

Pressure Fundamentals and Transmitter Selection



Selection Guide

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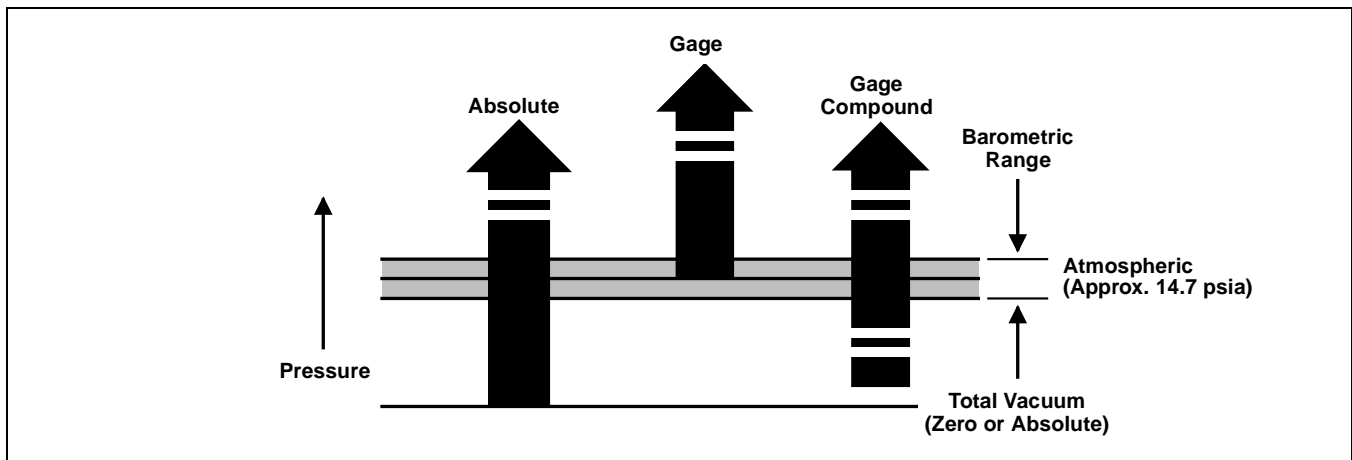


FIGURE 1. Definition of Pressures.

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INTRODUCTION

This document defines pressure and fundamentals of pressure measurement, as they relate to industry, and factors that should be considered in selecting a pressure transmitter. Included are definitions of functional specifications, performance specifications, and material selection, and their relationships to functional performance requirements.

PRESSURE DEFINITION

This section defines pressure as it is pertinent and as it is measured in industry.

General

Pressure is the action of one force against another force. Pressure is force applied to, or distributed over, a surface. The pressure P of a force F distributed over an area A is defined as

$$P = \frac{F}{A}$$

Glossary of Measurable Pressures

Absolute Pressure

Measured above total vacuum or zero absolute. Zero absolute represents total lack of pressure.

Atmospheric Pressure

The pressure exerted by the earth's atmosphere. Atmospheric pressure at sea level is 14.696 psia. The value of atmospheric pressure decreases with increasing altitude.

Barometric Pressure

Same as atmospheric pressure.

Differential Pressure

The difference in magnitude between some pressure value and some reference pressure. In a sense, absolute pressure could be considered as a differential pressure with total vacuum or zero absolute as the reference. Likewise, gage pressure (defined below) could be considered similarly with atmospheric pressure as the reference.

Gage Pressure

The pressure above atmospheric. Represents positive difference between measured pressure and existing atmospheric pressure. Can be converted to absolute by adding actual atmospheric pressure value.

Hydrostatic Pressure

The pressure below a liquid surface exerted by the liquid above.

Line Pressure

Force per unit area exerted on a surface by a fluid flowing parallel to a pipe wall.

Static Pressure

Same as line pressure.

Vacuum

Pressure below atmospheric.

Working Pressure

Same as line pressure.

PRESSURE MEASUREMENT FUNDAMENTALS

This section includes, in a general manner, the constituents of a pressure measurement system. Emphasis is given to electronic pressure transmitters.

General

The measurement of pressure is considered the basic process variable in that it is utilized for measurement of flow (difference of two pressures), level (head or back pressure), and even temperature (fluid pressure in a filled thermal system).

All pressure measurement systems consist of two basic parts: a primary element, which is in contact, directly or indirectly, with the pressure medium and interacts with pressure changes; and a secondary element, which translates this interaction into appropriate values for use in indicating, recording and/or controlling.

Primary Element

The primary element is in contact with the pressure medium, either directly or indirectly, and interacts with pressure changes. The primary element in flow measurements causes the differential pressure, which subsequently results in the flow computation.

The most typical category of primary element used in flow measurement is the head type, which basically is just some form of restriction in a flow line. Other common primary elements include the area type, such as the rotameter and the cylinder and piston methods; the head area type, such as weirs and flumes; and the force type, including target meters and swinging vanes. All these techniques, and others not mentioned, are similar to some extent. Only the basic head type is discussed herein.

Head Type Primary Element

The common types of head primary elements include Venturis, orifice plates, flow nozzles, and pitot tubes. Schematics of each of these head type elements are shown in Figure 2.

These elements all work on the theory (Bernoulli's) that the total energy at any point in a pipeline or conduit is equal to the total energy at any other point, if friction losses between the two points are ignored. Without going into detail, this means that there is a definite relationship between process velocity and static pressure on either side of some restriction. Again by-passing the details, this leads to the capability of determining a flow rate simply by measuring the pressure difference across a restriction (assuming other parameters with "constant" values are known).

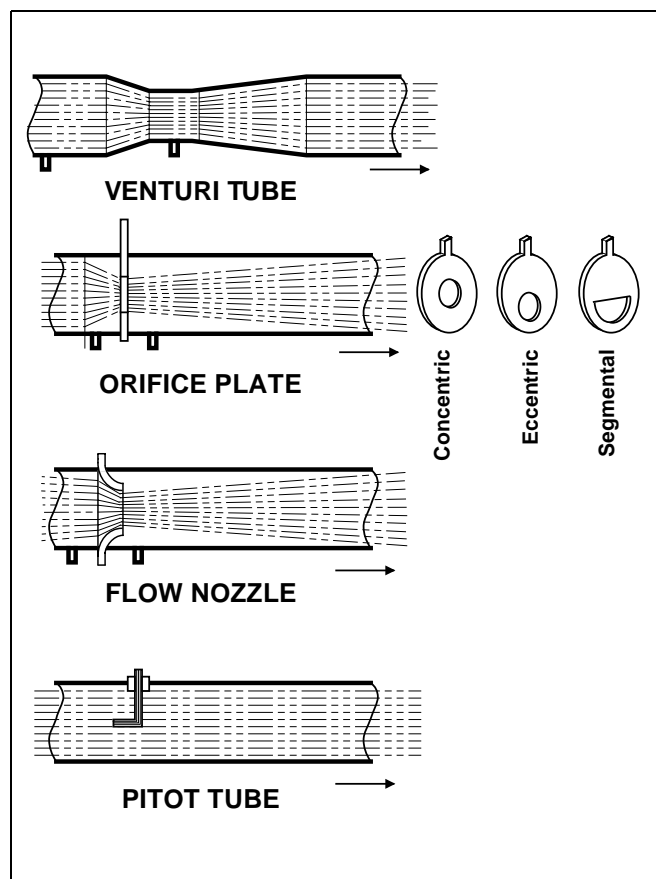


FIGURE 2. Head-Type Elements.

The Venturi tube produces a relatively large differential with a relatively small head loss. This element is often used where the process contains large amounts of suspended solids or if large head losses are unacceptable.

Orifice plates are widely used in industrial applications. They are effectively utilized for "clean" fluid flow measurement and where line pressure losses or pumping costs are not critical.

A flow nozzle is in a sense an orifice with a flared approach section. Line pressure loss is between that of an orifice and a Venturi, as is generally the cost. Often flow nozzles are used at the end of a pipe, discharging directly into the air, a tank, etc.

Pitot tubes are used when fluid velocity is of prime concern. Very small pressure losses are incurred, and they are relatively inexpensive, but they are very susceptible to plugging with processes containing solids.

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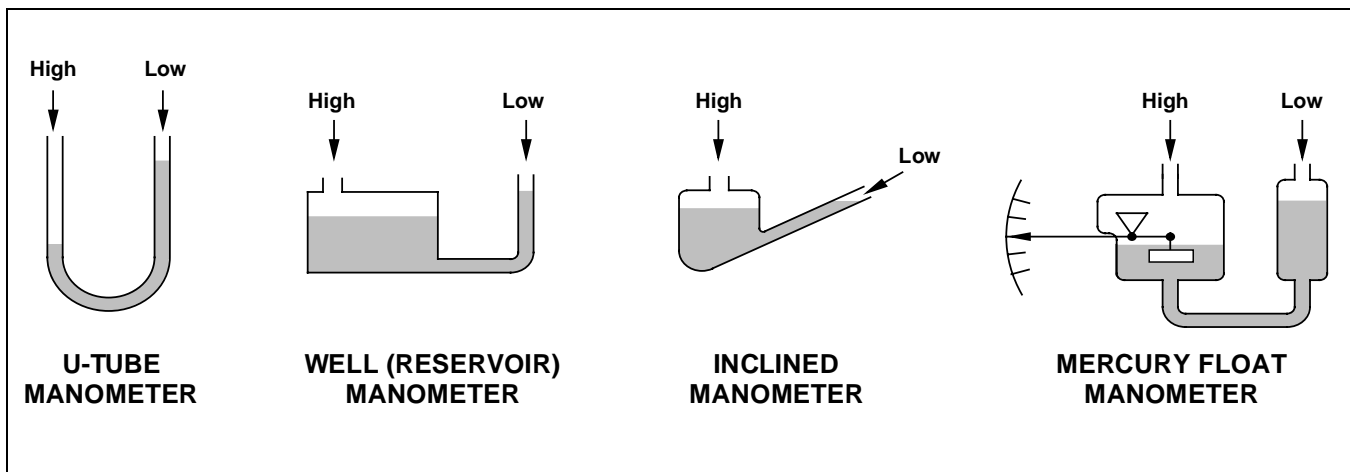


FIGURE 3. Manometers.

Secondary Element

The secondary element of a pressure measurement system translates the interaction of the primary element with the pressure medium into appropriate values for use in indicating, recording, and/or controlling.

Secondary elements in a general sense can be considered as wet meters or as dry meters. Wet meters, using this terminology, would be those elements with which the process fluid itself is in contact with liquid (commonly mercury) in the device. Dry meters use no liquid for contact with the process fluid.

Wet Meters

Wet meters include the oldest and simplest pressure indication method in industry—the liquid manometer. Where static pressures are low and only visual indication is required, visual manometers are used. Figure 3 shows the simple U-tube, well (or reservoir), and inclined manometers, respectively. Their similarity is obvious.

Where high pressures exist, mercury is often used as the liquid. Figure 3 also shows a typical mercury float-type manometer. Here the position of a float on the surface of the mercury defines the level of the mercury, which in turn defines the pressure required to give this level.

There are many other related “wet meter” techniques to use in pressure measurements, such as the inverted bell meter, and the ring balance meter.

Dry Meters

Dry (sometimes called mercuryless) meters are generally used where a direct operated indication or record of the differential pressure is required and where sealing fluids are harmful to the process. The bellows type, whereby a pressure across a bellows compresses a calibrated range spring which, ultimately, through links and levers, drives a pen on an instrument chart, is often used. The most widely used instrument, though, is the pressure transmitter.

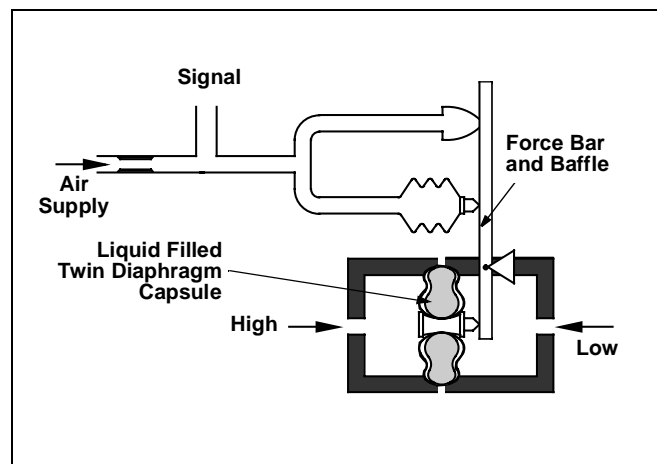


FIGURE 4. Pneumatic Transmitter.

Pressure Transmitters

The pressure transmitter is widely used where indication and/or a record of pressure is required at a location not adjacent to the primary element, and where overall high performance is mandatory. Both pneumatic and electronic transmissions are used.

Figure 4 shows a typical pneumatic transmitter. Here, the differential pressure to be measured is applied across a pair of metal diaphragms welded to opposite sides of a capsule; the space between the diaphragms and core member is filled with liquid. The force developed on the diaphragm by differential pressure is brought out of the transmitters by a rigid rod passing through a metal seal diaphragm. This force is opposed by a balancing force developed by pneumatic bellows. Imbalance between capsule force and pneumatic bellows force is sensed by a pneumatic nozzle-baffle. A simple pneumatic servomechanism responsive to nozzle pressure re-establishes the balance. As a result, pneumatic pressure is maintained exactly proportional to differential pressure and is used as output signal; a more or less standardized signals is 3 to 15 pounds per square inch.

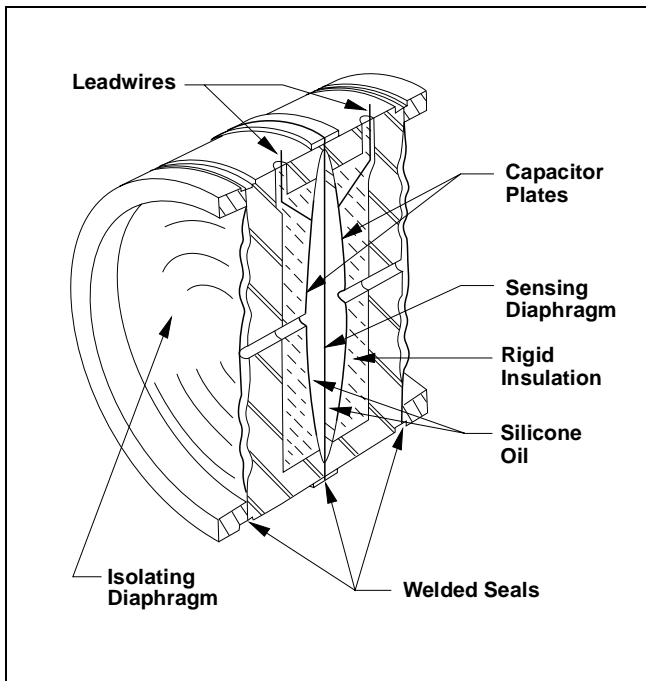


FIGURE 5. Electronic Transmitter.

An electronic-type transmitter is shown in Figure 5. This particular type utilizes a two-wire capacitance technique. Process pressure is transmitted through isolating diaphragms and silicone oil fill fluid to a sensing diaphragm in the center of the cell. The sensing diaphragm is a stretched spring element that deflects in response to differential pressure across it. The displacement of the sensing diaphragm is proportional to the differential pressure. The position of the sensing diaphragm is detected by capacitor plates on both sides of the sensing diaphragm. The differential capacitance between the sensing diaphragm and the capacitor plates is converted electronically to a 4–20 mA dc or 10–50 mA dc signal; these signals are standard in industry, with primary emphasis on 4–20 mA dc.

The mechanical element techniques most generally used to convert applied pressures into displacement are diaphragms, bellows, Bourdon tubes, and straight tubes. These devices are depicted in Figure 6. Diaphragm types include flat, corrugated, and capsule designs, and the Bourdon types include circular and twisted tube designs.

Theoretically, the flat diaphragm type shown in Figure 6, will exhibit the highest natural frequency value, defined by the following relationship:

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{M}}$$

(f_n = natural frequency, K = max. stiffness,
 M = min. mass)

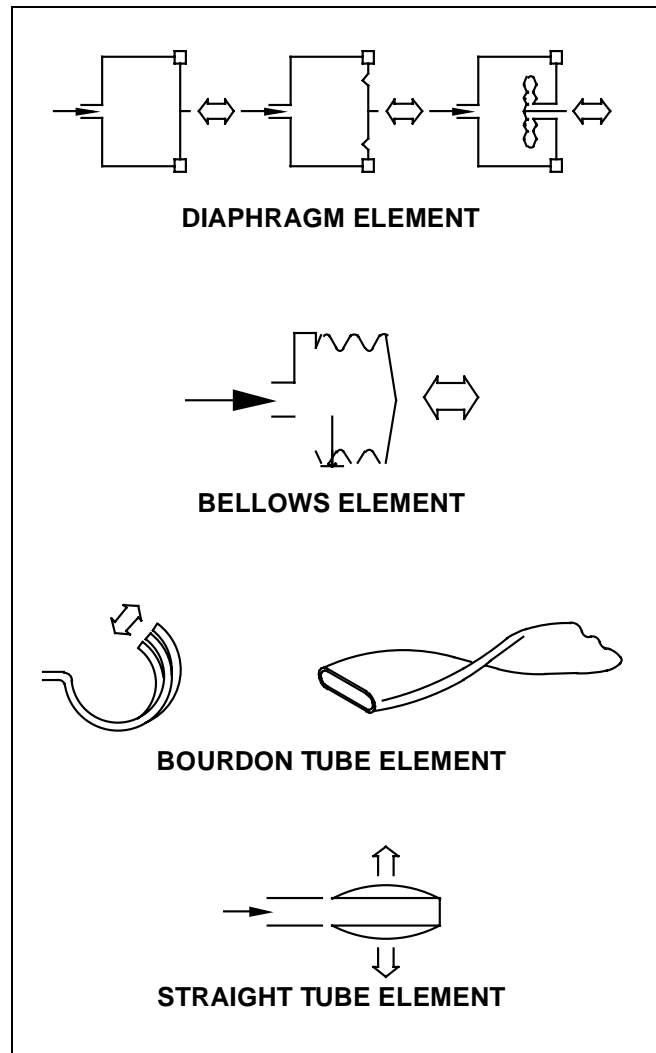


FIGURE 6. Mechanical Element Techniques.

This equation defines the natural frequency in a conventional seismic system processing one degree of freedom. Relating to this consideration, the sensitivity to vibratory or static acceleration increases in direct proportion to the total mass of the system and in inverse proportion to the total stiffness. The flat diaphragm type is characterized by having both, for a given diaphragm thickness, maximum stiffness (K) and minimum mass (M).

The above analysis pertains to the natural frequency only. The frequency response of a transducer cannot always be estimated easily in relation to the preceding paragraph.

Proper consideration must be given to the total volumetric displacement, dead volume, and constrictive orifices in the pressure port cavity. The amount of damping present also influences the frequency response.

It should be kept in mind that in many types of transducers, the electrical elements contribute to the overall values of the spring constant and mass, which determine the natural frequency. If a constant range is assumed, the type of force-summing member is generally dictated by the force and displacement necessary to actuate the transduction elements.

The electrical principles applied to the measurement of pressure displacement are many and varied. The great majority of transmitters employ one of the following:

| | |
|--------------------------|----------------|
| Capacitance | Photoelectric |
| Differential Transformer | Piezoelectric |
| Electrokinetic | Potentiometric |
| Force Balance | Reluctance |
| Inductive | Resistance |
| Ionization | Strain Gage |
| Magnetostrictive | Thermoelectric |
| Ohmstrictive | Vacuum Tube |
| Oscillating | |

No in-depth discussion of the above principles is presented herein as that would nearly require a text-book in itself. Each principle has certain advantages and disadvantages, however, but not necessarily with an equal mixture or ratio.

TRANSMITTER SELECTION

This section presents a number of considerations that should be viewed in selecting a transmitter. They include functional specifications, performance specifications, material selection and desirable features. Also included are the definitions of these specifications and the relationship to functional and performance requirements.

Functional Specifications

Temperatures

Both the maximum process and ambient temperatures need to be considered. Often the process temperature will exceed the limits of the sensing element. The sensing element of most electronic pressure transmitters will not operate properly above 225 °F (107 °C). This will require the use of good impulse piping practices to get the transmitter temperature back within operating limits. High ambient temperatures on solid state electronics adversely affect component life. Most electronics are not rated for service above 200 °F (93 °C) and there are many components with a 185 °F (85 °C) rating. High temperatures tend to cause more electronic failures. Again, it is good engineering practice to keep the electronics package as cool as possible.

Winterizing, either by steam tracing, electrical heaters, or heater controlled enclosures may also be a consideration.

Pressure

Both the operating pressure range and the maximum pressure should be considered. Gage pressure transmitters should have an overpressure rating of at least 150 percent of the maximum rating operating pressure with no other ill effect than having to recalibrate.

The minimum pressure should also be considered. As part of the normal operation, a vacuum may be applied. Many transmitters have to be ordered special to obtain this capability.

On differential pressure transmitters, overpressure may be accidentally applied to either the high or low side of the unit when a three-valve manifold is mis-sequenced. High overpressure capability eliminates a possible shut-down while the unit is being recalibrated or repaired.

The static line pressure for differential transmitters should also be called out. Units are available on the market with standard line pressure capability from 500 to 6,000 psi.

Environment

The transmitter should be capable of operating in environments with 0 to 100% relative humidity.

The working fluid and the ambient environment should be considered for corrosiveness. For instance, transmitters used on offshore oil rigs are subject to corrosion from salt water. Another example is a transmitter in a steam or cooling water system in the vicinity of acids or bases that tend to get into the atmosphere. The above applications have a non-corrosive working fluid, and a very corrosive ambient environment.

Hazardous Locations

Use of Instruments in Hazardous Locations:

The Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA), Subpart S, Electrical Considerations, has been in effect since 15 February, 1972. The purpose of OSHA is to accelerate the adoption of national standards for occupational safety. The Act gives the Secretary of Labor two years to promulgate the adoption of such standards.

All electrical instruments or electrical equipment used in hazardous locations must now be approved. Equipment or an installation is acceptable to the Assistant Secretary of Labor, and approved within the meaning of Subpart S if it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory, such as, but not limited to, Underwriters Laboratories Inc. and Factory Mutual Engineering Corp.

Definition of Hazardous Locations:**Class I, Division I**

Locations in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions.

Class I, Division II

Locations in which volatile flammable gases are handled, processed or used, but in which the hazardous liquids, vapors or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such systems or containers, or in case of abnormal operation of equipment.

Class II Locations

Locations which are hazardous because of the presence of combustible dust.

Class III Locations

Locations in which easily ignitable fibers or materials producing combustible flyings are present.

Group A

Atmospheres containing acetylene.

Group B

Atmospheres containing hydrogen or gases or vapors of equivalent hazards such as manufactured gas.

Group C

Atmospheres containing ethyl ether vapors, ethylene, or cyclopropane.

Group D

Atmospheres containing gasoline, hexane, naphtha, benzene, butane, alcohol, benzol, lacquer solvent vapors, or natural gases.

Group E

Atmospheres containing metal dust, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics.

Group F

Atmospheres containing carbon black coal or coke dust.

Group G

Atmospheres containing flour, starch, or grain dusts.

Explosion-Proof Enclosure

Explosion-proof enclosure means an enclosure for electrical apparatus which is capable of withstanding, without damage, an explosion which may occur within it, of a specified gas or vapor, and capable of preventing ignition of a specified gas or vapor surrounding the enclosure from sparks or flames from the explosion of the specified gas or vapor within the enclosure.

To make a system explosion-proof, the enclosure must be capable of withstanding an explosion, and the system must be installed per the national electrical code for hazardous locations.

Intrinsically Safe Equipment

Intrinsically safe equipment and wiring are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions will include accidental damage to any part of the equipment or wiring, insulation, or other failure of electrical components, application of overvoltage, adjustment and maintenance operations, and other similar conditions.

Equipment built for this requirement is designed with low energy storage components as outlined in ISA procedure RP12-2.

Several advantages to the intrinsic safety approach are listed below. These advantages have to be weighed against the initial higher purchase price. Today it is estimated that 60 percent of these types of installations are classified as intrinsically safe.

- Lower installation cost
- Less operator-dependent to maintain a safe system
- Easier to maintain and repair
- Accessible to repair without special precautions before opening the unit

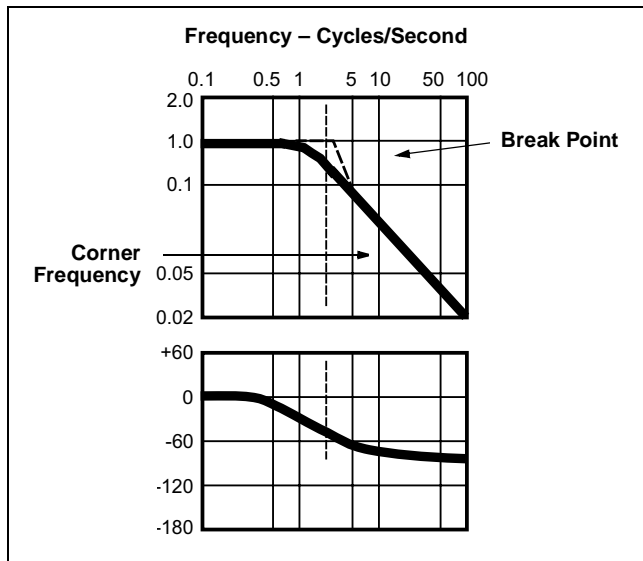


FIGURE 7. Typical Bode Diagram.

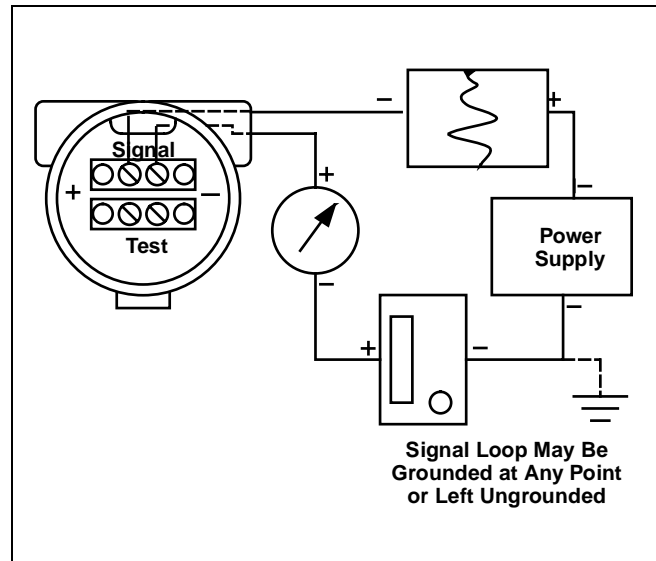


FIGURE 8. Two-Wire Schematic.

Damping

In some applications, pumps or other process noise pulses must be damped out to get good control or indication. The more the unit is damped, as specified by the corner frequency, the slower the response time. In other cases where the system dynamics require a fast transmitter response for best performance. A review of the specific application is necessary to determine the requirements for adequate performance. However, in most cases this is not a serious problem.

Damping is defined in terms of corner frequency or “time constant.” Corner frequency is the junction of two confluent straight line segments of a plotted curve (see Figure 7). In a first-order system, the frequency at which the magnitude ratio is down 3db.

$$db = \frac{20 \log E_O}{E_{in}}$$

For the output of a first order system forced by a step or an impulse, the time constant is the time required to complete 63.2 percent of the total rise or decay. In a Bode diagram, the breakpoint or corner frequency occurs where:

$$f_c = \frac{1}{2\pi T}$$

(T = time constant, f_c = corner frequency)

Output

The standard output for two-wire transmitters is 4–20 mA dc or 10–50 mA dc. There are also four-wire transmitters that can provide zero-based voltage signals. The most common is 0–5 V dc. Three-wire transmitters are also available, which can provide a 4–20 mA dc, 10–50 mA dc, or zero-based signal.

The two-wire device, as the name implies, only has two wires to the transmitters. These wires are used for both power and signal (see Figure 8). The two-wire unit requires an external dc voltage power supply.

The three-wire device also requires an external dc voltage power supply with one lead as common for both signal and power.

The four-wire device has two wires for signal and two for power. The power required is usually 115 V ac, and the unit has a built-in transformer, rectifier, and regulator.

TABLE 1. Illustrations of the Use of Range and Span Terminology.

| Typical Ranges | Name | Range | Lower Range Value | Upper Range Value | Span | Supplementary Data |
|---|-----------------------|-------------|-------------------|-------------------|------|-------------------------|
|  | — | 0 to 100 | 0 | 100 | 100 | — |
|  | Suppressed Zero Range | 20 to 100 | 20 | 100 | 80 | Suppressed Ratio = 0.25 |
|  | Elevated Zero Range | -25 to 100 | -25 | 100 | 125 | — |
|  | Elevated Zero Range | -100 to 0 | -100 | 0 | 100 | — |
|  | Elevated Zero Range | -100 to -20 | -100 | -20 | 80 | — |

Zero Elevation or Suppression

Zero Elevation—for an elevated zero range, the amount the measure variable zero is above the lower range value. It may be expressed either in units of measured variables or in percent of span (see Table 1).

Zero Suppression—for a suppressed zero range, the amount the measured variable zero is below the lower range value. It may be expressed either in units of the measured variable, or in percent of span (see Table 1).

Gage pressure ranges are usually expressed in pounds per square inch gage (i.e., 0–100 psig). The range may have a suppressed zero (i.e., 50 to 100 psig), or it may be a compound range (i.e., 20 inHg vacuum to 50 psig).

Absolute ranges are usually expressed in inches of mercury absolute or psia (i.e., 0–30 HgA or 0–100 psia). The most common range with a suppressed zero is the barometric range (i.e., 28 to 32 inHgA).

Power Supply and Load Limits

The choice of a power supply for two-wire transmitters will depend on the load. Most transmitters are capable of operating over a wide range of load limits (see Figure 9).

Wiring should consist of twisted pairs. Most transmitters do not require shielding, but it is recommended to eliminate noise pickup from electric motors, inverters, or other noise generating electrical equipment in the area getting into the receiver.

The size of the wire is usually not critical; 18-gauge is usually sufficient. The resistance of the wire adds to the total load, and in most cases simply requires a power supply of sufficient voltage to handle the entire voltage drop across the system.

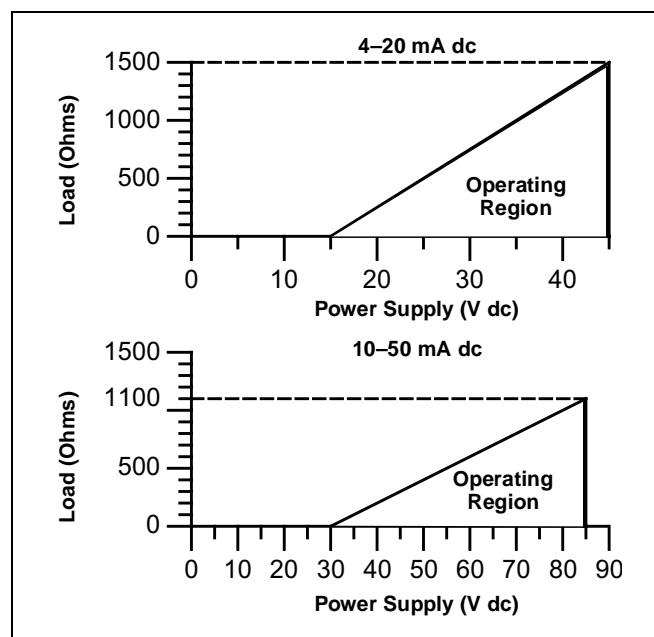


FIGURE 9. Load Limitations.

Special considerations should be given when using computers, especially where sampling times are short. Electronic transmitters often have internally generated driving frequencies, which may show up as high frequency noise on the output. As an example, assume the sample time is 85 microseconds, and assume some 50 kHz frequency noise on the line, which would have an equivalent period of approximately 6.4 microseconds. The integration time to average out this noise is only 13.4 cycles. This does not allow enough time to completely integrate a high level noise. If it is significantly high, a filter should be considered.

Performance Specifications

To evaluate the performance specifications of a transmitter and be able to compare the specifications of various manufacturers, their definitions must be understood. Until a few years ago, there were few industry-accepted standards, and specifications were sketchy. In 1970, the “Scientific Apparatus Makers Association,” SAMA, published a Control Terminology Standard (Ref. 3). The review of performance specifications includes a discussion taken from the above terminology standard, along with those performance specifications to be given consideration.

Accuracy

As a performance specification, accuracy shall be assumed to mean reference accuracy unless otherwise stated.

Accuracy as expressed in the above standard terminology does not include any mention of a time base. It also does not include the effects of temperature. Accuracy is basically the type of performance you would expect to achieve on a bench check in the laboratory.

Reference Accuracy

Reference accuracy is a number or quantity that defines the limit that errors will not exceed when the device is used under reference operating conditions.

Reference accuracy includes the combined linearity, hysteresis, and repeatability errors. The units being used are to be stated explicitly. It is preferred that a \pm sign precede the number or quality. The absence of a sign infers a \pm sign.

Reference accuracy can be expressed in the following forms:

- ± 1 °F
- $\pm 0.5\%$ of upper range value
- $\pm 0.5\%$ of calibrated span
- $\pm 1\%$ of actual output reading

Reference Operating Conditions

Reference operating conditions specify the range of operating conditions of a device, within which operating influences are negligible. The range is usually narrow. It does not include the effects of ambient temperature, humidity, vibration, or shock (see Figure 10).

Linearity

Linearity is the closeness to which a curve approximates a straight line. Expressed as independent linearity, terminal-based linearity or zero-based linearity. When expressed simply as linearity, it is assumed to be independent linearity.

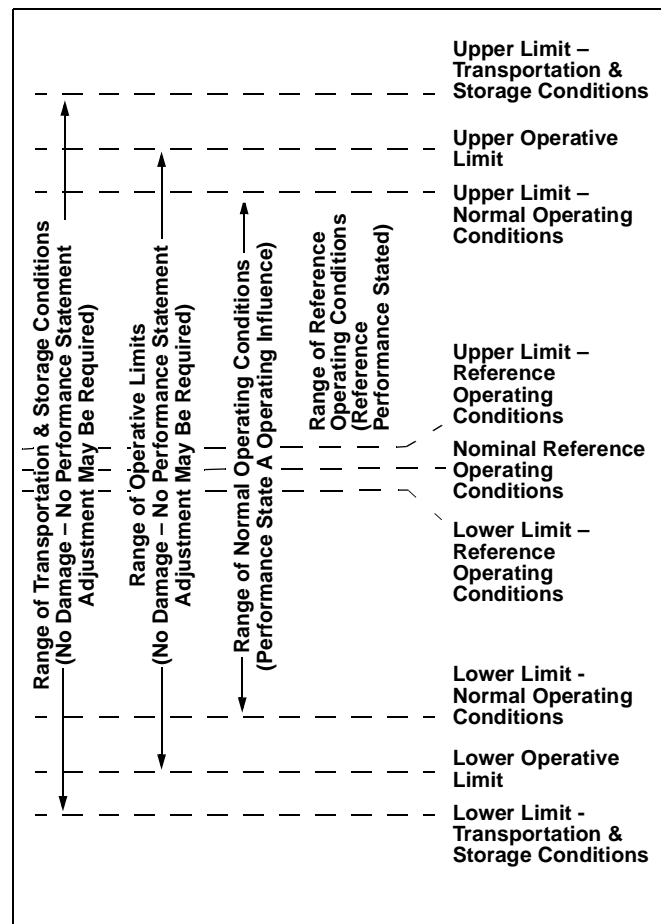


FIGURE 10. Diagram of Operating Conditions.

Independent Linearity

Independent linearity is the maximum deviation of the actual characteristic from a straight line so positioned as to minimize the maximum deviation (see Figure 11).

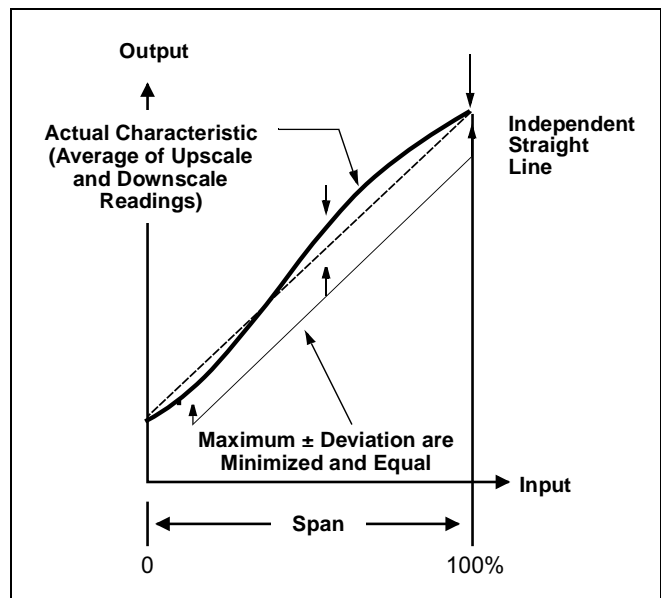


FIGURE 11. Independent Linearity.

Zero-Based Linearity

Zero-based linearity is the maximum deviation of the actual characteristic from a straight line so positioned as to coincide with the actual characteristic at the lower range value and to minimize the maximum deviation (see Figure 12).

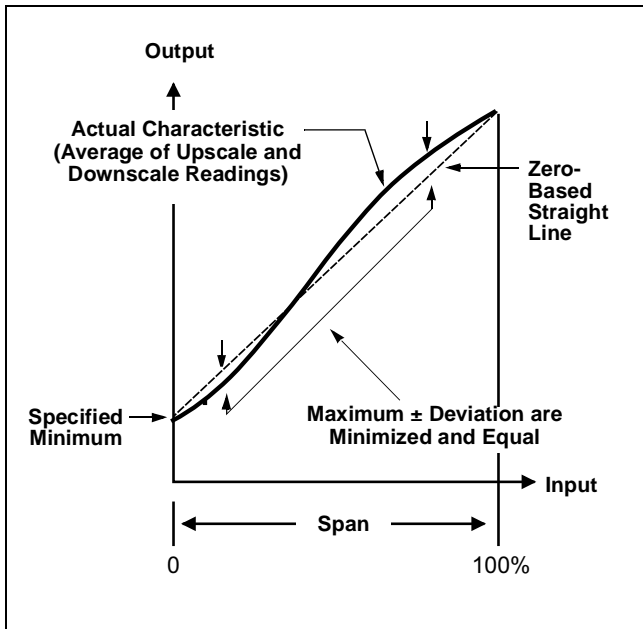


FIGURE 12. Zero-Based Linearity.

Terminal-Based Linearity

Terminal-based linearity is the maximum deviation of the actual characteristics from a straight line coinciding with the actual characteristic at upper and lower range values (see Figure 13).

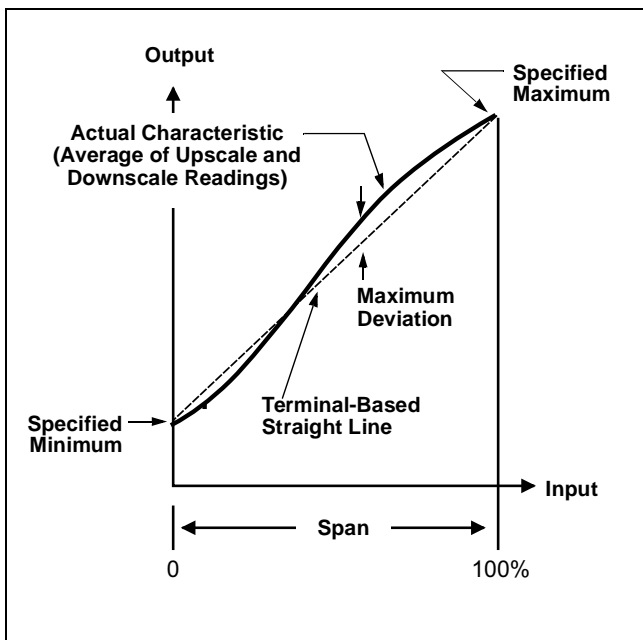


FIGURE 13. Terminal-Based Linearity.

Hysteresis

Hysteresis is the maximum difference for the same input between the upscale and downscale output values during a full range traverse in each direction. (Definition actually includes hysteresis and dead band errors.) (See Figure 14.)

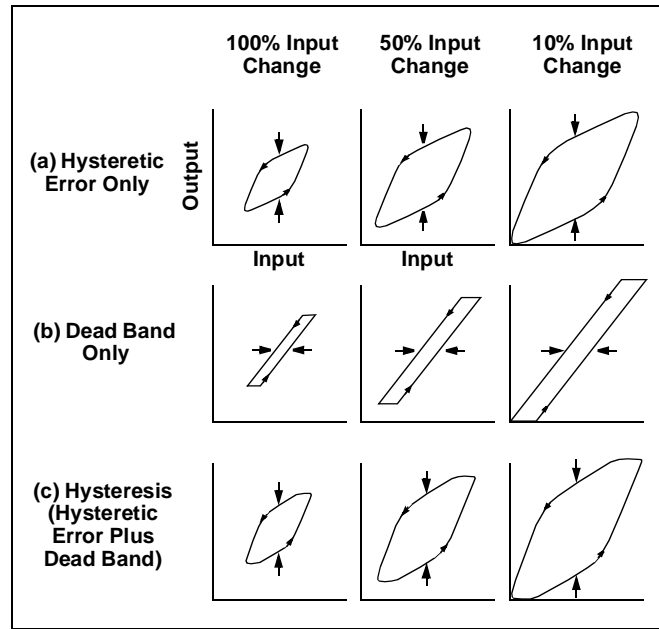


FIGURE 14. Hysteretic Error, Dead Band, and Hysteresis.

Repeatability

Repeatability is the closeness of agreement among a number of consecutive measurements of the output for the same value of the input under the same operating conditions, approaching from the same direction. It does not include hysteresis (see Figure 15).

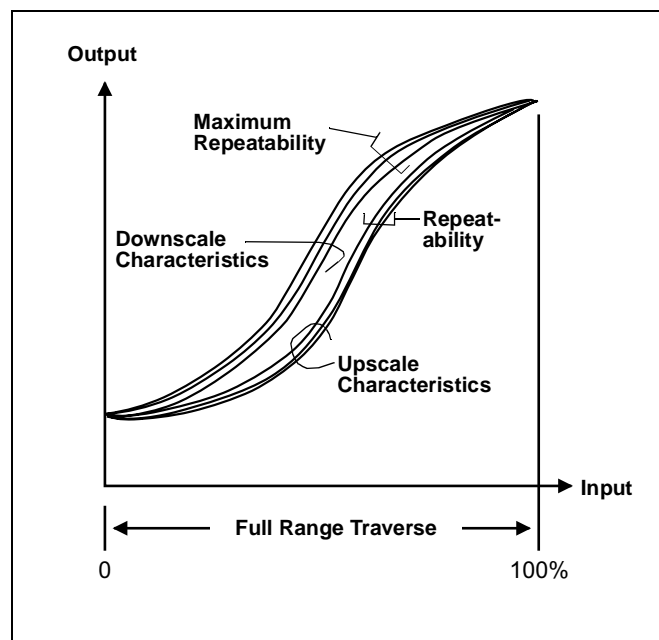


FIGURE 15. Repeatability.

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Reproducibility

Reproducibility is the closeness of agreement among repeated measurements of the output for the same value of input mode under the same operating conditions over a period of time, approaching from both directions. Normally this implies a long period of time. It includes hysteresis, drift, and repeatability. Between repeated measurements, the input may vary within normal operating conditions.

Note that reproducibility is a time-based performance specification. This characteristic is also implied when drift or stability is called out. Reproducibility can be checked by a bench test (or laboratory, type calibration) placing the unit in service under normal operating conditions, and after a period of time, bringing the unit out of service for another bench test.

Temperature Effect

The temperature effect, unless otherwise stated, is assumed to include both the zero error and the total effect. It can be expressed a number of ways:

- $\pm 0.5\%$ of span/100 °F
- $\pm 0\%$ of max. range/100 °F between 50 °F and 150 °F
- ± 0.01 °F/°F between -15 and 185 °F

Overpressure Effect

On a differential pressure transmitter, overpressure may be either on the high side or the low side. It can be expressed a number of ways:

- $\pm 0.25\%$ of upper range limit for 2,000 psi
- $\pm 1.0\%$ of calibrated span for 500 psi

NOTE

The importance of reasonably high overpressure capability on differential pressure transmitters provides added assurance that improper sequencing of the three-valve manifold will lessen the chance that the unit will be damaged or even need recalibration.

Static Pressure Effect

Static pressure effect is the affect of line pressure applied to both the high and low sides of a transmitter. It involves both zero and span errors.

Zero errors can be easily corrected by simply rezeroing the transmitter at its operating pressure. Span errors, however, are a different situation.

The determination of span errors requires expensive, sophisticated equipment. For this reason, most manufacturers make no statement about this effect, making it difficult to make appropriate corrections. Ideally, when specified, span errors should be systematic and therefore easy to correct. In this case, corrections can be made by calculating the effect and compensating for it during calibration, or by placing a simple algorithm in a computer-based receiver.

Vibration Effect

Most specifications refer to sinusoidal vibration, which may or may not be the type exhibited in service. The axis of vibration is an important consideration for some of the force balance type transmitters, which are more sensitive to vibration in certain planes. The ability of a transmitter to withstand shock is often as important as the vibration considerations. It is difficult to perform laboratory tests that relate well to the ruggedness of the unit to withstand in a given environment, and trial installations tend to be far more meaningful.

Power Supply Effect

Power supply effect is the effect of power supply variations on the performance of transmitters designed within the last few years is usually insignificant. Electronic components and techniques are now available which virtually eliminate any problem.

Load Effect

Load effects, like power supply effects, have virtually been eliminated in transmitters designed within the last three years.

Materials

A number of materials are available for wetted pressure parts including 316SST, NiSpan, Monel,[®] Hastelloy-C,[®] Duranickel and tantalum. The most common standard diaphragm is 316SST. More exotic materials are usually available at a premium price.

Other wetted parts to be considered are the “O-ring” seals, which are available in a variety of materials.

Unless specifically requested, bolts are usually cadmium-plated carbon steel. Stainless steel bolts usually have to be called out and specified.

The electronics housing should be called out as explosion-proof, or weather-proof, or both, if the application requires it.

Features

Range adjustability is a feature that should be considered. An adjustable span reduces the number of spare parts that have to be kept on hand. Zero elevation and suppression is essential on liquid level measurements using head pressure, and for gage pressure, it allows more sensitivity over the span of interest. Minimum interaction of the zero adjustment on span is desired. A zero adjustment is often necessary to balance out pressure heads from impulse piping or wet legs. Once the unit has been calibrated on a bench test, it is difficult to compensate for any span change in the field. Having the zero adjustment external is also a convenient feature. This is especially true in hazardous locations where an explosion-proof enclosure is used.

Adjustable damping is a convenient feature. This is especially true where pulsations in the process tend to cause poor monitoring or control.

Protective features to be considered should include reverse polarity protection. This is becoming standard on most new transmitters and prevents damage to the transmitter when it is wired incorrectly. Current limiting, which limits the output at 150 to 200 percent, should also be considered to protect the receiver. Lightning suppression should be a consideration when mounting outside in an open area.

Installation considerations should include mounting flexibility and whether or not special precautions have to be taken. It is convenient not to have the unit position sensitive. Weight and size may be a consideration if the units are to be rack mounted in an enclosure. Flange adapters, vent and drain valves, and integral terminal strip all make the transmitter faster and easier to install.

Local indications should be considered where operators are working in an area some distance away from the control room. This is particularly convenient when tank level is needed by an operator.

Steam tracing either for the purpose of winterizing or to keep a process from freezing up or being too viscous may be a consideration. A temperature controlled heated enclosure to increase accuracy by eliminating temperature effects may also be a consideration.

All the features that make up an easily maintainable transmitter should be considered. Modular plug-in circuit boards and easily accessible test points minimize field down-time. Interchangeable parts minimize spare parts inventory, which can amount to a significant investment in capital. Good local service also minimizes potential down-time.

Reliability is another important consideration. Generally, this factor is based on actual previous experience with the transmitter. Since factory testing cannot completely duplicate the environment, the handling, and the operating conditions experienced in the field.

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