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AT9000 Advanced Transmitter Electronic Differential Pressure/ Pressure Transmitter

User's Manual



Yamatake Corporation

CM2-GTX100-2001
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NOTICE

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Safety

Instructions

Preface

Correct installation and periodic maintenance are essential to the safe use of your differential pressure transmitters.

Read the safety instructions provided in this manual carefully and understand them fully before starting installation, operation, and maintenance work.

Inspection

On delivery, make sure that the specifications are correct and check for any damage that may have occurred during transportation. This equipment was tested under a strict quality control program before shipment. If you find any problem in the quality specifications, please contact your Yamatake Corporation representative immediately, providing the model name and serial number.

The name plate is mounted on the top of the enclosure.

Precautions

The following symbols are used in this manual to ensure user safety.

WARNING

This symbol is used to warn of hazards where failure to observe a safety instruction may result in death or serious injury.

CAUTION

This symbol is used to warn of hazards where failure to observe a safety instruction may result in injury or physical damage.

To ensure safe operation, be sure to observe the safety instructions provided on the next page.

Yamatake Corporation will assume no responsibility, or offer any guarantee for any failure resulting from violation of these safety instructions.

Precautions

General Precautions

1. Checking the Product

When you accept the AT3000 Advanced Transmitter, check its appearance to make sure that it is not damaged.

A Advanced Transmitter with semi-standard or special specifications may have different accessories.

2. Check the specifications

The specifications are marked on the name plate on the outside of the transmitter case. Make sure that the specifications match your order by referring to the specifications.

In making an inquiry, identify the model No. and the product No.

3. Transportation

We recommend to transport the transmitter to the installation site in the packaged state in order to prevent damages from occurring during transportation.

4. Storage Environment

(1) Storage location

During storage, protect the transmitter from rain water as well as from heavy vibration and shock. Store it at normal temperature and humidity (about 25°C, 65%RH) as much as possible.

(2) Store the transmitter in original packaging if possible.

(3) If a used transmitter must be stored for some period, wash it thoroughly after making sure that no fluid remains in the pressure receiving section.

5. Installation Environment

In order to maintain the original performance and reliability for a long time, install the transmitter in the following environment:

(1) Ambient temperature

(a) The temperature gradient and temperature changes in installation environment should be as small as possible.

(b) If a transmitter is exposed to heat radiated from the process side, lower its ambient temperature as much as possible by insulating it or by selecting a well-ventilated location for installation.

(c) If a process fluid can freeze, prevent freezing by means of heat insulation.

(2) Environment

Avoid corrosive environment as much as possible.

Install in explosion proof and intrinsically safe conditions.

(3) Shock and vibration

Install the transmitter where shocks and vibrations will be as small as possible.

6. Application of Pressure to transmitter

In applying pressure to this transmitter, observe the following rules.

- (1) The locking bolts of the adapter flange are loose when shipped. Tighten them to the specified torque.
- (2) Do not apply a pressure that exceeds the specified level.
- (3) Do not tighten or loosen bolts while pressure is being applied to the transmitter.
- (4) When a transmitter is used for measuring a poisonous substance, handle it carefully even after the pressure is released.

7. Electronic Parts

- (1) This transmitter has several CMOS electronic components. Since static electricity can easily cause the functional destruction of a CMOS component, never directly touch them or touch a circuit with your hands.
- (2) If components must be touched, equalize the potential of the components before doing so.
- (3) When the printed wiring board (PWB) is removed, protect it in a non-conductive bag.

MEMO

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Chapter 1 : Installation

1-1 : Introduction

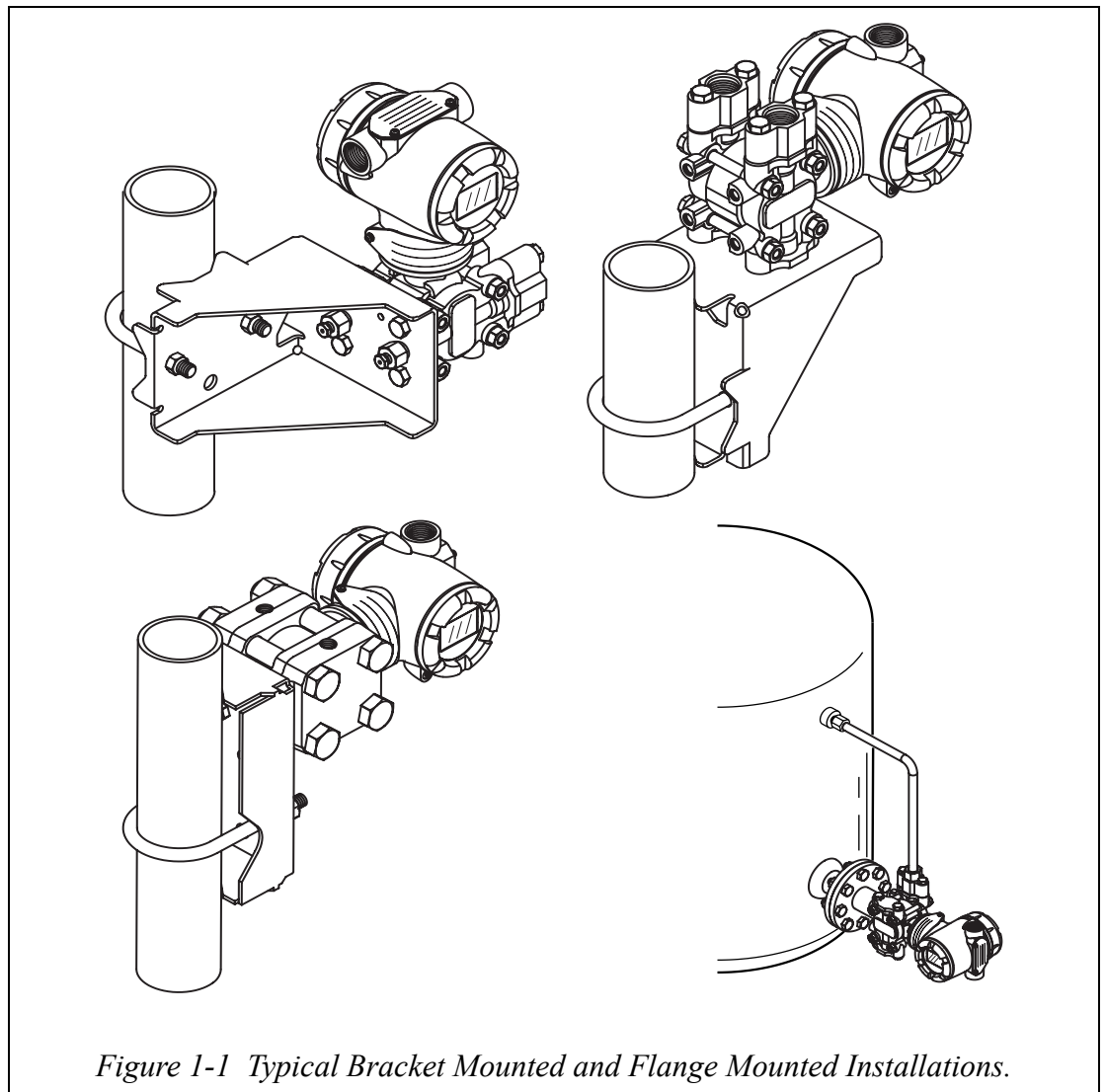
This section Provides information about installing the AT9000 Advanced Transmitter. It includes procedures for mounting, piping and wiring the transmitter for operation.

1-2 : Mounting AT9000 Advanced Transmitter

Summary

You can mount all transmitter models except those with integral flanges to a 2-inch (50 mm) vertical or horizontal pipe using our optional angle or flat mounting bracket or a bracket of your own. Those models with integral flanges are supported by the flange connection.

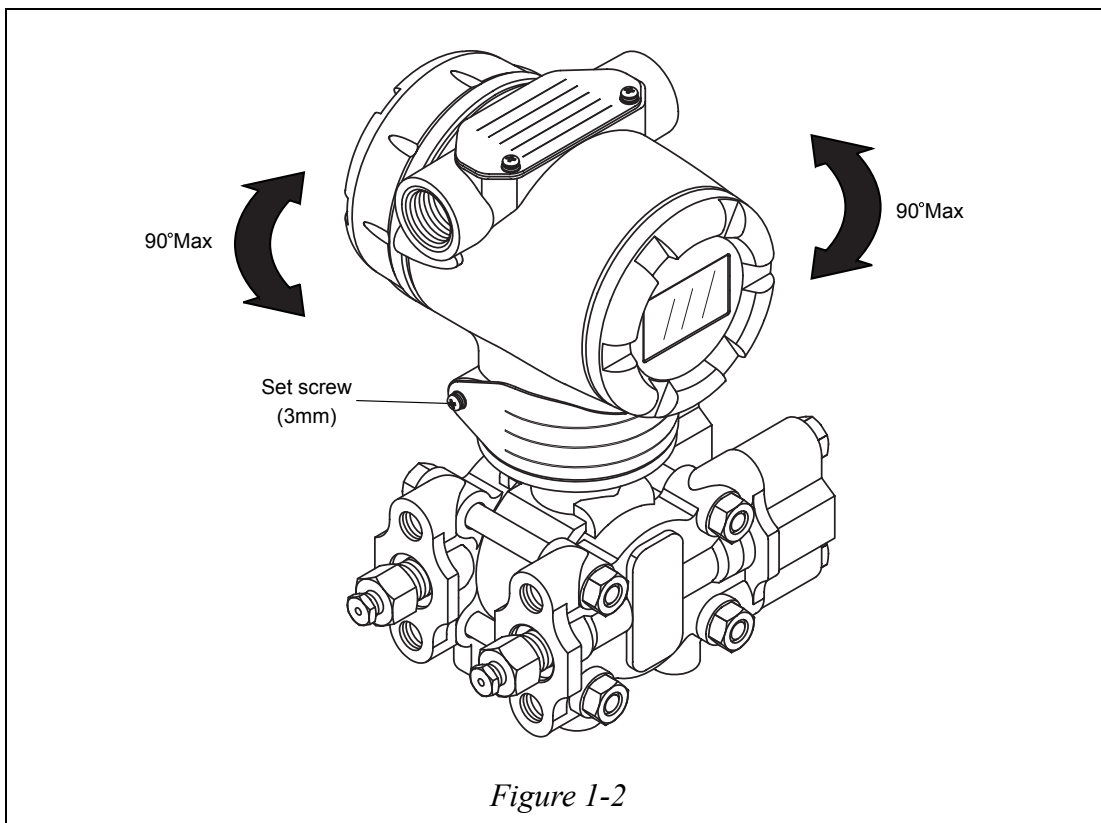
Figure 1-1 shows typical bracket mounted and flange mounted transmitter installations for comparison.



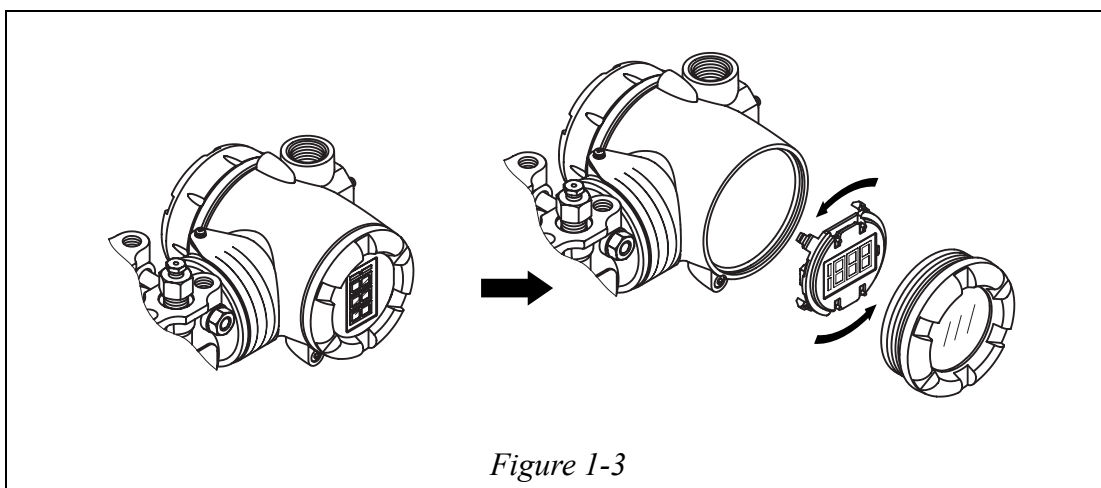
Methods of changing direction of indicator after mounted are shown below.

a) Rotate electronics housing 90° horizontally.

Loosen 3 mm set screw on outside neck of transmitter. Rotate electronics housing in a maximum of 90 degree increments (left or right) from the center to a position you require and tighten the set screw.



b) Rotate digital display module



Flange mounting

To mount a flange mounted transmitter model, bolt the transmitter's flange to the flange pipe on the wall of the tank. Tighten the bolts to a torque of

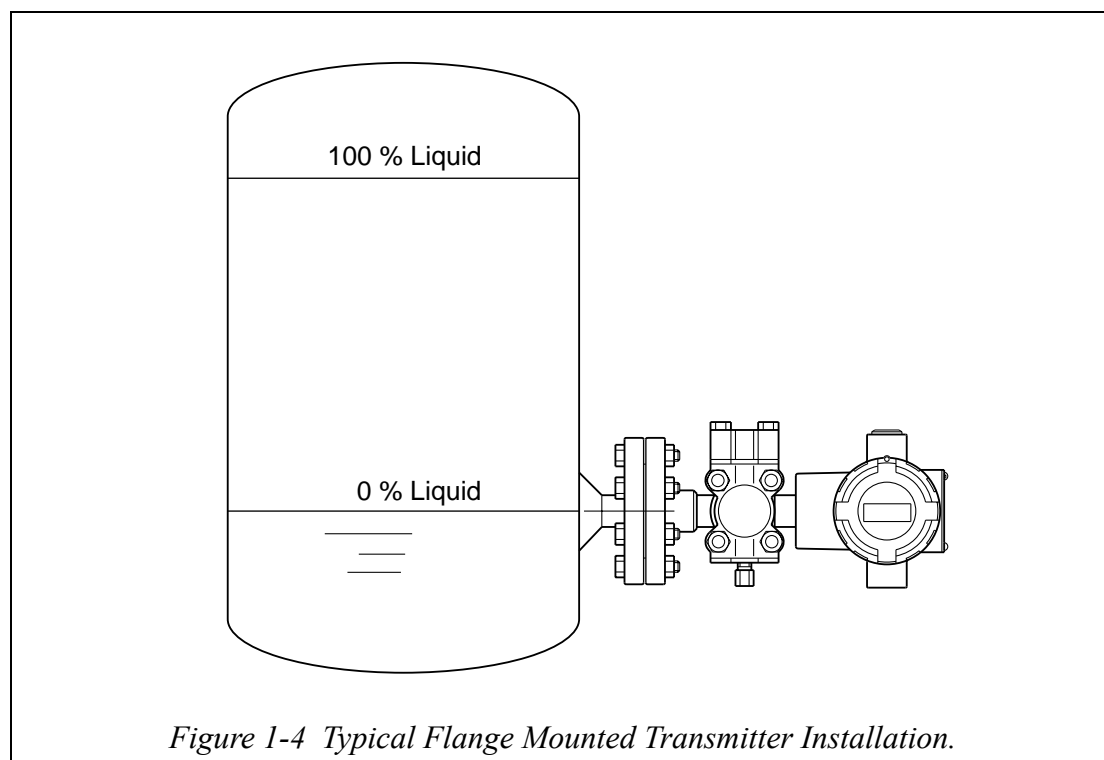
SNB : $20 \pm 1 \text{ N} \cdot \text{m}$

SUS304 : $10 \pm 1 \text{ N} \cdot \text{m}$

ATTENTION

On insulated tanks, remove enough insulation to accommodate the flange extension.

Figure 1-4 shows a typical installation for a transmitter with the flange on the high pressure (HP) side so the HP diaphragm is in direct contact with the process fluid. The low pressure (LP) side of the transmitter is vented to atmosphere (no connection).



Remote seal mounting

Use the procedure in "Table 1-1 Mounting Remote Diaphragm Seal Transmitter" to mount a remote diaphragm seal transmitter model. Figure 1-5 shows a typical installation for a remote diaphragm seal transmitter for reference.

ATTENTION

Mount the transmitter flanges within the limits stated here for the given fill-fluid in the capillary tubes with a tank at one atmosphere.

Table 1-1 Mounting Remote Diaphragm Seal Transmitter

Step	Action
1	Mount transmitter at a remote distance determined by length of capillary tubing.
2	<p>If Transmitter Model Number Is... GTX35R GTX40R Then Connect Remote Seal on... H mark side of transmitter to upper flange mounting on tank wall.</p> <p><u>ATTENTION</u> On insulated tanks, remove enough insulation to accommodate the flange extension.</p>
3	<p>If Transmitter Model Number is... GTX35R GTX40R Then Connect Remote Seal on... Opposite side of transmitter to lower flange mounting on tank wall.</p> <p><u>ATTENTION</u> On insulated tanks, remove enough insulation to accommodate the flange extension.</p>
4	Tighten bolts to torque of SNB7: $20 \pm 1 N \cdot m$, SUS304: $10 \pm 1 N \cdot m$.

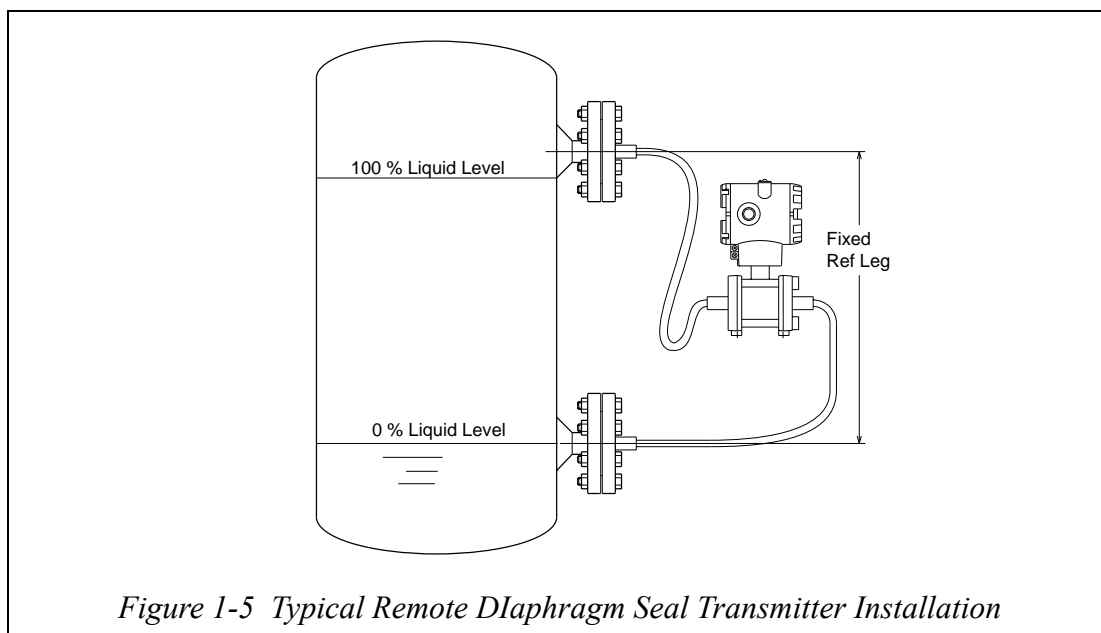


Figure 1-5 Typical Remote Diaphragm Seal Transmitter Installation

ATTENTION

Calculation of Allowable Transmitter Installation Location in Remote Seal Type Differential Pressure Transmitter.

When installing a remote seal type differential pressure transmitter on an enclosed tank, we recommend the installation of the main unit below the lower flange. However, it is sometimes necessary to install the transmitter main unit between the upper and lower flanges due to piping restrictions.

The condition that must be satisfied to ensure normal transmitter operations is specified here.

If a transmitter is installed in the position shown in Figure 1-6, the inner pressure of the tank (P_0) and the head pressure of the liquid sealed in the capillary can be applied to its main unit (low limit flange side).

The transmitter functions normally as long as the pressure applied to its diaphragm surface is equal to or higher than the low limit P (kPa abs.) of the allowable pressure of its main unit.

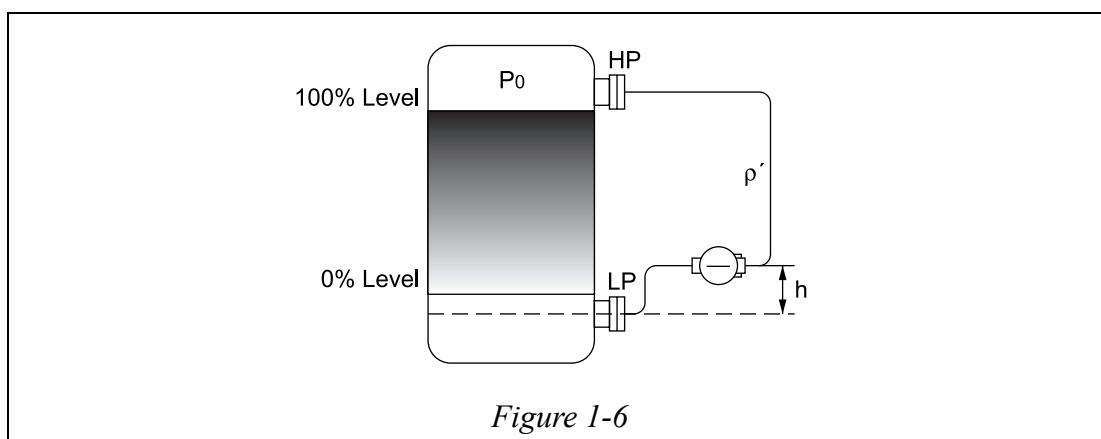


Figure 1-6

This condition can be expressed with the following formula;

$$P_0 + ((\rho'h)/102) \geq P(1kPa= 102mmH_2O)$$

Therefore, $h \leq (P_0 - P) \times 102 / (\rho')$

Table 1-2

	Specific gravity of sealed liquid ρ'	Low limit of allowable pressure P (kPa abs.)	Liquid contacting temperature range (°C)
General application (*1)	0.935	2	-40 to 40
High temperature application (-*2)	1.07	2	-5 to 90
High temperature & vacuum application (*3)	1.07	0.1333	-5 to 50
High temperature & high vacuum application (*4)	1.09	0.1333	-10 to 250
Oxygen application, chlorine application (*5)	1.87	53	-10 to 40

Remarks

1. An application where the pressure in the tank P_0 becomes a vacuum requires special caution.
2. If the above condition is not met, the pulling force applied to the diaphragm surface will exceed the specified range.

Foaming occurs because the pressure of sealed liquid exceeds the saturated vapour pressure and can cause zero point shifting. Negative pressure applied to the diaphragm can cause buckling and destroy the diaphragm.

3. When the liquid contacting temperature exceeds the levels shown in the table, the low limit of the allowable pressure also changes. Check the specifications.
4. *1. GTX□□R-□A
 *2. GTX□□R-□B
 *3. GTX□□R-□C
 *4. GTX□□R-□D
 *5. GTX□□R-□H&J

<Example of calculation>

Let's take up an example in which a remote seal type transmitter of the of the general specifications is used for a vacuum application (3kPa abs.)

- Liquid contacting pressure :Normal pressure (24°C)
- Low limit of allowable pressure (ρ) :2 kPa abs. (15mmHg abs.)
- Specific gravity of sealed liquid (ρ') :0.935
- Inner pressure of tank (ρ_0) :3kPa abs.

The condition that must be met to satisfy the transmitter specifications is as follows:

$$h \leq (P_0 - P) \times 102 / (\rho')$$

$$h \leq (3 - 2) \times 102 / 0.935 = 109mm$$

Therefore, the high limit of the transmitter position is 109mm.

1-3 : Piping AT9000 Advanced Transmitter

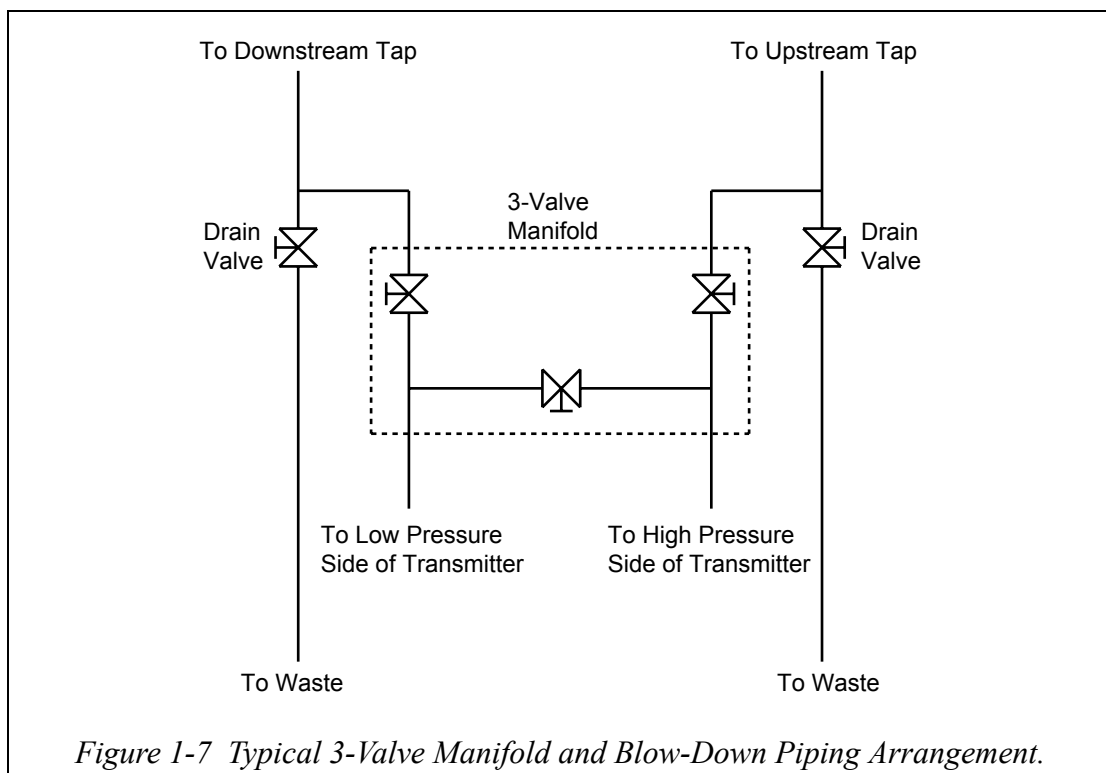
Summary

The actual piping arrangement will vary depending upon the process measurement requirements and the transmitter model. Except for flanged and remote diaphragm seal connections, process connections are made to 1/4 inch or 1/2 inch NPT female connections in the process head of the transmitter's meter body. For example, a differential pressure transmitter comes with double ended process heads with 1/4 inch NPT connections but they can be modified to accept 1/2 inch NPT through optional flange adapters.

The most common type of pipe used is 1/2 inch schedule 80 steel pipe.

Many piping arrangements use a three-valve manifold to connect the process piping to the transmitter. A manifold makes it easy to install and remove a transmitter without interrupting the process. It also accommodates the installation of blow-down valves to clear debris from pressure lines to the transmitter.

Figure 1-7 shows a diagram of a typical piping arrangement using a three-valve manifold and blow-down lines for a differential pressure transmitter being used to measure flow.



Process connections

Table describes typical process connections for a given type of transmitter.

Table 1-3 Process Connections

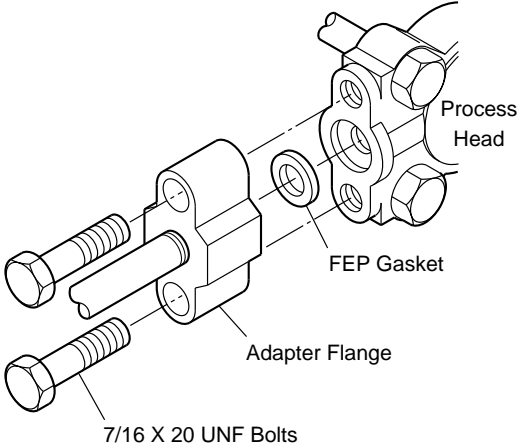
Transmitter type	Process Connection
Differential Pressure	Process heads with 1/4 inch NPT internal thread connection. Flange adapters and manifolds with 1/2 inch internal thread connections are optional.
Gauge Pressure	Process head with 1/2 inch NPT internal thread connection. Process heads with 1/4 inch NPT internal thread connection. (GTX□□G) Flange adapters and manifolds with 1/2 inch internal thread connections are optional (GTX□□G)
Absolute Pressure	Process heads with 1/2 inch NPT internal thread connection (GTX□□A)
Flange Mounted Liquid Level	1.5, 2 or 3 inches flange with flush or 2, 3 or 4 inches extended diaphragm on high pressure side*. Reference side has standard differential pressure process head.
Remote Diaphragm Seals	See Model Selection Guide for description of available Flanged, Button-diaphragm (G1-1/2), and Wafer type process connections.

Installing flange Adapter

Table 1-4 gives the steps for installing an optional flange adapter on the process head.

Slightly deforming the gasket supplied with the adapter before you insert it into the adapter may aid in retaining the gasket in the groove while you align the adapter to the process head. To deform the gasket, submerge it in hot water for a few minutes then firmly press it into its recessed mounting groove in the adapter.

Table 1-4 Installing Adapter Flange

Step	Action												
1	Carefully seat FEP (white) gasket into adapter groove.												
2	Thread adapter onto 1/2 inch process pipe and align mounting holes in adapter with holes in end of process head as required.												
3	<p>Secure adapter to process head by hand tightening 7/16-20 UNF hexhead bolts. Example-Installing adapter on process head</p> <p>ATTENTION Apply an anti-seize compound on the stainless steel bolts prior to threading them into the process head.</p> 												
4	<p>Evenly tighten adapter bolts to the following torque;</p> <table border="1" data-bbox="435 1319 1377 1496"> <thead> <tr> <th>Adapter material</th> <th>CS/SS</th> <th>CS/SS</th> <th>PVC</th> </tr> </thead> <tbody> <tr> <td>Bolt material</td> <td>SNB7/SS630</td> <td>SS304</td> <td>SNB7/SS304</td> </tr> <tr> <td>Torque N•m</td> <td>20 ±1</td> <td>10 ±0.5</td> <td>7 ±0.5</td> </tr> </tbody> </table>	Adapter material	CS/SS	CS/SS	PVC	Bolt material	SNB7/SS630	SS304	SNB7/SS304	Torque N•m	20 ±1	10 ±0.5	7 ±0.5
Adapter material	CS/SS	CS/SS	PVC										
Bolt material	SNB7/SS630	SS304	SNB7/SS304										
Torque N•m	20 ±1	10 ±0.5	7 ±0.5										

1-3-1 :Piping for Liquid, Gas or Steam Flow Rate Measurement

Recommended Piping - Example 1

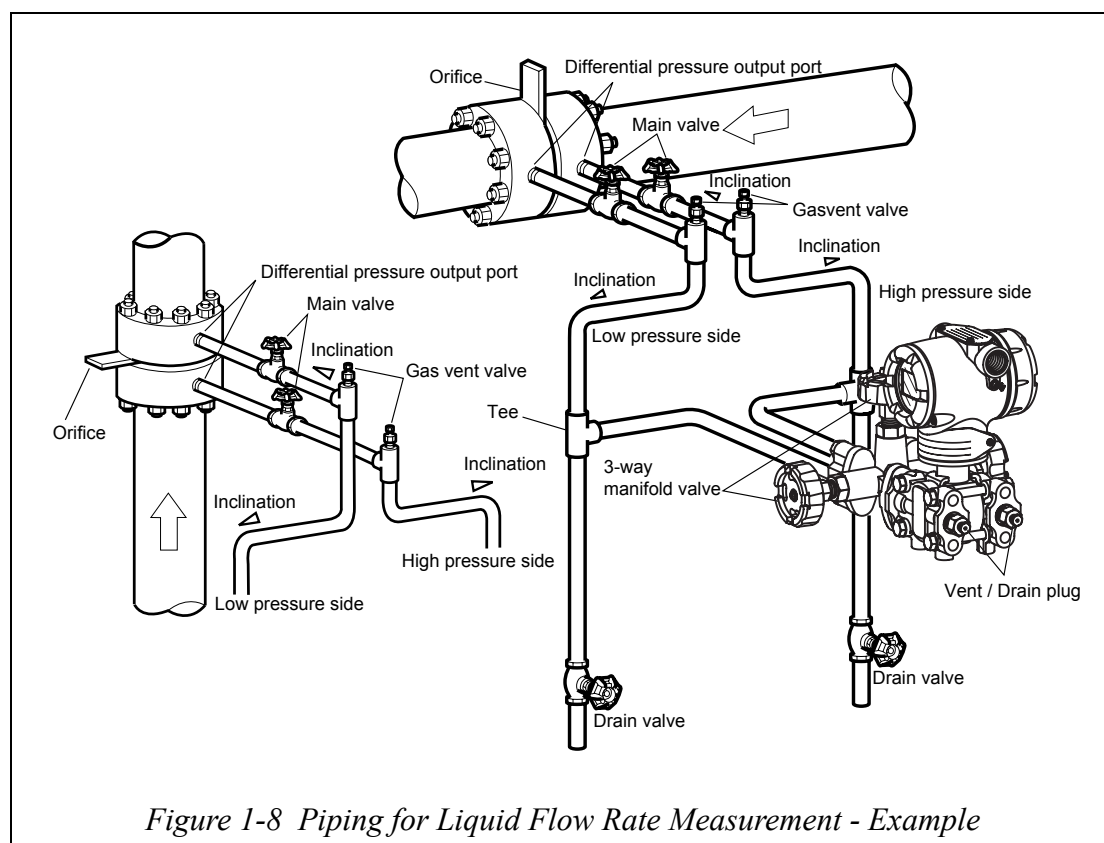
The illustration shows a typical example for liquid Flow Rate Measurement. This Differential pressure transmitter is located below the differential pressure output port of the process pipe. This minimizes the static head effect of the condensate.

The following apply:

Grade the pipe at the differential pressure output part.

Inclination symbol ∇ in illustration: Low level \triangle High level

After piping work, ensure that the connecting pipe, the 3-way manifold valve, and the transmitter have no pressure leak.



This transmitter is located underneath the differential pressure output port of the process pipe.

Recommended Piping - Example 2

The illustration shows a typical example for Gas Flow Rate Measurement. This Differential pressure transmitter is located above the differential pressure output port of the process pipe. The condensate drains away from the transmitter.

The following apply:

Grade the pipe at the differential pressure output part.

Inclination symbol in illustration: Low level High level

After piping work, ensure that the connecting pipe, check for pressure leaks around the 3-way manifold valve, and the transmitter.

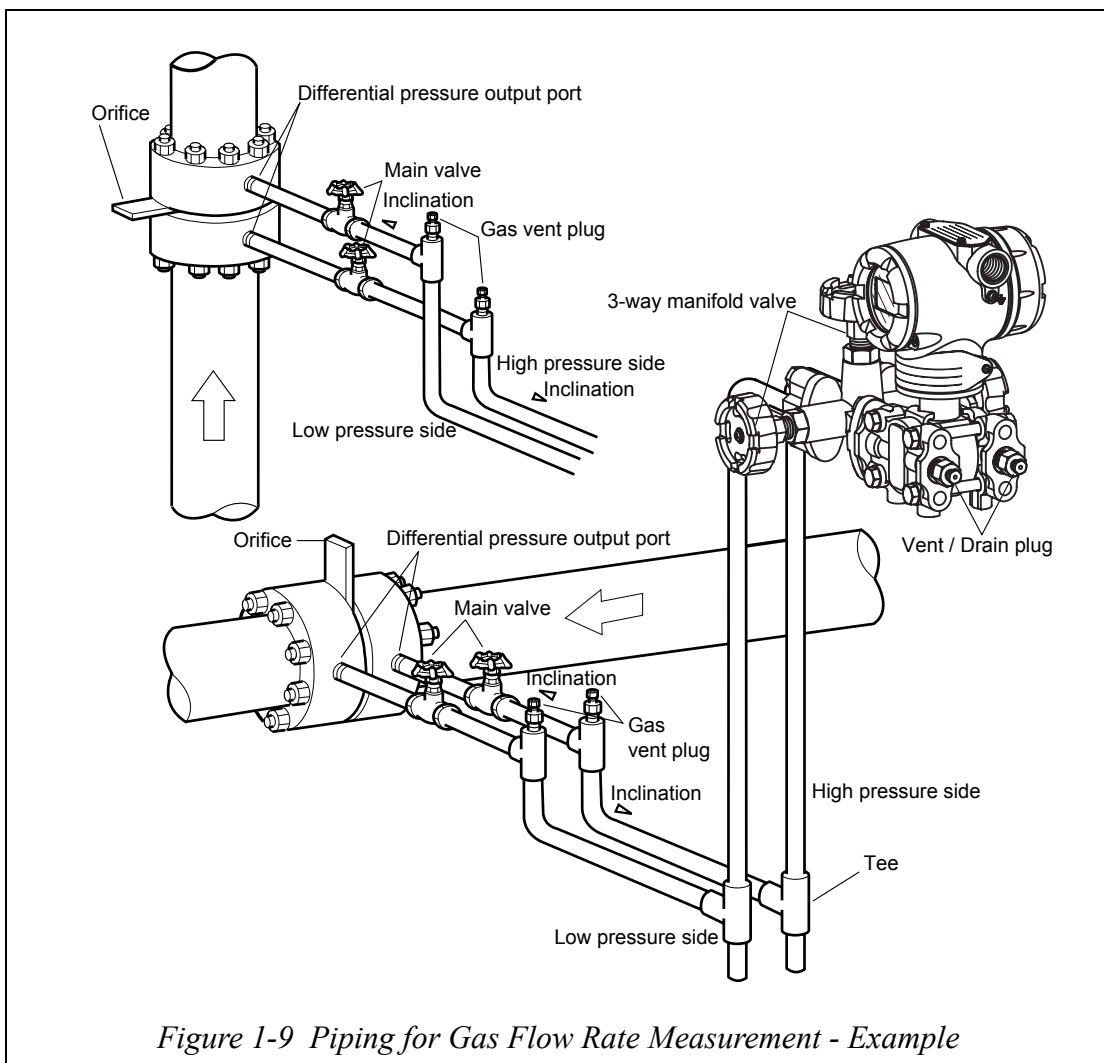


Figure 1-9 Piping for Gas Flow Rate Measurement - Example

This transmitter is located above the differential pressure output port of the process pipe.

Recommended Piping - Example 3

The illustration shows a typical example for Steam Flow Rate Measurement. Recommended for a Differential pressure transmitter located below the differential pressure output port of the process pipe.

The following apply:

Grade the pipe at the differential pressure output part.

Inclination symbol \triangleleft in illustration: Low level \triangleleft High level

After piping work, ensure that the connecting pipe, the 3-way manifold valve, and the transmitter have no pressure leaks.

If the process pipe is vertically mounted, mount seal pots at different levels to prevent zero drift. But in this case, you cannot apply the previously-used zero adjustment procedure (using a 3-way manifold valve). For zero shift occurring at different levels, use an HART® communicator.

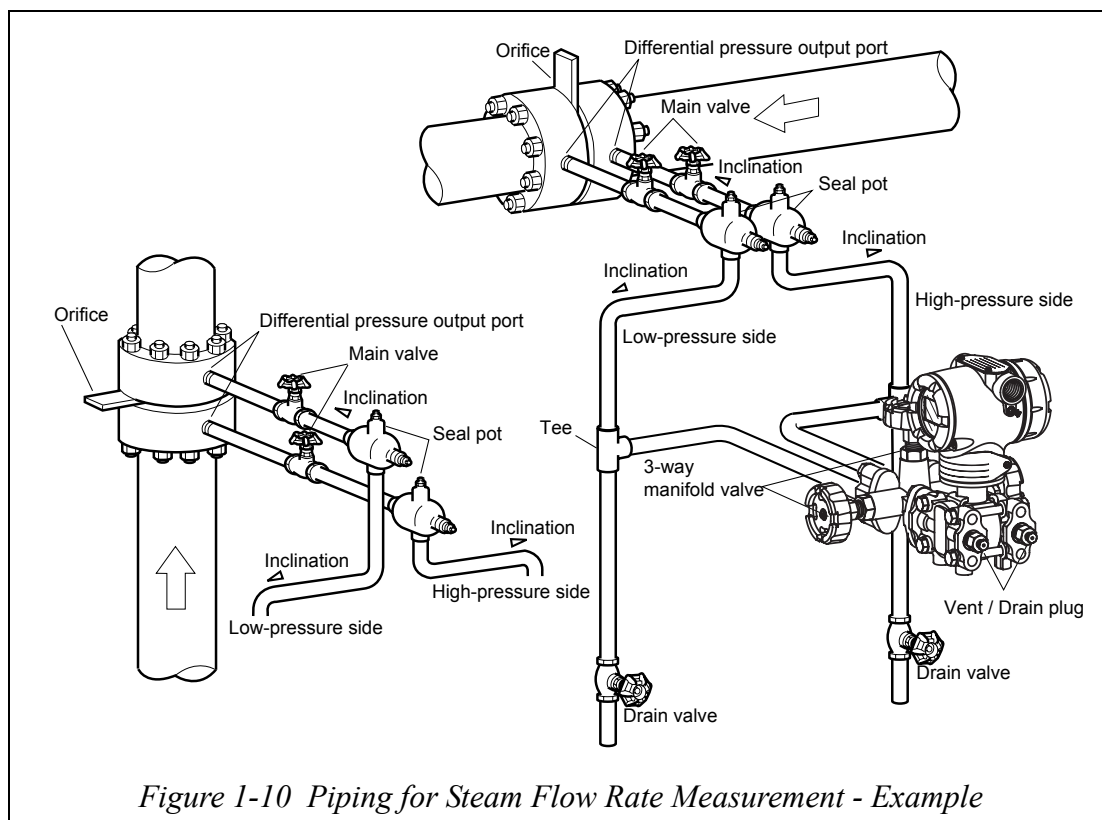


Figure 1-10 Piping for Steam Flow Rate Measurement - Example

This transmitter is located under the differential pressure output port of the process pipe.

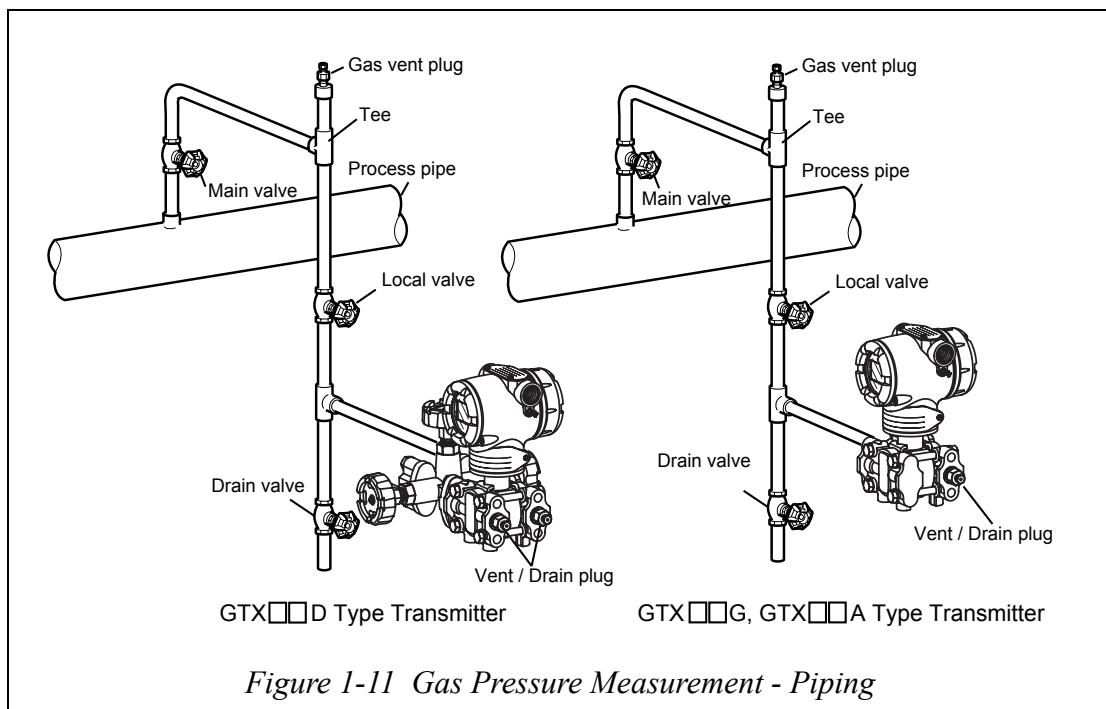
1-3-2 :Pressure Measurement - Piping

Recommended piping - Example

For gas-pressure measurement, piping should be performed following the typical example shown here. Always observe these points:

At the differential pressure output, make pipe vertical.

After completing piping work, check for pressure leaks around connecting pipe and transmitter.



Piping method

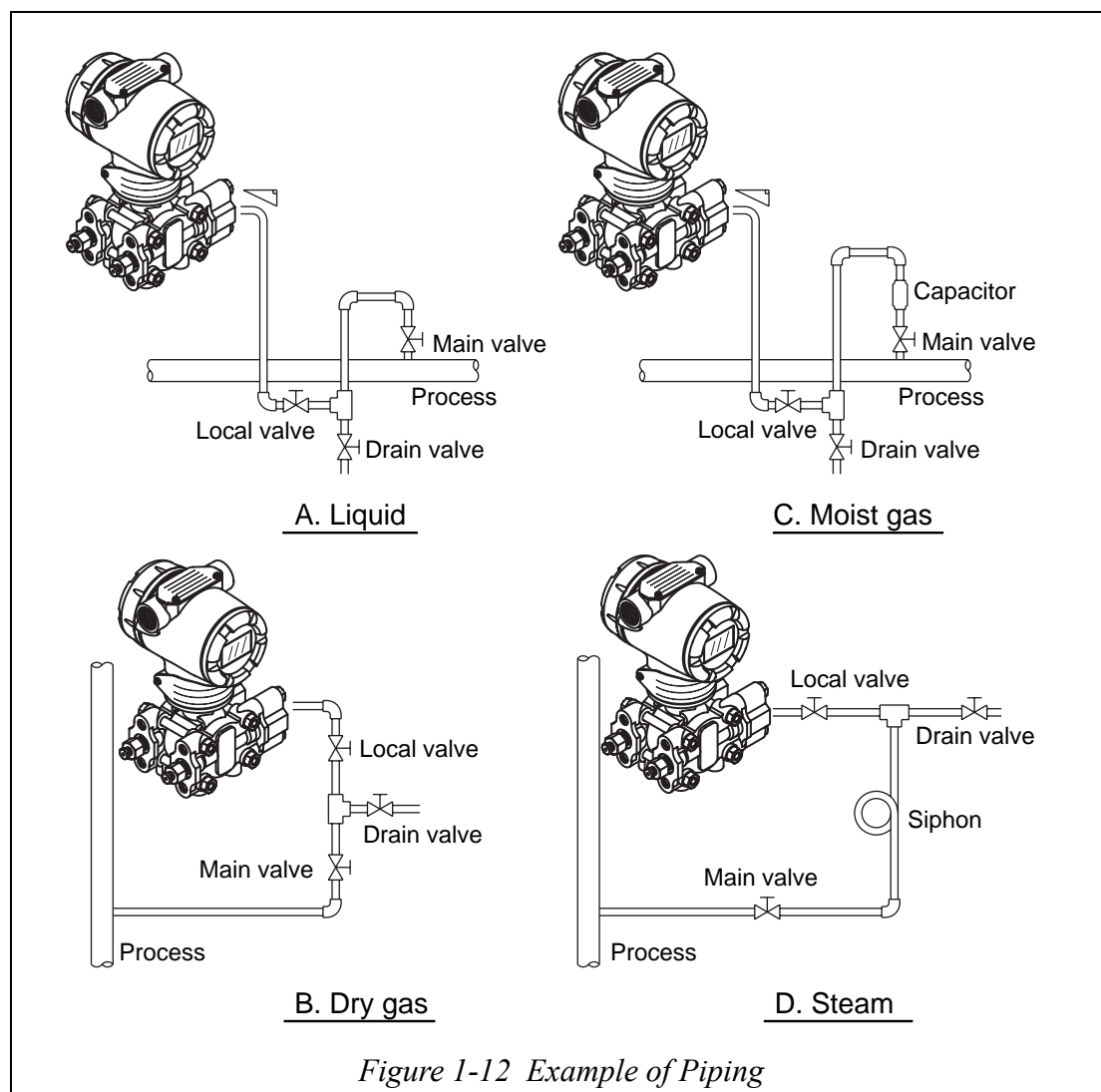
The piping method for the fluid to be measured depends on the meter installation position and the pipe line state. Typical examples of piping are shown in Figure 1-12.

Connect pipes by the following procedure:

- (1) Use a T-shaped joint for the connecting pipeline.
- (2) Install a main valve between the entrance of the connecting pipe and the T-shaped joint.
- (3) If the process is a horizontal line, tilt the pipe to allow draining from the pressure line.

~Note *In case of a high pressure process, select a joint of appropriate specifications and shape and a pipe of appropriate shape and material with care.*

- (4) Determine the connecting pipe schedule number and the nominal thickness of the connecting pipe from the process based on conditions such as the process pressure.



Auxiliary equipment

- (1) Oil sealing and air purging

If the pressure medium (such as suspension, high viscosity, and corrosive fluid) should not be led directly to the element, avoid it by means of sealing or purging. Various sealing and purging methods are available. Consult us for each case.

- (2) Preventing pulsations

If the process has serious pulsations or great pressure fluctuations, provide a throttle valve in the middle of the connecting pipe to prevent pulsations.

1-3-3 :Liquid Level Measurement - Piping (GTX__D/GTX__G)

1-3-3-1 Piping

Introduction

For measurement by GTX__D type of liquid level in a tank, the piping method depends on whether the tank is open or enclosed. For enclosed tanks, piping is modified according to whether you use the gas sealing method (dry leg) or the liquid sealing method (wet leg).

H mark

H indicating high pressure is marked on the center body of this transmitter. Check the mark during piping work. The low-pressure side has no mark.

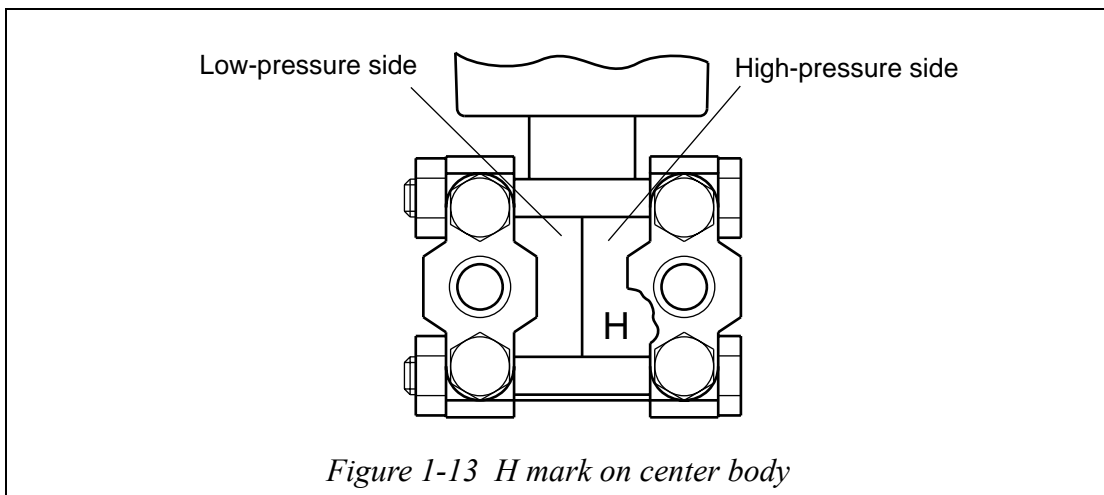


Figure 1-13 H mark on center body

Before your start

The following parts are requirements for piping work. Refer to illustration.

- 3-way manifold valve
- Pipe
- Main valve
- Union or flange
- Tee
- Drain valve
- Drain plug
- Seal pot (for enclosed tank and wet-leg only)

1-3-3-2 Open Tank - Piping

Recommended piping - Example

For open tanks, connect the high-pressure side of this transmitter to the lower part of the tank. Open the low-pressure side to the air.

After completing piping work, check for pressure leaks around the connecting pipe, the transmitter, and the 3-way manifold valve. The illustration shows a typical installation.

Connect the high-pressure side of this transmitter to the lower part of the tank.

Install this transmitter below the lowest liquid level to be measured.

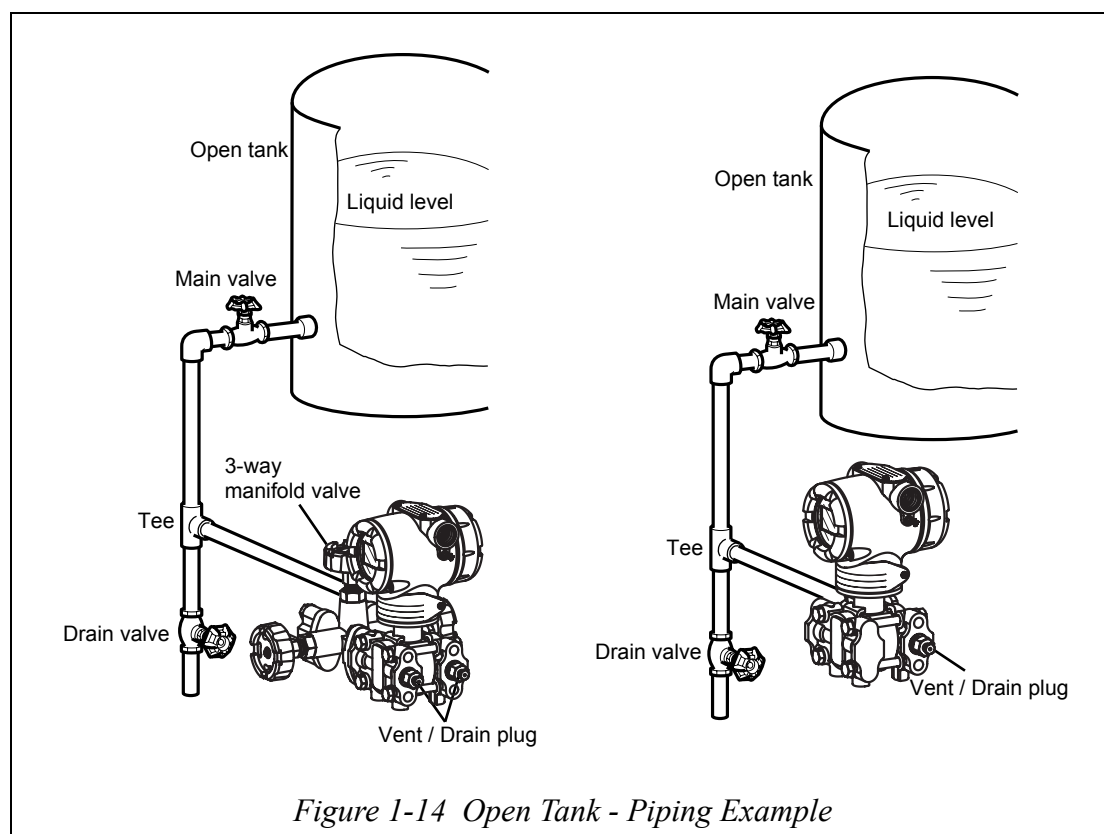


Figure 1-14 Open Tank - Piping Example

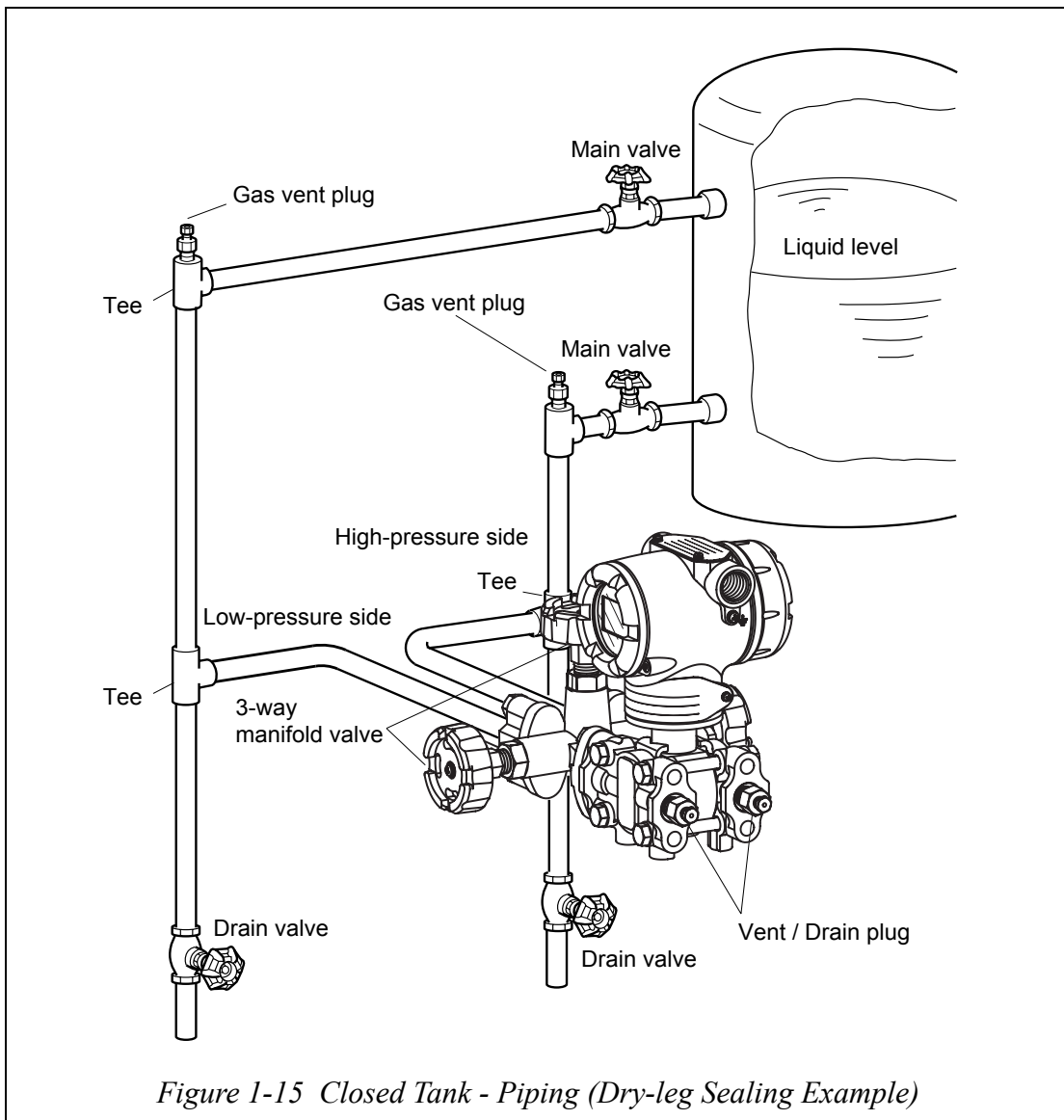
1-3-3-3 Closed Tank - Piping

Recommended piping for dry leg - Example

When using the dry-leg method, connect the high-pressure side of the transmitter to the lower part of the tank. Connect the low-pressure side to the gas-sealing pipe of the tank.

After completing piping work, check for pressure leaks around the connecting pipe, the transmitter, and the 3-way manifold valve. The following shows a typical installation.

Always connect the high-pressure side of this transmitter to the lower part of the tank. Install this transmitter below the lowest liquid level to be measured.



Recommended piping for wet leg - Example

When using the wet-leg method, connect the high-pressure side of the transmitter to the sealing pipe of the tank. Connect the low-pressure side to the lower part of the tank.

After completing piping work, check for pressure leaks around the connecting pipe, the transmitter, and the 3-way manifold valve. The illustration shows a typical installation.

Be sure to connect the low-pressure side of this transmitter to the lower part of the tank.

Install this transmitter below the lowest liquid level to be measured.

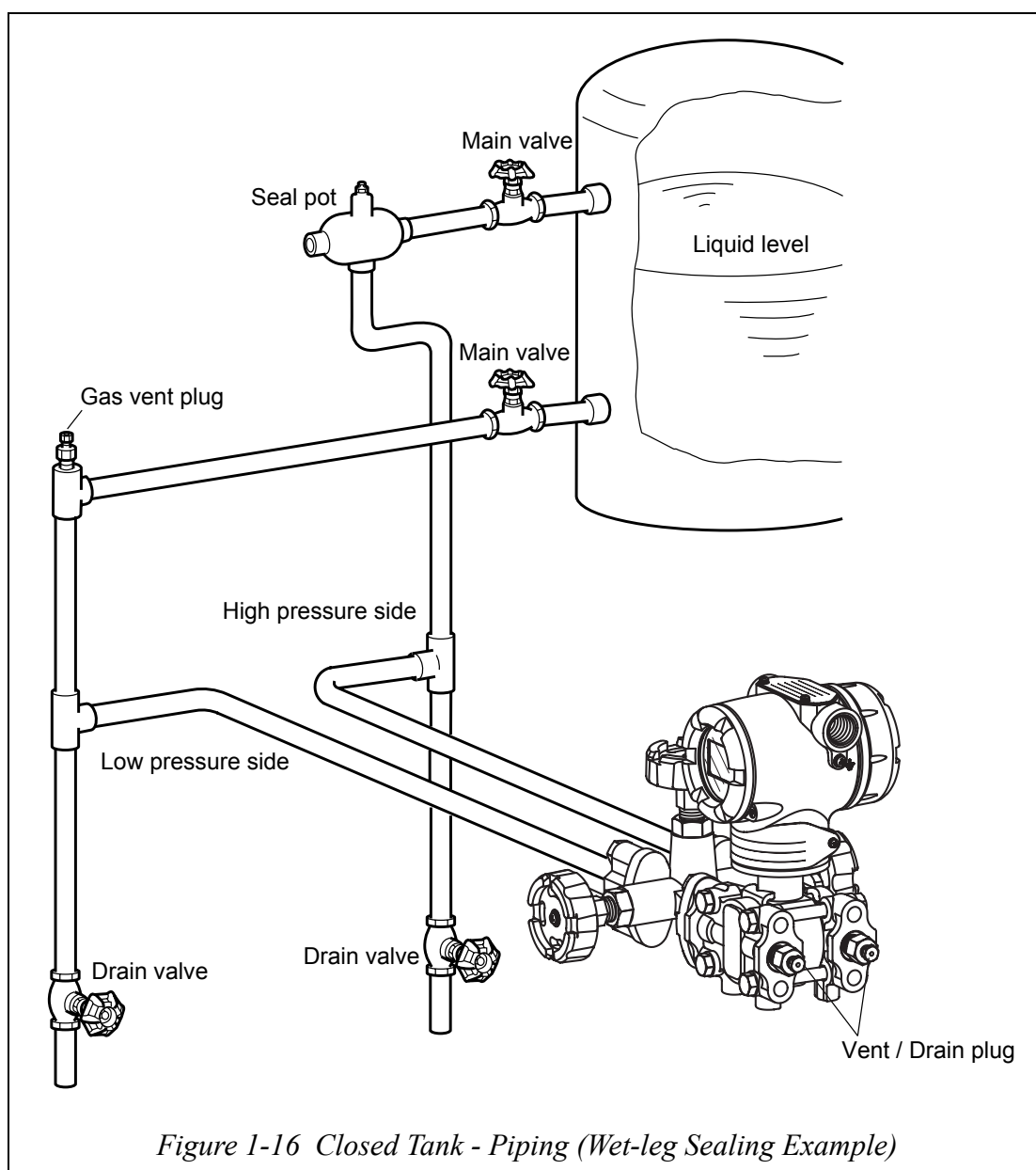


Figure 1-16 Closed Tank - Piping (Wet-leg Sealing Example)

ATTENTION

For liquid or steam, the piping should slope a minimum of 25.4 mm (1 inch) per 305 mm (1 foot). Slope the piping down towards the transmitter if the transmitter is below the process connection so the bubbles may rise back into the piping through the liquid. If the transmitter is located above the process connection, the piping should rise vertically above the transmitter, then slope down towards the flowline with a vent valve at the high point. For gas measurement, use a condensate leg and drain at the low point (freeze protection may be required here).

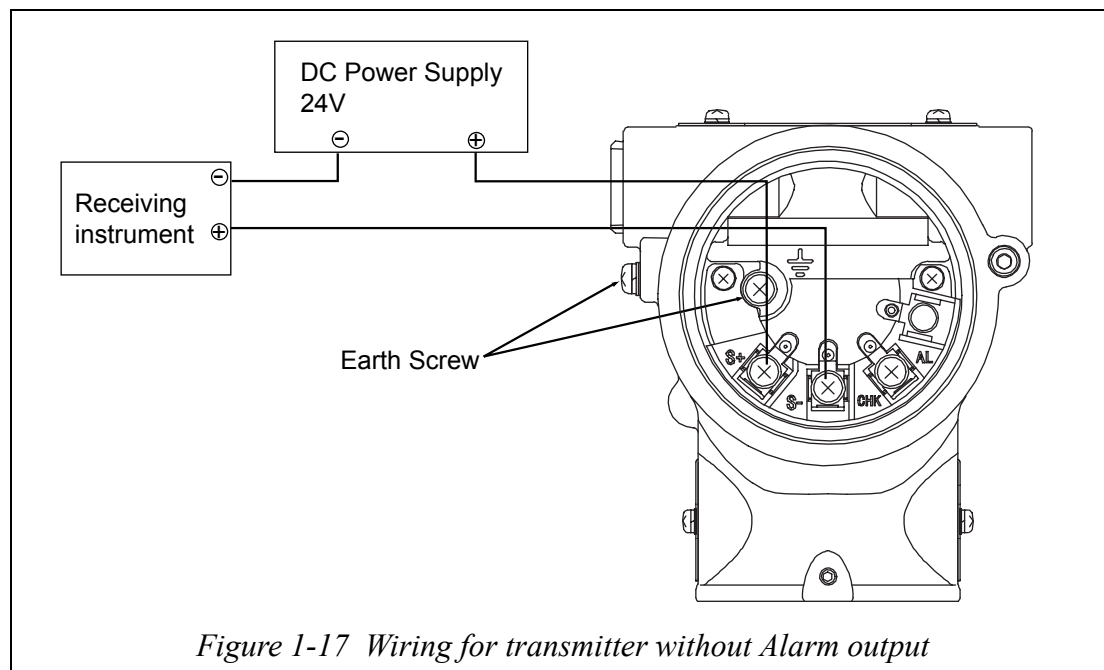
1-4 : Wiring AT9000 Advanced Transmitter

1-4-1 :Wiring for Transmitter -- Regular Model

Introduction

Following wiring instructions when no explosion-proof standards apply.

Wire and cable this transmitter as shown in the illustrations.



- ~Note**
1. *External load resistance of at least 250Ω required for communications with an HART® communicator. If total load resistance of the receiving instrument is less than 250Ω insert the necessary resistance to the loop.
(Refer to Connecting communicator)*
 2. *In using Yamatake's field type indicator (Model NWS300, Model NWA300), please consult us.*

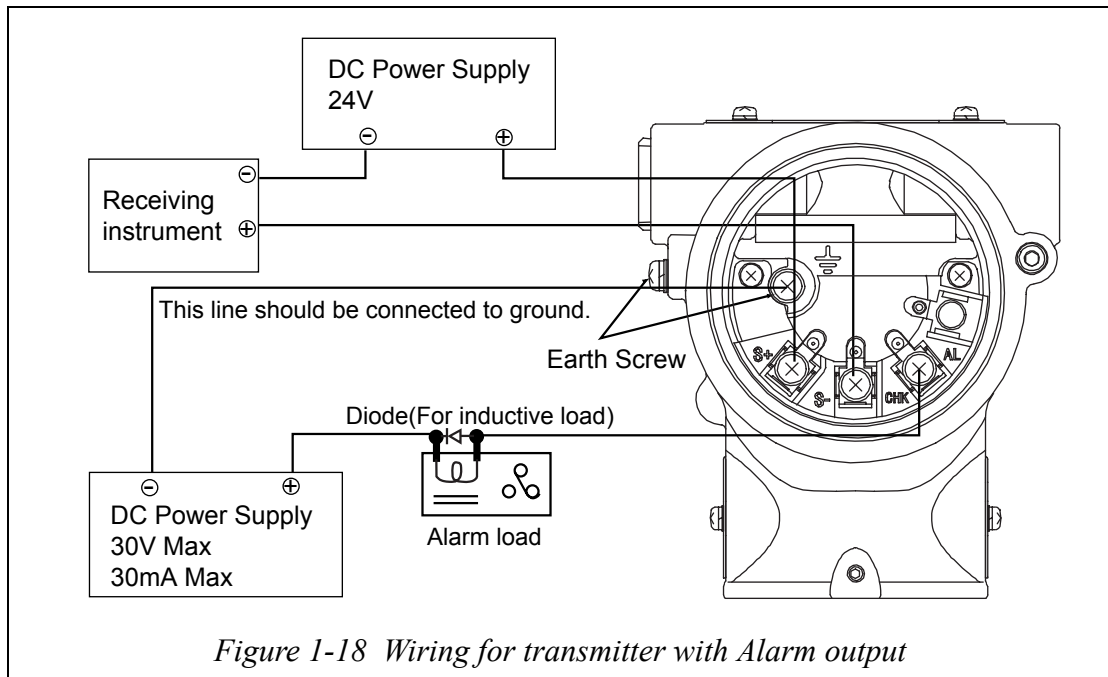


Figure 1-18 Wiring for transmitter with Alarm output

~Note Current cannot be checked for a transmitter with alarm contact output.

Conduit pipe for cables

Lead cables into the transmitter case, as follows:

Mount a conduit pipe in the conduit hole (1/2NPT female thread) provided on the side of a transmitter, and lead cables through the pipe.

Seal the part that contacts with the conduit pipe. Use a sealing agent or a seal plug to prevent entry of water.

Install transmitter so that the cables lead into it, from the bottom.

Grounding

If a shielded cable is used, earth (ground) the shield at the receiver only (single point ground). Connecting the shield to signal ground is recommended to make the electric potential difference lower.

If the transmitter is not grounded through a pipe stanchion, ground the transmitter using an earth terminal in the transmitter.

To ground the transmitter, the ground resistance must be 100Ω or lower.

External Grounding or Bonding Connection

The connection of the grounding or equipotential bonding conductor with the external grounding terminal must comply with the following method.

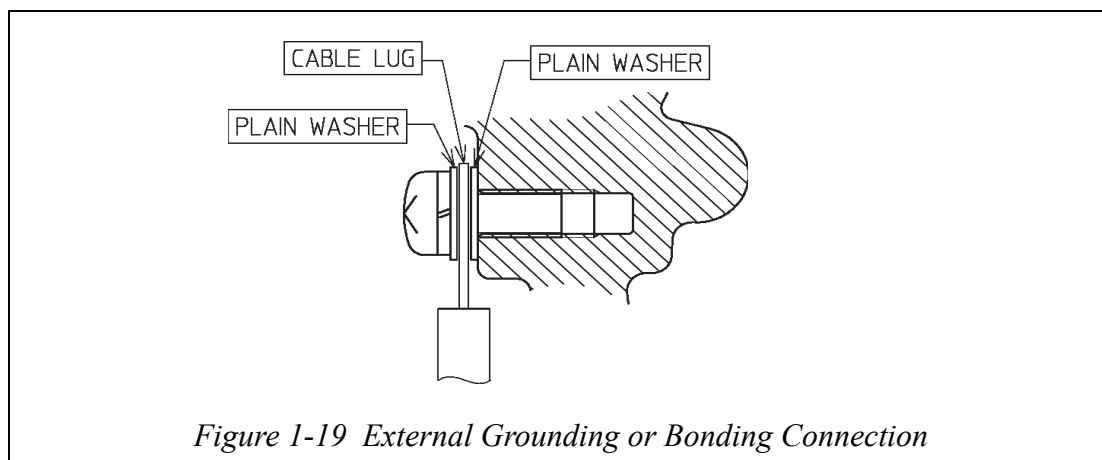


Figure 1-19 External Grounding or Bonding Connection

Supply power and external load resistance

Confirm the relationship between the external load resistance and the supply voltage. As shown in the illustration, the relationship should be inside the shaded area.

External resistance: the total resistance connected to the output terminals of a transmitter (includes resistances of all cables in the loop plus the internal resistance of the instruments).

The horizontal axis represents the supply voltage of a transmitter, and vertical axis represents the external load resistance

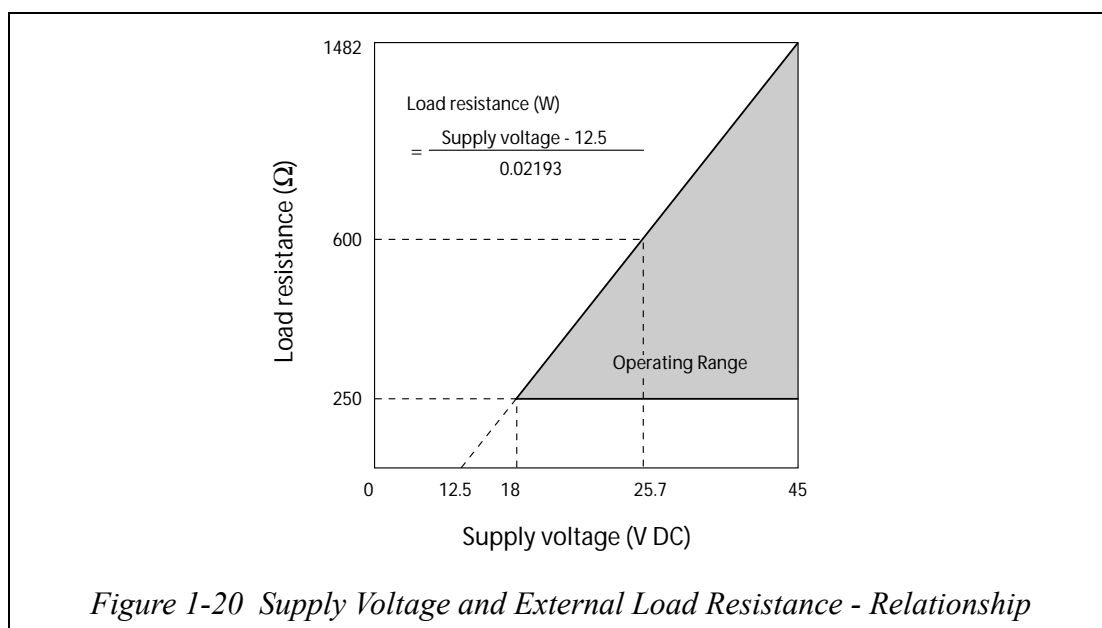


Figure 1-20 Supply Voltage and External Load Resistance - Relationship

- ~Note
1. 45 volt operation is permitted.
 2. For communication with HART® communicator, a load resistance of 250 Ω or more is needed.

Summary

For wiring the transmitter, you simply connect the positive (+) and negative (-) loop wires to the positive (+) and negative (-) signal terminals on the terminal block in the transmitter's electronics housing as shown in Figure 1-21.

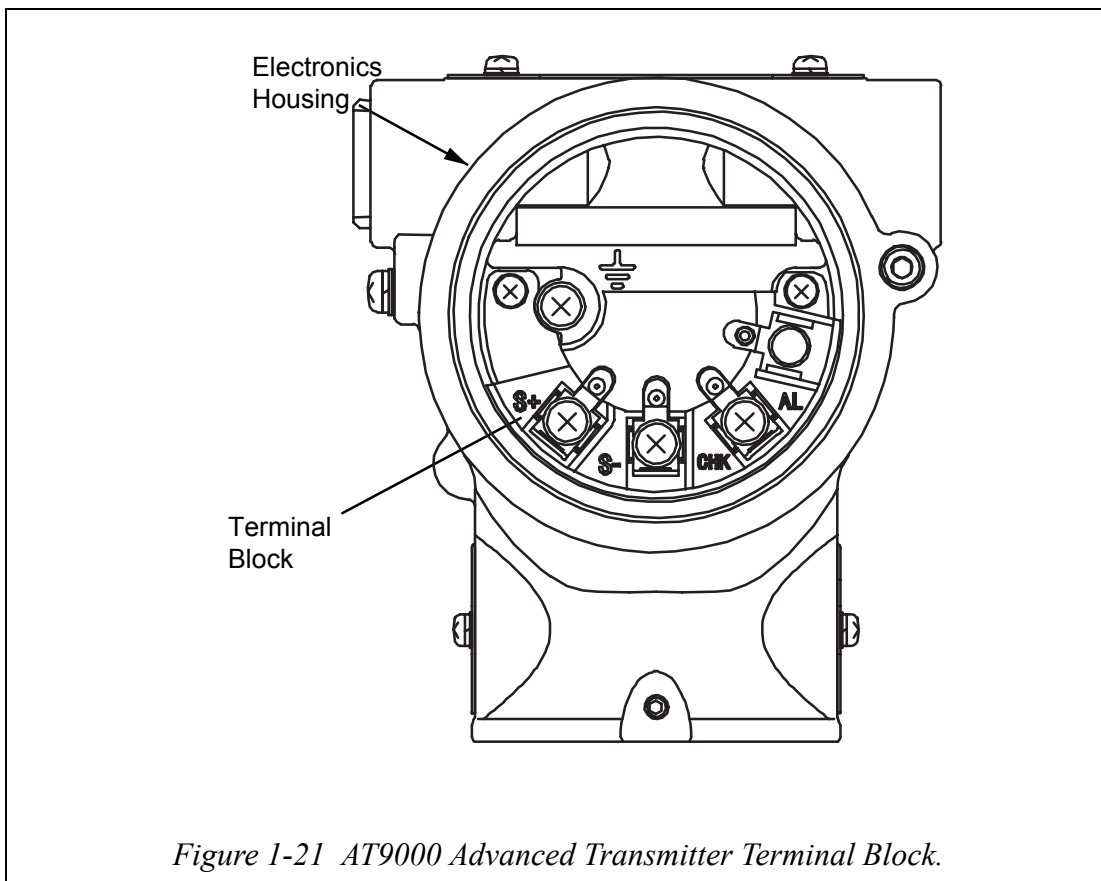


Figure 1-21 AT9000 Advanced Transmitter Terminal Block.

Chapter 2 : Operation of the Transmitter

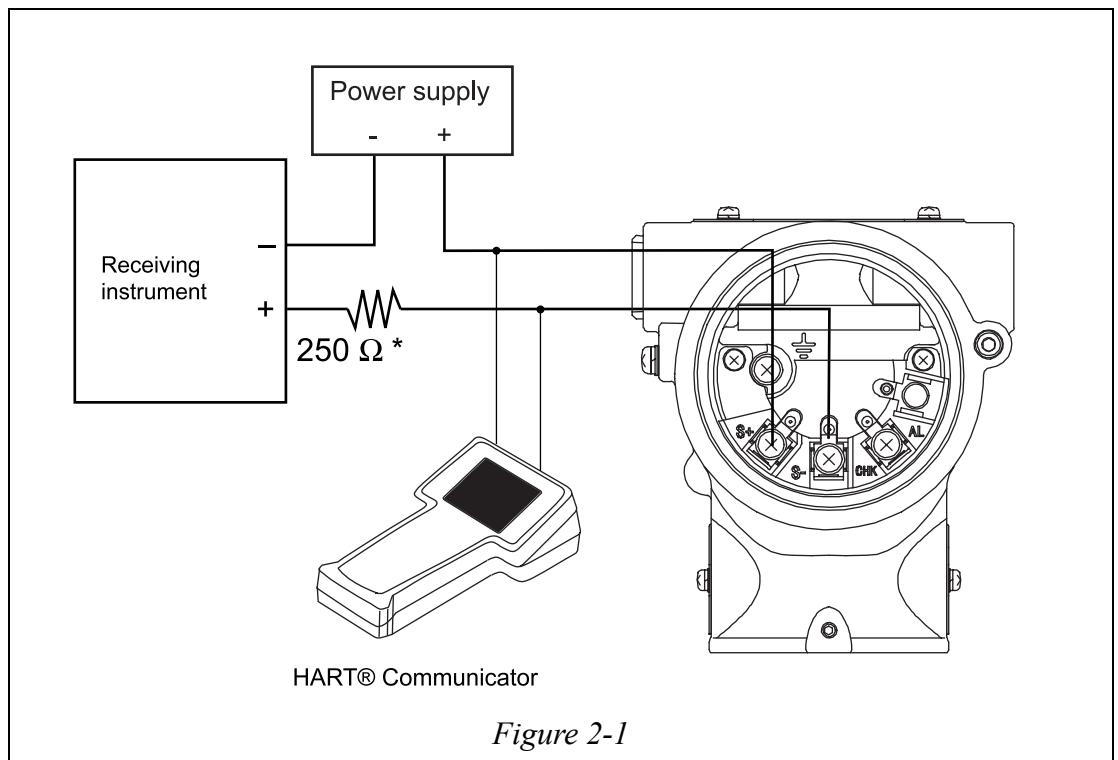
2-1 : Preparation

Instructions for connecting HART® Communicator to this transmitter.

Basic instructions for Key-pad operation.

2-1-1 :Connecting communicator

You connect the communicator directly to signal terminals on the transmitter's terminal block or at any location in the 4 to 20 mA loop. (Polarity of the communicator connection does not matter)



2-1-2 :HART® communicator keyboard



Figure 2-2 HART® Communicator

2-1-3 :Symbols on communicator screen

See manual of 375 communicator.

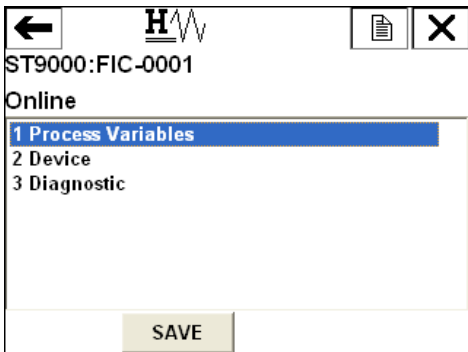
2-1-4 : Keying in alphanumeric characters

See manual of 375 communicator.

2-2 : Setting and Checking Specifications

2-2-1 :Establishing Communications

This procedure starts communications between the transmitter and the communicator:

STEP	Action and/or Description
1	Turn on communicator. The communicator runs a self-test check then determines if it is connected to a transmitter.
2	<p>If you receive a communication error message (No Device Found), check the following:</p> <ul style="list-style-type: none"> • Loop resistance: Is there a minimum of 250 Ω resistance between the communicator and the power supply? • Power supply: Is power applied? Is there greater than 11 volts at the transmitter? <p>Correct any problems, and try communicating again. If the message, or any other error message, appears again, refer to “Chapter 7 : Maintenance and Troubleshooting”.</p>
3	<p>When the “Online” display - shown below - appears, you have established communication with the transmitter.</p> <div data-bbox="772 1088 1241 1438" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;">  </div> <p>The flashing heart icon in the upper right corner indicates the communicator and the transmitter are communicating.</p>

2-2-2 :Setting Tag No.

Procedure

This shows how to change or enter tag number.

(Device) - (Device information) - (Tag)

After entering a tag number with pressing ENTER, press SEND to download the change to the transmitter.

2-2-3 :Checking Output Format

Procedure

This shows how to change output format, which linear calculation or square root calculation

used for measuring differential pressure between a primary element with DP type transmitter.

(Device) - (Basic Setup) - (Transfer Function)

2-2-4 :Checking Display Setting

Procedure

This shows how to configure display format and/or its ranges.

(Device) - (Display)

Menu items when Display Mode is %:

- 1 Display Mode
- 2 Display Function
- 3 Transfer Function

Menu items when Display Mode is pressure:

- 1 Display Mode
- 2 Transfer Function

Menu items when Display Mode is scale:

- 1 Display Mode
- 2 Display Function
- 3 Transfer Function
- 4 EULO (0%)
- 5 EUHI (100%)
- 6 Disp. Unit
- 7 User Unit
- 8 Exponent

2-2-5 : Display Mode

%:	Displaying PV with %
pressure:	Displaying PV with pressure unit
scale:	Displaying scaling PV

2-2-6 : Display Function

Linear:	Displays flow linear.
Square root:	Displays flow by square root extraction.

2-2-7 :Checking Engineering Unit of Measured Pressure

Procedure

This function is to check a pressure unit of the transmitter.

(Device) - (Display) - (Disp. Unit)

inH₂O

inHg

mmH₂O

psi

bar

mbar

g/Sqcm

kg/Sqcm

mmHg

Pa

kPa

MPa

2-2-8 :Checking Low and High Limits of Setting Range

Procedure

This is to configure the measuring range of the transmitter.

(Device) - (Basic Setup)

- Select Lower Ranges Value (0%) or Upper Range Value (100%) to key in the desired setting.

- Press ENTER. This takes you back to “Basic Setup” menu.

- Press SEND to download change to transmitter.

If the number of digit you key in is more than four, the set range is not appeared on “Basic Setup” menu.

LRL and URL are to refer only.

2-2-9 :Adjusting Damping Time Constant

Procedure

You can adjust the damping time to reduce the output noise.

(Device) - (Other) - (PV damping)

When PV damping menu, key in appropriate damping time from 0.0 to 128.0, and the press ENTER. A display will prompt when you enter the value out of range that the value is out of range.

2-2-10 :Checking Fill fluid temperature compensation

Procedure

This function implemented by inputting the height between the flanges on which the transmitter is mounted.

(Device setup) - (Detailed setup) - (Signal condition) - (Height)

Key in the height between the flanges in meter.

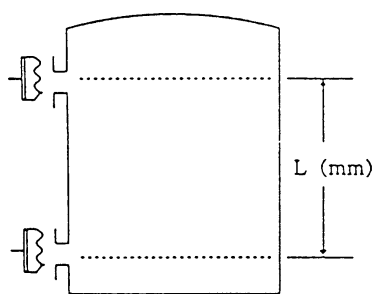
When communicating with the transmitter without this function, the screen shows “0.00 m”.

Keying in “0” disables the function.

Sealed liquid temperature correction function

When the liquid level of a tank is measured using a remote sealing type differential pressure transmitter, the density of the sealed liquid in the capillary tube changes as the ambient temperature changes. This ordinarily causes about 4~5% zero shifting.

The GTX□□R has a composite semiconductor sensor with a function for correcting sealed liquid temperature by means of temperature measurement and arithmetic operation with a microprocessor. This assures accurate level measurements. (The zero shift is reduced to 1/5 from the previous level.)



Example of zero shift

L (Difference between flanges): 2500 mm (2.5 m)

R (Measurement span): 2500 mm (2.5 m)

A (Temperature coefficient of sealed liquid):0.001/°C

T (Ambient temperature change): 55°C

$$Zero\ shift = \frac{A \times T \times L}{R} \times 100 \dots (1)$$

From (1)

Zero shift of a model without temperature correction:

$$\frac{0.001 \times 55 \times 2500}{2500} \times 100 = 5.5 \%$$

(Conventional transmitter)

Zero shift of a model with temperature correction

function: 1%

2-3 : Measurement with model GTX__D

2-3-1 :Flow Rate Measurement

2-3-1-1 Preparation for Measurement

⚠ WARNING

- Make sure that the process is in the manual control mode.
If in automatic control mode, switch to manual control before starting the following procedures.
- Drain poisonous fluids with care, making provisions to protect personnel.
- Always close the differential pressure output valve (main valve), the drain valve, the gas vent plug (Refer to Figure 1-8 and Figure 1-9) and the high pressure side and low pressure side stop valves of the 3-way manifold valve. Also, open the equalizer valve of the 3-way manifold valve.

Procedure 1

Lead process pressure into the pressure receiving part of the transmitter, using this procedure:

Step	Description
1	Gradually open the main valves of both the high-pressure side and the low-pressure side (Refer to Figure 1-8 and Figure 1-9). Lead process fluid into the connecting pipe.1
2	<p>Fill with process fluid, the pressure-receiving part of the transmitter.</p> <ol style="list-style-type: none"> 1. Gradually open the high pressure side stop valve. Close, after the pressure receiving part has completely filled with process fluid. 2. Gradually open the low pressure side stop valve. Close, after the pressure receiving part has completely filled with process fluid.

The diagram shows a 3-way manifold valve assembly. It features a central body with three main ports. On the left, there is a 'Low-pressure side' port with a 'Low-pressure side stop valve'. On the right, there is a 'High-pressure side' port. At the top, there is an 'Equalizer valve'. At the bottom right, there is a 'Vent / Drain plug'. The entire assembly is labeled as a '3-way manifold valve'.

Step	Description
3	Decrease to zero, the differential pressure applied to the transmitter. <ul style="list-style-type: none"> • Gradually open the high-pressure side stop valve to lead process pressure into the pressure receiving part of the transmitter. • In this state, equal pressure is applied to the high-pressure side and the low-pressure side of the transmitter (equal pressure state).
4	Check for pressure leaks in the connecting pipe, the 3-way manifold valve, and the transmitter.

Procedure 2

Perform zero-point calibration, using this procedure:

Zero point calibration by HART® communicator operation

Check that the transmitters input is 0 kPa and its output is 0% at Online display. (Refer to "2-2-1 : Establishing Communications").

If the screen display is not 0 kPa perform zero-point calibration using this procedure.

(Device)-(Calibration) - (Correct Input)

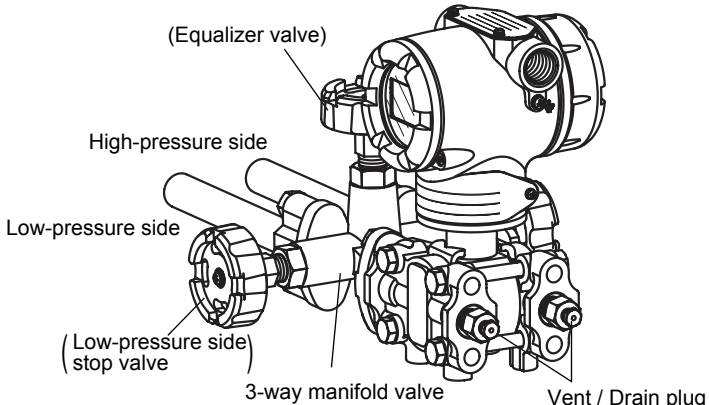
- Select “Zero Trim”.
- You will be warned to remove the loop from automatic control. After doing so,
- press OK.
- When prompted, adjust pressure source to apply pressure equal to zero, then press OK.
- When pressure is stable, press OK.

2-3-1-2 Starting Measurement

Procedure 3

Apply the differential pressure of the process by operating valves, using this procedure.

How to apply process pressure

Step	Description
1	Ensure that the 3-way manifold valve is in the following state: <ol style="list-style-type: none"> 1. High-pressure side stop valve: Fully open 2. Low-pressure side stop valve: Fully closed 3. Equalizer valve: Fully open
2	<ol style="list-style-type: none"> 1. Close the equalizer valve. 2. Open the low-pressure side stop valve gradually. <div style="text-align: center;">  </div>

CAUTION

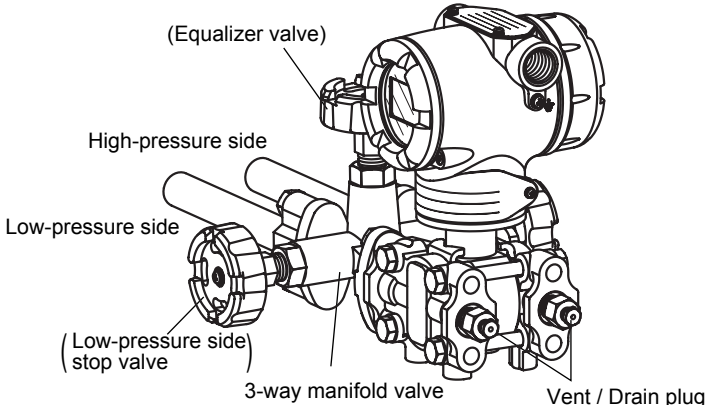
Securely close the cover of the transmitter case. Imperfect closure allows entry of water, and may damage internal terminals as well as the electronics module. Such damage may require parts replacement, possibly of the entire module.

- If input and output values do not match, check the range and re-calibrate.
- If the displayed data value is unstable, adjust the damping time constant.

2-3-1-3 Stopping Measurement

Procedure

Stop the transmitter, using this procedure:

Step	Description
1	Turn off the transmitter
2	<p>Operate the 3-way manifold valve by the following procedure:</p> <ol style="list-style-type: none"> 1. Close the low-pressure side stop valve. 2. Open the equalizer valve. 3. Close the high-pressure side stop valve 
3	Close the main valves on the high and low pressure sides. Refer to Figure 2-8 and Figure 2-9.

⚠ CAUTION

- If you plan to leave the transmitter OFF for a long period of time, always drain process fluid from the connecting pipe and the pressure-receiving part.
- Leave the equalizer valve open.

2-3-2 :Gas Pressure Measurement

2-3-2-1 Preparation for Measurement

WARNING

-
- Ensure that the process is in the manual control mode.
If the process is in automatic control mode, switch to manual before starting the procedure.
 - Drain poisonous fluids with care, making provisions to protect personnel.
 - Close the differential pressure output valve (main valve), the local valve, the drain valve, and the gas vent plug. Refer to "Figure 1-11 Gas Pressure Measurement - Piping".
-

How to measure gas pressure

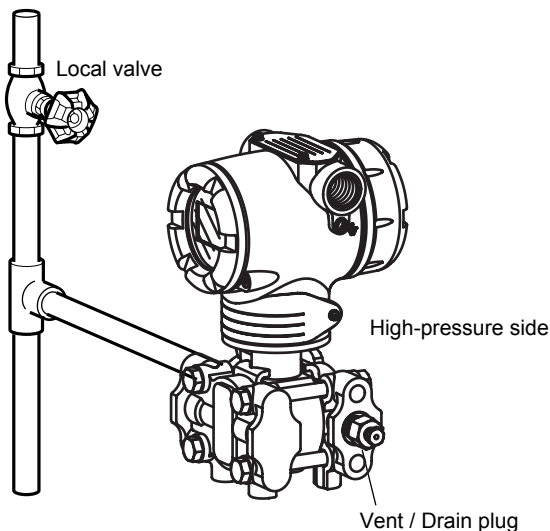
Perform zero-point adjustment and introduce process pressure into the transmitter, using this procedure:

- Zero-point adjustment

Step	Description
1	Open both the high-pressure side and low-pressure side vent plugs and open the pressure receiving part to the air.
2	Refer to procedure 2 on page 2-8. Perform zero-point calibration.
3	After completing zero-point calibration, close the high-pressure side vent plug.

Introducing process pressure and venting air

Step	Description
1	1. Open the main valve (refer to "Figure 1-11 Gas Pressure Measurement - Piping".) to introduce process pressure into the connecting pipe. 2. Open the local valve gradually, to introduce process pressure into the pressure-receiving part of the transmitter.
2	1. Open the high-pressure side vent plug gradually, to vent air from the center body. 2. After vent air, close the vent plug and the local valve.
3	Check for pressure leaks in the connecting pipe and the transmitter.

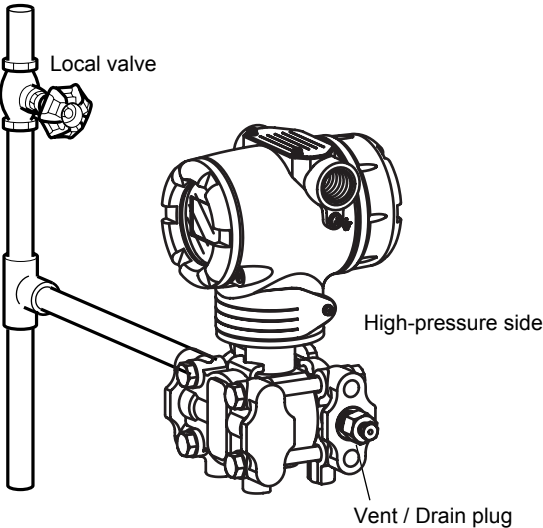


2-3-2-2 Starting Measurement

Procedure

Operate the valves using this procedure, to apply process pressure to the transmitter.

- How to apply process pressure

Step	Description
1	<p>Open the local valve gradually.</p>  <p>The diagram illustrates the transmitter assembly. A vertical pipe on the left has a 'Local valve' at the top. A horizontal pipe connects this to the 'High-pressure side' of the transmitter. The transmitter has a cylindrical top section with a cover and a lower section with various ports. A 'Vent / Drain plug' is located on the lower section.</p>

CAUTION

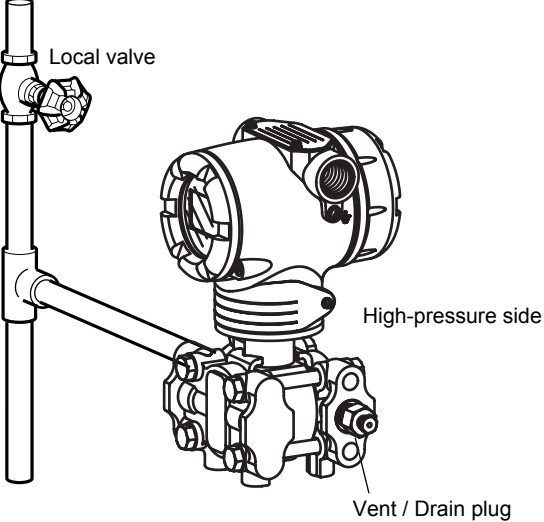
Securely close the cover of the transmitter case. Failure to do so will result in entry of water, and cause damage to internal terminals and the electronics module.

- If input and output values fail to match, check the range and re-calibrate.
- If the displayed data value is unstable, adjust the damping time constant.

2-3-2-3 Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Close the local valve. <div style="text-align: center; margin-top: 20px;">  <p>The diagram shows a transmitter unit connected to a vertical pipe. A local valve is located on the pipe above the transmitter. The transmitter has a high-pressure side and a vent/drain plug at the bottom.</p> </div>
3	Close the main valve. (Refer to "Figure 1-11 Gas Pressure Measurement - Piping".)

⚠ CAUTION

If you plan to leave the transmitter OFF for a long period of time, completely drain process fluid from the connecting pipe, and from the pressure receiving part.

2-3-3 :Liquid Level Measurement of Open Tank and Closed Tank (Dry Leg)

2-3-3-1 Preparation for Measurement

WARNING

-
- Place the process in the manual control mode.
If the process is in the automatic control mode, switch to manual before performing work.
 - Drain poisonous fluids carefully, taking provisions to protect workers.
 - Check that the differential pressure output valve (main valve), the drain valve, the gas vent plug (refer to "Figure 1-14 Open Tank - Piping Example".) are closed, as well as the high pressure side and low pressure side stop valves of the 3-way manifold valve. Also, make sure that the equalizer valve of the 3-way manifold valve is open.
-

Calculating setting range

Calculate the setting range. Refer to "2-8 : Set Range Calculation for Liquid Level Measurement".

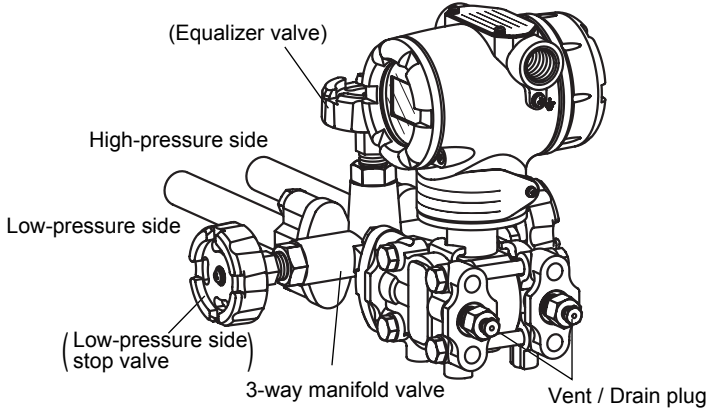
Procedure

Perform zero-point adjustment and introduce process pressure into the transmitter by this procedure:

Zero-point calibration

Step	Description
1	Open the drain plugs and the stop valves of both the high-pressure side and the low-pressure side. Open the pressure receiving part to the air. If fluid remains in the pressure receiving part, blow it to drain.
2	Refer to procedure 2 in page 2-8 and perform zero-point calibration.
3	After completing zero-point calibration, close the high-pressure side drain plug and the high-pressure side stop valve.

Introducing process pressure

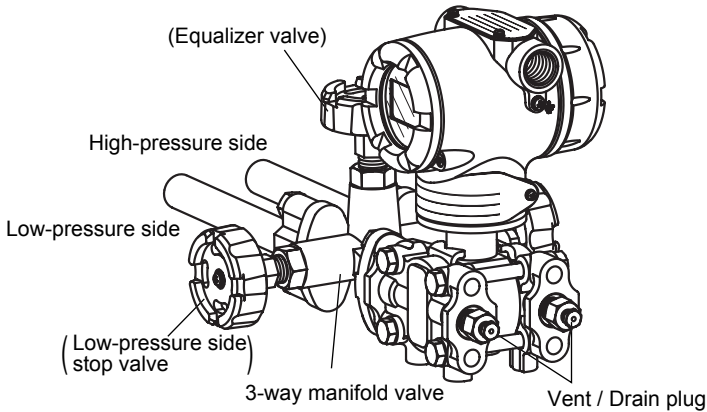
Step	Description
1	<p>1. Open the main valve (refer to "Figure 1-14 Open Tank - Piping Example") to introduce process pressure into the connecting pipe.</p> <p>2. Open the high-pressure side stop valve gradually to introduce process pressure. After introducing process pressure into the pressure receiving part of the transmitter, close the high-pressure side stop valve.</p> 
2	<p>Check for pressure leaks in the connecting pipe, the 3-way manifold valve, and the transmitter.</p>

2-3-3-2 Starting Measurement

Procedure

Operate the valves with this procedure, to apply the differential pressure of the process to the transmitter.

How to apply process pressure

Step	Description
1	<p>Check that the 3-way manifold valve is in the following state:</p> <ol style="list-style-type: none"> 1. High-pressure side stop valve: Fully closed 2. Low-pressure side stop valve: Fully open 3. Equalizer valve: Fully closed 
2	<ol style="list-style-type: none"> 1. Open the high-pressure side stop valve gradually.

CAUTION

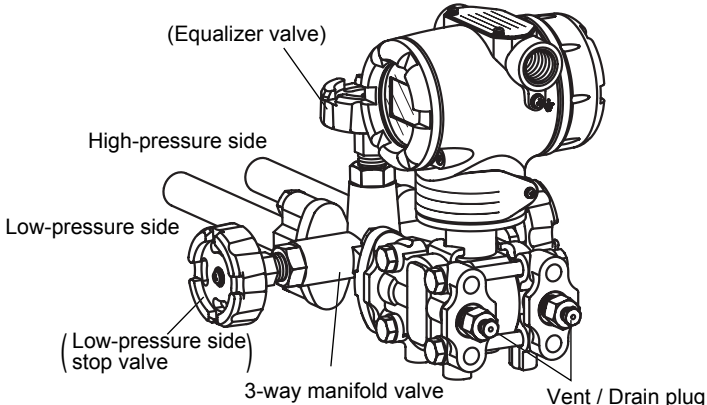
Securely close the cover of the transmitter case. Failure to do so will result in entry of water, and cause damage to internal terminals and the electronics module.

- If the input and output values do not match, check the range and re-calibrate.
- If the displayed data value is unstable, adjust the damping time constant.

2-3-3-3 Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Operate the 3-way manifold valve using this procedure: <ol style="list-style-type: none"> 1. Close the low-pressure side stop valve. 2. Open the equalizer valve. 3. Close the high-pressure side stop valve. 
3	Close the main valve. Refer to "Figure 1-14 Open Tank - Piping Example".

⚠ CAUTION

- If you plan to leave the transmitter OFF for a long period, drain process fluid from the connecting pipe and the pressure receiving part.
- Leave the equalizer valve open.

2-3-4 :Liquid Level Measurement of Closed Tank (Wet Leg)

2-3-4-1 Preparation for Measurement

WARNING

-
- Place the process in manual control mode.
If the process is in automatic control mode, change it to the manual control mode before performing this work.
 - Drain poisonous fluids with care, making provisions for protecting workers.
 - Make sure that the differential pressure output valve (main valve), the drain valve, the gas vent plug (refer to "Figure 1-16 Closed Tank - Piping (Wet-leg Sealing Example)".) and the high pressure side and low pressure side stop valves of the 3-way manifold valve are closed. Also, make sure that the equalizer valve of the 3-way manifold valve is open.
-

Calculating setting range

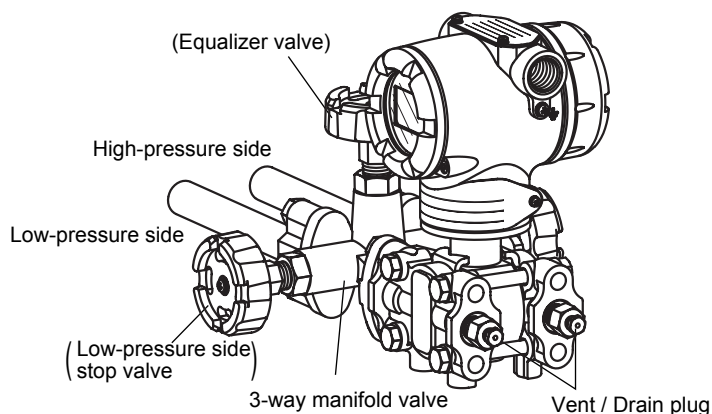
For the procedure for obtaining the setting range by calculation, refer to "2-8 : Set Range Calculation for Liquid Level Measurement".

Procedure

Perform zero-point adjustment and introduce process pressure into the transmitter using this procedure:

Zero-point calibration

Step	Description
1	Feed sealing liquid from the seal pot to fill the connecting pipe with sealing liquid.
2	Gradually open the stop valves of both the high-pressure side and the low-pressure side, and the drain plugs, to fill the pressure receiving part of the transmitter with sealing liquid.
3	When sealing liquid flows out from the drain plugs, close the stop valves of both the high pressure side and the low pressure side and the drain plugs. In this state, the same pressure is applied to the high pressure side and the low pressure side of the transmitter (equal pressure state).
4	Referring to procedure 2 in page 2-8, perform zero point calibration.
5	After completing zero-point calibration, close the equalizer valve. Open the stop valve and the drain plug of the low-pressure side to drain sealing liquid. Close the stop valve and the drain plug of the low-pressure side.



Introducing process pressure

Step	Description
1	Open the main valve (Refer to "Figure 1-16 Closed Tank - Piping (Wet-leg Sealing Example)".) to introduce process fluid into the connecting pipe.
2	Gradually open the low pressure side stop valve to introduce process fluid. After introducing process fluid into the pressure receiving part of the transmitter, close the low pressure side stop valve.
3	Make sure that the connecting pipe, the 3-way manifold valve, and the transmitter have no pressure leaks.

2-3-4-2 Starting Measurement

Procedure

Operate the valves by the following procedure to apply the differential pressure of the process to the transmitter and display the measured value by operating the HART® communicator.

How to apply process pressure

Step	Description
1	Make sure that the 3-way manifold valve is in this state: 1. High-pressure side stop valve: Fully closed 2. Low-pressure side stop valve: Fully closed 3. Equalizer valve: Fully closed
2	Fill the liquid sealing pipe with sealing liquid.
3	1. Gradually open the high-pressure side stop valve. 2. Gradually open the low-pressure side stop valve.

CAUTION

Close the cover of the transmitter case securely. Imperfect closure allows entry of water, damaging internal terminals and the electronics module.

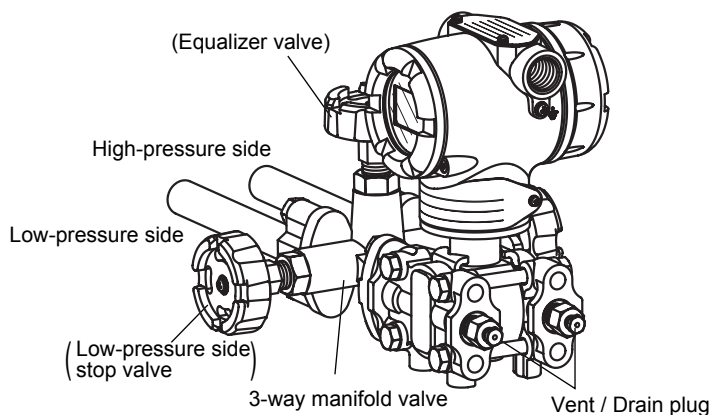
- If the input and output values are inconsistent, check the range and perform calibration again.
- If the displayed data value is unstable, adjust the damping time constant.

2-3-4-3 Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Operate the 3-way manifold valve by the following procedure: 1. Close the low pressure side stop valve. 2. Open the equalizer valve. 3. Close the high pressure side stop valve.
3	Close the main valve. (Refer to Figure 1-16.)



CAUTION

- If the transmitter is to be left off for a long period of time, drain process fluid from the connecting pipe and the pressure receiving part.
- Leave the equalizer valve open.

2-4 : Measurement with Model GTX__D/GTX__A

2-4-1 :Pressure Measurement

2-4-1-1 Preparation for Measurement

WARNING

-
- Make sure that the process is in the manual control mode.
If the process is in the automatic control mode, switch it to manual mode.
 - For hazardous fluids (poisons etc.) take any necessary actions to prevent physical hazard and ensure that work proceeds with adequate care.
 - Before starting a measurement procedure, ensure closure of the pressure valve (main valve), the local valve, the drain valve, and the gas vent plug (Refer to Figure 1-12).
-

Gas pressure measurement

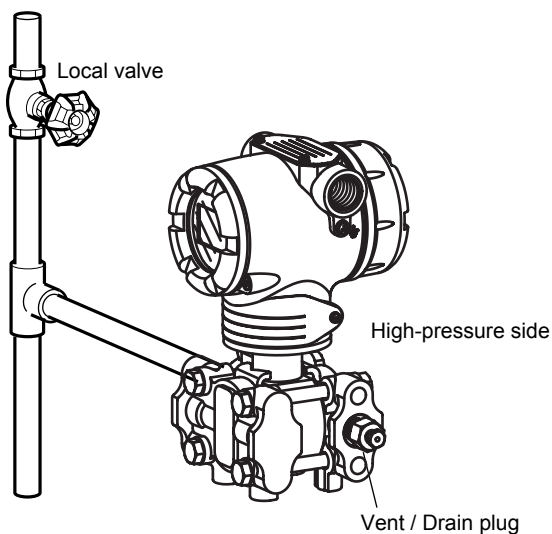
Perform zero-point calibration and introduce process pressure, with this procedure:

- Zero point calibration

Step	Description
1	Open the vent plug to release the pressure receiving part to the open air.
2	Referring to procedure2 in page 2-8, perform zero-point calibration.
3	When calibration is complete, close the vent plug.

- Introducing process pressure and venting air

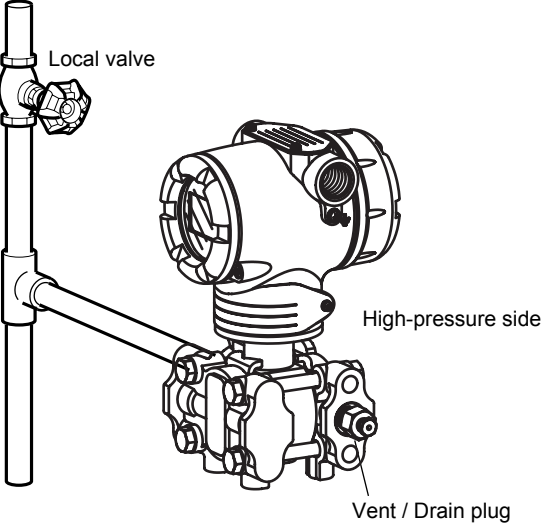
Step	Description
1	1. Introduce the process pressure into the connecting pipe by opening the main valve (Refer to "Figure 1-12 Example of Piping"). If the process temperature is high, allow cooling time so that the connecting pipe is stable at a safe temperature, before starting work. 2. Open the local valve gradually to introduce the process pressure into the pressure receiving part of transmitter.
2	1. Vent air from the center body by gradually opening the vent plug. 2. After venting air completely, close the plug and the local valve.
3	Ensure zero leakage exists at the connecting pipe and transmitter.



2-4-1-2 Starting Measurement

Procedure

Operate the valve with the following procedure and apply the process pressure to transmitter.

Step	Description
1	<p>Open gradually the local valve.</p>  <p>The diagram illustrates the transmitter's connection to a process line. A vertical pipe on the left has a 'Local valve' at the top. A horizontal pipe connects this valve to the 'High-pressure side' of the transmitter. The transmitter is shown with its case cover removed, revealing the internal components. A 'Vent / Drain plug' is located at the bottom of the transmitter body.</p>

CAUTION

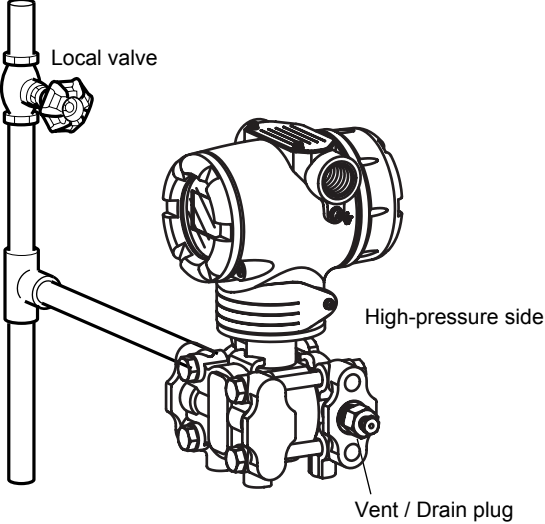
Securely close the case cover of the transmitter. Take precautions against moisture ingress into the transmitter body. Water entering the transmitter will damage the internal terminals and the electronics module.

- If the output value does not correctly reflect the input value, check again the range and calibrate the transmitter.
- If the displayed data value is unstable, adjust the damping time constant

2-4-1-3 Stopping Measurement

Procedure

Stop the operation of the transmitter by this procedure:

Step	Description
1	Turn OFF the transmitter.
2	Close the local valve. <div style="text-align: center; margin-top: 20px;">  <p>The diagram shows a vertical pipe on the left with a 'Local valve' at the top. A horizontal pipe connects this to the 'High-pressure side' of a transmitter. The transmitter has a circular face with a lens and a 'Vent / Drain plug' at the bottom right.</p> </div>
3	Close the main valve. (Refer to Figure 1-12)

⚠ CAUTION

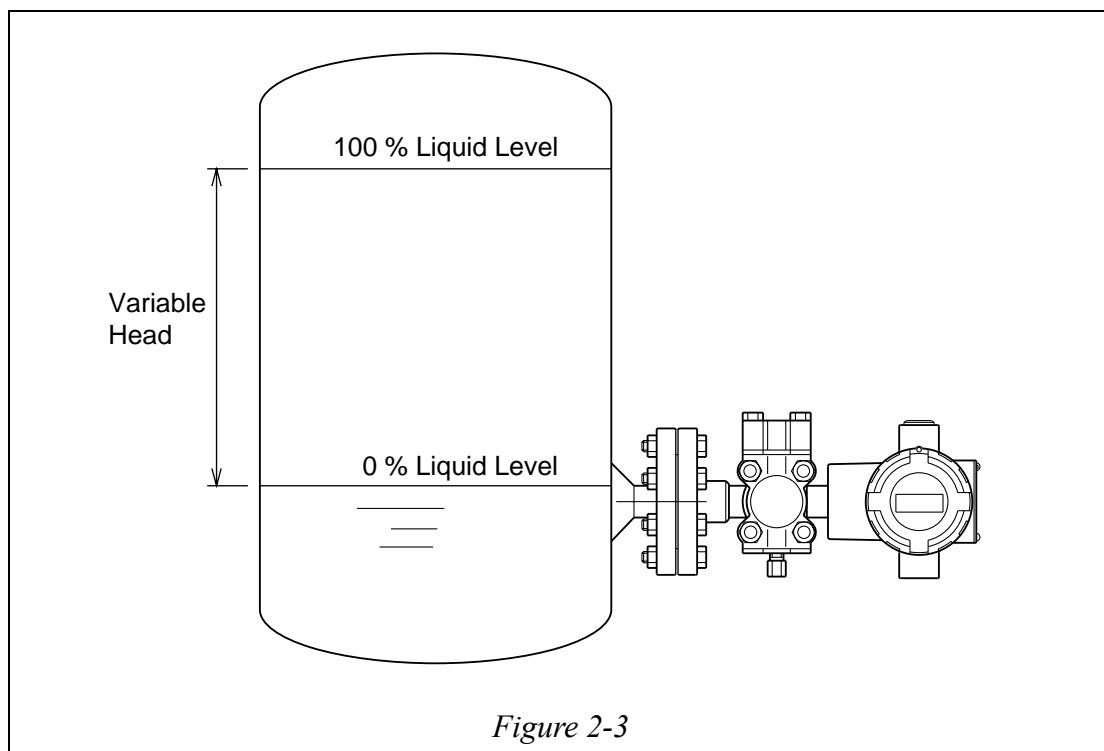
When a long-term shutdown is planned, completely drain all process fluid from the connecting pipe and from the pressure receiving part of transmitter.

2-5 : Measurement with Model GTX__F

2-5-1 :Pressure Measurement

2-5-1-1 Preparation for Measurement

When setting the zero point, set all the diaphragm surface area to be wet with the measured liquid for high accuracy. Even when the diaphragm surface area is not completely wet, make sure that the zero point is set at a level higher than the center of the diaphragm.



2-5-1-2 Starting Measurement

The transmitter is ready for operation when zero-point adjustment is completed. This procedure is described in the previous section. Before starting, always check the following:

- (1) Check the correspondence between input and output values.
 - If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.
- (2) Check the displayed data.
 - If unstable value is displayed, adjust the damping time constant.
- (3) Perform the following items carefully:
 - Disconnect the HART® communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
 - Close the case cover. Screw in the cover firmly until it can no longer be turned.
 - This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

2-5-1-3 Stopping Measurement

Procedure

Turn off the transmitter.

CAUTION

When a long-term shutdown is planned, completely drain all process fluid from the connecting pipe and from the pressure receiving part of transmitter.

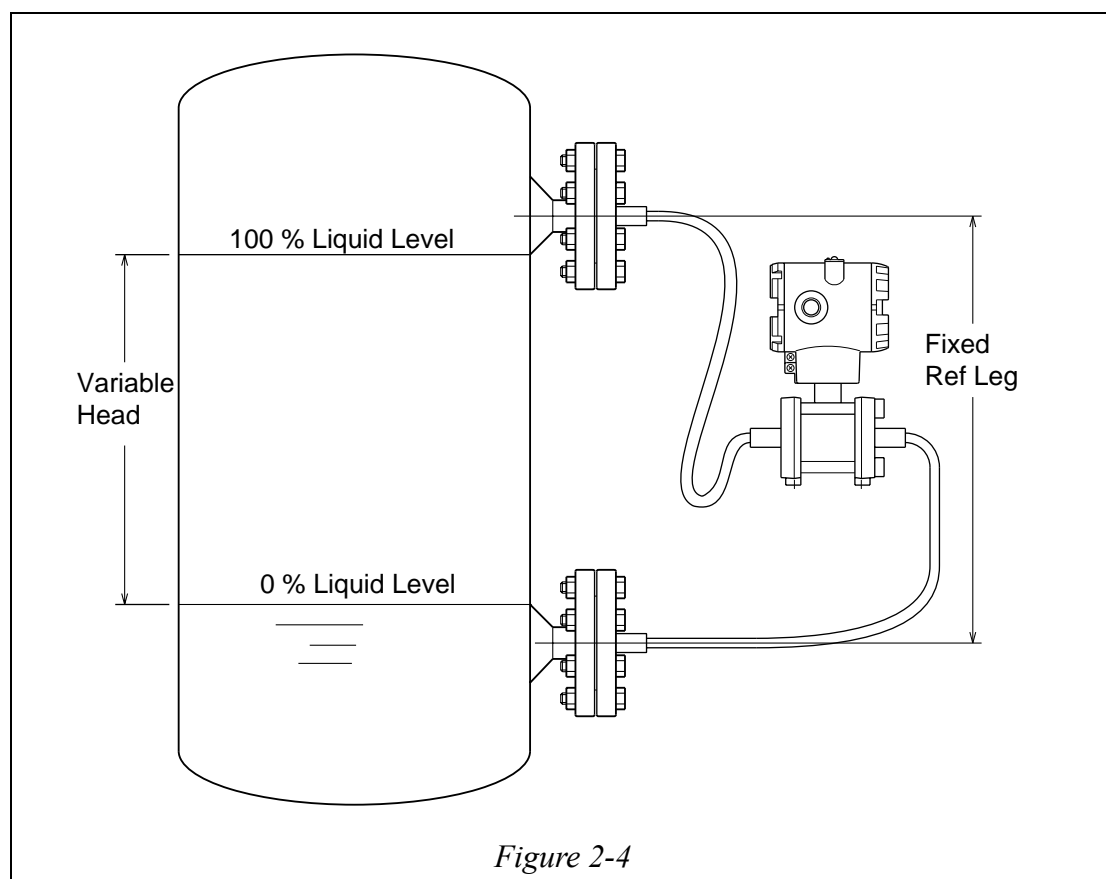
2-6 : Measurement with Model GTX__U/GTX__R

When starting operation, adjust the transmitter in its actual process state. The specific gravity of the sealed-in liquid is stated in the specifications in Appendix A. Specific gravity changes with temperature at the rate of $0.0008/^\circ\text{C}$. Use the temperature of the capillary tube for items related to specific gravity, in this section.

2-6-1 :Pressure Measurement

2-6-1-1 Preparation for Measurement

When setting the zero point, set all the diaphragm surface area to be wet with the measured liquid for high accuracy. Even when the diaphragm surface area is not completely wet, make sure that the zero point is set at a level higher than the center of the diaphragm.



2-6-1-2 Starting Measurement

The transmitter is ready for operation when zero-point adjustment is completed. This procedure is described in the previous section. Before starting, always check the following:

- (1) Check the correspondence between input and output values.
 - If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.
- (2) Check the displayed data.
 - If unstable value is displayed, adjust the damping time constant.
- (3) Perform the following items carefully:
 - Disconnect the HART® communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
 - Close the case cover. Screw in the cover firmly until it can no longer be turned.
 - This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

2-6-1-3 Stopping Measurement

Procedure

Turn OFF the transmitter.

CAUTION

When long-term shutdown is planned, always dismount the transmitter flange from the tank, clean diaphragms with a soft brush, wash using a solvent, and store. Take care not to deform or damage the diaphragms.

2-6-2 :Cautions Related to Flow Rate Measurement

Refer to the instructions on flange mounting for flow-rate measurement, to operate the transmitter for flow rate measurement.

Always complete zero-point checking before introducing fluid to the pipe. This precaution is warranted since the GTX__R/GTX__U has a structural characteristic that prevents mounting of an equalizing valve or stop valve.

For vertical pipes with differential-pressure take-out flange port, the high-pressure side flange and the low-pressure side flange exhibit a level difference. In this case, determine the zero point by setting LRV.

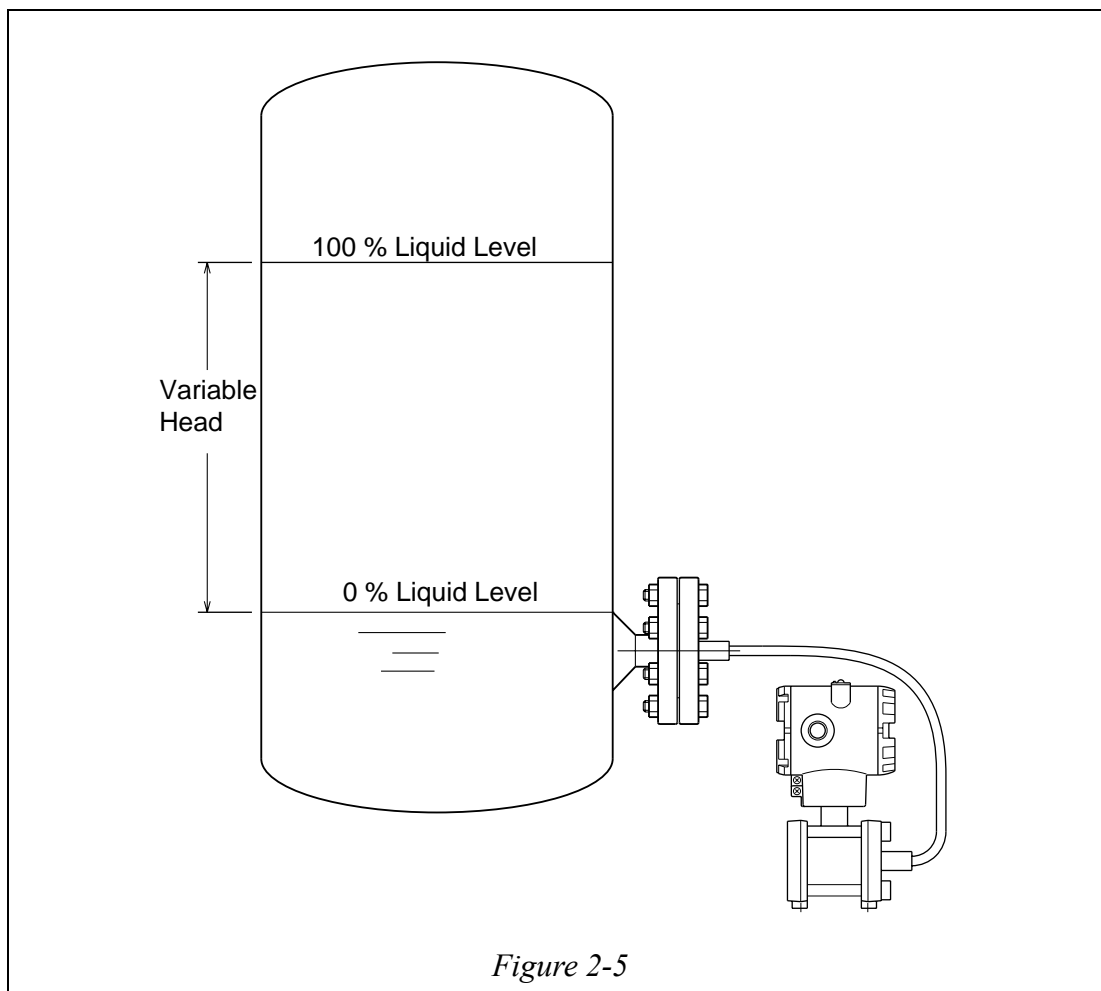
2-7 : Measurement with Model GTX__U

When starting operation, adjust the transmitter in its actual process state. The specific gravity of the sealed-in liquid is stated in the specifications of Chapter3. Specific gravity changes with temperature at the rate of 0.0008/°C. Use the temperature of the capillary tube for items related to specific gravity, in this section.

2-7-1 :Pressure Measurement

2-7-1-1 Preparation for Measurement

When setting the zero point, set all the diaphragm surface area to be wet with the measured liquid for high accuracy. Even when the diaphragm surface area is not completely wet, make sure that the zero point is set at a level higher than the center of the diaphragm.



2-7-1-2 Starting Measurement

The transmitter is ready for operation when zero-point adjustment is completed. This procedure is described in the previous section. Before starting, always check the following:

- (1) Check the correspondence between input and output values.
 - If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.
- (2) Check the displayed data.
 - If unstable value is displayed, adjust the damping time constant.
- (3) Perform the following items carefully:
 - Disconnect the HART® communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
 - Close the case cover. Screw in the cover firmly until it can no longer be turned.
 - This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

2-7-1-3 Stopping Measurement

Procedure

Turn OFF the transmitter.

CAUTION

When long-term shutdown is planned, always dismount the transmitter flange from the tank, clean diaphragms with a soft brush, wash using a solvent, and store. Take care not to deform or damage the diaphragms.

2-8 : Set Range Calculation for Liquid Level Measurement

2-8-1 :Open Tank or Closed Tank (Dry Leg) or Remote Seal Set Range Calculation

Set range calculation Ex. Model GTX__D

Calculate the set range using these procedures:

The following symbols are used to express density and distance.

It is assumed that the density is fixed, during liquid level measurement.

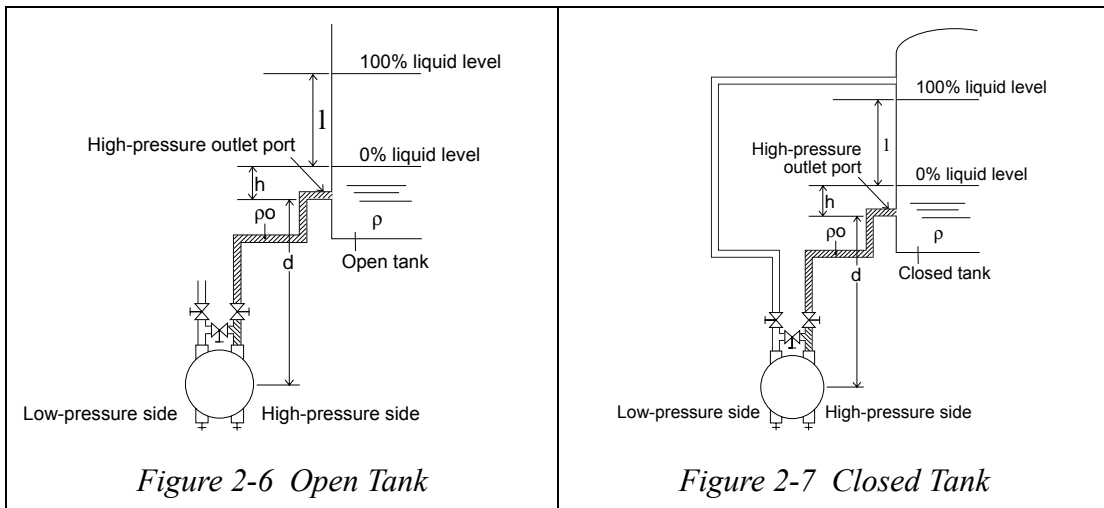
ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of liquid in high pressure side connecting pipe

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter



Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $h\rho + d\rho_0 = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $l\rho + h\rho + d\rho_0 = (l+h)\rho + d\rho_0 = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $h\rho + d\rho_0$; High limit (URV): $(l+h)\rho + d\rho_0$

Example of calculation: $l = 1500 \text{ mm}$, $h = 250 \text{ mm}$, $d = 500 \text{ mm}$, $\rho = 0.9$, $\rho_0 = 1.0$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(250 \times 0.9) + (500 \times 1.0) = 725 \text{ mmH}_2\text{O} = 7.110 \text{ kPa}$

Differential pressure at 100% liquid level = $\{(1500 + 250) \times 0.9\} + (500 \times 1.0) = 2075 \text{ mmH}_2\text{O} = 20.35 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): $7.110 \text{ kPa}\{725 \text{ mmH}_2\text{O}\}$, High limit (URV): $20.35 \text{ kPa}\{2075 \text{ mmH}_2\text{O}\}$

Set range calculation Ex. Model GTX__G

Calculate the set range using these procedures:

The following symbols are used to express density and distance.

It is assumed that the density is fixed, during liquid level measurement.

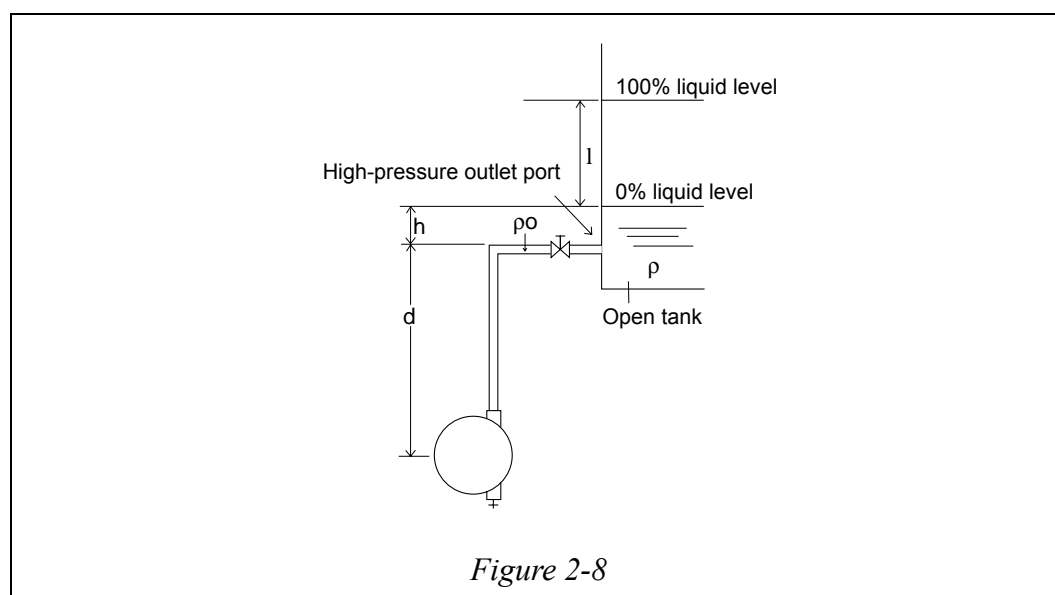
ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of liquid in connecting pipe

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter



Pressure at 0% liquid level = $h\rho + d\rho_0 = \text{LRV}$

Pressure at 100% liquid level = $l\rho + h\rho + d\rho_0 = (l+h)\rho + d\rho_0 = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $h\rho + d\rho_0$; High limit (URV): $(l+h)\rho + d\rho_0$

Example of calculation:

$l = 1500 \text{ mm}$, $h = 250 \text{ mm}$, $d = 500 \text{ mm}$

$\rho = 0.9$, $\rho_0 = 1.0$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(250 \times 0.9) + (500 \times 1.0) = 725 \text{ mmH}_2\text{O} = 7.110 \text{ kPa}$

Differential pressure at 100% liquid level = $\{(1500 + 250) \times 0.9\} + (500 \times 1.0) = 2075 \text{ mmH}_2\text{O} = 20.35 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): $7.110 \text{ kPa} \{725 \text{ mmH}_2\text{O}\}$, High limit (URV): $20.35 \text{ kPa} \{2075 \text{ mmH}_2\text{O}\}$

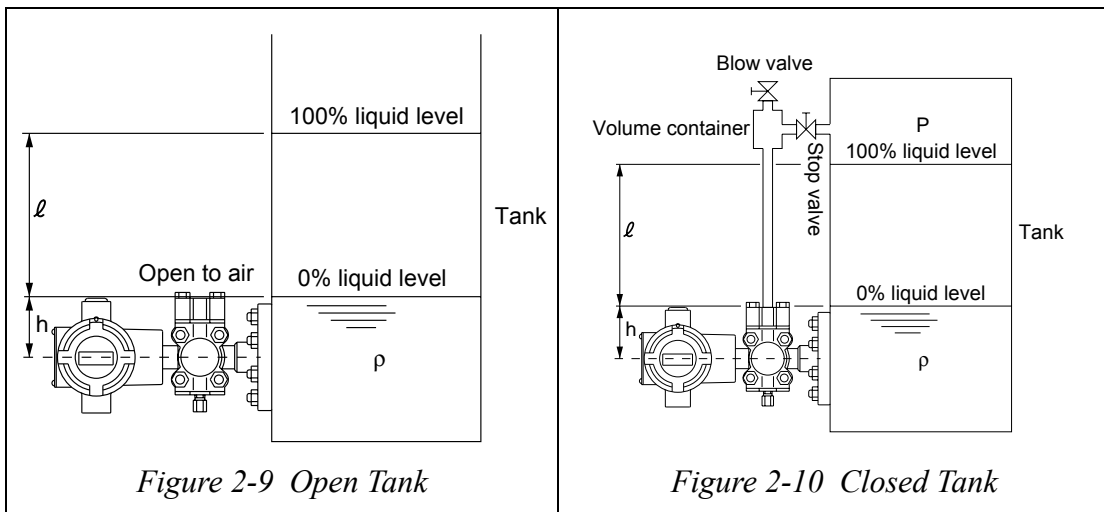
Set range calculation Ex. Model GTX__F

Calculate the set range using these procedures:

The following symbols are used to express density and distance.

It is assumed that the density is fixed, during liquid level measurement.

- ρ : Specific gravity of liquid in tank
- l : Distance between 100% liquid level and 0% liquid level (measurement range)
- h : Distance between 0% liquid level and high-pressure outlet port
- d : Distance between high-pressure outlet port and transmitter



Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $h\rho = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $l\rho + h\rho = (l+h)\rho = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $h\rho$; High limit (URV): $(l+h)\rho$

Example of calculation:

$l = 1500 \text{ mm}, h = 250 \text{ mm}$

$\rho = 0.9, \rho_0 = 1.0$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(250 \times 0.9) = 725 \text{ mmH}_2\text{O} = 7.110 \text{ kPa}$

Differential pressure at 100% liquid level = $\{(1500 + 250) \times 0.9\} = 2075 \text{ mmH}_2\text{O} = 20.35 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): $7.110 \text{ kPa}\{725 \text{ mmH}_2\text{O}\}$, High limit (URV): $20.35 \text{ kPa}\{2075 \text{ mmH}_2\text{O}\}$

Set range calculation Ex. Model GTX__R

Calculate the set range using these procedures:

The following symbols are used to express density and distance.

It is assumed that the density is fixed, during liquid level measurement.

ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of sealed liquid

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter

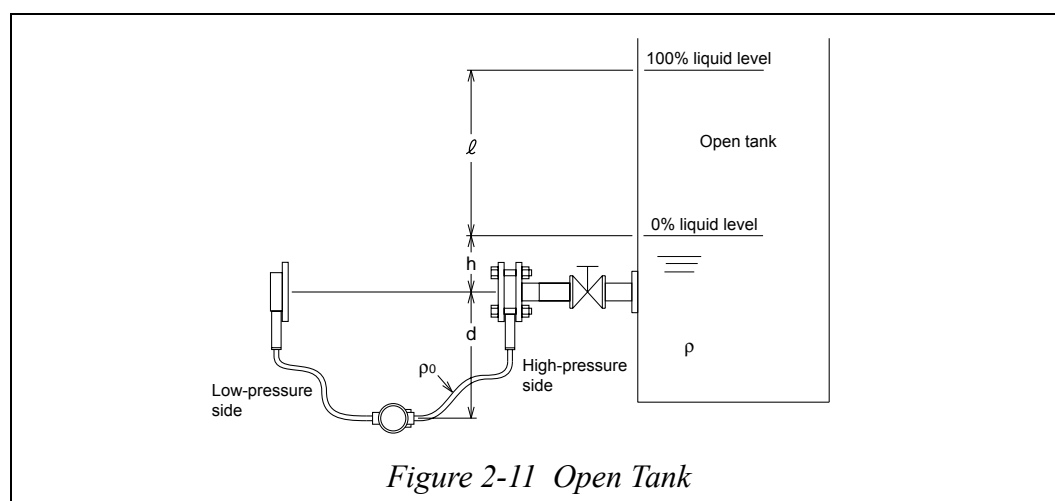


Figure 2-11 Open Tank

Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $hr = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $l\rho + h\rho = (l+h)\rho = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $h\rho$; High limit (URV): $(l+h)\rho$

Example of calculation:

$l = 1500 \text{ mm}$, $h = 250 \text{ mm}$, $d = 500 \text{ mm}$, $\rho = 0.9$, $\rho_0 = 0.935$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $250 \times 0.9 = 225 \text{ mmH}_2\text{O} = 2.206 \text{ kPa}$

Differential pressure at 100% liquid level = $(1500 + 250) \times 0.9 = 1575 \text{ mmH}_2\text{O} = 15.45 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): 2.206 kPa, High limit (URV): 15.45 kPa

Set range calculation Ex. Model GTX__U

Calculate the set range using these procedures:

The following symbols are used to express density and distance.

It is assumed that the density is fixed, during liquid level measurement.

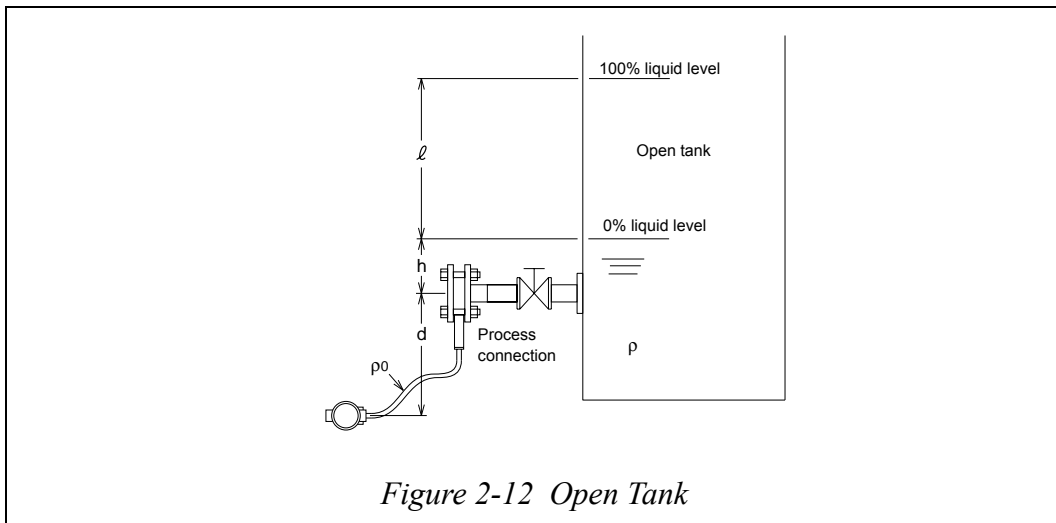
ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of sealed liquid

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter



Differential pressure at 0% liquid level = $h\rho + d\rho_0 = \text{LRV}$

Differential pressure at 100% liquid level = $l\rho + h\rho + d\rho_0 = (l+h)\rho + d\rho_0 = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $h\rho + d\rho_0$; High limit (URV): $(l+h)\rho + d\rho_0$

Example of calculation:

$l = 1500 \text{ mm}, h = 250 \text{ mm}, d = 500 \text{ mm}, \rho = 0.9, \rho_0 = 1.0$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(250 \times 0.9) + (500 \times 1.0) = 725 \text{ mmH}_2\text{O} = 7.110 \text{ kPa}$

Differential pressure at 100% liquid level = $\{(1500 + 250) \times 0.9\} + (500 \times 1.0) = 2075 \text{ mmH}_2\text{O} = 20.35 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): 7.110 kPa, High limit (URV): 20.35 kPa

2-8-2 :Closed Tank (Wet Leg or Remote Seal) -- Set Range

Set range calculation Ex. Model GTX__D

Calculate the set range using these procedure:

The following symbols are used to express density and distance.

It is assumed that the density is fixed during liquid level measurement.

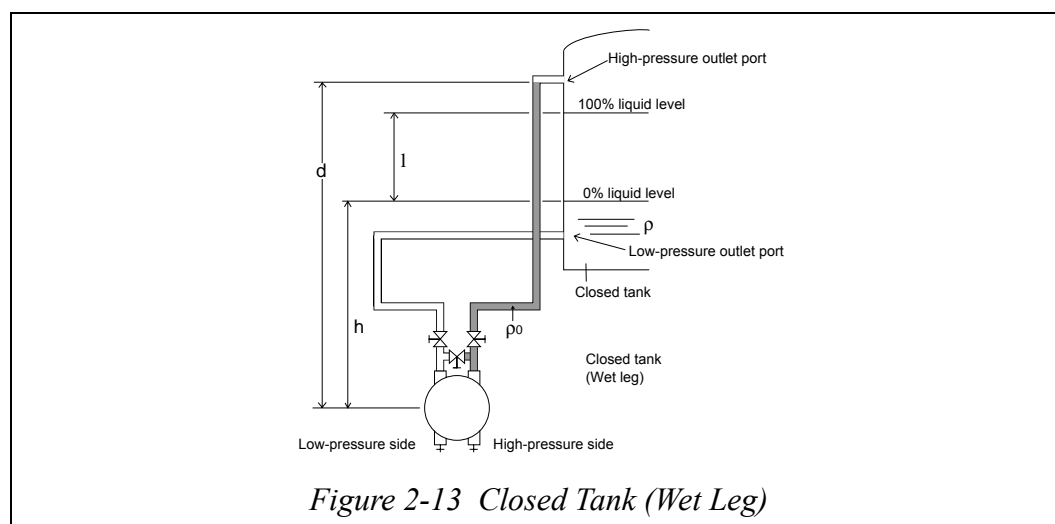
ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of sealing liquid

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter



Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - h\rho = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - (l+h)\rho = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $d\rho_0 - h\rho$, High limit (URV): $d\rho_0 - (l+h)\rho$

Example of calculation:

$l = 1500 \text{ mm}$, $h = 250 \text{ mm}$, $d = 2000 \text{ mm}$, $\rho = 0.9$, $\rho_0 = 1.0$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(2000 \times 1.0) + (250 \times 0.9) = 1775 \text{ mmH}_2\text{O} = 17.41 \text{ kPa}$

Differential pressure at 100% liquid level = $(2000 \times 1.0) + (1500 + 250) \times 0.9 = 425 \text{ mmH}_2\text{O} = 4.168 \text{ kPa}$

Therefore, set the range as follows:

Low limit (LRV): $17.41 \text{ kPa} \{1775 \text{ mmH}_2\text{O}\}$, High limit (URV): $4.168 \text{ kPa} \{425 \text{ mmH}_2\text{O}\}$

Set range calculation Ex. Model GTX__F

Calculate the set range using these procedure:

The following symbols are used to express density and distance.

It is assumed that the density is fixed during liquid level measurement.

ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of sealing liquid

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and high-pressure outlet port

d : Distance between high-pressure outlet port and transmitter

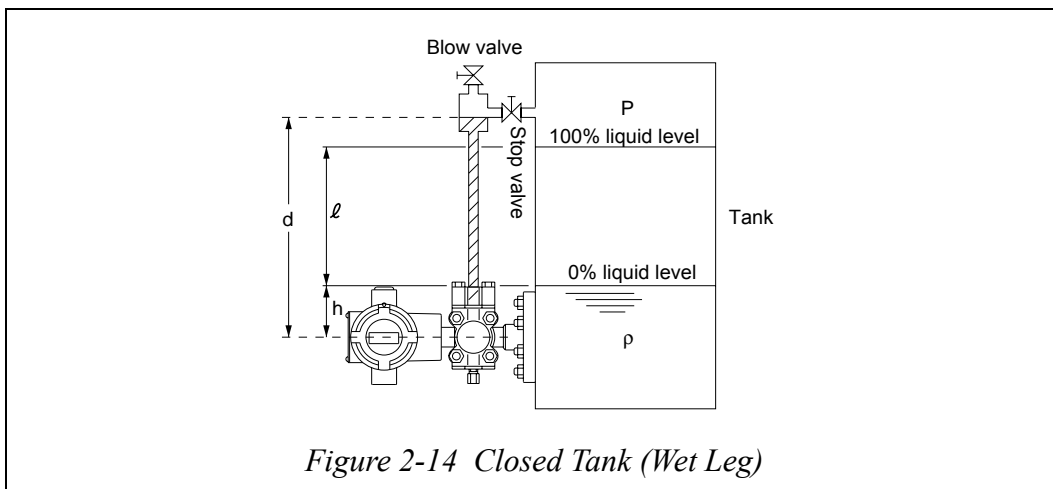


Figure 2-14 Closed Tank (Wet Leg)

Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - h\rho = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - (l+h)\rho = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $d\rho_0 - h\rho$, High limit (URV): $d\rho_0 - (l+h)\rho$

Example of calculation:

$$l = 1500 \text{ mm}, h = 250 \text{ mm}, d = 2000 \text{ mm}, \rho = 0.9, \rho_0 = 1.0$$

If the above conditions are assumed, the following results are obtained:

$$\text{Differential pressure at 0\% liquid level} = (2000 \times 1.0) + (250 \times 0.9) = 1775 \text{ mmH}_2\text{O} = 17.41 \text{ kPa}$$

$$\text{Differential pressure at 100\% liquid level} = (2000 \times 1.0) + (1500 + 250) \times 0.9 = 425 \text{ mmH}_2\text{O} = 4.168 \text{ kPa}$$

Therefore, set the range as follows:

Low limit (LRV): 17.41 kPa {1775 mmH₂O}, High limit (URV): 4.168 kPa {425 mmH₂O}

Set range calculation Ex. Model GTX__R

Calculate the set range using these procedure:

The following symbols are used to express density and distance.

It is assumed that the density is fixed during liquid level measurement.

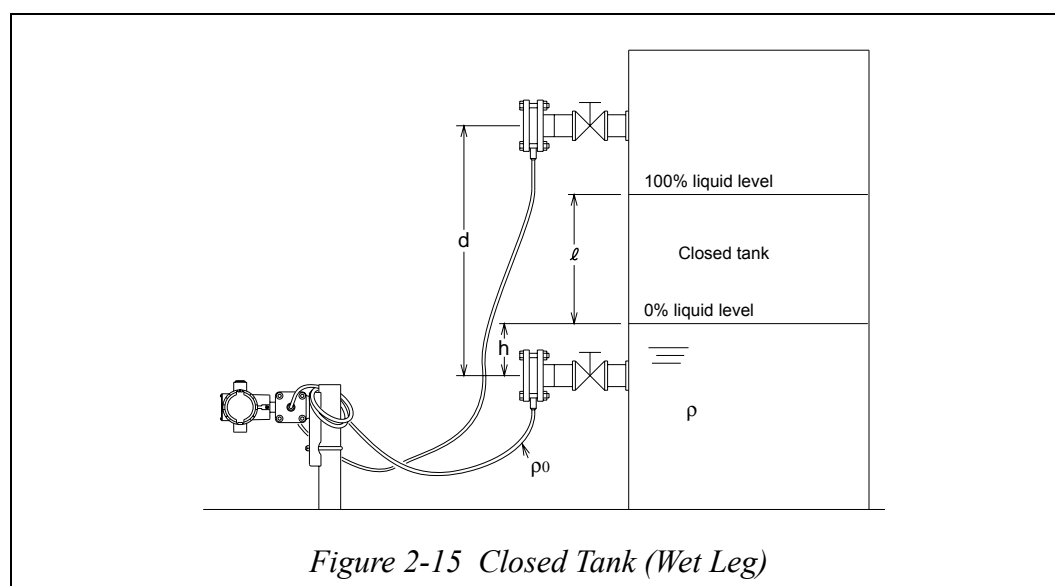
ρ : Specific gravity of liquid in tank

ρ_0 : Specific gravity of sealed liquid

l : Distance between 100% liquid level and 0% liquid level (measurement range)

h : Distance between 0% liquid level and lower flange of tank

d : Distance between upper flange of tank and lower flange of tank



Differential pressure at 0% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - h\rho = \text{LRV}$

Differential pressure at 100% liquid level (Pressure on high-pressure side - Pressure on low-pressure side) = $d\rho_0 - (l+h)\rho = \text{URV}$

Therefore, set the range as follows:

Low limit (LRV): $d\rho_0 - h\rho$, High limit (URV): $d\rho_0 - (l+h)\rho$

Example of calculation:

$l = 1500 \text{ mm}$, $h = 250 \text{ mm}$, $d = 2000 \text{ mm}$, $\rho = 0.9$, $\rho_0 = 0.935$

If the above conditions are assumed, the following results are obtained:

Differential pressure at 0% liquid level = $(2000 \times 0.935) - (250 \times 0.9) = 1645 \text{ mmH}_2\text{O}$
= 16.13 kPa

Differential pressure at 100% liquid level = $(2000 \times 0.935) + (1500 \times 250) \times 0.9 = 295 \text{ mmH}_2\text{O}$
= 2.893 kPa

Therefore, set the range as follows:

Low limit (LRV): 16.13 kPa {1645 mmH₂O}, High limit (URV): 2.893 kPa {295 mmH₂O}

2-9 : Indicator (Optional)

2-9-1 : Display unit of indicator

The display unit of an indicator consists of the following:

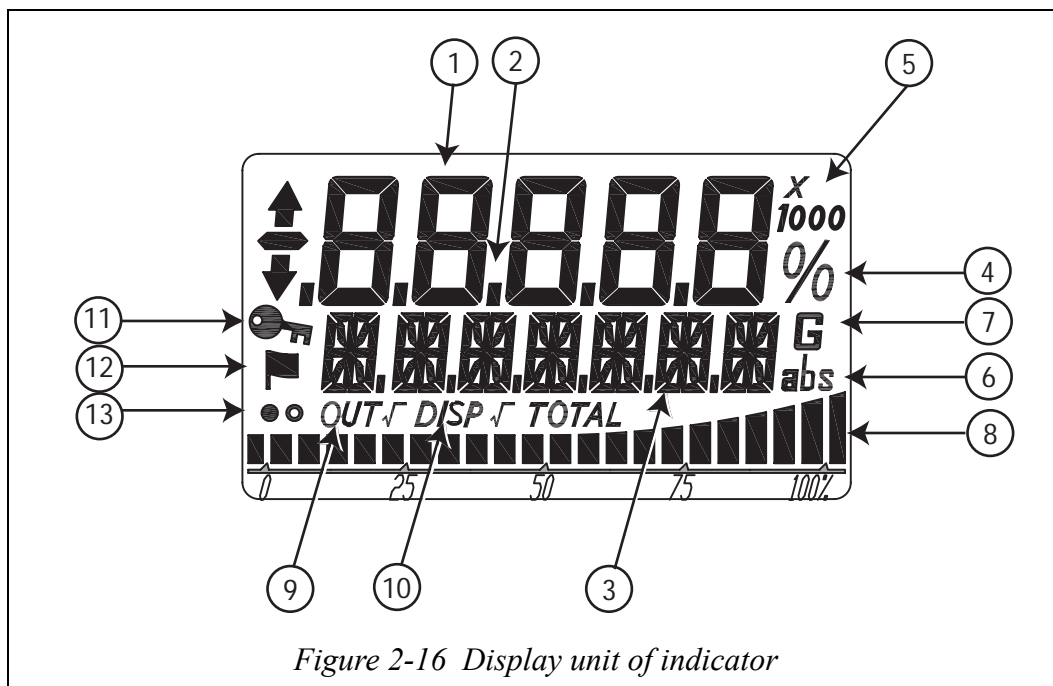


Figure 2-16 Display unit of indicator

No.	Display Mark	Contents of display
1	Digital Display (5digits)	PV (% , actual, pressure) Status Number
2	Digital Display (5digits)	Decimal point
3	16 segments (7digit)	Unit, Status
4	%	%
5	Exponent	None, ×10, ×100, ×1000
6	Absolute pressure	Abs
7	Gage pressure	G
8	Bar Graph	Bar Graph of output%
9	Output square root extraction	OUT √
10	Display square root extraction	DISP √
11	Key mark	Write Protect
12	Flag mark	Status Record
13	Status Record	● and ○

2-9-2 :Bar Graph Display

Percentage terms of the indicated values are displayed as graphs with the 22 segments.



For descriptive purposes let us refer to the 22 segments as, from left to right, S0 - S21. Lighting or blinking of each segment is indicated as follows according to the percentage terms of the indicated value (DISP).

DISP ≤ -5%	S0 Blinking	
-5% < DISP ≤ 0%	S0 Lit	
0% < DISP ≤ 5%	S0 to S1 Lit	
5% < DISP ≤ 10%	S0 to S2 Lit	
10% < DISP ≤ 15%	S0 to S3 Lit	
15% < DISP ≤ 20%	S0 to S4 Lit	
20% < DISP ≤ 25%	S0 to S5 Lit	
25% < DISP ≤ 30%	S0 to S6 Lit	
30% < DISP ≤ 35%	S0 to S7 Lit	
35% < DISP ≤ 40%	S0 to S8 Lit	
40% < DISP ≤ 45%	S0 to S9 Lit	
45% < DISP ≤ 50%	S0 to S10 Lit	
50% < DISP ≤ 55%	S0 to S11 Lit	
55% < DISP ≤ 60%	S0 to S12 Lit	
60% < DISP ≤ 65%	S0 to S13 Lit	
65% < DISP ≤ 70%	S0 to S14 Lit	
70% < DISP ≤ 75%	S0 to S15 Lit	
75% < DISP ≤ 80%	S0 to S16 Lit	
80% < DISP ≤ 85%	S0 to S17 Lit	
85% < DISP ≤ 90%	S0 to S18 Lit	
90% < DISP ≤ 95%	S0 to S19 Lit	
95% < DISP ≤ 100%	S0 to S20 Lit	
100% < DISP ≤ 105%	S0 to S21 Lit	
105% < DISP	S0 to S20 Lit, S21 Blinking	

2-9-3 :External Zero/Span Adjustment Display

When an external zero or span adjustment is executed using an external zero/span adjustment mechanism and the range change is complete, one of the following messages is displayed in the 16 segments (7 digits) that display the unit, depending on the adjustment.

When an external zero adjustment is complete: ZERO.SET

When an external span adjustment is complete: SPAN.SET

The message is displayed for 3 seconds and then it disappears to return to the unit display.

2-9-4 :Square Root Extraction Display

The segments for the square root extraction display are OUT $\sqrt{\quad}$ and DISP $\sqrt{\quad}$.

Each display lights up or goes out according to the output format and square root extraction display settings of the transmitter.

Transmitter setting		Square Root Extraction Display	
Output	Indicator	OUT $\sqrt{\quad}$	DISP $\sqrt{\quad}$
Linear	Linear	Goes out	Goes out
Linear	Square root (Flow rate)	Goes out	Lights up
Square root (Flow rate)		Lights up	Goes out

2-9-5 :Write Protect Display

The segment for the write protect display is a lock mark.

The lock mark lights up or goes out according to the write protect state of the transmitter.

When light protect is ON: The lock mark lights up.

When light protect is OFF: The lock mark goes out.

2-9-6 :Status Record Display

The segment for the status history display is a flag mark.

The flag mark lights up or goes out according to the presence or absence of status history of the transmitter.

When the status history exists: The flag mark lights up.

When the status history does not exist: The flag mark goes out.

Lighting of the flag mark indicates that the diagnostic status has been ON in the past.

2-9-7 :Display Update Mark

This mark indicates that the transmitter is working.

The ● and ○ marks alternately blink every 0.5 seconds.

Display Update Cycle

The update cycle of the PV display (7 segments, 5 digits) is about 0.5 seconds.

2-10 : External Zero/Span Adjustment function (Optional)

A transmitter with External Zero/Span adjustment function enables zero/span point adjustment work without using communicator.

Set to any value an output corresponding to current input.

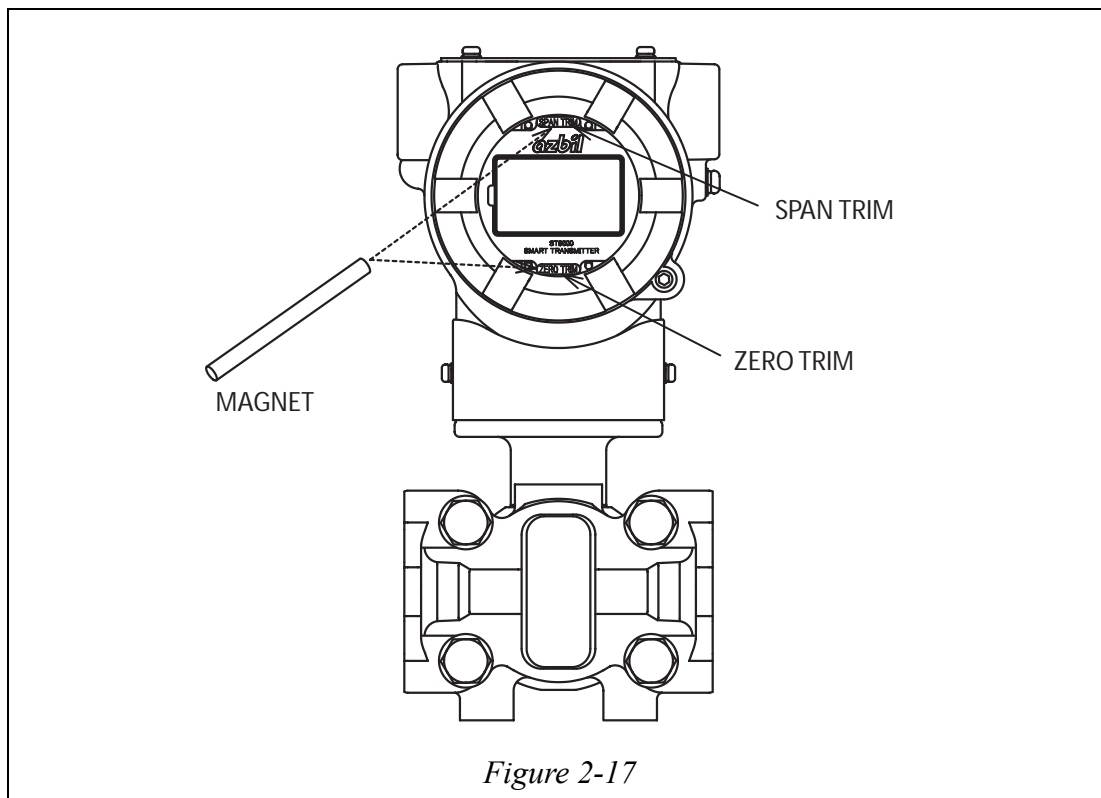


Figure 2-17

Procedure

How to adjust zero point.:

STEP	Procedure
1	Make sure that the zero pressure is applied to the transmitter.
2	Touch the magnet on the grass at the ZERO TRIM point for 3 seconds or more. And remove it when ammeter reading equals 4mA.

How to adjust span point.:

STEP	Procedure
1	Make sure that the desired upper range value pressure is applied to the transmitter.
2	Touch the magnet on the grass at the SPAN TRIM point for 3 seconds or more. And remove it when ammeter reading equals 20mA.

MEMO

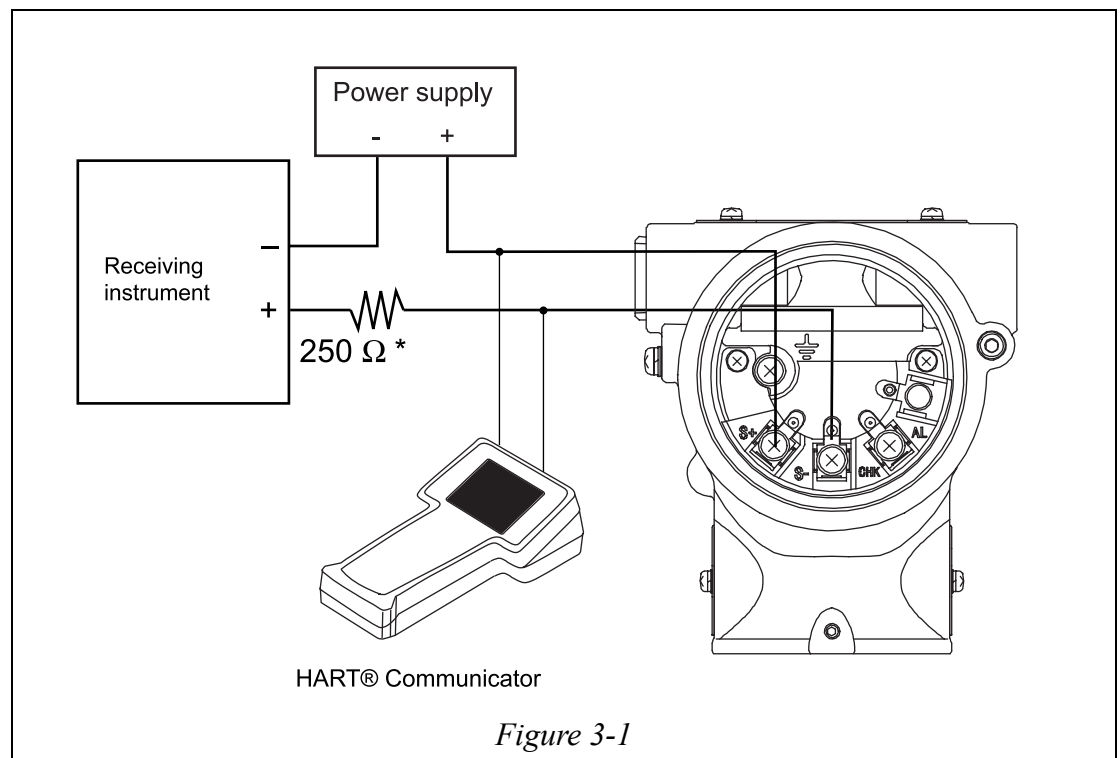
Chapter 3 : Operation Using HART® Communicator

3-1 : Starting Communications

Instructions for connecting HART® Communicator to this transmitter.
Basic instructions for Key-pad operation.

3-1-1 :Connecting communicator

You connect the communicator directly to signal terminals on the transmitter's terminal block or at any location in the 4 to 20 mA loop. (Polarity of the communicator connection does not matter)



3-1-2 :HART® communicator keyboard



Figure 3-2 HART® Communicator

3-1-3 :Symbols on communicator screen

See manual of 375 communicator.

3-1-4 : Keying in alphanumeric characters

See manual of 375 communicator.

3-1-5 :Establishing communications

This procedure starts communications between the transmitter and the communicator:

STEP	Action and/or Description
1	Turn on communicator. The communicator runs a self-test check then determines if it is connected to a transmitter.
2	<p>If you receive a communication error message (No Device Found), check the following:</p> <ul style="list-style-type: none"> • Loop resistance: Is there a minimum of 250 Ω resistance between the communicator and the power supply? • Power supply: Is power applied? Is there greater than 11 volts at the transmitter? <p>Correct any problems, and try communicating again. If the message, or any other error message, appears again.</p>
3	<p>When the “Online” display - shown below - appears, you have established communication with the transmitter.</p> <p>The flashing heart icon in the upper right corner indicates the communicator and the transmitter are communicating.</p>

3-1-6 :Checking basic data

This procedure checks the transmitter's factory-set configuration parameters:

STEP	Action and/or Description
1	From the “Online” menu, enter “Process Variable” by pressing the right arrow key on the communicator keypad.
2	Press the down arrow key to scroll down to menu-item “2 Review”. When highlighted press the right arrow key to enter review function.

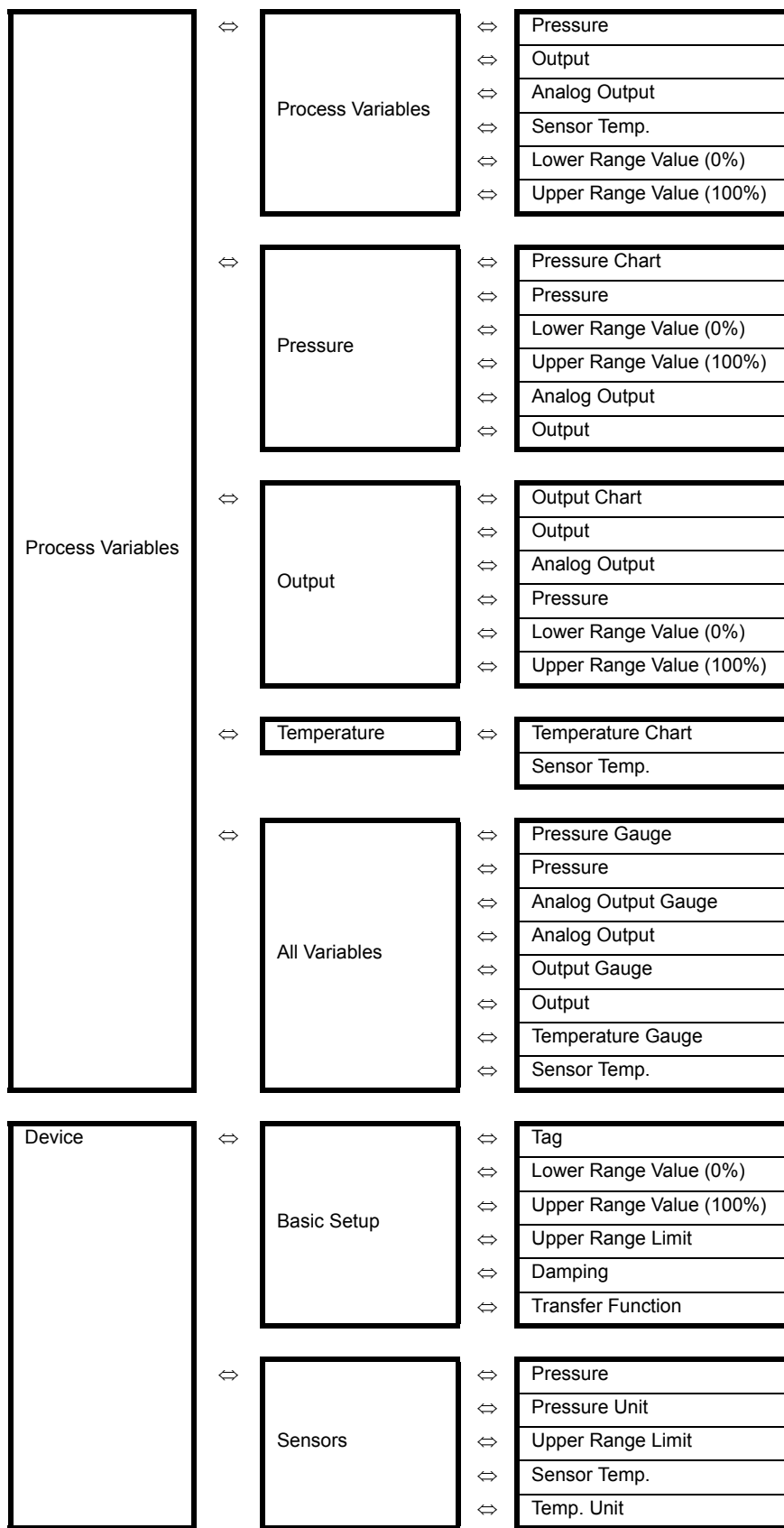
STEP	Action and/or Description
3	Press Page Up and/or Page Dn to scroll through the configuration data including: <ul style="list-style-type: none"> • Model • Measurement type • Manufacturer • Pressure unit • PV URL (Upper Range Limit) • PV LRL (Lower Range Limit) • PV Damping • PV% Range • Transfer function (linear or square root) • Upper Range Value (100%) • Lower Range Value (0%) • Analog output (in mA) • AO Alarm type • Sensor serial number • PROM ID • Device ID • Tag name • Message • Universal revision number • Field device revision number • Software revision number • Polling address • Number of required preambles
4	Press left arrow to go back to the “Process Variable” menu

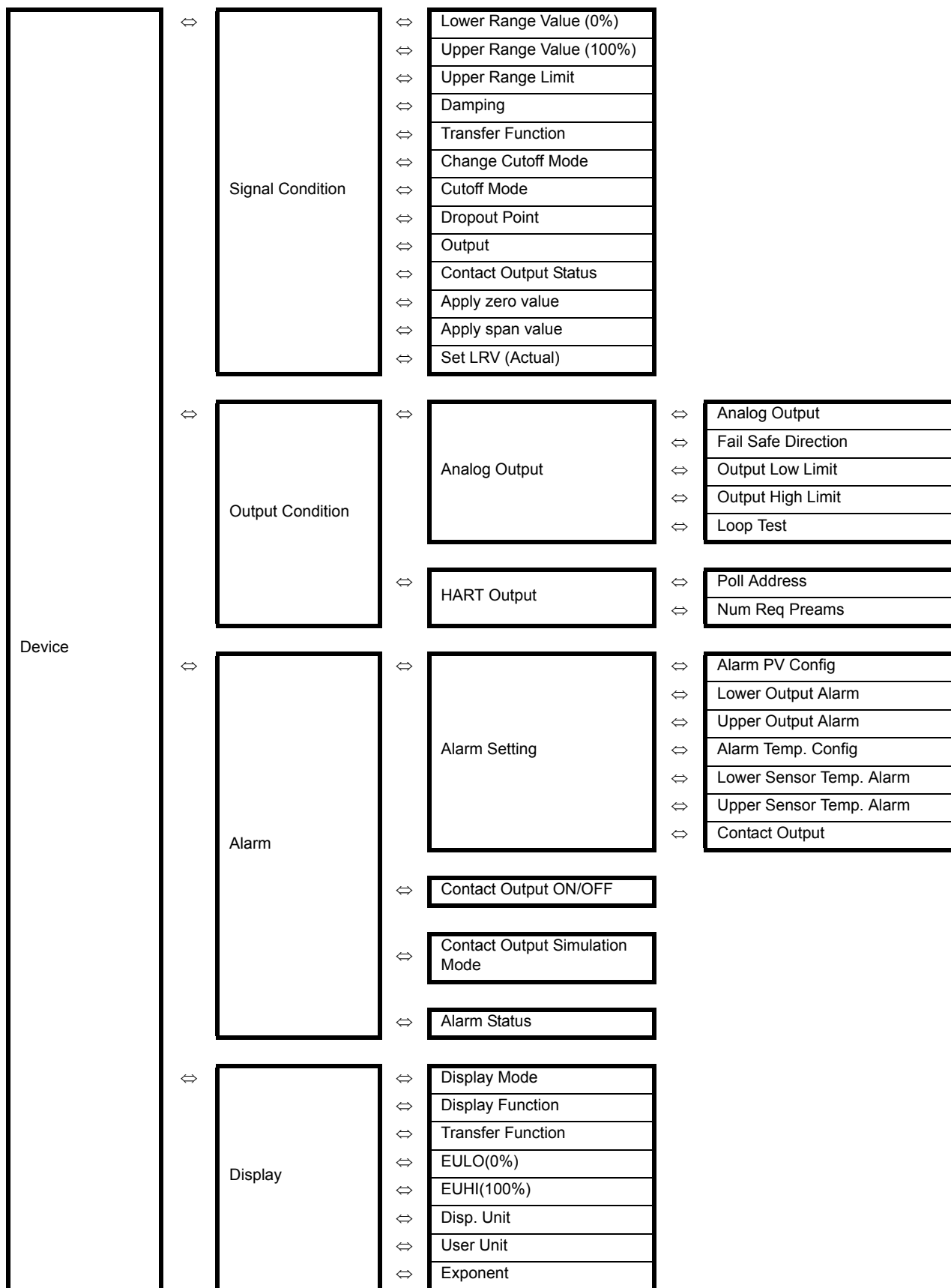
3-2 : Configuration

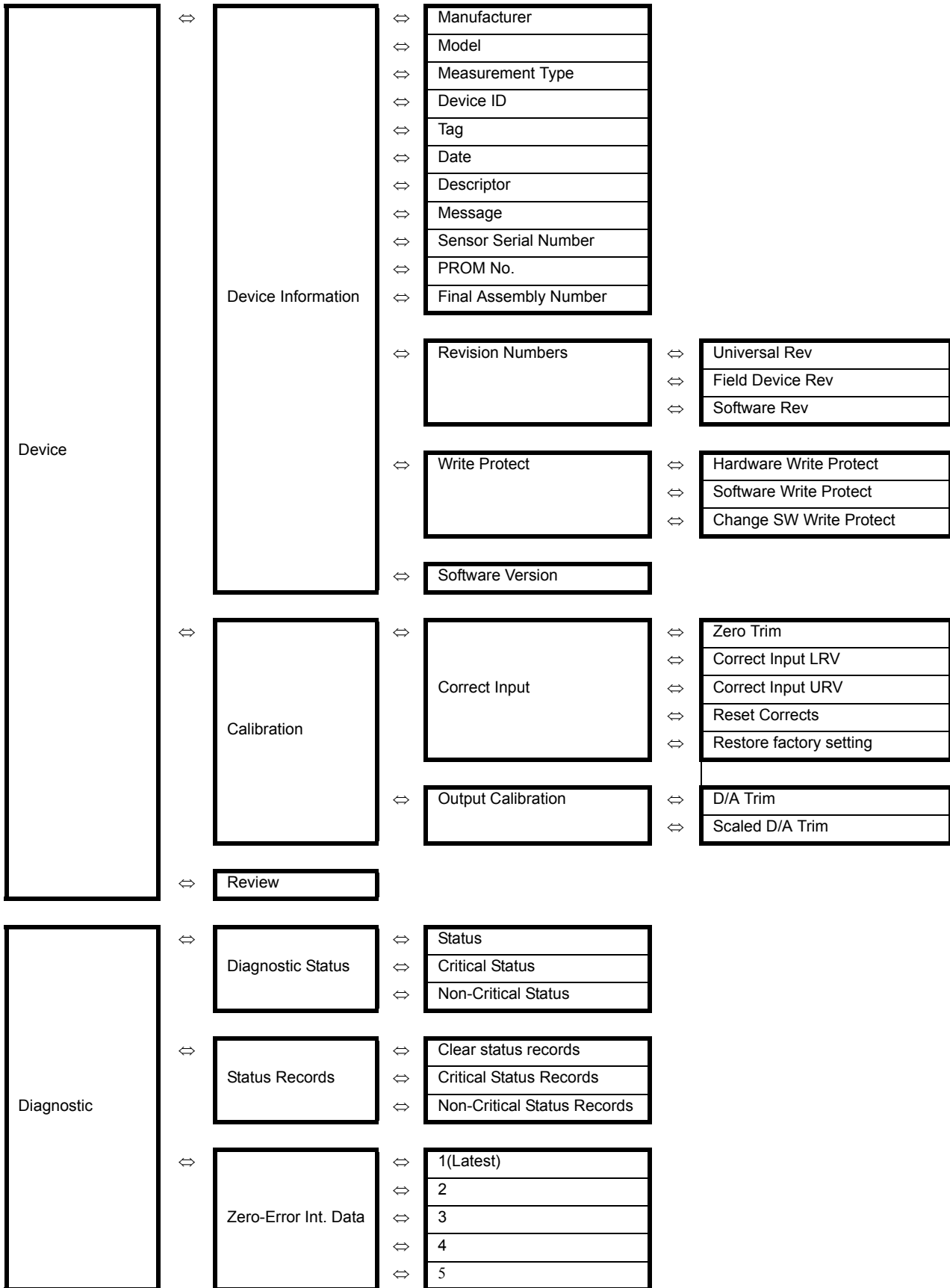
This section introduces you configuration of AT9000 with HART® option using the HART® Communicator.

This section also provides an overview of the HART® Communicator, including menus and keyboards.

3-2-1 :HART® communicator menu summary







3-2-2 :Changing tag no.

This shows how to change or enter tag number.
(Device) - (Basic setup) - (Tag)

After entering a tag number with pressing ENTER, press SEND to download the change to the transmitter.

3-2-3 :Changing output format

This shows how to change output format, which linear calculation or square root calculation used for measuring differential pressure between a primary element with DP type transmitter.

(Device) - (Basic setup) - (Transfer Function)

3-2-4 :Indicator display format

This shows how to configure display format and/or its ranges.

(Device) - (Display)

Menu items when Display Mode is %:

- 1 Display Mode
- 2 Display Function
- 3 Transfer Function

Menu items when Display Mode is Pressure:

- 1 Display Mode
- 2 Transfer Function

Menu items when Display Mode is scale:

- 1 Display Mode
- 2 Display Function
- 3 Transfer Function
- 4 EULO (0%)
- 5 EUHI (100%)
- 6 Disp Unit
- 7 User Unit
- 8 Exponent

3-2-4-1 Display Mode

%:	Displaying PV with %
pressure:	Displaying PV with pressure unit
scale:	Displaying scaling PV

3-2-4-2 Display Function

Linear:	Displays linear.
Square root:	Displays flow by square root extraction.

3-2-4-3 EULO (0%) / EUHI(100%)

EULO and EUHI must be configured between -19999 and +19999 to indicate PV with an engineering unit.

EULO (0%):	The value to be indicated when the output is 0%
EUHI (100%):	he value to be indicated when the output is 100%

3-2-4-4 EU

Engineering Unit to be displayed.

3-2-4-5 Exponent

Selects the exponent (X10, X100, etc.) for the device display.

X1
X10
X100
X1000

3-2-4-6 User Unit

User Unit is user defined unit to be display.

Cutoff Mode

3-2-5 :Cutoff Mode

This shows how to configure low flow cut value.

This function is effective only when Square Root is selected for the output format.

(Device) - (Signal condition) - (Cutoff Mode)

Def. (7.1%Lin.):Cutoffmode is default.(Flowmode is default, dropout is linear, and dropout point is 7.1%.)

Zero. Flow:Def.:Dropout is zero, and flowmode is default.

Lin. Flow:Def.:Dropout is linear, and flowmode is default.

Zero. Flow:Bi-dir.:Dropout is zero, and flowmode is bi-directional.

Lin. Flow:Bi-dir.:Dropout is linear, and flowmode is bi-directional.

Dropout: Select behavior below the cutoff value. Select either zero or linear.

Flow mode: Select calculation method of flow output. Select either default (square root of positive output) or bi-direction (square root of both positive and negative outputs).

3-2-6 :Selecting unit of measurement

This function is to select a pressure unit of the transmitter.

(Device) - (Sensors) - (Pressure Unit)

A pressure unit is able to be selected from the following;

inH₂O
inHg
mmH₂O
mmHg
psi
bar
mbar
g/Sqcm
kg/Sqcm
Pa
kPa
MPa

3-2-7 :Setting range values

This is to configure the measuring range of the transmitter.

(Device) - (Signal Condition)

- Select Lower Range Value (0%) or Upper Range Value (100%) to key in the desired setting.
- Press ENTER. This takes you back to “Signal Condition” menu.
- Press SEND to download change to transmitter.

If the number of digit you key in is more than four, the set range is not appeared on “Signal Condition” menu.

3-2-8 :Adjusting damping time

You can adjust the damping time to reduce the output noise.

(Device) - (Signal condition) - (Damp)

When damping menu, key in appropriate damping time from 0.0 to 128.0, and the press ENTER. A display will prompt when you enter the value out of range that the value is out of range.

3-3 : Start-up and Operation

This section identifies how to access typical data associated with the start-up and the operation of AT9000 with HART® communication option. It includes the procedure for running an analog output check

3-3-1 :Running analog output check

You can put the transmitter into a constant-current source mode, which maintains the output that is set between 4 mA (0%) and 20 mA (100%).

This shows how to configure the transmitter in a constant-current source mode and to return to its original output.

(Device) - (Output condition) - (Analog output) - (Loop test)

You will be prompted to put the loop into manual mode. After doing so, press OK.

- Select 4 mA to set the output signal level to 4 mA (0%).
- Select 20 mA to set the output signal level to 20 mA (100%).
- Select Other and press ENTER, then use communicator's keyboard to enter other values.
- Select End and press ENTER. The communicator will notify you that it is returning transmitter to its original output.

3-3-2 :Configuring ranges with applying pressure

This shows how to configure ranges with applying 4 mA /20 mA input pressure.

(Device) - (Signal condition) - (Apply zero values)

You will be warned to remove the loop from automatic control. After doing so, press OK.

- A display will prompt you to apply new 4mA input.
When “Current applied process value” display appears, choose “Set as 4 mA value” then press ENTER.
Return the loop to automatic.

(Device) - (Signal condition) - (Apply span value)

You will be warned to remove the loop into manual mode. After doing so, press OK.

- A display will prompt you to apply new 20mA input.
When “Current applied process value” display appears, choose “Set as 20 mA value” then press ENTER.
Return the loop to automatic.

3-3-3 :Alarm Settings

This shows how to configure alarm and contact output operations.

(Device) - (Alarm) - (Alarm Settings)

Two kinds of alarm are available: Output alarm and Sensor Temp. alarm.

When alarm condition is detected, it is logged in the status history of the device.

3-3-3-1 Output alarm

There are 4 settings of configuration.

(Alarm Settings) - (Alarm PV Config)

Alarm settings: No Alarm, Lower limit, Upper Limit, Lower/Upper Limit.

Lower Limit: Threshold of the Lower Limit alarm (Setting range: -200% to 200%)

Upper Limit: Threshold of the Upper Limit alarm (Setting range: -200% to 200%)

Setting values with the Upper Limit less than or equal to the Lower Limit is prohibited

Operation

The following operations are executed depending on the alarm setting.

- Lower/Upper Limit: If the output value is greater than or equal to the upper limit, or the output value is less than or equal to the lower limit, the alarm is detected.
- Upper Limit: If the output value is greater than or equal to the upper limit, the alarm is detected.
- Lower Limit: If the output value is less than or equal to the lower limit, the alarm is detected.
- No Alarm: No alarm is detected regardless of what value the output value, upper limit, or lower limit is.

The hysteresis is fixed and always 5% of the output.

<Example of the operation>

Alarm settings = Lower/Upper Limit, Upper Limit = 85%, Lower Limit = 15%

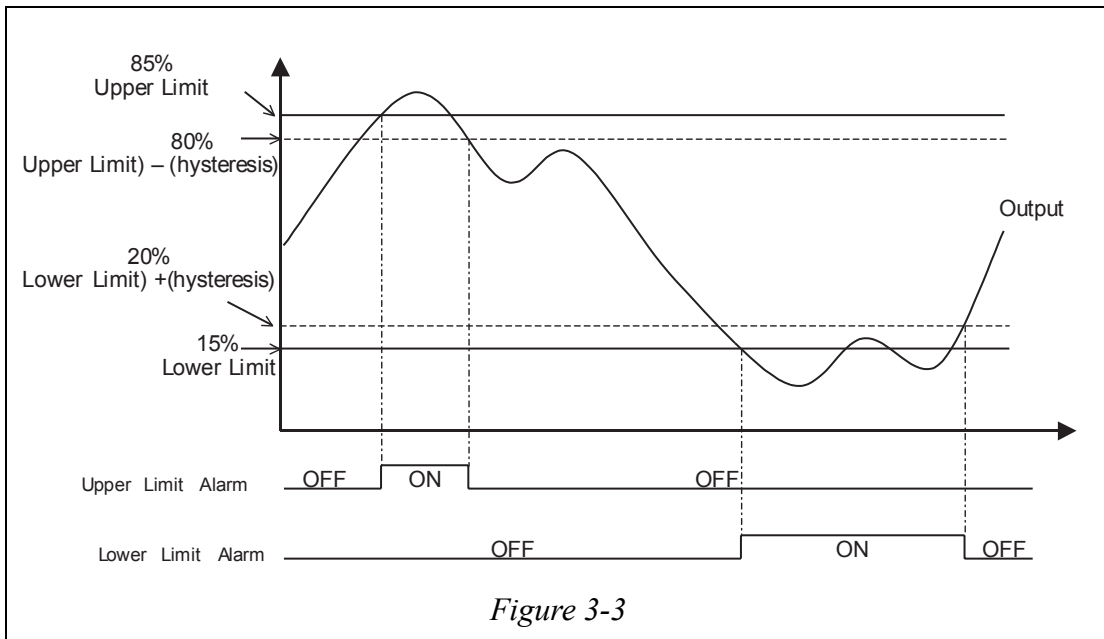


Figure 3-3

3-3-3-2 Sensor Temp. alarm.

There are 4 settings of configuration.

(Alarm Settings) - (Alarm Temp. Config)

Alarm settings: No Alarm, Lower limit, Upper Limit, Lower/Upper Limit.

Lower Limit: Threshold of the Lower Limit alarm (Setting range: -40 to 85 degrees Celsius)

Upper Limit: Threshold of the Upper Limit alarm (Setting range: -40 to 85 degrees Celsius)

Setting values with the Upper Limit less than or equal to the Lower Limit is prohibited

Operation

The following operations are executed depending on the alarm setting.

- Lower/Upper Limit: If the sensor temperature is greater than or equal to the upper limit, or the sensor temperature is less than or equal to the lower limit, the alarm is detected.
- Upper Limit: If the sensor temperature is greater than or equal to the upper limit, the alarm is detected.
- Lower Limit: If the sensor temperature is less than or equal to the lower limit, the alarm is detected.
- No Alarm: No alarm is detected regardless of what value the sensor temperature, upper limit, or lower limit is.
The hysteresis is fixed and always 5% of the output.

3-3-4 :Write Protect

This function prevents users from changing the settings of the transmitter using the communicator or external zero/span adjustment function.

There are two types of write protect, hardware write protect and software write protect.

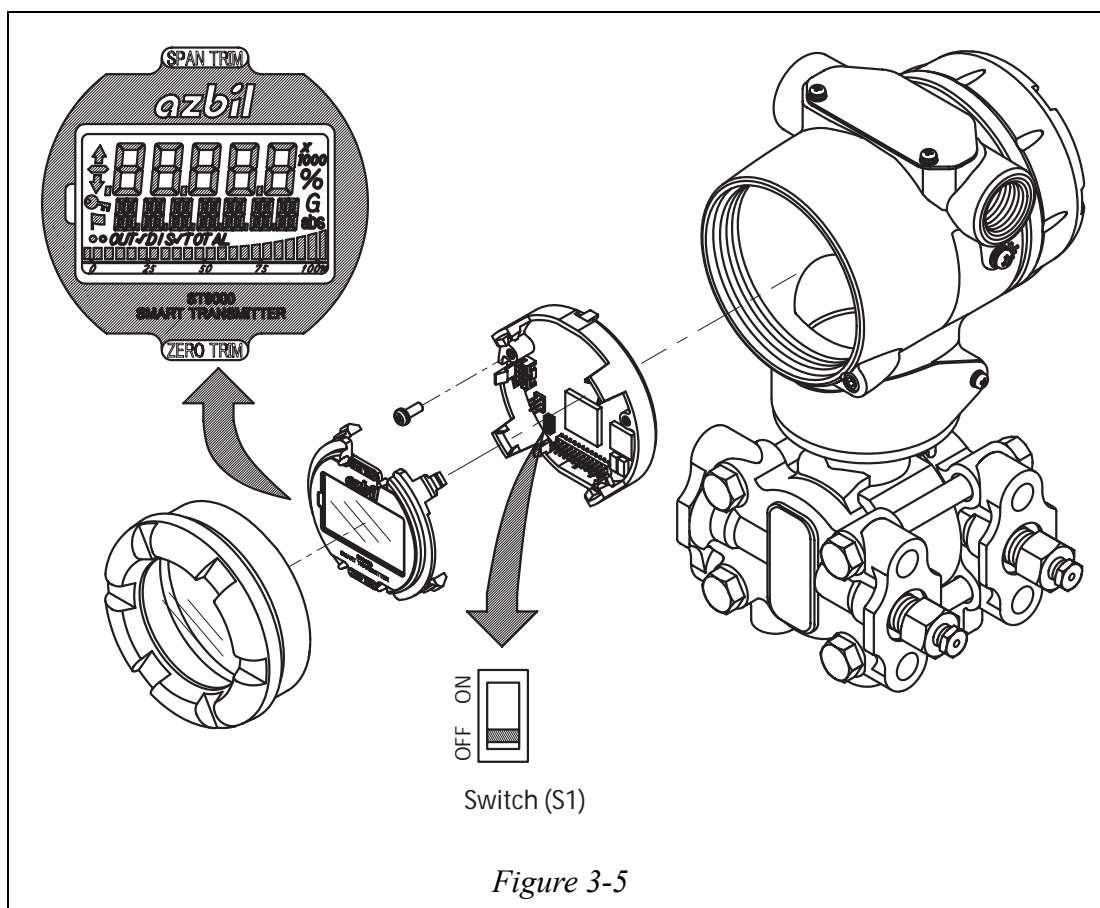
(Device) - (Device Information) - (Write Protect)

3-3-4-1 Hardware write protect

Switching the write protect ON and OFF can be executed with the slide switch (S1) on the electronics module.

Protect ON: Slide the slide switch (S1) to the ON side.

Protect OFF: Slide the slide switch (S1) to the OFF side..



3-3-4-2 Software write protect

Switching the write protect ON and OFF can be executed with the communicator.

When the hardware write protect is ON, switching with the communicator is not available.

3-4 : Calibration

This section provides information about calibrating the transmitter's analog output and measuring range. It also covers the procedure for resetting calibration to default values.

3-4-1 :Calibrating analog output signal

You can calibrate the transmitter's analog output circuit at its and 100% levels by using the transmitter in its constant-current source mode.

(Device) - (Calibration - (Output Calibration) - (D/A trim)

STEP	Action/Description
1	<p>You will be warned to remove the loop from automatic control. After doing so, press OK.</p> <p>When prompt appears, connect a precision millimeter or volt meter (0.03% accuracy or better) in loop to check readings. Press OK.</p>
2	<p>The following display prompts will appear:</p> <ul style="list-style-type: none"> • Setting field device output to 4 mA. Press OK. • Enter meter value. Key in meter value, then press OK. • Is field device output 4.000 mA equal to reference meter? 1 Yes 2 No <p>If not equal, select No, press ENTER, then key in new meter value. (returns to “Enter meter value” prompt until field device output equals reference meter.)If equal, select Yes, press ENTER.</p>
3	<p>The following display prompts will appear:</p> <ul style="list-style-type: none"> • Setting field device output to 20 mA. Press OK. • Enter meter value. Key in meter value, then press ENTER. • Is field device output 20.000 mA equal to reference meter? 1 Yes 2 No <p>If not equal, select No, press ENTER, then key in new meter value. (Returns to “Enter meter value” prompt until field device output equals reference meter.) If equal, select Yes, press ENTER. Prompt notifies you that the field device will be returned to its original output.</p>

3-4-2 :Calibrating range

The AT9000 Advanced Transmitter has two-point calibration. This means when you calibrate two points in the range, all the points in that range adjust to that calibration.

(Device) - (Calibration) - (Correct Input)

- Select “Correct Input LRV” or “Correct Input URV”.
- You will be warned to remove the loop from automatic control. After doing so, press OK.
- When prompted, adjust pressure source to apply pressure equal to LRV (0%) or URV (100%), then press OK.
- When pressure is stable, press OK.
- When prompted, remove pressure.

3-4-3 : Resetting calibration

A Corrects Reset returns the zero and span calibration factors to their default values. The transmitter calculates its output based on the characterization equation alone, without any compensation for the residual errors.

(Device) - (Calibration) - (Correct Input) - (Reset Corrects)

- When prompted, remove the loop from automatic control. Press OK.
- Prompt notifies you that a Reset Corrects is about to occur. Press OK.
- When message “Reset Corrects OK” appears, press OK.
- Calibration is reset to default values.
- When prompted, return the loop to automatic control and press OK.

Chapter 4 : Maintenance

This section explains the maintenance of the AT9000 Advanced Transmitter and a range of interesting ways to ensure that your transmitter's performance goals may be continuously met during its operating life, including instructions for:

- disassembly and assembly procedures,
- output checking,
- calibration procedures, and troubleshooting procedures.

At the start of operation or during operation, deal with performance problems by following these procedures. If you cannot fix the problem, it is possible that there is a problem with the product itself and you should contact your Yamatake representative immediately.

4-1 : Disassembly and Assembly

4-1-1 : Before You Start

WARNING

- Never open the case cover while the transmitter is ON or in a hazardous location.
- Handle the explosion-proof transmitter with care. It may lose its explosion-proof performance due to corrosion, deformation, damage to the case cover, or damage to a screw or a joined part.
- The explosion-proof performance of the special explosion-proof pressure transmitter is not guaranteed unless it is LOCKED. Always tighten the case cover completely, and lock the case cover.

Dismounting and mounting the case cover

This transmitter has a locking structure. Before dismounting the case cover, unlock the mechanism using a hexagonal wrench (included).

When remounting, insert the case cover fully and lock it, using a hexagonal wrench.

CAUTION

After mounting the case cover, make sure that no dust or rain gains ingress into the transmitter case.

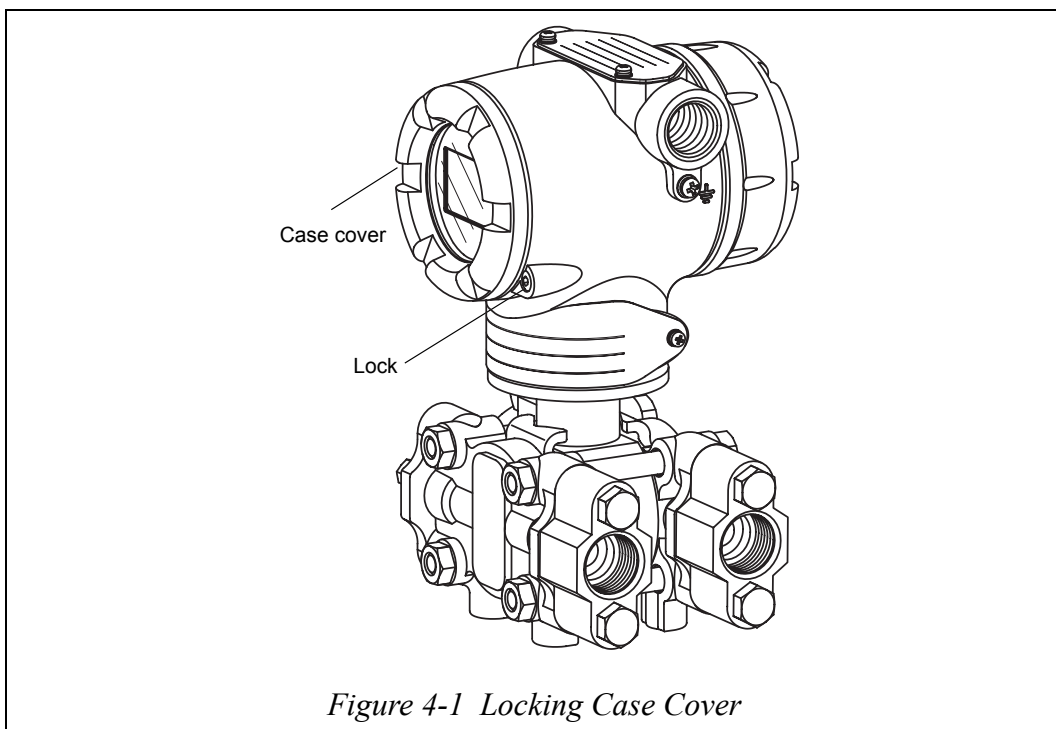


Figure 4-1 Locking Case Cover

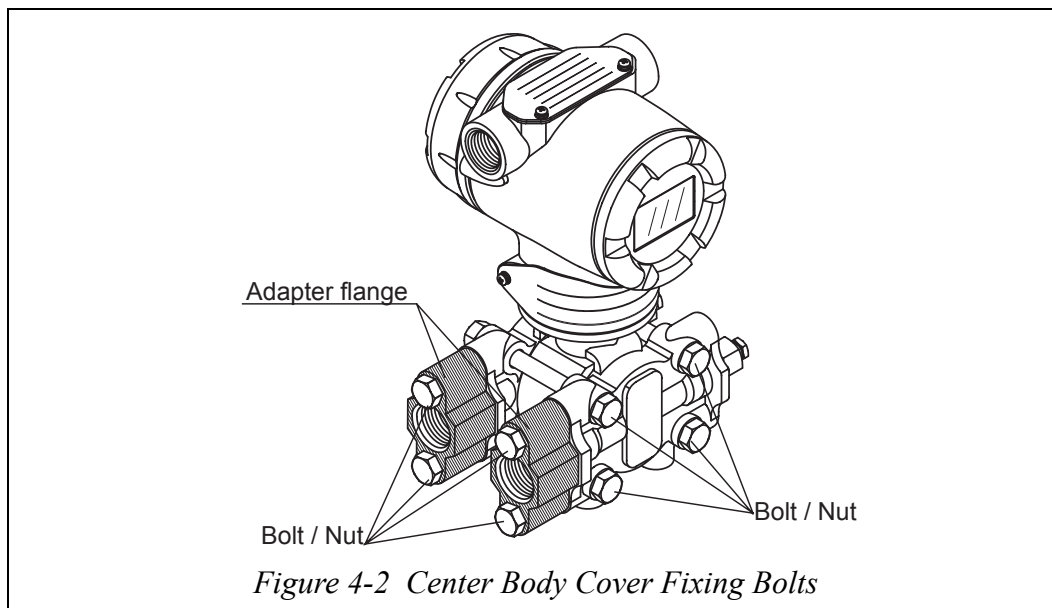
4-1-2 :Mount Center Body Cover and Adapter Flange

Dismount covers

Remove the four sets of bolts & nuts, shown in the illustration.

Remarks:

After dismounting, handle the center body cover carefully. Avoid damage to the diaphragm.



Mount covers and adapter flanges

When mounting the centers body cover and adapter flanges, tighten the bolts to the following torque.

Replace the seal gasket, if it is damaged.

Table 4-1 Cover Bolts / Nuts and Tightening Torque

Model No.	Wetted parts material (other than diaphragm)	Bolt/Nut Material	Bolt/Nut tightening torque N·m		
			Cover material Carbon steel/Stainless steel		Cover material PVC
			When new gasket is used	When existing gasket is reused	When new / existing gasket is used
GTX15D	SUS316	SUS304	15±1	10±1	-
GTX31D GTX41D	SUS316 Hastelloy C	Carbon steel	22±2	17±1	10±1
		SUS630			-
		SUS304	15±1	10±1	10±1
GTX31D GTX41D GTX71D	Tantalum SUS316L	Carbon steel	22±2	17±1	10±1
		SUS630			-
		SUS304	15±1	10±1	10±1
GTX32D GTX42D GTX72D	SUS316	Carbon steel SUS630	90±20		-
		SUS304	55±10		-
GTX60G GTX71G	SUS316 Hastelloy C	Carbon steel	22±2	17±1	10±1
		SUS630			-
		SUS304	15±1	10±1	10±1
GTX60G GTX71G	Tantalum SUS316L	Carbon steel	22±2	17±1	10±1
		SUS630			-
		SUS304	15±1	20±1	10±1
GTX82G	SUS316 Hastelloy C	Carbon steel SUS630	90±20		-
		SUS304	55±10		-
GTX30A GTX60A	SUS316 Hastelloy C Tantalum SUS316L	Carbon steel SUS630	22±2	17±1	-
		SUS304	15±1	10±1	10±1
GTX35F GTX60F	SUS316	Carbon steel SUS630	22±2	17±1	-
		SUS304	15±1	10±1	-

Table 4-2 Adapter Flange Bolt / Nut Tightening Torque

Bolt/Nut Material	Bolt/Nut tightening torque N·m	
	Adapter flange material Carbon steel/Stainless steel	Adapter flange material PVC
Carbon steel	20±1	7±0.5
SUS630		-
SUS304	10±0.5	7±0.5

4-1-3 :Washing the Center Body

Introduction

The transmitter and the pipes must be kept clean to maintain its accuracy and achieve satisfactory performance. Deposits accumulated in the pressure chamber of the transmitter may result in measurement errors.

Rinsing the center body (GTX□□D/GTX□□A/GTX□□G/GTX□□F)

Rinse the center body using the following procedure:

- (1) Remove the hexagon head bolts of the center body and dismount the cover.
- (2) Wash the diaphragm and the inner surface of the cover with a solvent and a soft brush. Take care not to deform or damage the diaphragm.
- (3) In reassembling the center body, replace the cover gasket with a new one as necessary.
- (4) Tighten the cover bolts at the specified tightening torque. (Refer to "Table 4-1 Cover Bolts / Nuts and Tightening Torque")

Remarks related to cold area

If you stop the operation after measuring liquid that can be frozen (such as water) in a cold area, drain the liquid from the center body (by loosening the drain plug.)

Maintenance of sensor

The sensor does not need any special routine maintenance/inspection. When the flange is dismounted for maintenance, wash the diaphragm using a soft brush and solvent. Work carefully without deforming or damaging the diaphragm.

4-2 : Calibrating Set Range and Output Signals

Some calibration work must be performed by Yamatake or our authorized service provider. Generally, this work requires a high-precision reference input device and highly accurate measuring equipment. Such work is not ordinarily performed by end-users of Yamatake equipment. These instructions are provided for the benefit of users who must perform calibration work themselves.

Calibration includes input calibration (set range) and output calibration (output signals).

4-2-1 : Calibrating Set Range Based on Reference Input

4-2-1-1 Preparation

The low limit (LRV) and the high limit (URV) of the set range are calibrated by inputting reference pressure.

Calibrate the LRV and the URV, in that order.

Equipment

Prepare the following equipment before calibration:

- Standard pressure generator: Pressure generated must be close to the measurement range of the transmitter.
Accuracy requirement: $\pm 0.05\%$ F.S. or $\pm 0.1\%$ setting
- Power supply: 24V DC
- Precision resistance: $250\ \Omega \pm 0.005\%$
- Voltmeter: Digital voltmeter with accuracy (10V DC range) of $\pm 0.02\%$ rdg+1 dgt
- HART® communicator

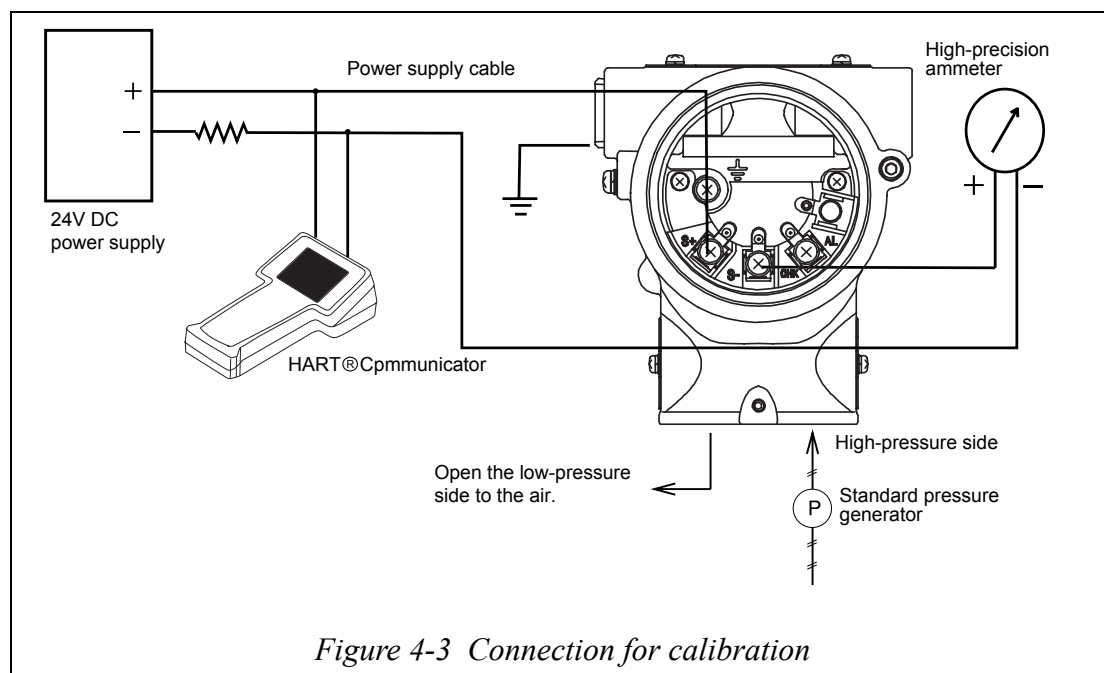
Calibration conditions

All of the following conditions must be met, before performing calibration:

- A laboratory without any air currents. Wind will apply pressure to the pressure receiving unit on the side open to the air, influencing the calibration accuracy.
- Standard temperature of 23°C and humidity of 65%. Normal pressure range (15°C~35°C) and the normal humidity range (45%~75%) are allowable, if no sudden changes occur.
- Accuracy of the measuring equipment must be at least 4 times that of the transmitter.

Set up for calibration

Wire the transmitter in a similar way to that shown below.



Set range

Before starting calibration work, use the HART® Communicator to check that the set range of the transmitter agrees with the specifications. If they do not correspond, use the HART® Communicator to set the correct range.

The set range is calibrated assuming that the low limit 20 kPa and the high limit is 100 kPa.

4-2-1-2 Calibrating Low Limit

How to calibrate the low limit value:

It is assumed that the HART® communicator and the transmitter have just started normal communications.

The AT9000 Advanced Transmitter has two-point calibration. This means when you calibrate two points in the range, all the points in that range adjust to that calibration.

(Device) - (Calibration) - (Correct Input)

- Select “Correct Input LRV”.
- You will be warned to remove the loop from automatic control. After doing so,
- press OK.
- When prompted, adjust pressure source to apply pressure equal to LRV (0%) then press OK.
- When pressure is stable, press OK.
- When prompted, remove pressure.

4-2-1-3 Calibrating High Limit

How to calibrate the high limit value:

(Device) - (Calibration) - (Correct Input)

- Select “Correct Input URV”.
- You will be warned to remove the loop from automatic control. After doing so,
- press OK.
- When prompted, adjust pressure source to apply pressure equal to URV (100%) then press OK.
- When pressure is stable, press OK.
- When prompted, remove pressure.

4-2-2 :Calibrating Output Signals

4-2-2-1 Before You Start

Output signal calibration (adjustment of the D/A conversion unit) is unnecessary under ordinary operating conditions. Normally, this work is performed by an authorized service provider of Yamatake. For end-users who must perform this work, prepare the following equipment in advance:

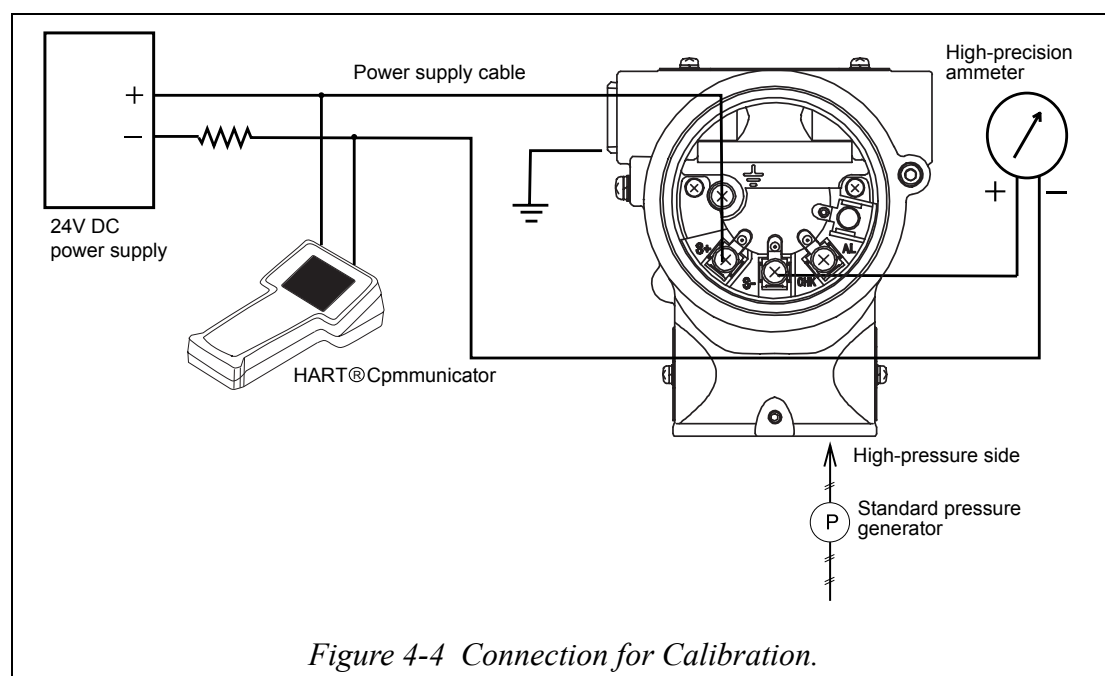
Equipment

- High-precision ammeter with accuracy of 0.03% FS or higher
- Resistor with a resistance of $250\Omega \pm 0.005\%$
- HART® communicator

Set-up

Refer to Figure 4-4. Connect the HART® communicator and an ammeter.

Refer to 3.2.1 Starting Communications. Check to ensure proper wiring. Check that the HART® communicator and the transmitter are in the normal communication status.



4-2-2-2 Calibrating Analog Output Signal

You can calibrate the transmitter's analog output circuit by using the transmitter in its constant-current source mode.

(Device) - (Calibration) - (Correct Input) - (D/A trim)

STEP	Action/Description
1	<p>You will be warned to remove the loop from automatic control. After doing so, press OK.</p> <p>When prompt appears, connect a precision milliammeter or volt meter (0.03% accuracy or better) in loop to check readings. Press OK.</p>
2	<p>The following display prompts will appear:</p> <ul style="list-style-type: none"> • Setting field device output to 4 mA. Press OK. • Enter meter value. Key in meter value, then press OK. • Is field device output 4.000 mA equal to reference meter? <ul style="list-style-type: none"> 1 Yes 2 No <p>If not equal, select No, press ENTER, then key in new meter value. (returns to “Enter meter value” prompt until field device output equals reference meter.) If equal, select Yes, press ENTER.</p>
3	<p>The following display prompts will appear:</p> <ul style="list-style-type: none"> • Setting field device output to 20 mA. Press OK. • Enter meter value. Key in meter value, then press ENTER. • Is field device output 20.000 mA equal to reference meter? <ul style="list-style-type: none"> 1 Yes 2 No <p>If not equal, select No, press ENTER, then key in new meter value. (Returns to “Enter meter value” prompt until field device output equals reference meter.)</p> <p>If equal, select Yes, press ENTER.</p> <p>Prompt notifies you that the field device will be returned to its original output.</p>

Chapter 5: Troubleshooting

The following describes the meaning of the status messages and the related troubleshooting procedures.

	Status message	Meaning	Required action	Display of Indicator
Internal data inconsistency	Invalid database	Configuration data and/or calibration data is corrupt.	Tap [Exit] and try communicating again. Verify configuration data and recalibrate the device.	Err.09 CONFIG
Critical failure	Analog/Digital Conversion Fault	Analog/Digital conversion failure	Invalid sensor and/or electronics board. Contact appropriate personnel.	Err.01 A-D CNV
	Sensor Characteristic Data Fault	Sensor characteristic data failure	Contact appropriate personnel.	Err.02 PROM
	Suspect Input	Input data error	Invalid sensor and/or electronics board. Contact appropriate personnel.	Err.03 INPUT
	CPU Fault	CPU operation failure	Bad electronics board. Contact appropriate personnel.	Err.04 CPU
	NVM Fault	Nonvolatile memory failure	Bad electronics board. Contact appropriate personnel.	Err.05 NVM
	RAM Fault	RAM failure	Bad electronics board. Contact appropriate personnel.	Err.06 RAM
	ROM Fault	ROM failure	Bad electronics board. Contact appropriate personnel.	Err.07 ROM
	Output Circuit Fault	Output circuit failure	Bad electronics board. Contact appropriate personnel.	Err.08 OUTPUT

	Status message	Meaning	Required action	Display of Indicator
Non-critical status	Meter Body Over Temperature	Meter body temperature is too high.	Reinstall the device to decrease the temperature to within specifications.	AL.20 M/B.TEMP
	Excess Zero Correct	The zero correction factor is outside the acceptable limits for accurate operation.	Check the input and be sure it matches the calibrated range value.	AL.21 ZERO.CAL
	Excess Span Correct	The span correction factor is outside the acceptable limits for accurate operation.	Check the input and be sure it matches the calibrated range value.	AL.22 SPAN.CAL
	In Output Mode	The device is operating in output mode.	Go to the output mode menu to clear the output mode.	Output % OUTMODE
	Meter Body Overload or Meter Body Fault	- The input pressure is more than two times The upper range limit for The device. - Device error.	Check the PV value and replace the device with a larger range model if necessary.	AL.24 OVRLOAD
	Correct Reset	Calibration data is cleared.	Calibrate the lower and upper range values.	AL.26 NO.CALIB
	External Zero/Span Adjustment Fault	External zero/span adjustment error.	Contact appropriate personnel.	AL.28 SWITCH
	Contact Output Simulation Mode	The device is operating contact output simulation mode.	To clear contact output simulation mode, go to the alarm/contact output menu.	[Blank] DO.SIM
	Output Alarm Detected	The output is going over upper/lower limit of output alarm.	Check the output.	AL.51 OUT%.AL
	Sensor Temp. Alarm Detected	The sensor temperature is going over upper/lower limit of sensor temp. alarm.	Check the sensor temperature.	AL.52 TEMP.AL

If the transmitter does not work normally or at all, check the following items.

Phenomenon	Measures
Nothing appears on the display.	<ul style="list-style-type: none"> • Make sure the power supply voltage is correctly applied. • Make sure the wire connection of the power supply is provided.
Output remains zero and does not change.	<ul style="list-style-type: none"> • Make sure the settings are correct. • Make sure the flow rate is within the low flow cut range. • Make sure the pipes are not blocked.
Output is out of alignment.	<ul style="list-style-type: none"> • Make sure that no fluid is leaking from the pipes. • Make sure the fluid is not flowing backward. • Make sure the connection direction of the HP and LP sides is correct. • Make sure the transmitter is not set at a tilt.

Also check the following points.:

- Check the result of self-diagnosis with the Communicator.
- Check that the connection direction of the HP and LP sides is correct.
- Check for any leakage at the connections on the pipes.
- Check for any loosened bolts on the clamping portions of the product.
- Check for any loosened and/or broken wires.
- Check for any wrong wiring connections.
- Check that the power supply voltage and load resistance are in accordance with the specifications.
- Check that the pressure and temperature are in accordance with the specifications.
- Check for the presence of any sources of strong magnetism or noise near by.

If even after checking the above items the transmitter still does not work properly, stop using it and unplug it. Then contact us at our branch office, sales office, or your local retailer.

MEMO

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