Siemens Energy & Automation	APPLICATION DATA

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Draft Range Pressure Measurement

BACKGROUND

While the term draft range pressure lacks a precise definition, it is generally recognized as a gauge or differential pressure less than 5.0" H_2O. Often these are non-zero-based spans, the most common range being - 0.1" H_2O to 0.3" H_2O for furnace atmospheric pressures.

Draft pressure measurement controls or protects many different processes in various markets from heat treating to power utilities. Draft pressure transmitters and higher range pressure transmitters have the same major requirements: accuracy, stability, and reliability. The sensitivity, stability and inherent accuracy of the silicon sensor in the DSIII line of pressure transmitters make it ideally suited for these applications.

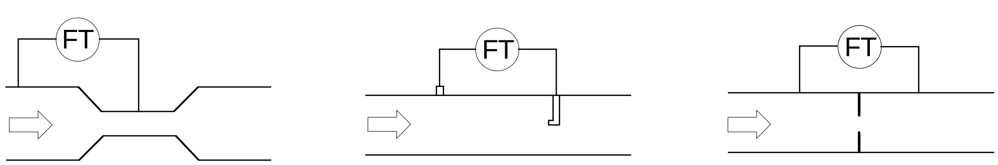
However, selecting a high performance draft transmitter is only half the battle. Installation details that at higher pressures can be overlooked become a major source of error at very low draft pressures. This paper discusses various draft pressure transmitter applications and processes and later provides application and installation tips.

APPLICATIONS AND PROCESSES

Below are several applications and processes that require draft range transmitters.

Air Flow

The objective here is to accurately measure the low differential pressure (DP) generated by the flow of air or gas through primaries such as pitot tubes, averaging pitot tubes, orifice plates, and venturis. These flow primaries are known as square law devices because the flow is proportional to the square root of the DP developed by the device. Some examples of applications that require flow measurement follow.



Venturi Tube   Pitot Tube   Orifice Plate

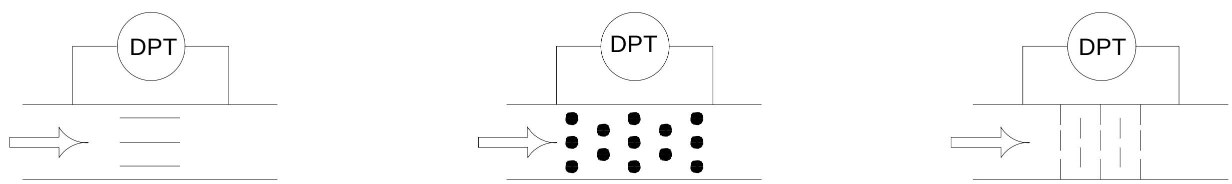
Boilers
Air flow into a boiler is measured with an averaging pitot tube or venturi to control fuel-air ratio. Waste gases that are a result of boiler operation can also be measured with a pitot tube or averaging pitot tube.

Furnaces
Fuel or cover gas flow into a furnace can be measured with any of the devices mentioned, selection depending upon the accuracy required.

Pressure Drop

Measurement of the DP across devices such as air heaters, precipitators, scrubbers, and other filter-type elements is performed to determine when they require service. An example of an application follows:

Boilers
To maximize efficiency, we measure the pressure drop across parts of a boiler that can build up soot or ash (e.g., air heaters, scrubbers, economizers, and precipitators) to determine when maintenance is needed.

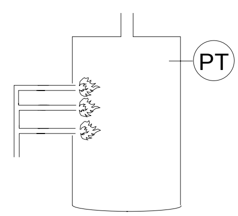


Various Filter Elements

Pressure

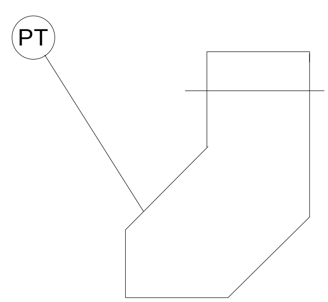
It is often necessary to measure the gauge pressure in devices such as boilers, heat treat furnaces, glass furnaces, reheat furnaces, and soaking pits. Several applications follow:

Boilers
To assure efficient operation and complete combustion, we measure the gauge pressure in the interior of a boiler furnace in order to keep it slightly negative (typically -0.25" H_2O) by controlling the boiler inlet or outlet dampers.



Boiler
Furnace

Furnaces
A slight positive pressure (typically +0.1" H_2O) is required in most thermal market furnaces. This assures good fuel economy and efficient use of cover gas through control of the damper in the furnace stack.



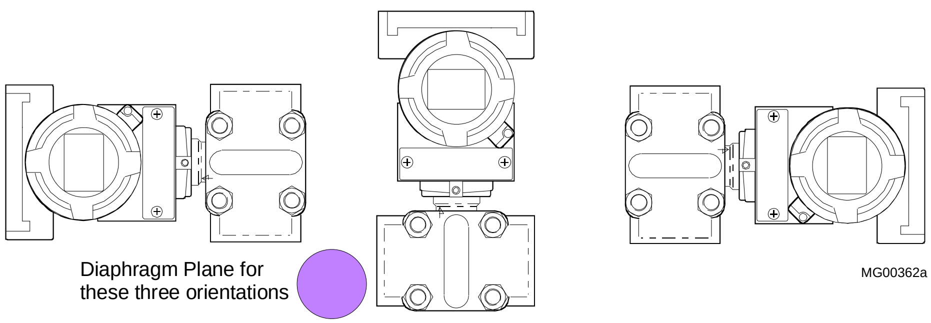
Furnace
Stack

APPLICATION AND INSTALLATION TIPS

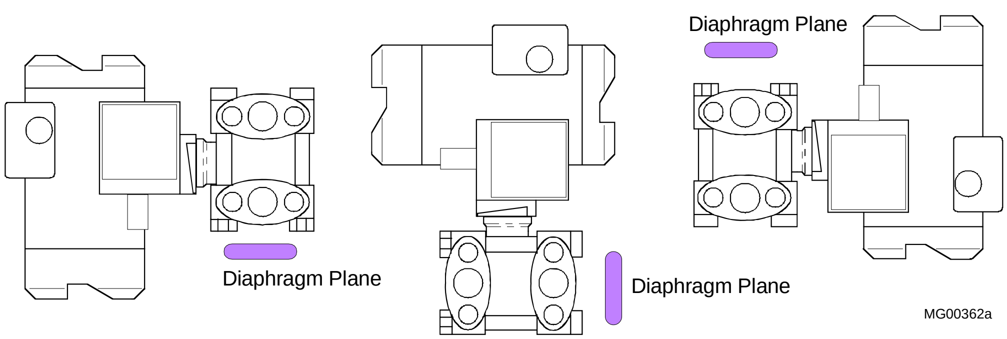
Transmitter Mounting

A transmitter's orientation and mounting can be critical in draft pressure measurement. There are two main points to remember: the transmitter must be rigidly mounted and the mounting must not be affected by environmental conditions (e.g. heat, vibration, shock).

A SITRANS P Model 7MF4433 DP transmitter is calibrated at the factory with the process diaphragms perpendicular to the ground. This orientation is shown in the center transmitters in the two figures below. Rotation from this orientation can cause a zero-shift, depending on the direction of rotation. In the top figure, the center transmitter is rotate 90° left and right but the diaphragm remains perpendicular to the ground so there is no zero-shift. However, in the lower figure, when the center transmitter is re-orientated from the vertical, as shown by the left and right transmitters, a zero-shift is induced because the diaphragm changes from perpendicular to the ground to parallel. Maximum zero-shift is about 1.5" H_2O occurring when the process diaphragms are parallel to the ground. At higher pressures this may not be critical, but at draft pressures it can be significant. For example, a 1" H_2O shift on a 0.4" H_2O span is a 250% error!



No Change in Diaphragm Orientation



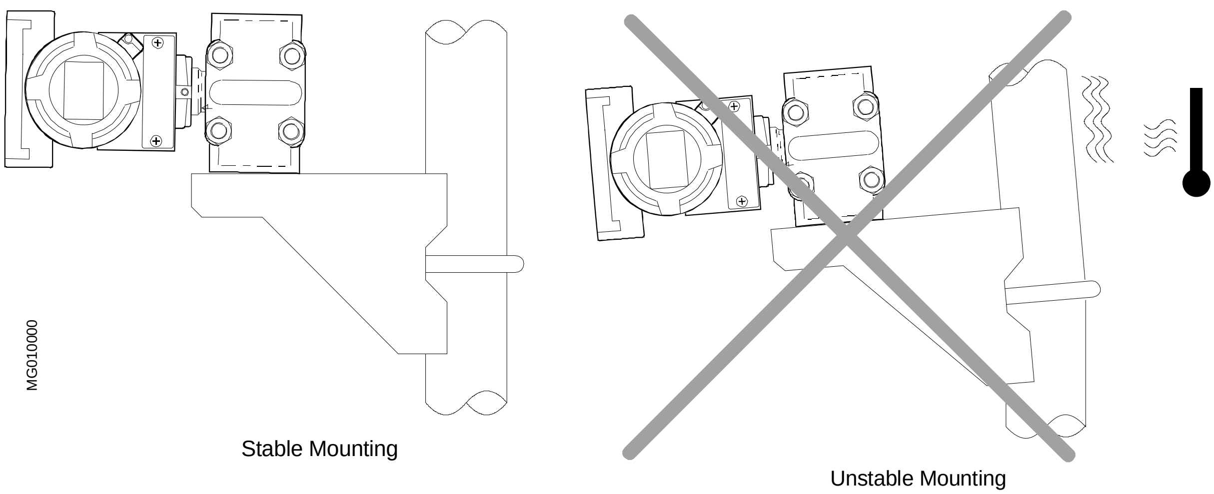
Diaphragm Orientation Changes

Zero-shift is easily eliminated either during bench test or after installation using the magnetic pushbuttons on the SITRANS P[1]. During a bench test, the transmitter can be oriented in its final mounting position and then calibrated. If the transmitter is already installed, simply correct for Zero position error using the

[1] PDM software and a HART-based hand-held are options available for transmitter calibration and configuration

pushbuttons to select transmitter Operating Mode 7 (Set Zero Position Correction). Zero correction must be performed with a stable zero differential across the transmitter pressure inputs.

A draft transmitter must be rigidly mounted. A change in transmitter orientation due to temperature variations, bumps, vibration, etc. can cause a zero-shift; see the figure below. Note that even a minimal 0.001" H_2O shift represents a 0.25% error at a span of 0.4" H_2O. For this reason, use the supplied bracket to mount the transmitter to a wall, I-beam, or pipe that is not likely to vibrate or to be bumped and will remain stable in spite of ambient temperature changes. A zero-shift error introduced by transmitter orientation can easily be zeroed out, but the varying effects of an unstable mounting can *not* be corrected by recalibrating the transmitter.

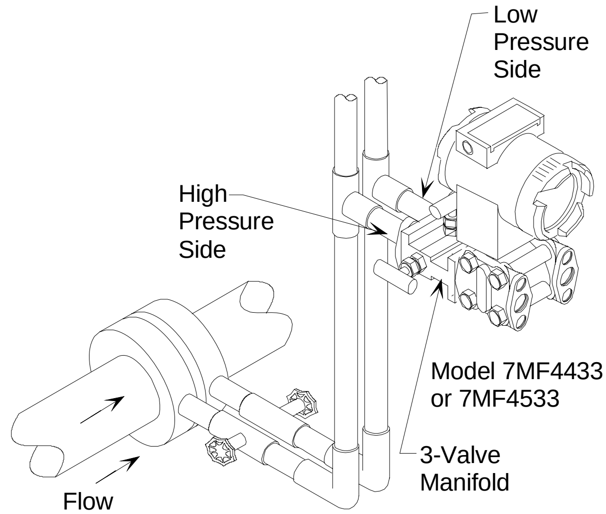


Impulse Piping

Measurement errors can occur when “good practice” is not followed during impulse pipe installation. For example, impulse pipe must be installed such that no unwanted liquid or gas can accumulate in the transmitter process flange cavity.

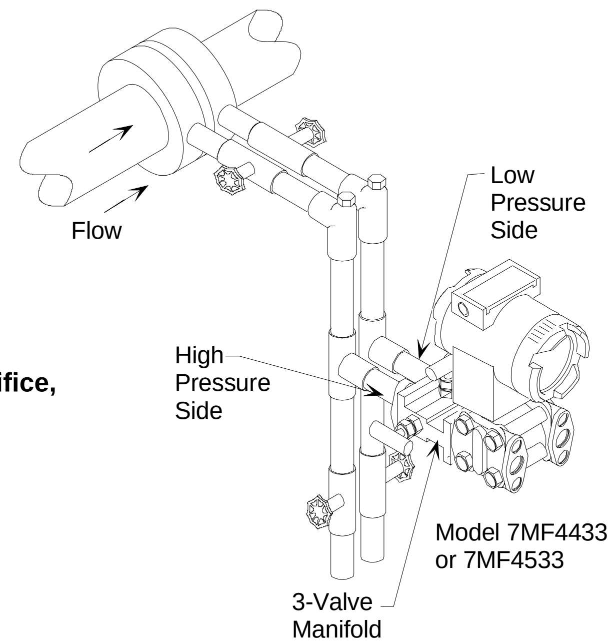
In draft pressure applications, the process fluid is usually air or gas so care must be taken to prevent any accumulation of liquid (e.g., condensate) in the impulse piping to the transmitter. Always mount the transmitter *above* the process connections and slope all horizontal runs to the process downward at one inch per foot. This will prevent liquid from accumulating at the transmitter.

Transmitter ABOVE Orifice, For Gas Flow



When the process fluid is a liquid, mount the transmitter *below* the process connections with all horizontal runs to the process sloped upward at one inch per foot. This will prevent air or gas from accumulating at the transmitter.

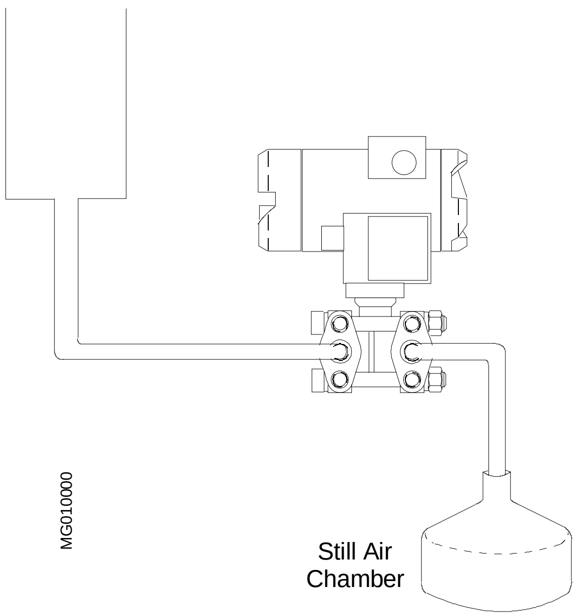
Transmitter BELOW Orifice, For Liquid

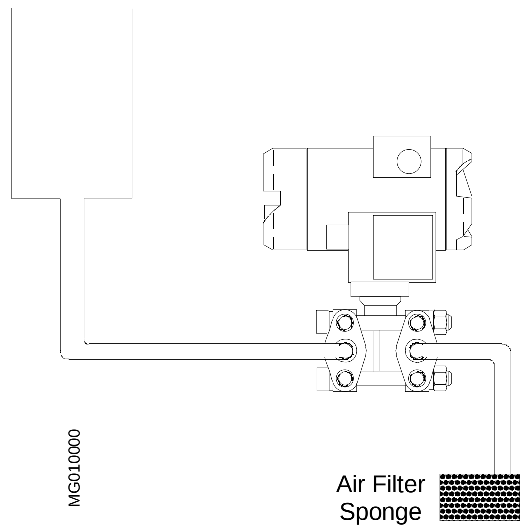


Gauge Pressure Measurement

Often draft pressure measurements will be straight gauge pressure applications as opposed to true DP applications. In these situations the Low Pressure (LP) port of the differential transmitter must be vented to atmosphere. *This should not be done by simply leaving the port unconnected* because air flowing past the open LP port (from heating and cooling fans, natural wind currents, traffic, etc.) will cause a slight vacuum resulting in measurement errors.

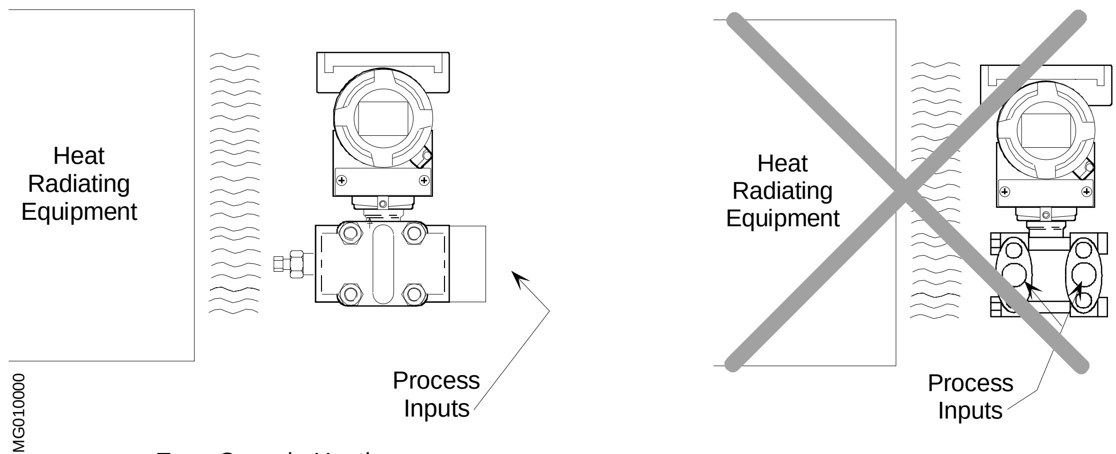
The solution is to pipe the LP port as shown below. Vent the open end of this pipe into a “still air chamber” which is vented to atmosphere. The “still air chamber” can be as simple as a one gallon milk jug. Another solution is to put a porous sponge, like that used for an air filter, around the end of the LP pipe. Other techniques will also work. The goal is to have a stable reference to atmosphere that is unaffected by air currents.





Capsule Heating

Uneven radiant heating can cause draft pressure transmitter errors. The SITRANS P 7MF4433 is a two-diaphragm, balanced, fluid filled system. The fill has a known thermal expansion coefficient that is included in transmitter compensation. However, if one side of the capsule is heated differently than the other, measurement errors will occur; see the following two figures.



Even Capsule Heating

Uneven Capsule Heating

Identify and protect the transmitter from possible sources of radiant heating when selecting a mounting location for a draft transmitter. These sources include boilers, furnaces, heaters, ovens and even the sun. If the source of heat can not be eliminated, mount the transmitter so that the capsule is evenly heated by the source, as shown in the above left figure.

Accuracy

A transmitter can be ranged using your plant-standard pressure source and transmitter Operating Modes 2 and 3 (Set Zero and Set Full Scale respectively) to set up zero and full scale. Alternatively, range the transmitter using the "blind" method and Operating Modes 5 and 6 (Set Zero Blind and Set Full Scale Blind respectively). Both procedures are described in the User's Manual[2]. If the accuracy of the plant-standard pressure source is insufficient, the "blind" method may offer optimal accuracy.

Static Pressure Effects

In some applications, very low pressures are measured at high static pressures. Maximum performance can be obtained by calibrating the transmitter to remove any zero-shift due to mounting position and static pressure at the same time. This should be done with the transmitter in its final position, with the static pressure applied, and with zero DP across the transmitter.

[2] Refer to UMSITRPDS3-1, User's Manual SITRANS P, Series DSIII Transmitter for Pressure, Differential Pressure, Flanged Level, and Absolute Pressure Model 7MF4*33-…

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