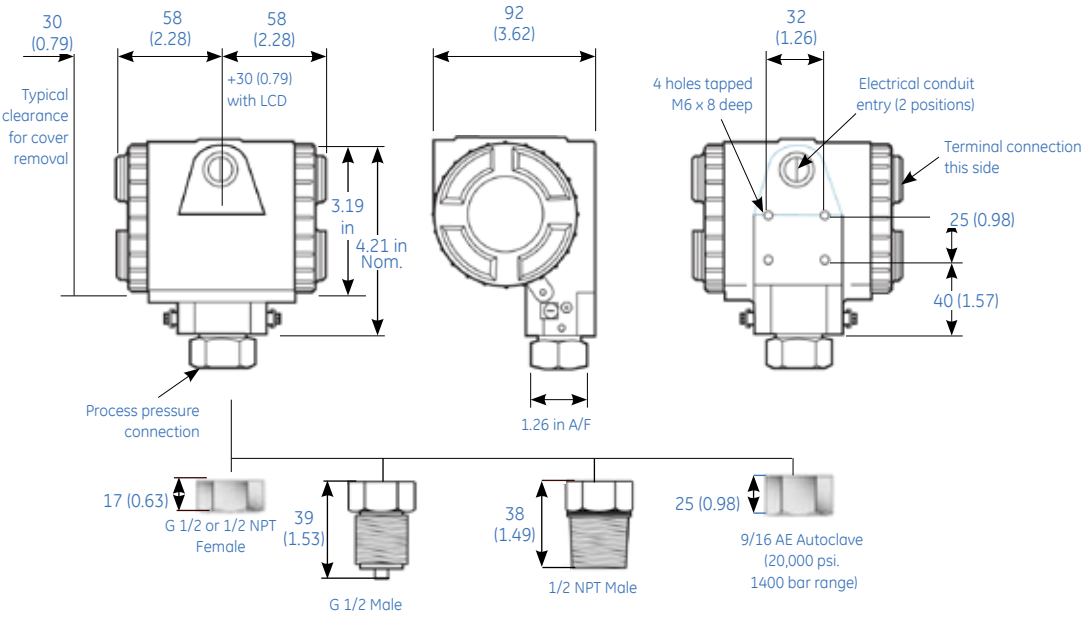
The electronics are enclosed in a compact and lightweight aluminum alloy housing which, in most cases, enables direct mounting to the process, eliminating the need for additional hardware. Alternatively, a stainless steel housing is available.



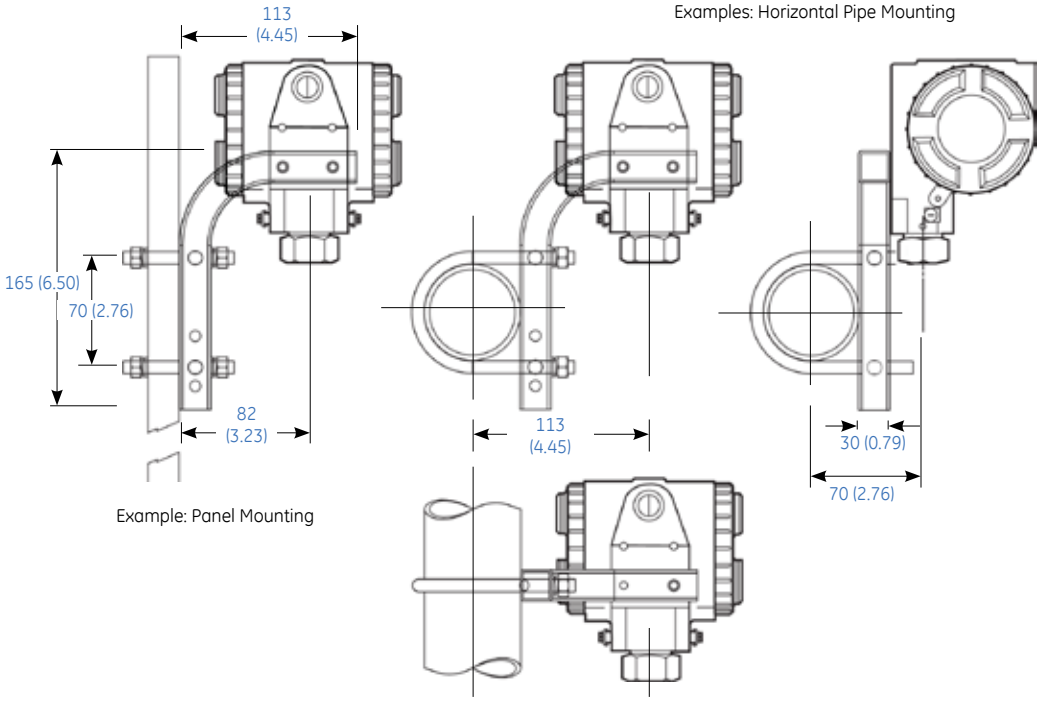
RTX 1000 (H) with LCD display

4-20 mA Pressure Transmitters

Installation Drawings



Installation - With Optional Mounting Bracket



Note: All dimensions in mm (inches).

Standard Specifications

Pressure Measurement

Pressure Ranges
Standard ranges which can be calibrated to intermediate span/pressure unit:
0 to 10 psi (700 mbar) gauge or absolute (RTX 1000A and RTX 1010A only)
0 to 30 psi (2 bar) gauge or absolute
0 to 100 psi (7 bar) gauge or absolute
0 to 300 psi (20 bar) gauge or absolute
0 to 1000 psi (70 bar) gauge or absolute
0 to 3000 psi (200 bar) sealed gauge or absolute
0 to 10,000 psi (700 bar) sealed gauge or absolute
0 to 20,000 psi (1400 bar) sealed gauge or absolute

Range Adjustment
Full 4 - 20mA output change for any user span setting within Upper Range Limit (URL) as below:

RTX 1000A: 10 - 100% URL
RTX 1000H: 1 - 100% URL
e.g. RTX 1000 H: 30 psi (2 bar) device can be adjusted down to a span of 0.3 psi (0.02 bar) (100:1 down ranging)

Zero offset - for absolute configurations:
RTX 1000A: 0 - 90% URL
RTX 1000H: 0 - 99% URL
For gauge configurations, the zero (4 mA) output can be set anywhere within the range below:
RTX 1000A: -15 psi (-1 bar) to 90% URL
RTX 1000H: -15 psi (-1 bar) to 99% URL
e.g., 30 psi (2 bar) gauge device can be set 4-20 mA for -15 to 15 psi (-1 to 1 bar). Down ranged to 3 psi (0.2 bar) span, 4-20 mA can be set anywhere within range to a zero offset of 26 psi (1.8 bar), e.g., calibrated range of 26 to 30 psi (1.8 to 2 bar). See Ordering Information for exceptions.

Overpressure
Rated pressure can be exceeded by the following multiples without degrading performance:
6x URL for 10 psi (700 mbar) range
4x URL 2000 psi (135 bar) max for ranges 30 psi (2 bar) to 1000 psi (70 bar)
2x URL 13,000 psi (900 bar) max for ranges 3000 psi (200 bar) to 10,000 psi (700 bar)
29,000 psi (2000 bar) max for range 20,000 psi (1400 bar)

Pressure Containment
High pressure application as below may damage sensor but process media leakage will not occur:

10x URL for 10 psi (700 mbar) gauge range

6x URL 3000 psi (200 bar) max ranges 30 psi (2 bar) to 1000 psi (700 bar) gauge
3000 psi (200 bar) for ranges up to 1000 psi (70 bar) absolute
20,000 psi (1400 bar) for ranges 3000 to 10,000 psi (200 to 700 bar) sealed gauge or absolute
30,000 psi (2100 bar) for range 20,000 psi (1400 bar) sealed gauge or absolute

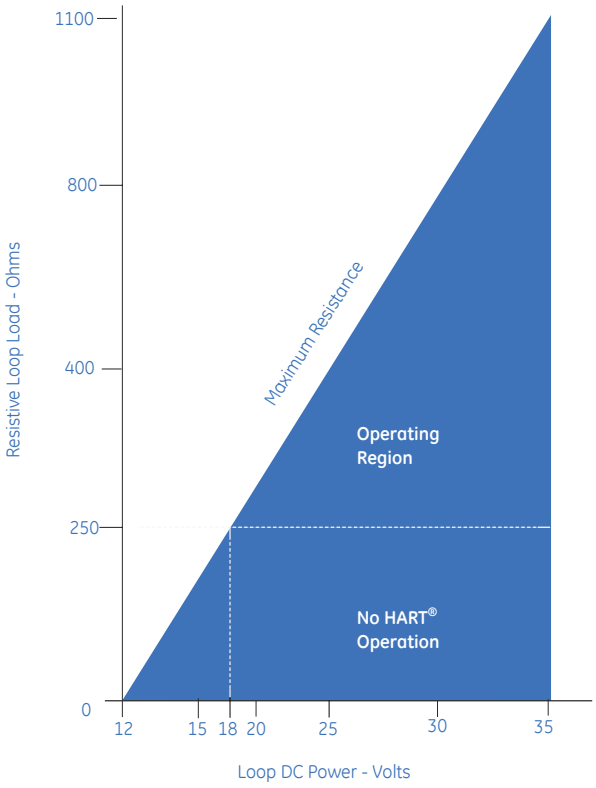
Process Media
Any liquid, gas or vapor compatible with Hastelloy C276 diaphragm and 316 stainless steel or Hastelloy C276 body. NB. 20,000 psi range: compatible with Inconel 625. RTX1010 and RTX1020 models constructed from materials compliant with NACE MR 0175.

Output Current
4 - 20mA (2 wire configuration).
RTX 1000 H:- HART® digital signal superimposed.

Failure Mode (NAMUR NE 43 compliant)
If pressure is applied outside upper or lower range settings, output saturates at Under Range 3.8 mA Over Range 20.5mA. Display flashes out of range.

In the event of failure, output will be driven to <3.6mA or >21 mA (user configurable) and, if installed, the display will confirm the alarm status.

Transmitter Supply Voltage



Performance

Accuracy - RTX 1000A:
0.15% Span (including the effects of non-linearity, hysteresis and repeatability)

Accuracy - RTX 1000H:
For calibrated Span >= 10% URL: 0.075% Span including non-linearity, hysteresis and repeatability.
For calibrated Span < 10% URL:
(0.025% + 0.005 [URL/Span])% Span

Long Term Stability
At standard reference conditions, maximum calibration change 0.2% URL over a 5 year period.

Time Response
100 ms time constant (63% response to step change in pressure with damping set to 0.1 sec).

Operating Temperature Ranges

Ambient	-40° to 185°F* (-40 to 85°C)
Process	-40° to 250°F (-40 to 120°C)
Compensated	-40° to 185°F (-40 to 85°C)
*(LCD option	-4° to 160°F (-20 to 70°C)

Temperature Effects - RTX 1000A:
Over -40° to -4°F (-40° to 20°C), 0.5% URL + 1% Span
-4° to 120°F (20° to 50°C), 0.25% URL + 0.75% Span
Over 120° to 185°F (50° to 85°C), 0.5% URL +1% Span

Temperature Effects - RTX 1000H:
-40°F to 185°F (-40°C to 85°C), maximum output deviation from room temperature calibration at 72°F (23°C): 0.1% configured span+0.2% reading+0.1% URL *(Reading expressed as % of configured span).*

Mounting Position Effect
Negligible effect for ranges < 10 psi (700 mbar), the 'g' offset effect can be adjusted via zero controls.

Vibration Resistance
Negligible effect at 5g from 5Hz to 2kHz.

Humidity Limit
0-100% RH.

Damping
RTX 1000H: Adjustable 0.1 to 30 seconds.
RTX 1000A: 0.1 or 1 second (switch-selectable)

Physical

Electrical Connections
1/2 - 14 NPT, PG13.5 or M20 Female conduit entry.

Process Connections
Ranges up to 10,000 psi: G 1/2 Female,
1/2 NPT Female
20,000 psi range 13/16"- 16 UN Female with 60° cone (9/16" AE medium tube autoclave fitting).
G 1/2 male to BS EN 837-1 (DIN 16288)
1/2" NPT Male

Electrical Housing
Low copper aluminium alloy with epoxy painted coating or stainless steel. Sealed to NEMA 4X (IP 67).

Shipping Weight
Aluminium Housing: 2.7 lbs (without options)
Stainless Steel Housing: 6 lbs (without options).

Hazardous Area Approvals

(O) None

(I) ATEX Intrinsically Safe
II 1G Ex ia IIC Ga T4 (-40°C ≤ Ta ≤ +80°C)
Ex ia IIC Ga T5 (-40°C ≤ Ta ≤ +40°C)
II 2D Ex tb IIIC T120°C Db IP6X (-40°C ≤ Ta ≤ +80°C)

(D) ATEX Flameproof
II 2G Ex d IIC T5 Gb (-40°C ≤ Ta ≤ +80°C)
II 2D Ex tb IIIC T120°C Db IP6X (-40°C ≤ Ta ≤ +80°C)

(F) FM and CSA

Intrinsically Safe:	Class I Division 1 Groups A, B, C, D
	Class II Division 1 Groups E,F,G
	Class III, Division 1
	T3A (80°C max), T4 (40°C max)
Explosionproof:	Class I, Division 1, Groups A, B, C, D
	Class II, Division 1, Groups E, F, G
	Class III, Division 1
	T5 (80°C max)
Non-incendive:	Class I, Division 2, Groups A,B,C,D
	Class II, Division 2, Groups F, G
	Class III, Division 2
	T5 (80°C max), T6 (40°C max)

CE Marking
Product is CE marked for electromagnetic compatibility directive 2004/108/EC, pressure equipment directive 97/23/EC, and on hazardous area approval options I and D, use in potentially explosive atmospheres 94/9/EC.
EMC: BS EN 61000-6-1: 2007, BS EN 61000-6-2: 2005, BS EN 61000-6-3: 2007, BS EN 61000-6-4: 2007, BS EN 61326-1: 2006, BS EN 61326-2-3: 2006.
PED: Pressure accessory, Category I.
"Maximum Span" range is equivalent to maximum working pressure (Ps) as referred to in the PED.

Options

(A) Digital indicator: RTX 1000H: Graphic display;
RTX 1000A: 5 Digit LCD Indicator.
(B) Mounting bracket for 2" pipe/panel, supplied in 316 stainless steel.
(C) Material traceability for pressure containment parts to EN 10204 Type 3.1 material certification.

Calibration Standards

Products manufactured by GE Measurement & Control Solutions are calibrated against precision calibration equipment which is traceable to International Standards.

Continuing development sometimes means specification changes without notice.

Ordering Information

1) Model Number

Please determine the specific model number required by appropriate selection from the following coded areas (example is given below):

RTX 10 Base Model Number

Code	Diaphragm	Process Wetted body	Fill Fluid
00	Hastelloy C*	316 Stainless Steel*	Silicone Oil
10	Hastelloy C*	Hastelloy C*	Silicone Oil
20	Inconel 625	Inconel 625	Silicone Oil

Code	Output
A	4 - 20 mA
H	4 - 20 mA + HART

Code	Max Span	Min Span (Code A)	Min Span (Code H)
04	0-700 mbar (0 - 10 psi)	50 mbar (0.75 psi) for Gauge 100 mbar (1.5 psi) for Absolute	N/A
07	0-2 bar (0 - 30 psi)	200 mbar (3 psi)	50 mbar (0.75 psi) for Gauge, 100 mbar (1.5 psi) for Absolute
10	0-7 bar (0 - 100 psi)	700 mbar (10 psi)	70 mbar (1 psi) for Gauge, 100 mbar (1.5 psi) for Absolute
13	0-20 bar (0 - 300 psi)	2 bar (30 psi)	200 mbar (3 psi)
16	0-70 bar (0 - 1,000 psi)	7 bar (100 psi)	700 mbar (10 psi)
18	0-200 bar (0 - 3,000 psi)	20 bar (300 psi)	2 bar (30 psi)
22	0-700 bar (0 - 10,000 psi)	70 bar (1,000 psi)	7 bar (100 psi)
24	0-1400 bar (0 - 20,000 psi)*	140 bar (2,000 psi)	14 bar (200 psi)

Code	Type
A	Absolute
G	Gauge (sealed gauge for ranges above 70 bar (1000 psi)

Code	Process Connection
1	G1/2 female
2	1/2 - 14 NPT female
3	G1/2 male to BS EN 837-1 (DIN 16288)
4	1/2" NPT male
5	9/16 AE medium pressure tube autoclave fitting*

Code	Electrical Entry
M	M20 female
N	1/2 - 14 NPT female (via adaptor)
P	PG 13.5 female (via adaptor)

Code	Electronics Housing
O	Aluminium Alloy
S	Stainless Steel

Code	Approval
O	None
I	ATEX Intrinsically Safe
D	ATEX Flameproof
F	FM/CSA Intrinsically Safe / Explosion Proof / Non Incendive**

Code	Options
O	None
LA	Digital Indicator (with output code A
LH	Digital Indicator (with output code H)
B	Mounting Bracket
T	EN 10204 Type 3.1 Material Certification

RTX 10 00 H - 07 - G - 2 - N - O - D - LHB Typical Model Number

* For pressure range 1400 bar (20,000 psi) units, specify RTX 1020x-24-x-5-x-x-x-xxx.
For 20,000 psi device (range code 24) diaphragm and process wetted body is Inconel 625.
Available with process connection code 5 only and approvals options O or I.
Process connection code 5/Autoclave fitting applies to range code 24 (0 - 20,000 psi) only

** Approval code F (FM, CSA) requires electrical entry code N (1/2 - 14 NPT female)

In addition to the specific model number, the following must be specified:

2) Regional Configuration

Options:

Europe — The content of the user manual, calibration certificate (and ATEX hazardous area installation instructions if required), are localized for the European market. The maximum working pressure (MWP) is specified and marked in "bar". Only ATEX hazardous location approvals are available (as an option).

North America — The content of the user manual, calibration certificate (and CSA and FM hazardous area installation instructions if required) are localized for the North American market. The maximum working pressure (MWP) is specified and marked in "psi". Only CSA and FM hazardous location approvals are available (as an option).

Note: The unit of measurement for the configured (calibrated) span may be different to that for the MWP. Refer to the Pressure Range Units section below for available options.

Note: Customers requiring no hazardous area approval may choose either the European or North American regional configuration.

Note: The available hazardous locations approvals are defined in the "Hazardous Area Approvals" section of the datasheet.

3) Output Configuration

Also known as "ranging," this is used to set the 4-20 mA span, calibration units and optional LCD.

If different values than zero-based and maximum span as defined in specific model code are required, values need to be specified in accordance with the following instructions.

RTX10*0H

The RTX10*0H is generally downrangeable 100:1 (refer to the table below for exceptions), so the Pressure Lower Range Value (LRV) (4 mA) and Pressure Upper Range Value (URV) (20 mA) points should be chosen anywhere in the range -1 bar to MWP observing the following rules:

1. URV - LRV >= 1% MWP
2. If reverse output is required, then LRV > URV (and LRV - URV >= 1% MWP).

Pressure Range Code	MWP	Max. downranging Ratio (Min. Pressure)
07G	2 bar/30 psi G	40:1 (50 mbar/0.75 psi)
07A	2 bar/30 psi A	20:1 (100 mbar/1.5 psi)
10G	7 bar/100 psi G	100:1 (70 mbar/1 psi)
10A	7 bar/100 psi A	70:1 (100 mbar/1.5 psi)
13*	20 bar/300 psi	100:1 (200 mbar/3 psi)
16*	70 bar/1,000 psi	100:1 (700 mbar/10 psi)
18*	200 bar/3,000 psi	100:1 (2 bar/30 psi)
22*	700 bar/10,000 psi	100:1 (7 bar/100 psi)
24*	1400 bar/20,000 psi	100:1 (14 bar/200 psi)

*G-Gauge, A - Absolute, * - Gauge, Sealed Gauge or Absolute*

RTX10*0A

The RTX10*0A is generally downrangeable 10:1 (refer to the table below for exceptions), so the Pressure LRV (4 mA) and Pressure URV (20 mA) points should be chosen anywhere in the range -1 bar to MWP observing the following rules:

1. URV - LRV >= 10% MWP
2. If reverse output is required, then LRV > URV (and LRV - URV >= 10% MWP).

Pressure Range Code	MWP	Max. Downranging Ratio (Min. Pressure)
04G	700 mbar/10 psi G	14:1 (50 mbar/0.75 psi)
04A	700 mbar/10 psi A	7:1 (100 mbar/1.5 psi)
07*	2 bar/30 psi	10:1 (200 mbar/3 psi)
10*	7 bar/100 psi	10:1 (700 mbar/10 psi)
13*	20 bar/300 psi	10:1 (2 bar/30 psi)
16*	70 bar/1,000 psi	10:1 (7 bar/100 psi)
18*	200 bar/3,000 psi	10:1 (20 bar/300 psi)
22*	700 bar/10,000 psi	10:1 (70 bar/1,000 psi)
24*	1400 bar/20,000 psi	10:1 (140 bar/2,000 psi)

*G-Gauge, A - Absolute, * - Gauge, Sealed Gauge or Absolute*

4) Pressure Units

RTX10*0H

Any of the following units may be chosen:

HART Code	Units	HART Code	Units
1	inH_2O @ 68°F	9	g/cm^2
2	inHg @ 0°C	10	kg/cm^2
3	ftH_2O @ 68°F	11	Pa
4	mmH_2O @68°F	12	kPa
5	mmHg @ 0°C	13	torr
6	psi	14	atm
7	bar	57	%
8	mbar		

The display (if fitted) is normally configured 0.0—100.0%FS.

RTX10*0A

Any of the following units may be chosen:

- % (default)
- mbar
- bar
- psi
- kPa
- inH_2O
- ftH_2O
- mmH_2O
- mH_2O
- inHg
- mmHg
- kgf/cm^2

The display, if fitted, is normally configured 0.0 — 100.0% FS.

5) ATEX IS/Flameproof Installation Instruction Language

Options: English (Default), Spanish/English, Portuguese/English, French/English, Italian/English, German/English.

6) Optional Pressure Tests:

This test is optional. Omit specifying if not required. If required, test a, b or c is to be specified.

a. 1.1 x Full Scale (URL) for 5 minutes duration. Available on RTX1000A/H, RTX1010A/H and RTX1020A/H.

b. 1.5 x Full Scale (URL) for 5 minutes duration:
Pressure test not to exceed 900 bar (13,000 psi) maximum for RTX1000A/H and RTX1010A/H, 2000 bar (29,000 psi) maximum for RTX1020A/H.

c. Pressure elevated to 1500 bar (22,500 psi) for 5 minutes, reduced to 0 bar (0 psi) for 5 minutes, then raised to 1500 bar (22,500 psi) for 15 minutes: Available on RTX1020A/H (Inconel variant) only.

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9.5 OTHER CONSIDERATIONS

9.4.13 It would be ideal to have a complete analysis of the fluid being monitored in order to determine the exact conversion factor for the depth measurement plus determine what chemicals are present. Chemical analysis will help to determine if corrosion will be a problem. In the absence of this analysis, it is best to figure on the worst case and specify the material of construction. Look in the corrosion tables in the Appendix D and select the material with the best possible chemical compatibility. Titanium is best, with Hastelloy C running a close second. GE Sensing has the capability of manufacturing its depth level pressure sensors from 316 stainless steel/Hastelloy C, or titanium. Experience gained from more than 100,000 depth/level pressure sensors installed worldwide has proven that titanium has the best corrosion track record. Included in this section is an analysis of a GE Sensing level sensor that was made of 316 stainless steel and Hastelloy C. A registered laboratory performed the analysis.

9.4.14 The diameter of the sensor is normally determined by the size of the well or conduit into which it is being installed. GE Sensing's 1830 series sensors have a body diameter of 17.5 mm, which makes it suitable for nearly every application except for the very small pipe.

9.4.15 In a standard installation where the instrumentation is located within a several hundred to a thousand feet, the 4 to 20 mA option is normally used. In some of the battery-operated datalogger applications, the millivolt sensors are used and the power pulsed to the sensor.

9.4.16 Selection of the range can be very subjective. In the case where the pump is being controlled to prevent a dry well, the sensor is normally placed above the pump so that a stop signal can be provided while both the pump and sensor are still submerged. In a monitoring application where the well will see only a small level change, a lower range sensor can be used and only submerged a short distance from the surface of the water. The advantage is the improved accuracy (accuracy is determined as a percentage of the full scale range) and many applications require a sensor to measure levels below 10 feet of H_2O. The GE Sensing 1830 series can measure levels as low as 2.3 feet of H_2O range in a 17.5 mm diameter. Also GE Sensing's advantage is the high overpressure ratings in the low-pressure ranges.

9.4.17 Cable length needs to be at least long enough to enter a termination enclosure. Since the vented cable is relatively expensive, it is normal practice to terminate just above the wellhead and then use conventional cable to complete the circuit to the control panel. It is critical to ensure that a desiccant be used to dry the air that may be breathed into the cable vent or conductors. The GE Sensing STE is designed to protect the vent and cable against moisture ingress.

9.4.18 It is recommended that the professional installer be equipped with a portable pressure calibrator, such as the GE Sensing DPI 610, to set up the entire system.

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10 APPLICATIONS

10.1 Groundwater

10.1.1 Hydrology

In order to understand the characteristics of water below the surface of the earth, the groundwater hydrologist must make a number of sub-surface measurements, which normally require the measurement of water level in a number of wells. The device of choice is the depth/level pressure sensor. This device allows level to be measured, including rate information that can help determine hydraulic conductivity and gradient, specific capacity, specific yield, and many other parameters, which can help define the ground water characteristics in a given geographical region. Since many of these measurements help to define a wide area, GE Sensing's accuracy of better than 0.1%FS is important. In fact, typically the PTX 1830's have better than ±0.04%FS accuracy.

10.1.2 Water Wells

The depth/level pressure sensor is used to monitor the level of water and to prevent dry running of the pump. Normally the sensing system is set up to monitor the level of the water below the datum point. The datum point is often the top of the well casing.

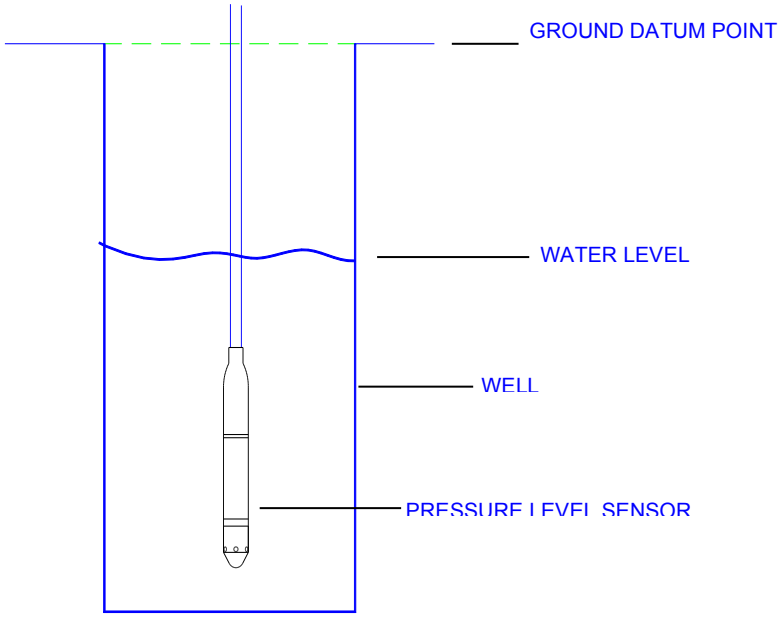


FIGURE 10.1: Water Well

10.1.3 Pump Test and Long-Term Monitoring

Please review Section 3 on measurement accuracy prior to reading this section. This will help clarify potential pitfalls in running a test as accurately as possible.

Pressure sensors have been used in level at least since the mid 1970's when Terra Technology, Inc. first produced the PDL-100 datalogger. This was the first battery-operated portable device for logging pressures at a programmable timed interval. With the advent of this technology came the use of these devices (rather than bubbler tubes or diameters) in well testing applications where a transducer is lowered into the hole and logged with the electronics either at a timed or logarithmic interval to determine well yield. This section of the applications is intended to be a functional guide for anyone laying out a pump test or a long-term monitoring station for installation.

Pumping tests and long pump monitoring regimes are commonplace in hydrologic studies of groundwater, construction de-watering, long-term resource protection and well yield tests. Pressure sensors are well suited for these types of monitoring when configured with electronic monitoring devices (dataloggers). A variety of these systems exist; many will work with the GE Sensing sensor technology. A four-channel datalogger is a nice choice for a four-point pumping test as it will simultaneously monitor 4 sensors at a time, has an integral graphic capability, and can export data from one platform to another.

When performing a pump test, the groundwater scientist must first determine if the wells available are adequate to assess the parameters to be studied. An example would be a study of groundwater movement in an area traversed by a stream and how they interrelate. This may be further complicated by a hazardous waste site in this area and how the pollutants may be migrating in the ground and finding their way to the stream. Once, in the judgment of the professional on site, an adequate number of wells exist, the pump test parameters can be developed and the test equipment assembled and the test undertaken. Typical equipment for such a test would include the following:-

1. Pumps of a sufficient size and capacity to withdraw the estimated cubic meters per minute (m^3/min) as desired.
2. Provisions for discharging the water, a special permit may be required.
3. A set of test equipment to include a water level or dip meter, and enough datalogging and pressure transmitter equipment to monitor all of the wells that are of interest.
4. A spare datalogger and transmitters in case there are any problems. Renting a spare seems wasteful until the time that a datalogger or sensor is damaged and must be replaced; then it is worth its weight in gold.
5. It is important to pre-test the equipment and gain familiarity with it before going into the field.
6. Use all information available to select modeling software or other items that require site information.

Generally pumping tests are undertaken either to determine well-yield, such as a pumping test for municipal

well, or for remediation site planning for well containment, or for industrial sites for injection wells or supply wells.

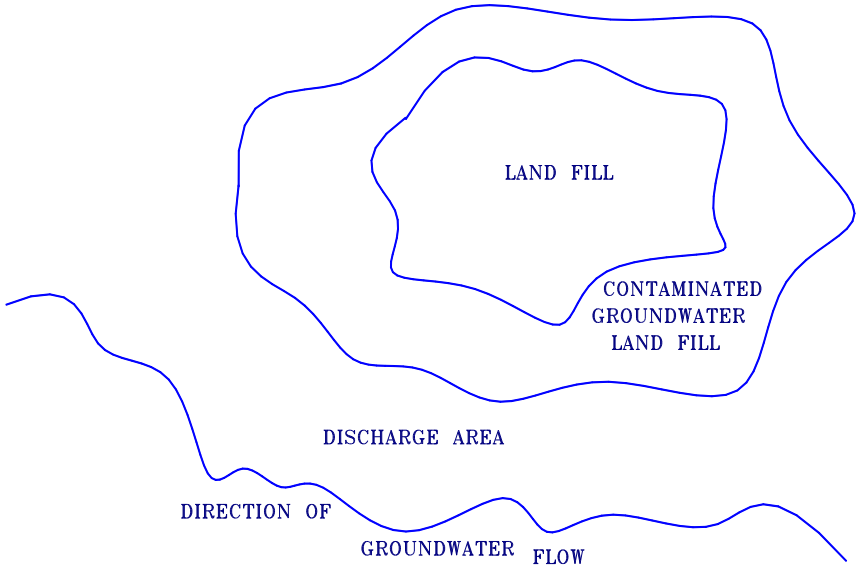


FIGURE 10.2: Example of Groundwater Plumes

10.2 Surface Water

Measurement of surface water is important in a number of applications including flood warning systems, irrigation projects, hydroelectric power installations, lock control in canals, storms sewers, and reservoir monitoring.

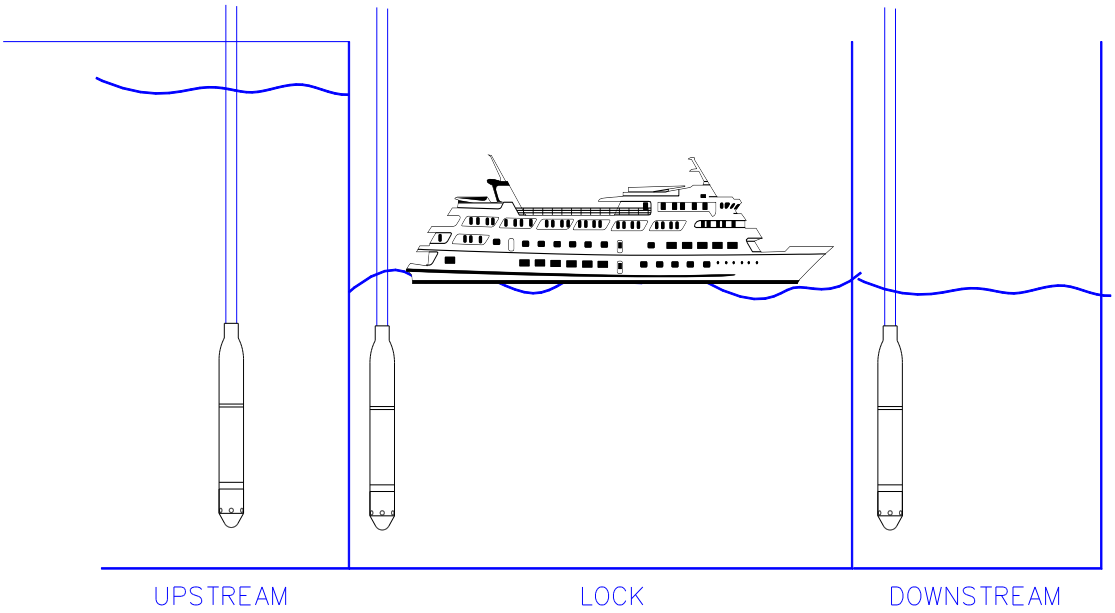
10.2.1 Monitoring of rivers, lakes, dams, and other tributaries is important in predicting potential floods as well as predicting the availability of surface water for use in industrial and municipal water applications.

10.2.2 In the USA, a mathematical model of the watershed has been meticulously built based on the input of thousands of depth/level sensors monitoring every river, and all of their tributaries, coupled with knowledge of snow accumulation. The exact effect of temperature vs. snow/ice melt off, plus what happens when severe rainfall is superimposed, is also factored into the model.

Accuracy is important in maintaining this model at its peak efficiency. Predicting a flood that does not occur can be a serious problem. More importantly, not predicting the flood and giving warning can be a disaster. GE Sensing's 1830 Series depth/level pressure sensors are the most accurate and reliable in the industry. The all-titanium design with its 5-year corrosion warranty and 400% overpressure ensures the reliability of the key element in this complex system.

10.2.3 In most canals, a series of locks are used to allow the ships or boats to traverse elevated areas. The ship approaches the lock and enters at its existing level. The lock doors are then closed and water is either pumped in or out of the lock, raising or lowering the ship to the new level. If the level is different on the outside from the inside of the lock, the doors will be difficult to open. When they are opened, a wave can be generated from the differential levels. If this occurs, it is possible to damage the ship or the locks.

Using three depth sensors will allow the level to be measured and controlled upstream, in the lock, and downstream. The control system will not allow the doors to open unless the levels are within a predetermined range.



TYPICAL CANAL LOCK SYSTEM

FIGURE 10.3

10.2.4 Depth/level is an important measurement in controlling the pumps or valves in irrigation systems. Sometimes the source is from wells and others from lakes or dammed rivers. The extraction is regulated by the control system using the level sensors for input.

10.2.5 Hydroelectric power systems are normally regulated by the hydrostatic head available. The pitch can be varied to take full advantage of the water flow available. The higher the pressure, the steeper the pitch. In some of the smaller applications, a series of level sensors are used to detect a wave, allowing the intakes to be controlled to maximize the benefit of the extra hydrostatic head provided by the wave.

10.3 **Waste Water:** Monitoring and control of waste water is an important application which has its own idiosyncrasies. The sensors have to deal with the possibility of becoming clogged from solids and grease, which makes the design criteria unique.

10.4 Application Note for PTX 1290 Lift Station Pressure Transmitter

In the measurement of water level, one of the most demanding applications is sensing level in a sewage pumping (lift) station. The pumping station is used in flat geographical areas to elevate the effluent to a level that will allow gravity to move it, e.g., in Florida, there are more than 46,000 sewage lift stations, primarily because of the flat terrain.

There are four main methods of measuring the level -

1. Float switches
2. Bubbler systems
3. Ultrasonic Level Transmitters
4. Submersible Pressure Transmitters.

In order to understand the advantages and disadvantages of each of these methods, let us look at a typical lift station. Normally there are 2 or 3 pumps in a lift station. Multiple pumps provide redundancy as well as increased pumping capacity. In recent years, the variable speed pump has become popular. This allows the pumping rate to be varied in order to reduce the wear on each pump. The rate of pumping can also be matched to the rate of in-flow. Measurement of liquid level is critical in order to prevent the pump running dry or to prevent an overflow of sewage. Most municipalities require either 2 or 3 devices to provide redundancy.

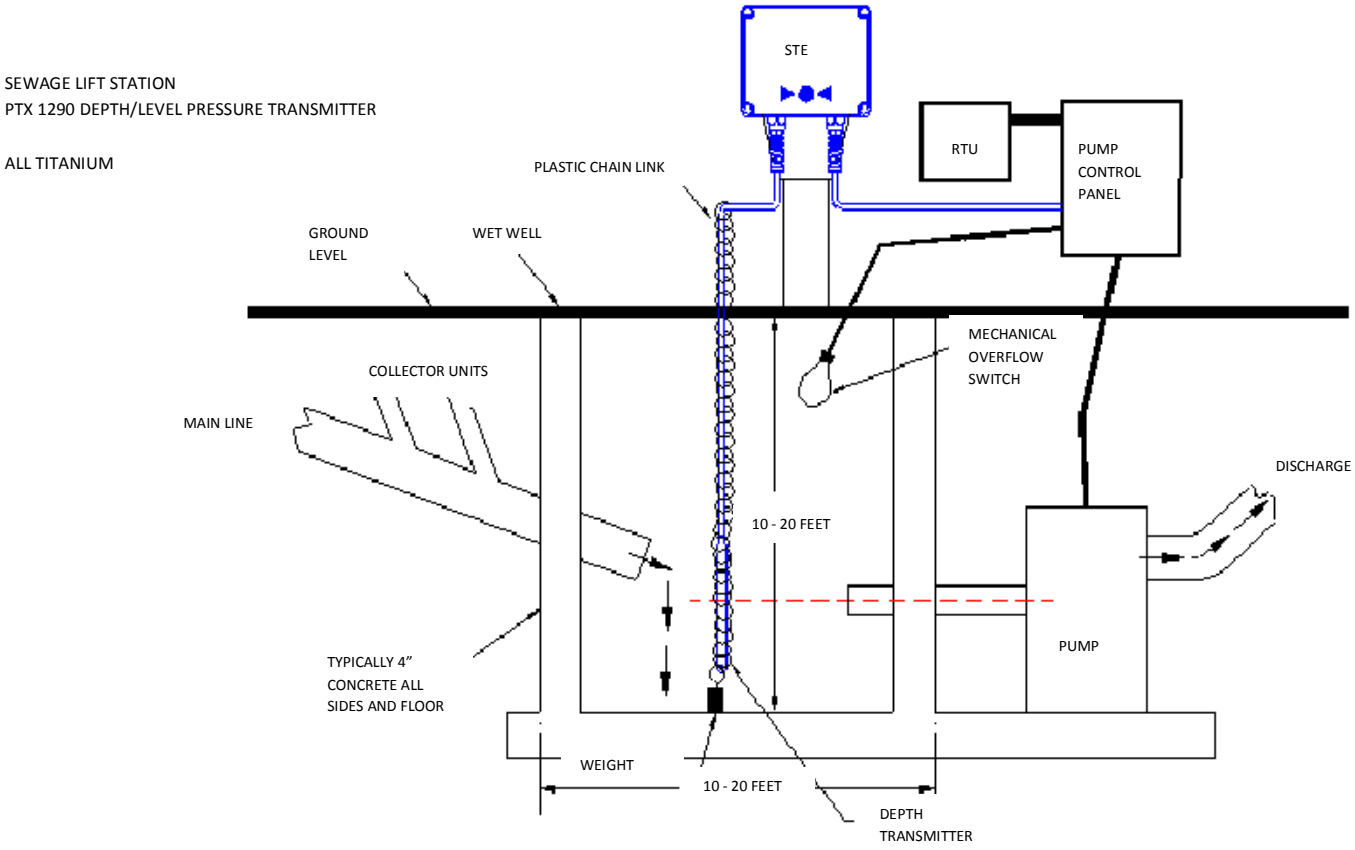


FIGURE 10.4: Sewage Lift Station

The effluent consists of raw sewage that may contain high amounts of grease and bio solids that can clog openings in pressure ports, bubbler tubes, or can cause float switches to hang up. Many times detergents cause foaming, which can cause problems with some types of level measuring devices.

SUBMERSIBLE PRESSURE TRANSMITTERS - are an economical solution to the measurement problem provided that the design eliminates the possibility of clogging by grease or bio solids. The submerged sensor can be located below the grease level near the bottom of the tank. GE Sensing's 1290 series sensors have Teflon-coated elastomeric diaphragm that prevents clogging. The Teflon reduces the likelihood of bio solids sticking to the diaphragm.

PTX-1290
Waste Water Submersible Pressure / Level Transmitter
The submersible pressure transmitter eliminates the foaming problem and is installed below the grease level. No routine maintenance is required other than keeping the desiccant refreshed in the terminal enclosure (every 6 to 12 months change). Of the four methods, the submersible pressure sensor has the lowest cost of ownership and provides the highest reliability.

One major pump manufacturer has come up with a clever installation technique that uses a plastic chain attached to a weight to prevent grease from floating it up. The transmitter cable is threaded through the chain that is dropped in from the top. This makes it easy to retrieve if desired. This replaces the more expensive stilling well that has a notorious reputation for clogging with grease build-up.

10.4.1 Variable speed pumping is a concept, which is normally applied to large pumping stations where a large volume of effluent must be moved. In a conventional installation, the pumps (normally 2 or 3) are switched on when the effluent level reaches a certain point, run at full speed, and then shut off when the level drops below the shut-off point.

In variable speed pumping, the rate of ingress of the effluent is monitored and controlled by bringing 1 or more pumps on line to keep pace with the influx. In this way, the pumps can be run at lower rpm's and only when necessary, thus prolonging the life by a factor of 5 to 10.

The depth/level pressure sensor is ideal for this application because of its ability to monitor rate as well as level. With the proper installation, it is the most cost effective method of sensing level in this application.

APPENDIX A: Pressure Units Conversion Chart

The following page has the chart.

There is also a free iPhone App available from GE Measurement and Control Solutions. Search for “Pressure Converter” and you will find it. It will work on your iPhone and iPad.

Finally, there are numerous unit converters available on-line.

APPENDIX A

PRESSURE UNITS CONVERSION CHART

	PSI	MBAR	BAR	ATM	Kpa	ft H_2O @ 68 F	mm Hg	in Hg @ 68 F	in H_2O	kg/cm^2
PSI	1	68.946	0.0689	460.068	6.895	2.31	51.884	2.043	27.68	0.07
MBAR	0.014	5041	0.001	0.0009	0.1	0.033	0.752	0.029	0.402	0.001
BAR	14.503	1000	1	0.987	100	33.514	752.47	29.625	402.164	1.02
ATM	14.696	1013.24	1.013	1	101.325	33.659	762.48	30.019	407.513	1.033
Kpa	0.145	10	0.01	0.0098	1	0.335	7.525	0.296	4.021	0.01
ft H_2O@68 F	0.433	29.837	0.0298	0.029	2.984	1	22.452	0.884	12	0.029
mm Hg	0.019	1.329	0.00133	0.00135	0.133	0.045	1	0.039	0.534	00133
in Hg @ 68 F	0.489	33.753	0.033753	0.035	3.375	1.131	25.4	1	13.575	0.035
in H_20	27.68	2.486	0.002486	0.00256	0.249	0.833	1.871	0.074	1	.0025
Kg/cm^2	14.233	980.662	0.9806	0.968	98.066	32.867	737.959	29.054	394.508	1

NOTE: CONVERSION FACTORS ARE APPROXIMATE IN MOST CASES

APPENDIX B: Density and Specific Gravity of Water at Various Temperatures

APPENDIX B

DENSITY AND SPECIFIC GRAVITY OF WATER AT VARIOUS TEMPERATURES

TEMP °F	DENSITY (LB/FT3)	SPECIFIC GRAVITY	FT/PSI	PSI/FT
32	64.420	1.033116831	2.235331	0.447361
40	62.430	1.00120279	2.306583	0.433542
50	62.410	1.000882046	2.307323	0.433403
60	62.370	1.000240558	2.308802	0.433125
62	62.355	1	2.309358	0.433021
70	62.300	0.999117954	2.311396	0.432639
80	62.220	0.997834977	2.314368	0.432083
90	62.110	0.996070884	2.318467	0.431319
100	62.000	0.994306792	2.322581	0.430556
110	61.860	0.992061583	2.327837	0.429583
120	61.710	0.989656002	2.333495	0.428542
130	61.550	0.987090049	2.339561	0.427431
140	61.380	0.984363724	2.346041	0.426250
150	61.200	0.981477027	2.352941	0.425000
160	61.000	0.978269585	2.360656	0.423611
170	60.800	0.975062144	2.368421	0.422222
180	60.580	0.971533959	2.377022	0.420694
190	60.360	0.968005773	2.385686	0.419167
200	60.120	0.964156844	2.395210	0.417500
212	59.830	0.959506054	2.406819	0.415486

* REFERENCED TO DENSITY OF WATER AT 62°F

APPENDIX C: Corrosion Paper

THE GENERAL ELECTRIC COMPANY p.l.c.

PLEASE REPLY TO: G.E.C. ENGINEERING RESEARCH CENTRE, CAMBRIDGE ROAD, WHETSTONE, LEICESTER, ENGLAND, LE8 3LH

TELEPHONE: (0533) 863434 TELEX: 341626 GECERC G FACSIMILE: (0533) 865390

1S6150

Mr. C. McKenzie
Druck Ltd.
Fir Tree Lane
Groby
Leicester

Extension 3624

W/ERC(1.5)/DHA/JC

22nd December 1988

Dear Sirs,

CORROSION OF 316L STAINLESS STEEL PRESSURE SENSORS

With reference to the recently received pressure sensors you supplied for metallurgical examination, I enclose our preliminary comments and findings.

Sensor 1

The first sensor was supplied as one half of a longitudinal section which had been acid etched to reveal the weld profile. This acid etching had obviously caused some additional corrosive attack on the component. Regardless of this fact it is apparent that corrosive attack had taken place in service in the stainless steel body under the Hastelloy diaphragm and also at the heat affected zone of the welded joint between the diaphragm and the stainless steel body.

Both the diaphragm and body materials were semi quantitatively examined and identified as Hastelloy and 316 stainless steel respectively.

Sensor 2

This complete sensor was supplied in the condition from which it had been removed from service (see Fig. 1). There was a white crystalline deposit covering the majority of the outside of the sensor body, particularly around the six inlet holes and the base of the device above the 'O' ring grooves (Fig. 1). This deposit has been identified as predominantly chloride salts of magnesium and calcium. Optical examination of the device showed that severe corrosion had occurred at the interface of the base of the component abovethe 'O' ring grooves where it slips into a PVC sleeve (Fig. 1). There was also severe corrosion penetration at localised points around the top two circumferential welds. At one position this corrosion appears to have fully penetrated the wall thickness and led to ingress of sea water into the device. Severe pitting had also occurred on the 316 body under the plastic conical cap screw at the top of the device.

Discussion

It is apparent that general aggressive pitting corrosion has occurred on this device in the stainless steel body during the service of the component.

It is clear that the component has been exposed to a marine environment and such exposure introduces a number of factors not present in atmospheric exposure and therefore the selection of a stainless steel grade for

seawater immersion is more complex. Although type 316 is known to give the best service in seawater, this material is also susceptible to corrosion under certain conditions. For example, in stagnant seawater or low velocity (< 1.5 m/s) water and particularly in contaminated harbours all types of stainless including 316 will pit severely from biofouling, where oxygen in the water is prevented from reaching the bare metal. Corrosion under such conditions can lead to pitting rates in excess of 12mm/year. Biofouling appears to have occurred on those transducers where calcium and magnesium deposits have been identified on the surface. Weldments in unstabilised grades are also subject to localised attack due to the welding process upsetting the heat treatment condition necessary for corrosion resistance. Another possible problem on this transducer is one of crevice corrosion in the interface between the 316 body and the PVC sleeve which fits over the bottom of the device. This appears to have led to accelerated corrosion in this area.

Summary

It would appear from the initial investigation that failure of these transducers has been caused by ingress of water into the device by corrosion of the stainless steel body. The degree of scaling and fouling on the surface and the amount of corrosion indicates that the device has been operating in relatively stagnant water which had led to accelerated pitting corrosion. Under such conditions this grade of stainless steel is not suitable for this application. There are other grades of stainless steel such as AL-6X a 20% Cr 24% Ni steel or SEA-CURE a 26% 2% Ni steel which would be more suitable though not totally immune to attack. It is therefore recommended that a total change of material be undertaken for devices to be used under such corrosive conditions and it is felt that a Titanium alloy would be a more suitable material for such an application.

Yours faithfully,

D.H. Allen
Group Head
Structural Mechanics Division

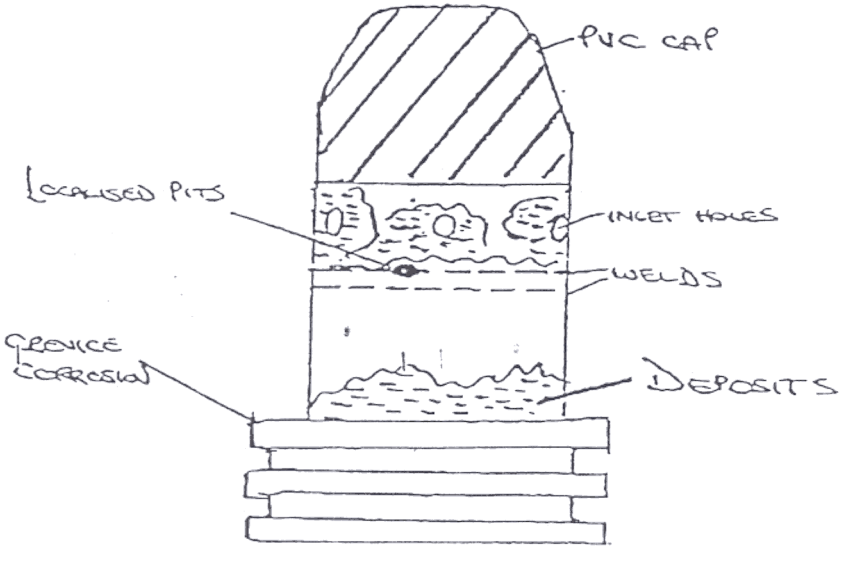


FIG 1

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APPENDIX D: Corrosion Table

APPENDIX D

	CARBON STEEL	316 SS	TITANIUM	NEOPRENE	POLY URETHANE	TEFLON
ACETIC ACID, AIR FREE	C	A	A	C	C	A
ALUMINUM SULFATE	A	C	A	A	?	A
AMMONIUM NITRATE	A	A	A	A	A	A
AMMONIUM PHOSPHATE	D	A	A	A	A	A
AMMONIUM SULFATE	C	B	A	A	A	A
BENZOIC ACID	C	A	A	D	?	A
CALCIUM CHLORIDE (ALKALINE)	?	D	A	A	A	A
CALCIUM HYPOCHLORITE	?	C	A	D	?	A
CARBON DIOXIDE, WET	C	A	A			A
CARBON TETRACHLORIDE	D	B	A	D	D	A
CARBONIC ACID	C	B	A	A	?	A
CHLORINE GAS, WET	D	D	A	D	D	A
CHROMIC ACID	D	B	A	D		A
COPPER SULFATE	C	B	A	A	A	A
FERRIC CHLORIDE	D	D	A	B	B	A
HYDROGEN SULFIDE, LIQUID	C	A	A	B	D	A
NITRIC ACID	C	A	A	B	D	A
SODIUM CHLORIDE	D	C	A	A	A	A
SODIUM HYPOCHLORIDE	D	D	A	A	A	A
SODIUMTHIOSULFATE	B	A	A	A	A	A
SULFURIC ACID	D	D	B	B	B	A
SULFUROUS ACID	D	B	A	B	B	A
VINEGAR	C	A	A	B	B	A
SEAWATER	D	C	A	B	A	A
ZINC CHLORIDE	D	B	A	A	A	A
ZINC SULFATE	C	A	A	A	A	A

A - NO EFFECT

B - MINOR EFFECT

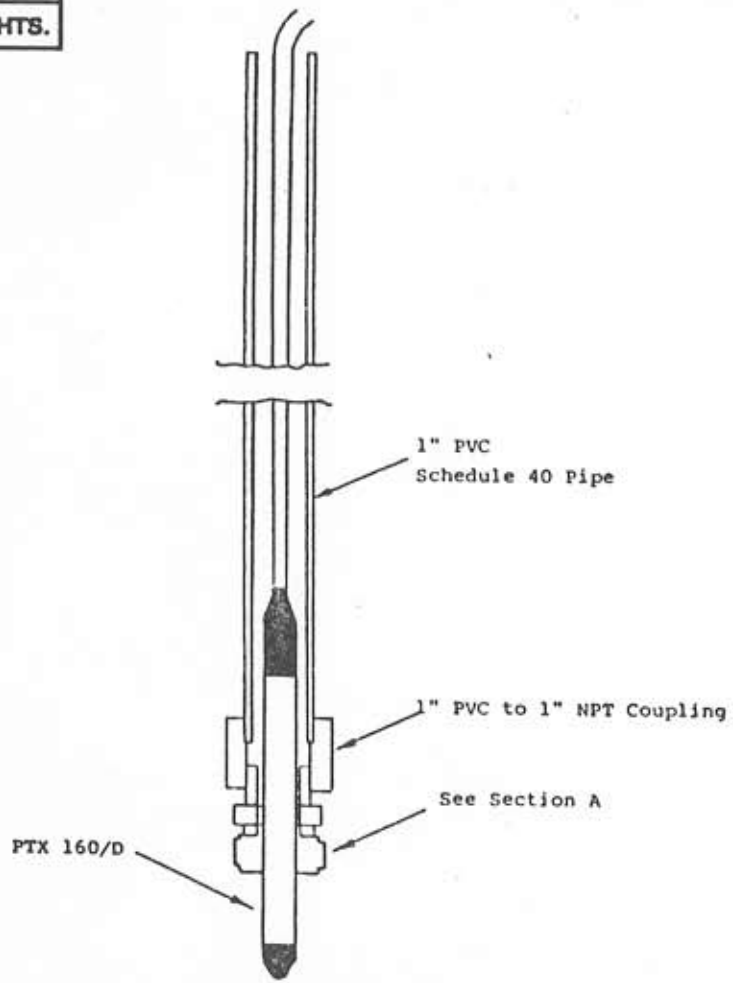
C - MODERATE EFFECT

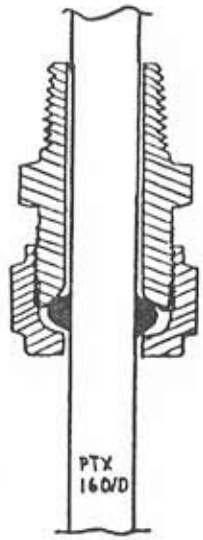
D - SEVERE EFFECT

APPENDIX E:
Still Tubes-Suggested Installation for GE Druck Submersible Pressure Sensors

DRG. No.	USED ON
E—A3—U121	
SHT 1 OF 2 SHTS.	

THIRD ANGLE PROJECTION





SECTION A

Thomas & Betts (T & B)
Portable Cord
Connector

GENERAL TOLERANCE ± U.O.S.
GENERAL DRAWING OFFICE PRACTICE TO B.S. 308

PART No.	DRAWING No.	MATERIAL, REMARKS

Druck Incorporated 4 Dunham Drive New Fairfield, CT 06812	SCALE NTS	ISSUE	-A-
		DRAWN	TAP
	DIMS. IN mm. U.O.S.	CHKD / APPD	
		DATE	11-10-87

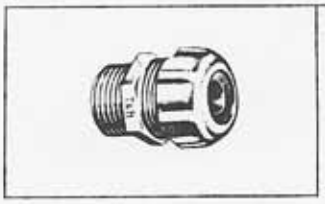
TITLE SUGGESTED INSTALLATION FOR PTX 160/D

DRAWING No. E—A3—U121A SHT 1 OF 2 SHTS

Flexible Cord & Power Cable Connectors

UL File No. E 13938 CSA File No. 589

Liquidtight strain relief connectors



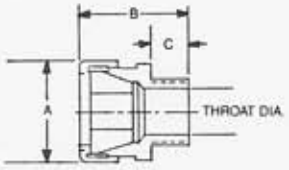


FIG. 1

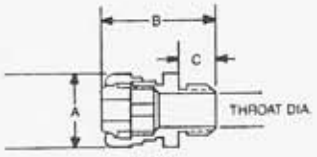


FIG. 2

Cat. No.	Min-Max Cable Size Range	Hub Size	Throat Dia. (Min.)	Fig.	Dimensions, Inches A	B	C
2516†	(.060-.125)	1/4"	23/64"	2	—	—	—
2517†	(.120-.250)	1/4"	23/64"	2	—	—	—
2518†	(.060-.150)	3/8"	29/64"	2	—	—	—
2519†	(.150-.300)	3/8"	29/64"	2	—	—	—
2520	(.125-.250)	1/2"	9/16"	1	1 1/8	1 21/32	9/16
→ 2521	(.250-.375)	1/2"	9/16"	1	1 1/8	1 21/32	9/16
2522	(.375-.500)	1/2"	9/16"	1	1 1/8	1 21/32	9/16
2523	(.450-.560)	1/2"	9/16"	1	1 1/8	1 21/32	9/16
* 2524	(.500-.625)	1/2"	5/8"	1	1 3/8	1 3/4	1 3/32
* 2525	(.625-.750)	1/2"	5/8"	1	1 3/8	1 3/4	1 3/32
2530	(.125-.250)	3/4"	13/16"	1	1 3/8	1 3/4	9/16
2531	(.250-.375)	3/4"	13/16"	1	1 3/8	1 3/4	9/16
2532	(.375-.500)	3/4"	13/16"	1	1 3/8	1 3/4	9/16
2534	(.500-.625)	3/4"	13/16"	1	1 3/8	1 3/4	9/16
2535	(.625-.750)	3/4"	13/16"	1	1 3/8	1 3/4	9/16
* 2536	(.750-.880)	3/4"	3/4"	1	1 3/8	1 15/16	5/8
2541	(.250-.375)	1"	49/64"	1	1 11/16	1 23/32	9/16
2542	(.375-.500)	1"	49/64"	1	1 11/16	1 23/32	9/16
2544	(.500-.625)	1"	49/64"	1	1 11/16	1 23/32	9/16
2545	(.625-.750)	1"	49/64"	1	1 11/16	1 23/32	9/16
2546	(.750-.880)	1"	63/64"	1	1 11/16	1 7/8	9/16
2547	(.875-.985)	1"	63/64"	1	1 11/16	1 7/8	9/16
* 2548	(.880-1.065)	1"	29/32"	1	2 1/16	2 3/8	25/32
* 2549	(1.065-1.205)	1"	29/32"	1	2 1/16	2 3/8	25/32
2558	(.880-1.065)	1 1/4"	1 17/64"	1	2 1/8	2 5/32	5/8
2559	(1.065-1.205)	1 1/4"	1 17/64"	1	2 1/16	2 5/32	5/8
* 2556	(1.187-1.375)	1 1/4"	1 1/4"	1	2 5/16	2 1/2	13/16
* 2557	(1.375-1.485)	1 1/4"	1 1/4"	1	2 5/16	2 1/2	13/16
2562	(.812-1.000)	1 1/2"	1 7/16"	1	2 5/16	2 1/2	13/16
2563	(1.000-1.187)	1 1/2"	1 7/16"	1	2 5/16	2 7/16	1 1/16
2564	(1.187-1.375)	1 1/2"	1 7/16"	1	2 1/4	2 7/16	1 1/16
* 2565	(1.375-1.625)	1 1/2"	1 29/64"	1	2 3/4	2 5/8	13/16
2573	(1.125-1.375)	2"	1 7/8"	1	2 3/4	2 5/8	13/16
2574	(1.375-1.625)	2"	1 7/8"	1	2 3/4	2 5/8	13/16
2575	(1.625-1.875)	2"	1 7/8"	1	2 3/4	3 1/2	13/16
* 2576	(1.750-1.965)	2"	1 29/32"	1	3 1/32	3 1/2	13/16
* 2577	(1.937-2.187)	2"	1 29/32"	1	3 1/32	3 1/2	13/16
2584	(1.750-1.965)	2 1/2"	2"	1	3 1/32	3 3/4	1 1/32
2585	(1.937-2.187)	2 1/2"	2"	1	3 1/32	3 3/4	1 1/32
* 2586	(2.156-2.360)	2 1/2"	2 5/32"	1	3 15/16	4 1/4	1 1/32
* 2587	(2.350-2.565)	2 1/2"	2 5/32"	1	3 15/16	4 1/4	1 1/32
2592	(2.156-2.360)	3"	2 13/32"	1	3 15/16	4 1/4	1 1/32
2593	(2.350-2.565)	3"	2 13/32"	1	3 15/16	4 1/4	1 1/32
2594	(2.535-2.750)	3"	2 13/32"	1	3 15/16	4 1/4	1 1/32
* 2595	(2.735-2.985)	3"	2 13/16"	1	4 1/16	4 13/16	1 1/8
* 2596	(2.970-3.220)	3"	2 13/16"	1	4 1/16	4 13/16	1 1/8

*Remove sufficient outer covering of cable to permit conductors to pass thru connector body.
†UL not applicable

Complies with J.I.C. standards

UL listed as liquid tight strain relief, and outlet bushing. CSA certified watertight.

Available with DURA-PLATE™ finish. See Page 212. Temp. rating 105°C.

Suitable for hazardous locations use in Class I, Div. 2; Class II, Div. 1 and 2; Class III, Div. 1 and 2, where general purpose equipment is specifically permitted per NEC Section 500-2(a).