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Pressure Transmitter Calibration Using Calibrator & HART Communicator

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ABSTRACT

This study has A Pressure Transmitter is an instrument connected to a Pressure Transducer. The output of a Pressure Transmitter is an analog electrical voltage or a current signal representing 0 to 100% of the pressure range sensed by the transducer. This article provides step-by-step Procedure for Pressure Transmitter Calibration and Ranging, LRV and URV configuration of transmitter.

Key words: Pressure Transmitter,Transducer, Rosemount Make, 3051 Series, Multimeter, HART communicator, Calibrator (Pressure range should be greater than the transmitter), Pressure Transmitter Manifolds.

I. INTRODUCTION

Transmitter vs. Transducer

First of all, let's discuss the terms Transducer and Transmitter. Some people will tell you that a Transducer and a Transmitter are the same things and therefore the terms are interchangeable.If you are curious, conduct a web search of the two terms and you will be surprised at the wide range of results!

Transducer

A transducer is a device that converts one form of energy to another.For example, an electrical transducer converts a sensed physical variable like temperature into an analog electrical signal.

Transmitter

A transmitter is a device that converts the electrical signal from the transducer into a much larger electrical signal that can be sent over a long distance to a PLC or a DCS.

Transmitter output signal

The transmitter output signal is usually a range of voltage (1 to 5 V) or current (4 to 20 mA) which represents the 0 to 100% of the sensed physical variable.

Pressure Transmitter

A Pressure Transmitter is an instrument connected to a Pressure Transducer.
The output of a Pressure Transmitter is an analog electrical voltage or a current signal representing 0 to 100% of the pressure range sensed by the transducer.

Pressure measurement

Pressure transmitters can measure absolute, gauge, or differential pressures.

Absolute pressure

Absolute pressure is referenced to a perfect vacuum which is considered 0 psi! We express vacuum pressure as 0 psi (a).
Atmospheric pressure is usually about 14.7 psi (a).

Gauge pressure

The most common pressure measurement is gauge pressure which is the total pressure minus the atmospheric pressure. Atmospheric pressure is 0 psi (g).

As we've discussed in our previous articles, the versatility of a differential pressure transmitter gives us the flexibility to measure level and flow as well as pressure.

A transducer is a device that converts one form of energy to another.– A transmitter is a device that converts the electrical signal from the transducer into a much larger electrical signal that can be sent over a long distance to a PLC or a DCS.– A Pressure Transmitter is an instrument connected to a Pressure Transducer.– The output of a Pressure Transmitter is an analog electrical voltage or a current signal representing 0 to 100% of the pressure range sensed by the transducer– Pressure transmitters can measure absolute, gauge, or differential pressures.

II. Pressure Transmitter Calibration

This article provides step-by-step Procedure for Pressure Transmitter Calibration and Ranging, LRV and URV configuration of transmitter.

Pressure Transmitter Details:

- Rosemount Make, 3051 series
- 3051T- Gauge & absolute pressure (models) 0.3 to 10000psi, 10.3 mbar to 689 bar
- 3051C, DP guage & absolute (models) 0.1 to H2o to 4000psi, 0.25 mbar to 276 bar
- Power supply range is 12VDC to 32VDC.

Main Steps to be followed:

First step to be followed is proper permit should be taken and ensure the interlocks should be by passed as well as MOS (Maintenance override to be put ON condition in DCS) for the particular tag.

Use Tool box meeting & proper PPE'S.

Required tools and suitable fittings (Such as connector and union) for calibration. Multimeter, HART communicator, Calibrator (Pressure range should be greater than the transmitter). For higher range use hydraulic pressure calibrators and for low ranges use low range calibrator.

How HART Works

"HART" is an acronym for **Highway Addressable Remote Transducer**. The HART Protocol makes uses Frequency Shift Keying (FSK) standard to superimpose digital communication signals at a low level on top of the 4-20mA. This enables two-way field communication to take place and makes it possible for additional information beyond just the normal process variable to be communicated to/from a smart field instrument.

The HART Protocol communicates at 1200 bps without interrupting the 4-20mA signal and allows a host application (master) to get two or more digital updates per second from a smart field device. As the digital FSK signal is phase continuous, there is no interference with the 4-20mA signal. The HART Protocol provides two simultaneous communication channels: the 4-20mA analog signal and a digital signal. The 4-20mA signal communicates the primary measured value (in the case of a field instrument) using the 4-20mA current loop - the fastest and most reliable industry standard. Additional device information is communicated using a digital signal that is superimposed on the analog signal.

The digital signal contains information from the device including device status, diagnostics, additional measured or calculated values, etc. Together, the two communication channels provide a low-cost and very robust complete field communication solution that is easy to use and configure.

III. Calibration Procedure

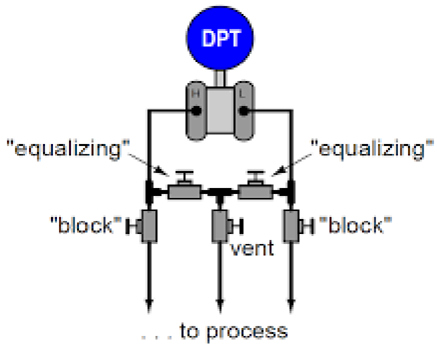
1. First isolate the main process isolation valve.
2. De-pressurize the pressure transmitter by opening the vent valve
3. Isolate the manifold valve and open the vent plug.

4. Fix proper instrument fitting (for eg:1/4”npt fitting)
5. Connect the calibrator fitting in to the vent plug entry of manifold valve.
6. The vent valve should be opened.
7. The HART communicator cable should be placed as per transmitter wiring diagram.
8. Apply pressure as per the range given in the transmitter or check with the HART communicator.
9. Check the transmitter reading by applying pressure for 25%, 50%, 75%, and span range.
10. If the transmitter needs to be calibrated use the HART communicator for calibration purpose.
11. Zero & span trims can be done by using HART communicator.
12. After calibration checking remove the pressure calibrator from the transmitter and flush the line.
13. So that hydraulic oil or water will not be inside the transmitter.
14. Close the vent plug.
15. Isolate the vent valve and open the main isolation valve.
16. Open the manifold isolation valve slowly, if u open fast sudden pressure may damage the transmitter diaphragm.
17. After completion of the calibration ensure the transmitter is reading showing properly.
18. Then enter the reading in calibration report format.
19. Check the reading in DCS also.

Close the work permit from field operator and shift Engineer.

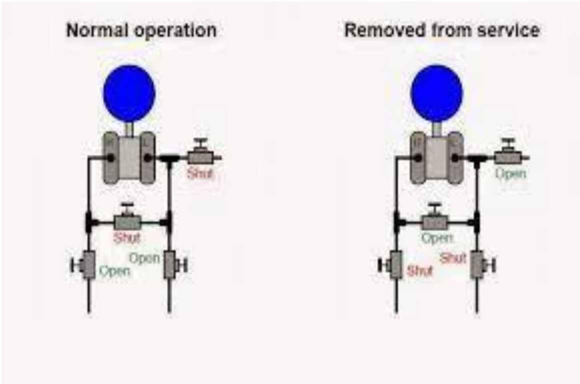
IV. Pressure Transmitter Manifolds

An important accessory to the DP transmitter is the valve manifold. This device incorporates manual valves to isolate and equalize pressure from the process to the transmitter, for maintenance and calibration purposes. The following illustration shows the three valves comprising a three-valve manifold (within the dotted-line box), as well as a fourth valve called a “bleed” valve used to vent trapped fluid pressure to atmosphere:

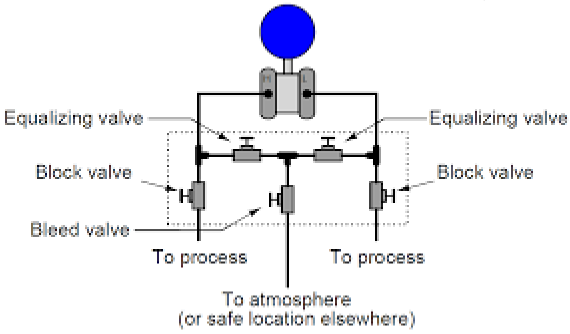


NOTE: The standard 3-valve manifold, for instance, does not provide a bleed valve – only block and equalizing valves. While this illustration shows the three valves as separate devices, connected together and to the transmitter by tubing, three-valve manifolds are more commonly manufactured as monolithic devices: the three valves cast together into one block of metal, attaching to the pressure transmitter by way of a flanged face with O-ring seals.Bleed valves are most commonly found as separate devices threaded into one or more of the ports on the transmitter’s diaphragm chambers.The following photograph shows a three-valve manifold bolted to a Honeywell model ST3000 differential pressure transmitter.A bleed valve fitting may be seen inserted into the upper port on the nearest diaphragm capsule flange:

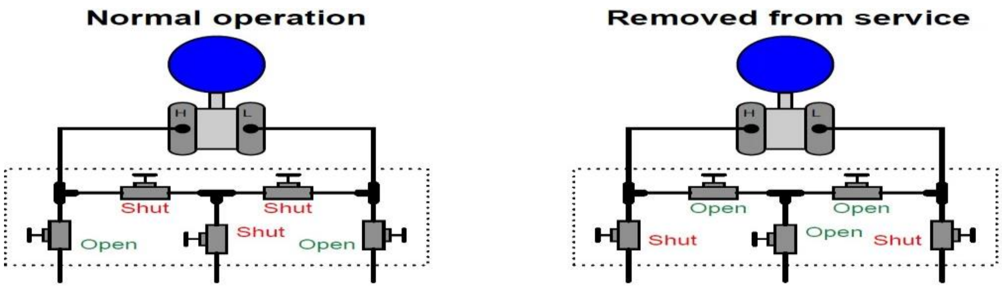
In normal operation, the two block valves are left open to allow process fluid pressure to reach the transmitter.The equalizing valve is left tightly shut so no fluid can pass between the “high” and “low” pressure sides.To isolate the transmitter from the process for maintenance, one must close the block valves and open the equalizing valve.The best sequence to follow is to first close the high-pressure block valve, then open the equalizing valve, then close the low-pressure block valve.This sequence ensures the transmitter cannot be exposed to a high differential pressure during the isolation procedure, and that the trapped fluid pressure inside the transmitter will be as low as possible prior to “venting” to atmosphere.Finally, the “bleed” valve is opened at the very last step to relieve pent-up fluid pressure within the manifold and transmitter chambers.To return the transmitter to live service, simply reverse these steps: close the bleed valve, open the low-pressure block valve, close the equalizing valve, and finally open the high-pressure block valve.Final valve positions for both states are shown in the following illustrations:



A variation on this theme is the five-valve manifold, shown in this illustration:



The presence of a built-in bleed valve in the five-valve manifold allows the technician to vent trapped pressure through a tube to some remote location, rather than directly venting at the transmitter.Valve positions for normal operation and maintenance on this manifold are as follows:



It is critically important that the equalizing valve(s) never be open on any transmitter manifold while both block valves are open! Doing so will allow process fluid to flow through the equalizing valve(s) from the high-pressure side of the process to the low-pressure side of the process.

If the impulse tubes connecting the manifold to the process are intentionally filled with a fill fluid (such as glycerin, to displace process water from entering the impulse tubes; or water in a steam system), this fill fluid will be lost.

Also, if the process fluid is dangerously hot or radioactive, a combination of open equalizing and block valves will let that dangerous fluid reach the transmitter and manifold, possibly causing damage or creating a personal hazard.

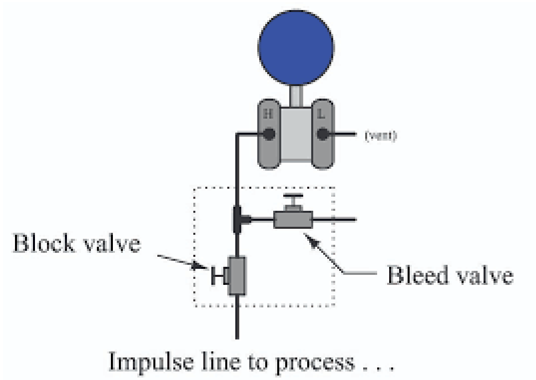
Speaking from personal experience, I once made this mistake on a DP transmitter connected to a steam system, causing hot steam to flow through the manifold and overheat the equalizing valve so that it seized open and could not be shut again!

The only way I was able to stop the flow of hot steam through the manifold was to locate and shut a sliding-gate hand valve between the impulse tube and the process pipe.

Fortunately, this cast steel valve was not damaged by the heat and was still able to shut off the flow.

Pressure transmitter valve manifolds also come in single block-and-bleed configurations, for gauge pressure applications.

Here, the “low” pressure port of the transmitter is vented to atmosphere, with only the “high” pressure port connected to the impulse line:



The following photograph shows a bank of eight pressure transmitters, seven out of the eight being equipped with a single block-and-bleed manifold.

The eighth transmitter (bottom row, second-from left) sports a 5-valve manifold:

If you look closely at the photograph, you can see the bleed valve fittings installed on all the upper ports.
Only the transmitter with the 5-valve manifold has two bleed valve fittings because it is the only DP transmitter of the group.
The other seven transmitters are all gauge pressure units, and so only have one port to bleed.
A good habit to cultivate when operating valve handles on transmitter manifolds is to "back off" the open valves approximately one-quarter turn after opening.

This discourages seizing in the full-open position, and also makes it possible for someone to more easily tell the states of the valves by feel: a closed valve will not easily turn (because it is tightened onto its seat) while an open valve is free to turn either direction a bit.

Since there should be no flow going through the valves of a transmitter manifold, it is irrelevant whether an open manifold valve is 100% open or 90% open or 80% open, so there is no harm in "backing off" an open valve from the full-open position.
It would of course be bad to do this with a closed valve, since any valve plug must be pressed tight into its seat in order to achieve positive shut-off.

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