

Selection Guide for Pressure Transducers

TRANSDUCER MARKETS

The pressure transducer market in general is large and includes devices that are used in appliances, on- and off-road vehicles, medical applications, industrial machinery and many applications in process control. In this guide, we will address some of the general criteria that need to be met in selecting pressure transducers.

Microprocessors

The introduction of the microprocessor into the controls marketplace was the engine that drove the significant expansion of the pressure transducer market over the past 15 years. It has also changed the nature of pressure transducers making it possible and practical to produce smart digital transducers. As more and more OEM's revamped their control systems to take advantage of the micro's power, they found that they needed measurement devices and pressure was one of the key parameters frequently measured.

For the purpose of this guide, the term "transducer" is meant to include not only devices having millivolt and voltage outputs, but also transmitters with a 4-20mA current output signal and/or digital communication signal. In today's competitive environment with ASIC's (Application Specific Integrated Circuits) being used the additional cost of an amplified voltage, current or digital configuration is sometimes minimal.

In most OEM applications the amplified voltage model is generally used because it is very compatible with the microprocessor controls being incorporated into the OEM's product. The 4-20mA output version is very popular in user applications because the current signal can be transmitted long distances throughout a factory with little or no degradation. Digital communication is also very compatible with microprocessor controls and can be transmitted long distances without degradation.

SELECTION CRITERIA

Isolation

One of the first big technical questions is whether the sensor in the transducer needs to be isolated from the media being measured. Generally, if the media is a clean, dry and noncorrosive gas then a non-isolated transducer is acceptable. However, if liquids or nonclean gases are anticipated, then media isolation is required. Frequently, a metal or ceramic diaphragm with appropriate fill fluid is incorporated into the design of the transducer.

Accuracy

When choosing a pressure transducer the next key selection question is the performance level required for the application. The first step is to determine the accuracy needed. Frequently, along with higher accuracy comes improvement in the product's overall performance with temperature changes and over time (stability).

Tech Sheet #I 303

Accuracy applies in laboratory conditions and only at a constant temperature of 23°C. Generally, accuracy includes linearity, hysteresis and repeatability. In many cases, however, accuracy includes the effects of temperature. The linearity may be expressed as terminal point, best-fit straight line, or independent. The most stringent version of linearity is terminal point, but this is rarely used because it shows the largest errors. Most manufacturers use best-fit straight-line approach. The effect is that the specification will look almost two times better than it would using the terminal point method. In selecting the transducer it is important to understand the approach used by the manufacturer.

Temperature Effects

Also it is profoundly important to question the potential supplier on long-term stability and repeatability with time and temperature. This is driven largely by the sensing technology employed in the transducer, and should be investigated by the customer. Some technologies are inherently more stable and repeatable than others. For example, a sputtered thin film sensor usually offers better stability than does a bonded foil or bonded semiconductor sensor. This is because the strain gages are molecularly attached to the insulating layer which is molecularly attached to the force collector diaphragm or beam. This molecular attachment prevents gage slippage during pressure and temperature changes, which results in drift. The presence of organic materials such as epoxy, glue and adhesive in the transduction portion of the sensor can be troublesome because they cause zero and span drift. The pressure and temperature variations that may occur in an application can cause minute changes in the transducer's calibration. This instability will show up eventually as calibration drift.

If the transducer is going to be in a very protected environment with constant temperature and the absence of vibration, shock, RFI and other environmental factors, then the accuracy and long-term stability specifications will define performance against these environmental factors strictly. Frequently, however, industrial transducers are located in some of the most demanding environments, and expected to operate as they do in benign applications. To the extent that transducers have designed-in protection appropriate for the environment and media to be measured, they will perform as expected.

Temperature is a major consideration because this factor has the biggest effect on the transducer's environmental performance. Most manufacturers offer a temperature compensation specification that defines thermal effects over a given range. The performance shown as a coefficient or error band is guaranteed over that temperature range and outside of that range larger errors should be anticipated. Installation techniques can be used to buffer the transducer from excessively high or low temperatures. Also, the customer can frequently minimize the temperature effects if the effects are repeatable.

Vibration and Shock Effects

Vibration and shock are environmental issues that depend upon the application and should also be reviewed.

Electrical Effects

In many industrial and commercial environments walkie-talkies are used frequently. In addition, transducers are often located near large motors and other “noisy” equipment. Many transducers are affected severely by the keying of walkie-talkies. Built-in Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) protection is fast becoming a requirement for usage within today’s operating environments. Also, Electrostatic Discharge (ESD) protects the transducer from static electricity, which can be generated during handling and in the application. “CE” marked products generally have a good measure of RFI, EMI and ESD protection built into the transducer’s electronics.

Hazardous Area Applications

If the transducer is to be used in a hazardous environment, either explosion proof or intrinsically safe approved transducers may be required. Since explosion proof enclosure designs are very expensive and often bulky, intrinsically safe pressure transducers are usually selected for use with approved zener barriers. Hazardous area approvals are granted by type numbers designating the level of approval for various gases.

Form, Fit and Function

Once the appropriate transducer is selected from a performance standpoint there are several form, fit and function parameters that need to be addressed. The pressure port, pressure range, the output and the electrical termination need to be specified in order to define the product.

Process Connections

Pressure ports of 1/8”, 1/4”, 1/2” NPT male and 7/16” male straight thread are common in industrial applications. Applications with low pressure ranges may require hose barbs or simple push on connections. The customer preference is typically dependent upon the industry and application that is being addressed. For example, the 1/8”NPT male is commonly used in the OEM refrigeration market, while the 7/16”-20 SAE male port is frequently requested for hydraulic applications due to its superior sealing capability, minimizing the possibility of leakage.

Pressure Range Considerations

Pressure measured is typically from vacuum to 60,000 psi, in steps with gauge, vacuum, absolute or differential pressure references. More steps afford the ability to match the application’s normal operating pressure point. When selecting a pressure range it is desirable that the normal operating pressure is 50-90% of the pressure range. For example, a 0-100 psig range would be a good selection for normal operation at 50-90 psig. Accuracy is usually a percentage of the total span of the transducer, so that it is desirable to size the transducer with the lowest span possible given that it covers the highest pressure measurement to be encountered. Pressure ranges of the transducer may also affect the type of material the manufacturers use for the wetted parts. Some lower pressure transducers are not compatible with corrosive applications.

Transducer Output Considerations

Transducer outputs usually available are industry standards, such as millivolt, voltage and current signals. Digital outputs with communication capability are available as well. The most common outputs are 0-100mV, 4-20mA, 0-5Vdc and 0-10Vdc. Other outputs are usually the result of the specific requirements of a large volume OEM. The 4-20mA output is the simplest since it is usually a two-wire configuration. The amplified voltage versions are normally three wire with the same common for the supply power and output. However, a differential four-wire version is available from some manufacturers for those customers who require it. This has separate power and output commons. The millivolt output is a four-wire standard Wheatstone bridge output without amplification and with separate power and signals commons.

Electrical Connections

Electrical terminations possible include cable, bendix, DIN style connectors and others. Cable versions are requested from customers who believe that the addition of connectors lessens reliability. Their point is well taken, since some installations - on refrigeration compressors, for example - have significant levels of vibration, which can loosen connectors that have screw terminals, while soldered connectors can be attacked by an ambient corrosive environment. Hirschmann (DIN) connectors, both full size and miniature, have become popular options across the application spectrum, because they offer the convenience of screw terminals and modest cost.

Differential Pressure Transducers

When specifying differential pressure transmitters, it is necessary to consider the line or static pressure to which both sides of the measurement will be exposed and consider the effects caused by that anticipated line pressure. Because of the possibility that full line pressure may be applied accidentally during startup or calibration procedures, it is important to review the specifications if full line pressure is applied to one side of the differential measurement. This is sometimes referred to as the overpressure effect.

Zero and Span Adjustments

The ability of the user to access the zero and span adjustment of the transducer is sometimes a desirable feature, which is available on some pressure transducers. Some transducers have separate adjustment compartments isolated from the electronics. This might allow maintenance to be undertaken in so-called "hot" areas.

Hydraulic Applications

When applying transducers into hydraulic systems it may be necessary to consider the use of a snubber to dampen out hydraulic spikes or "water hammer" from reaching the transducer and over-ranging the sensor and causing it to fail. The presence of high pressure transient pulses is a leading cause of failure for most pressure transducers. Snubber devices installed ahead of the transducer are frequently effective insurance against this potential problem.

Diaphragm Seals

In high temperature, highly viscous or corrosive applications the use of diaphragm seals can isolate the transducer from the damaging media environment. Diaphragm seals can be attached to most pressure transducers.

SUMMARY

Transducer manufacturers have not made the selection process easy for customers because they publish specifications in a non-uniform fashion. It is incumbent on the customer to ask sufficient questions to ferret out the real answers to the questions about stability, repeatability and other performance specifications. Given that customers do this and the above issues are addressed, it becomes more likely that the proper choice of transducer will be made.

SELECTION GUIDE

Pressure range: psi bar kPa "wc" other

Pressure reference: Gauge Absolute Vacuum Differential

Pressure media (will determine if diaphragm isolation and special wetted parts are needed): _____

Excitation: _____ Vdc

Output: 0-100mV 4-20mA 0-5V 0-10V 1-6V 1-11V
 Digital 4 – wire 2 – wire 3-wire 3-wire 3-wire 3-wire

Note: Amplified voltage outputs are available in 4-wire version also.
 Digital outputs must specify protocol and wire configuration.

Accuracy (%FS): +/-1% +/-0.5% +/-0.25% +/-0.1% other

Temperature range: _____ Media _____ Ambient

Static pressure limit (for differential pressure transducers): _____

Pressure port: 1/4"-18NPT male 1/8"-27NPT male 7/16"-20 SAE-J-514 male
 1/2"-14NPT male other

Electrical termination: DIN plug Cable Bendix Conduit Submersible
 other

Environmental extremes: Shock Vibration Corrosive ambient

INSTRUMENT SECTION MEMBERS and WEBSITES

AMETEK, U. S. GAUGE DIVISION

BURKERT FLUID CONTROL SYSTEMS

MID-WEST INSTRUMENT

MOELLER INSTRUMENT CO., INC.

ORANGE RESEARCH

THUEMLING INSTRUMENT GROUP, INC.

TREND INSTRUMENTS INC.

WEISS INSTRUMENTS, INC.

This Tech Sheet was developed by the members of the Fluid Controls Institute (FCI) Instrument Section. FCI is a trade association comprising the leading manufacturers of fluid control and conditioning equipment. FCI Tech Sheets are information tools and should not be used as substitutes for instructions from individual manufacturers. Always consult with individual manufacturers for specific instructions regarding their equipment.