azbil

CM2-ATS100-2001

Advanced Differential Pressure and Pressure Transmitter

Model JTD/JTG/JTA/JTC/JTE/JTH/JTS

User's Manual

Azbil Corporation

azbil

Introductory Notes and Requests

- Please ensure that this manual is in the possession of the individual in charge of using this product.
- Reproduction or transmission of this manual, in whole or in part, is prohibited.
- The descriptions in this manual are subject to change without notice.
- It is our hope that this manual is complete and accurate, but in the event that there is content which is incomplete or whose accuracy is in question, please contact us.
- Please understand that we cannot in some cases accept responsibility for the results of use of this equipment by the customer.
- This product was designed, developed, and manufactured under the assumption that it would be used as a general-purpose model and as an explosion-proof model. Do not use this product for applications in which its operation directly affects human life, or for nuclear energy applications in radiation controlled areas.
  For applications such as
  • safety devices whose purpose is to protect people
  • direct control of transportation equipment
  • aircraft
  • spacecraft
  and the like, where safety is a necessity, be sure to use this product in a context in which the overall safety of the systems and equipment is taken into consideration using, for example, fail-safe design, redundant design, and periodic inspection. For information regarding system design, application design, usage methods, product applications, etc., consult with the relevant personnel at our company. Please understand that we cannot in some cases accept responsibility for the results of use of this equipment by the customer.
- HART® is a registered trademark of FieldComm Group.

Introduction

Thank you for purchasing an Azbil advanced transmitter series.

Structure of this Series

This series has the following models and model number configuration.

Differential Pressure Transmitters	Gauge Pressure Transmitters	Absolute Gauge Pressure Transmitters	Flange Type Differential Pressure Transmitters
JTD910S JTD920S JTD930S JTD921S JTD931S JTD960S JTD961S	JTG940S JTG960S JTG980S	JTA922S JTA940S	JTC929S JTC940S

Remote Seal Type Differential Pressure Transmitters	Remote Seal Type Gauge Pressure Transmitters	Remote Seal Type Absolute Pressure Transmitters
JTE929S JTE930S	JTH920S JTH940S JTH960S	JTS922S JTS940S

Note: If an external terminal box is attached, the model type will end in "W" rather than "S."

Usage Precautions

Introduction

In order to use this product safely, it is essential to install and operate it correctly, and to carry out periodic maintenance. Please read and understand the safety precautions described in this operation manual carefully before carrying out installation, operation, and maintenance.

Checks

- When you first receive the product, please confirm that there are no errors in the specifications, and that no damage occurred during transport. This product was shipped only after being tested under a rigorous quality control program. In the unlikely event that there are problems regarding quality or specifications, please notify us of the model number and production number appearing on the nameplate.
- The nameplate is affixed on the upper portion of the case.

Safety Precautions

In order to promote safe use of the product, this operation manual uses the following symbols.

⚠ **Warning**	Cautionary notes aimed at preventing dangerous situations when it is anticipated that such dangerous situations, in which the product user could be seriously or fatally harmed as a result of product misuse, might arise.
⚠ **Caution**	Cautionary notes aimed at preventing dangerous situations when it is anticipated that such dangerous situations, in which the product user could sustain minor injuries or physical damage could occur as a result of product misuse, might arise.

In order to use the product safely, be sure to follow the cautionary notes on the next page. We cannot warrant or take responsibility for damage resulting from handling of the product in violation of these cautionary notes.

■ Examples of visual indicators

⃠	This indicates an action that is prohibited.
❗	This indicates an instruction that the user should be sure to follow.

Product Usage Precautions

Usage Limitations and Requests

This product was designed, developed, and manufactured under the assumption that it would be used as a general-purpose model and as an explosion-proof model. Do not use this product for applications in which its operation directly affects human life, or for nuclear energy applications in radiation controlled areas.
For applications such as

- safety equipment whose purpose is to protect people
- direct control of transportation equipment
- aircraft
- spacecraft

and the like, where safety is a necessity, be sure to use this product in a context in which the overall safety of the systems and equipment is taken into consideration using, for example, fail-safe design, redundant design, and periodic inspection.
For information regarding system design, application design, usage methods, product applications, etc., consult with the relevant personnel at our company. Please understand that we cannot in some cases accept responsibility for the results of use of this equipment by the customer.

Installation Precautions

⚠Warning
Depending on the model, this product weighs over 10 kg. Be sufficiently careful when transporting or installing this product, for example by using a transportation apparatus or by having two or more people carry the product. Lifting and dropping the product without sufficient care can cause injuries or product damage.
When installing the product, make sure that the gaskets do not stick out at the connections with the process (connections between adapter flanges and connecting pipes and flanges). Also be careful not to forget to close vent and drain plugs. There is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.
Use this product within the limits of the described usage conditions (explosion proofing, pressure rating, temperature, humidity, voltage, vibration, shock, installation orientation, ambient atmosphere, and the like). There is a danger of scalding and other harmful health effects as a result of instrument failure, fire, etc.
To ensure safety, have personnel with specific technical expertise in instrumentation work, electrical work, etc., perform the installation, wiring, and the like. When working in a hazardous area, perform installation and deployment according to the construction methods prescribed by the hazard guidelines.

⚠Caution
After installing this product, do not use it as a scaffold, place your body weight on it, etc. This may cause damage to the product. In addition, there is a danger of slipping and being injured.
Bringing tools and the like into contact with the glass portion of the display can cause damage or injury.
Ground the product properly in accordance with the instructions in this operation manual. If the product is not properly grounded, the output may be affected. Also, improper grounding is contrary to the explosion-proofing guidelines.
Do not subject this product to shock or impact, as they can cause product damage.
Use a power supply for this product which has overcurrent protection capability.

Wiring Precautions

⚠Caution
Do not perform wiring work, turn on the electricity, etc., when your hands are wet. Also, do not perform hot swapping. There is a risk of electric shock. Do this work with dry hands or wearing gloves, and with the electricity turned off.
Be sure to thoroughly check the specifications to ensure that the wiring is carried out correctly. Incorrect wiring can cause instrument damage or malfunctions.
Supply power correctly based on the specifications. Inputting an incorrect power supply can damage the instrument, and the individual doing the work can become injured.

Maintenance Precautions

⚠Warning
When detaching this product from the process for maintenance and the like, clear vents and drains in order to remove residual pressure and residues in the measurement target. In addition, when clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.
When using the product in a hazardous area, do not open its case cover, electrical conduits, etc. There is a risk of explosion, etc.
When using the product in a hazardous area, check that the threaded parts of connecting surfaces on the case cover, electrical conduit connection port, etc., are not corroded, deformed, cracked, or otherwise damaged. If its explosion-proofing performance is impaired, the product can become an ignition source, and there is a risk of explosion. Perform periodic maintenance on this product, and replace it with a new one if corrosion etc., reaches significant levels.
Replace damaged seal gaskets. If this product is operated in a damaged state, it will not be possible to ensure sufficient performance of the seals, and there is a danger that the measured fluid will spurt out, possibly resulting in scalding and other harmful health effects.
If evidence of corrosion is observed in pressure-bearing parts such as bolts, nuts, cover flanges, and adapter flanges, replace them. Parts whose pressure-resistance has decreased can break and are thus dangerous. There is also a risk of physical injuries such as bruises and lacerations.
Be sufficiently careful of residues from measured fluids which are left behind in the product. If materials which affect the human body are contained in these residues, harmful effects on human health could result. When performing maintenance on a product which has been uninstalled, first clean the pressure-receiving parts adequately.

⚠Caution
Do not disassemble or alter this product. Doing so may lead to product failure, electric shock, etc. Explosion-proof instruments cannot be inspected or disassembled in hazardous areas. In addition, explosion-proof products cannot be used after having been altered.
If this product is used with high-temperature fluids, do not carelessly touch the body of the product. It will likely have become hot, so there is a risk of sustaining burns.
When this product is no longer to be used, dispose of it in accordance with local regulations, treating it as industrial waste. Also, do not reuse this product in whole or in part.

Communication Device Usage Precautions

If communication devices such as transceivers, cellular phones, PHS phones, or pagers are used in the vicinity of this product, depending on the transmission frequencies being used there may cases in which the product does not function properly, so please observe the following precautions.

- Before using a communication device, check the distance at which the communication device does not affect the operation of this product, and maintain that distance or more when using the communication device.
- Close the case cover of the transmission unit before using communication devices.

HART Communication Usage Precautions

- If, as a result of burnout, the output of this device drops to 6 mA or 3.2 mA (optional) or lower, HART communication may not be possible. In such cases, turn the power off and then on again before starting communication. If burnout and communication failure persist, there is a chance that the product is broken, so please contact us.

Usage precautions for devices using HART

- If, as a result of the effects of electrical noise in the installation environment, HART communication with the host is not possible, take countermeasures such as distancing the signal cable from the noise sources, re-evaluating the grounding conditions, and changing the signal cable to a shielded cable. Incidentally, even if HART communication is not possible due to noise, the 4-20 mA analog signal will not be affected.
- When using this product in multidrop mode, there is a limit to the number of units which can be used. If using multidrop, please consult our representative for more details.

Disposal precaution for Electrical and Electronic Equipment

Disposal of Electrical and Electronic Equipment (for Environmental Protection)
This is an industrial product subject to the WEEE Directive.
Do not dispose of electrical and electronic equipment in the same way as household waste.
Old products contain valuable raw materials and must be returned to an authorized collection point for correct disposal or recycling.

Product unpacking, verification, and storage

Unpacking

This product is a precision instrument. Handle it carefully in order to prevent accidents, injuries, etc.

Verifying accessories

Upon unpacking the product, verify that the main body and the following items have been included.

- Standard accessory: M3 size L-wrench (1)
- Operation Manual (with CD)

Checking specifications

The specifications appear on the product's nameplate. Compare them to the expected specifications. In particular, be sure to check the following specifications.

- Tag number (TAG No.)
- Model number (MODEL)
- Production number (PROD. No.)
- High and low limits of the setting range (RANGE)
- Supply voltage (SUPPLY)
- Explosion-proofing test conformity label (if explosion-proofing specification applies)

Note: The production number (PROD No.) is equivalent to the serial number specified in IEC 60079-0. A unique production number is assigned to each individual product.

Inquiries

Please direct inquiries regarding this product to the branch office or sales office of our company which is closest to you.
When making an inquiry, be sure to let us know the following numbers appearing on the nameplate.

- Model number (MODEL)
- Production number (PROD. No.)

Storage

If the product is to be placed in long-term storage immediately after purchase, please observe the following precautions.

- Store the product indoors in a low-vibration, low-shock area which has stable temperature and humidity.
- Store the product in the packed state in which it was delivered.

Table of Contents

Chapter 1 Functionality, Configuration, and Structure of this Device and CommStaff

This chapter describes the basic functionality, structure, and configuration of this device, as well as the basic functionality and configuration of CommStaff, the communicator required to operate this device. Please read this chapter to gain an understanding of the basics of this device and CommStaff if using the device for the first time.

1-1 Functionality and Configuration of this Device

1-1-1 Functionality and Configuration of this Device

This device measures differential pressure using a differential pressure sensor on a compound semiconductor sensor, and transmits gauge pressure, absolute pressure, flow rate, and liquid level data. In order to accurately measure differential pressure, compensation based on changes in static pressure and temperature is necessary. By measuring these changes using the differential pressure sensor and a temperature sensor on the compound semiconductor sensor, and performing comparison operations relative to actual measurement data stored at the time of factory shipping, the measured differential pressure is adjusted to the true differential pressure and output. This device is composed of a differential pressure sensor, a temperature sensor, a static pressure sensor, a multiplexer, and an A/D converter in the meter body, along with a microprocessor, various data storage elements, and a D/A converter in the transmission unit.

The diagram below illustrates the basic functionality and configuration of this device.
The flow rate, pressure, and liquid level of the process fluid are conveyed to the differential pressure sensor on the compound semiconductor chip in the main unit.
The output of this sensor undergoes A/D conversion simultaneously with the temperature and static pressure detected by the temperature sensor and static pressure sensor on the compound semiconductor sensor.
These converted signals are processed by the microprocessor, converted again to a 4-20 mA DC analog signal corresponding to the specified range, and output.

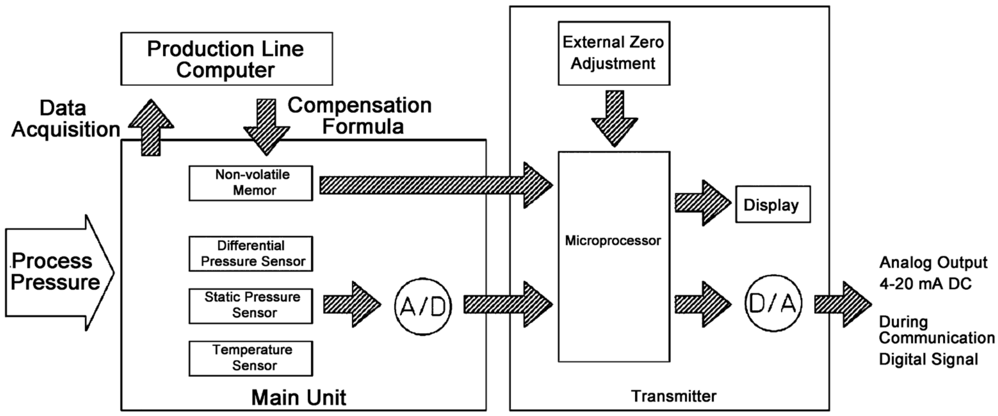


Figure 1-1. Block Diagram of this Device

Non-volatile memory: (EEPROM)	The input-output characteristics, temperature characteristics, static pressure characteristics, device type, settable range, etc., of the meter body are stored here. In addition, a variety of setting data for the transmission unit is held here even when the power is turned off.
A/D:	Analog signal from the compound semiconductor sensor is converted to a digital signal.
D/A:	Digital signal for the compensated differential pressure is converted to an analog signal.

1-1-2 Part Names

This device is composed primarily of a main unit, an electronics module, a terminal block with integrated indicators, a transmission unit case, and a case cover.

The following diagram shows the structure and part names of this device.

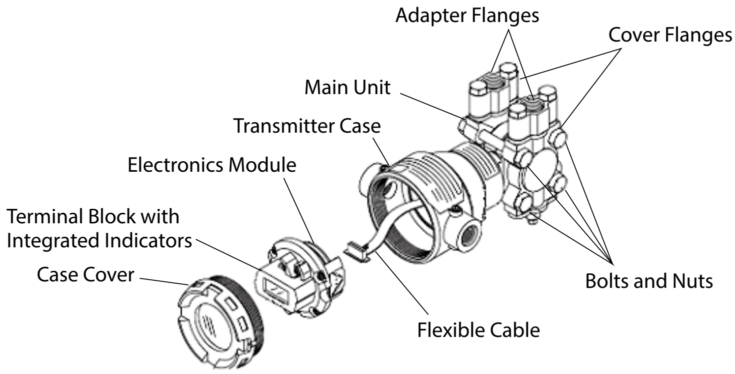


Figure 1-2. Structure of JTD Model

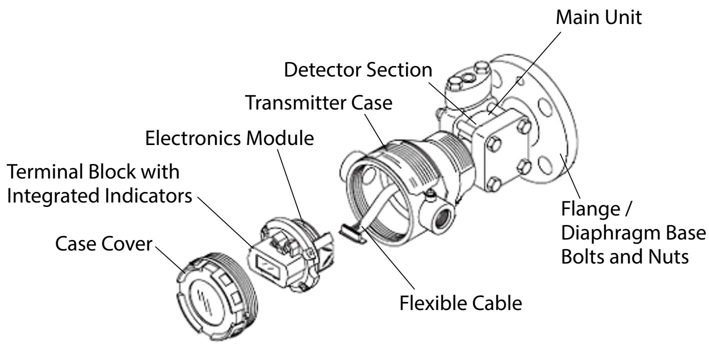


Figure 1-3. Structure of JTC Model

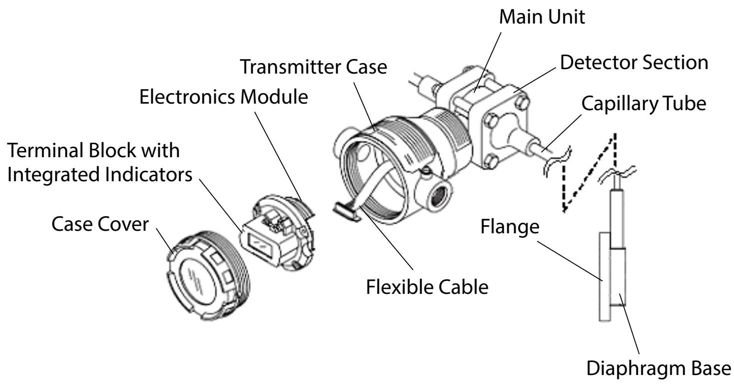


Figure 1-4. Structure of JTE and JTH Models

- Main unit: Composed of a compound semiconductor sensor, an A/D circuit, a pressure-receiving diaphragm, an excess pressure protection mechanism, etc.
- Cover flanges: Parts which sandwich the sides of the main unit to maintain pressure.
- Adapter flanges: Used attached to the cover flanges. Connected to connecting pipes.
- Bolts and nuts: Used in interposing the main unit between the cover flanges.
- Vent/drain plug: Used when clearing the vents and drains.
- Flange: In the JTC, JTE, and JTH models, used along with the opposing process flange to sandwich the diaphragm base.
- Diaphragm base: In the JTC, JTE, and JTH models, receives the measured pressure.
- Capillary tube: In the JTE and JTH models, connects the main unit and the diaphragm base.
- Electronics module: Electronic circuit which processes and transmits differential pressure signals etc.
- Flexible cable: Part which electrically connects the main unit and the electronics module.
- Transmission unit case: Houses the electronics module, terminal block, etc.
- Case cover: Cover for sealing the transmission unit case.
- Terminal block with integrated indicators: Terminals to which to connect electrical signals. CommStaff can also be connected here. The indicators are optional.

1-1-3 Indicators (Optional)

The names of the display indicators are as follows.

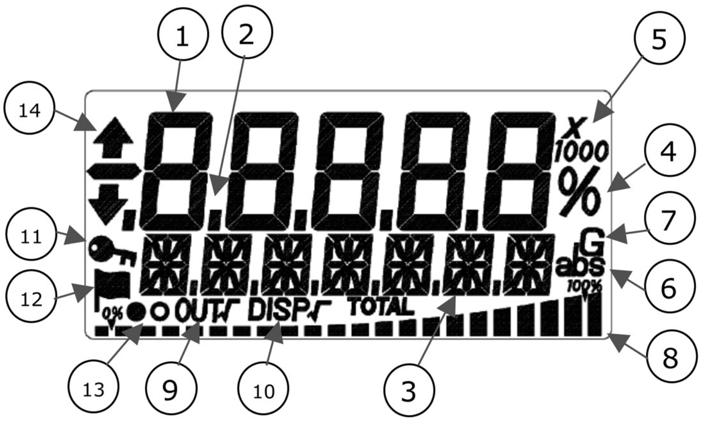


Figure 1-5. Indicator Display Unit

Table 1-1. Indicator Display Unit

No.	Indicator/Symbol	Indicator Description
1	Main indicator (4.5 digits) Value, error	Process variable (engineering unit scale, real pressure), % Status number
2	Decimal point (4 digits)	Decimal point
3	16-segments indicators (7 digits)	Units*, status External zero adjustment
4	%	Percentage
5	Exponent	×10, ×100, ×1000
6	Absolute Pressure	abs
7	Gauge Pressure	G
8	Bar graph	Bar graph of output %
9	Output square root	OUT √
10	Display square root	DISP √
11	Key symbol	Write-protected state
12	Flag symbol	Diagnostic History
13	Display update symbol	Alternating display: ● and ○
14	External zero adjustment	↑ or ↓

* Selectable units list (SI units)

kPa	MPa	Pa	hPa	kPaG	MPaG	kPa abs
MPa abs	Pa abs	hPa abs	g/cm^3	kg/m^3	m^3	l
kl	ml/h	l/h	kl/h	t/h	m^3/h	km^3/h
l/min	kl/min	m^3/min	kl/d	m^3/d	t/d	kg/h
mm	m	%	t	kg	none	

(i) Main display indicators

- When the display value is in the following range, the display limit value blinks.

Display value range	Blinking display value
Display value < -19999	-19999
Display value > 19999	19999

(ii) Bar graph indicators

The output values of this device are displayed in a 22-segment analog bar graph. The bar graph segments turn on or blink as follows.

	Output			Segment Display Status
	OUT <	-5%	Blinks	■
-5%	≤ OUT <	0%	Turns on	■
0%	≤ OUT <	5%	↓	■■
5%	≤ OUT <	10%	↓	■■■
10%	≤ OUT <	15%	↓	■■■■
15%	≤ OUT <	20%	↓	■■■■■
:	:	:	↓	:
:	:	:	↓	:
85%	≤ OUT <	90%	↓	■■■■■----■
90%	≤ OUT <	95%	↓	■■■■■----■■
95%	≤ OUT <	100%	↓	■■■■■----■■■
100%	≤ OUT <	105%	↓	■■■■■----■■■■
105%	< OUT		Only right end blinks	■■■■■----■■■■

(iii) Output square root and display square root indicators

Used to determine whether the output values and indicator display values are linear (differential pressure) or have been processed to calculate their square roots (flow rate).

Table 1-2. Linear/Square Root Indicator State

Indicator	Output	Indicator Displayed	Name
Linear (differential pressure)	Linear (differential pressure)	None	Linear
Square root (flow rate)	Linear (differential pressure)	DISP √	Display flow rate (display square root)
Square root (flow rate)	Square root (flow rate)	OUT √	Flow rate (square root)

(iv) External zero adjustment indicators

If the (optional) external zero adjustment functionality is in effect, its operating status is displayed as follows.

Table 1-3. External Zero Adjustment Operating Status

Adjustment Status	Indicator	
	Up and Down Arrows	16-Segment Indicators
Output rising	⬆	ZERO.ADJ
Output falling	⬇	

(v) Key symbol indicator

When the key symbol is displayed, write protection is in effect. For information regarding write protection, see section "3-1-2 Settings Confirmation".

(vi) Flag symbol indicator

If diagnostic history information is being retained in the transmission unit, the flag symbol is displayed. For information regarding items which are retained as history, see section "4-3-2 Diagnostics History Display".

(vii) Display update symbol indicator

Indicates that the transmission unit is operating.

(viii) Transmitter information indicators

Error numbers and error items representing the status of the transmitter's self-diagnostics are respectively displayed in the upper indicator section (main indicators) and the lower indicator section (16-segment indicators).

Example:

```
Err.02
PROM
```

For information regarding the meaning of the display contents, see section "4-4 Troubleshooting".

1-2 CommStaff Functionality and Configuration

1-2-1 Introduction

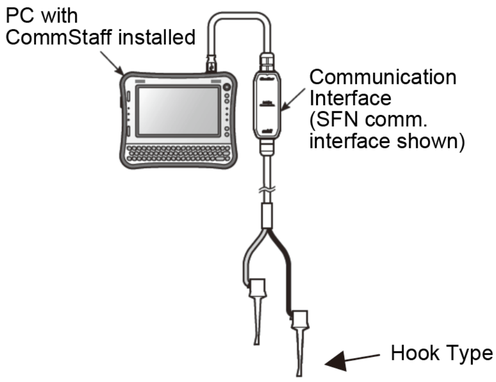
CommStaff is a configuration tool which communicates with Azbil smart devices (e. g., the Advanced Differential Pressure Transmitter) and performs the various device configuration operations. With CommStaff, communication is carried out by connecting a communication interface to a USB port of a PC, and connecting a communication cable to a communication terminal of an Azbil smart device.
CommStaff supports HART communication and Azbil's proprietary SFN communication.
SFN/DE communication and HART communication use their own respective special-purpose communication interfaces.

1-2-2 Precautions

* Precautions when changing the connected device
  While displaying dynamic values such as pressure, CommStaff continues to communicate with the device in order to update these dynamic values. If the communication cable is disconnected from the device in order to change the connected device, a communication error will occur in CommStaff. Consequently, in order to avoid this communication error, terminate CommStaff before disconnecting the communication cable from the device, and restart CommStaff after connecting the communication cable to the new device.
* Do not use with the PC connected to an AC power supply.
* Do not connect the communication interface before installing the CommStaff software on the PC. It will not be able to operate normally because the driver will not be found.

1-2-3 Configuration of CommStaff and Peripheral Devices

The configuration of CommStaff is as follows.



1-2-4 Usage Environment

The usage environment of the communication interface (CFS100 SFN DE) is as shown below.

Operating temperature:	0 - 50 °C
Operating humidity:	5 - 95 %

However, if the environmental conditions of the PC being used are stricter than the conditions above, use the interface within the usage condition range of the PC.
For information regarding the usage environment of the HART communication interface, see the MACTek product specifications.

1-2-5 Conditions for Connected Devices

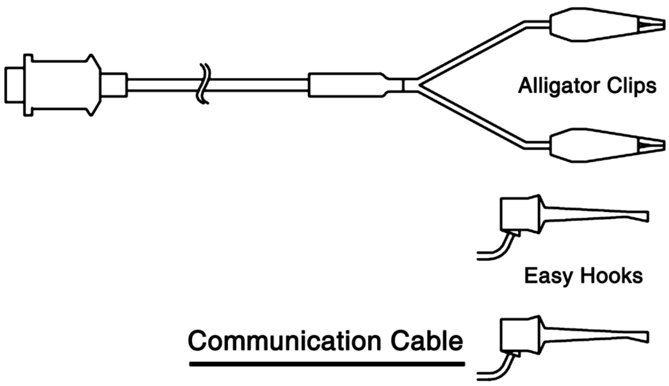
(1) PC

Check the CommStaff General Operation Manual.
Field Communication Software CommStaff User's Manual: CM2-CFS100-2001

(2) Communication Interface

Use a communication module that meets the following conditions.

SFN/DE communication interface	CFS100 SFN DE Azbil product model number • 80345962-001 (alligator clip type) • 80345962-002 (easy hook type)
HART communication interface	MACTek VIATOR USB HART MACTek product model number: 010031



Chapter 2 Installation of this Device

This chapter covers important points related to the installing this device and setting up its piping and wiring. Individuals in charge of installation work should read this chapter.

2-1 Installation Location Selection Criteria

2-1-1 General Installation Conditions

(1) Introduction

Follow the selection criteria described here in order to enable this device to exhibit peak performance over the long term.
Incidentally, when installing explosion-proof models, follow the guidelines in "Factory Electrical Equipment Explosion-Proofing Guidelines (Gas Vapor Explosion-Proofing 2006)" from the Research Institute of Industrial Safety, or "Factory Explosion-Proof Equipment Guide for Users" from the National Institute of Occupational Safety and Health.

(2) Installation Location Selection Criteria

Select an installation location for this device in accordance with the following criteria.

- Choose a location with as little temperature variation as possible.
- Avoid installing the device in an area which is exposed to radiant heat from the plant.
- For areas in which there is a risk that the measured fluid, sealing fluid, etc., might freeze, take heat insulation measures.
- Choose an area with minimal exposure to vibration and shock.
- Avoid installation in areas with a corrosive atmosphere.
- For external zero adjustment (optional), since the output of this device can undergo variation in locations with strong magnetism (locations with motors, pumps, etc., with 10 Gauss or higher), install the device at least 1 m away from such locations.
- Do not subject connecting pipes attached to this device to vibration.
- Use the device in the industrial electromagnetic environment specified in IEC 61326-1.

2-1-2 Explosion-Proof Transmitter Installation Criteria

(1) Installation of Explosion-Proof Transmitters

Explosion-proof transmitters which are approved by public authorities based on the Industrial Safety and Health Law are permitted to be used in hazardous areas as described below. An explosion-proofing test conformity label is affixed on the nameplate of these transmitters, and explosion-proofing requirements are listed. Check these to ensure that the device is installed properly.

(2) Pressure-Resistant Explosion-Proof Model Installation Criteria

Install pressure-resistant explosion-proof models in areas which correspond to the following electric machinery groups, explosive gas categories and temperature classes, and hazardous area groupings.

- Explosion class and ignition temperature of target gas
  IIC T4
  IIC: Electric machinery group and explosive gas category
  (including hydrogen)
  T4: Maximum surface temperature of 135 °C.
- Hazardous area grouping:
  Category 1 or Category 2 hazardous area
  Cannot be installed in a "special hazardous area."

- Temperature:
  Install the device in an area that satisfies the following temperature conditions.
  Ambient temperature

JT _9 _ _S with indicator:	-20 - +55 °C
JT _9 _ _S without indicator:	-20 - +60 °C
JT _9 _ _W with indicator:	-20 - +55 °C
JT _9 _ _W without indicator:	-20 - +60 °C

  Pressure-receiving part (main unit) contact liquid temperature: 110 °C

⚠Caution

- If this temperature is exceeded, explosion-proof performance specifications cannot be guaranteed. If there is a chance of this, take measures to ensure that the temperature stays within the temperature range, such as carrying out heat insulation measures or selecting a well-ventilated area.

- Be sure to install the provided (specified) pressure-resistant packing cable gland to the signal wiring port of the device.
  Also, if the orientation of the wiring needs to be changed, use the provided elbow joints. In order to ensure the explosion-proofing performance specifications based on explosion-proofing certification, do not use any items other than the pressure-resistant packing cable gland and the elbow joints.

- For the wiring, use cables with the following maximum allowable temperature.

JT _9 _ _S with indicator:	65 °C
JT _9 _ _S without indicator:	70 °C
JT _9 _ _W with indicator:	60 °C
JT _9 _ _W without indicator:	65 °C

- Reference Materials:
  "Factory Electrical Equipment Explosion-Proofing Guidelines (Technical Guidelines Conforming to International Standards 2008)" by the Research Institute of Industrial Safety

(3) Installation Criteria for Intrinsically Safe Explosion-Proof Models (Ex ia IIC T4 Ga, Ex ia IIIC T 105 °C Da)

The following are the electric parameters for intrinsically safe explosion-proof models.

- Electric parameters: Ui = 30 V, Ii = 93 mA, Pi = 1 W, Ci = 5 nF, Li = 0.6 mH
  The intrinsically safe explosion-proof models are for the following explosive gas and electrical equipment, and temperature class. Install these models in the hazardous zones shown below that satisfy the specified temperature condition.
- Explosion class and auto-ignition temperature of target gas: IIC T4
  IIC: Indicates an explosive gas group (IIC includes hydrogen) and electric equipment for the gas in the groupT4: The maximum surface temperature is 135 °C.
- Hazardous location classification: Zone 0, Zone 1, Zone 2
- Temperature: Install the device in an area that satisfies the following temperature conditions.
  Ambient temperature: -30 to +60 °C
  Temperature of liquid contacting the pressure-receiving part: -20 to +105 °C

  * The temperature of the liquid contacting the pressure-receiving part applies to the surface of the barrier diaphragm on the main unit.
  * This product has IP66 and IP67 certifications required by the ATEX intrinsically safe explosion-proof standard. This product is certified as IP50 by the Technology Institution of Industrial Safety.

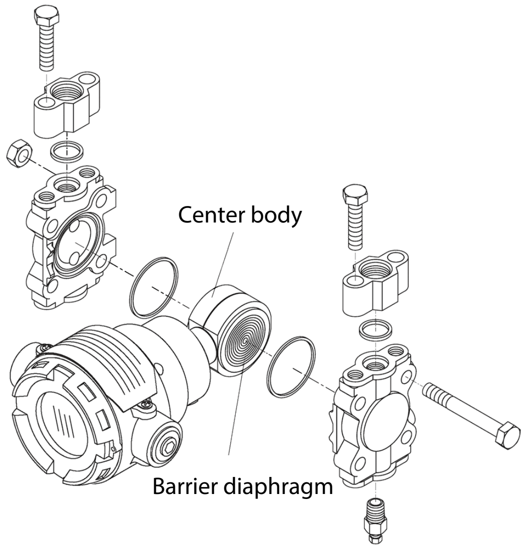


Figure 2-1.

Standards compliance: Technical Recommendation of National Institute of Occupational Safety and Health
Recommended Practices for Explosion-Protected Electrical Installations in General Industries (2008 technical recommendations conforming to international standards) Part 1 “General rules” (JNIOSH-TR-46-1:2015)

issued May 1st 2015

Recommended Practices for Explosion-Protected Electrical Installations in General Industries (2008 technical recommendations conforming to international standards) Part 6 “Intrinsically safe explosion-proof structure “i” ” (JNIOSH-TR-46-6:2015)

issued May 1st 2015

- Withstand voltage test
  This product does not satisfy the withstand voltage specifications required by the above standard. The conditions of the withstand voltage test are as follows:
  Applied between the supply terminal (+ and - terminals are connected) and the ground terminal in the terminal box
  Applied voltage: 500 V DC (specified in section 6.3.13 in Part 6 of the above standard)
  Applied for: 1 minute

2-1-3 Equipment use conditions

(1) Use conditions for intrinsically safe explosion-proof models

- If installed and used in an area that requires EPL Ga equipment, make sure that ignition sparks will never be emitted due to friction or a shock.
- If installed and used in an area that requires EPL Da equipment, electrostatic discharge must be prevented by taking measures such as wearing antistatic shoes or wristbands, or laying antistatic floor mats.
- This product does not satisfy the withstand voltage specifications required by Recommended Practices for Explosion-Protected Electrical Installations in General Industries (2008 technical recommendations conforming to international standards). Accordingly, use of insulation barriers is recommended. If zener barriers are used, connect the transmitter and zener barriers to the same equipotential bonding system.

2-2 Installation

2-2-1 Installation Dimensions

See the dimensions diagram (in the specifications sheet or delivery specifications) for this device.

2-2-2 Installation Location

See the general installation conditions in 2-1-1.

2-2-3 Transmitter Body Installation

(1) Components Required for Installation

In order to install this device, have the following items ready.

- Mounting bracket (U-bolts, nuts, and mounting bolts provided) ---- optional
  Select one of the two types of brackets.
  • Bracket (left diagram in Figure 2-2)
  • Round bracket (right diagram in Figure 2-2)
  * The round bracket allows a more compact installation than was possible in the past.
- 2B pipe

(2) Installation Method

(i) Pipe stanchion installation

Using the mounting bracket (selectable from two types), fasten the device to the vertical or horizontal 50A (2B) pipe with a U-bolt. There are four bolt holes on the rear surface of the pressure receiving main body; mount the bracket there. The pipe should be fastened securely to its foundation, with no unsteadiness.

(ii) Line mount installation

If the pipe is 50A (2B), attach it in the same way as for the pipe stanchion. If the pipe is not 50A (2B), attach a 50A (2B) pipe to the line pipe.

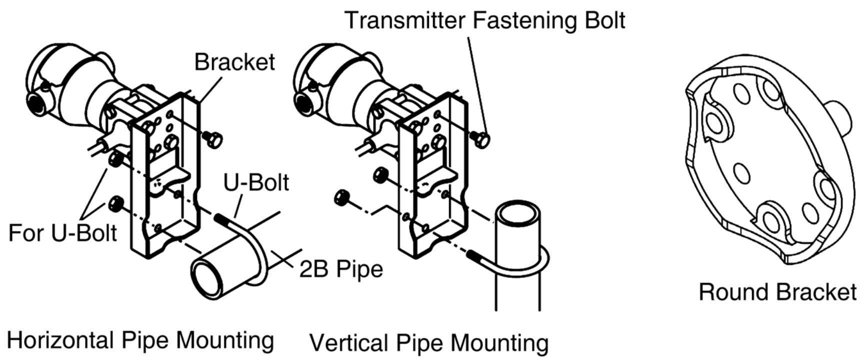


Figure 2-2. Transmitter Body Installation

* The flange type (JTC type) is attached directly to the tank.

(iii) Installation precautions for pressure/differential pressure remote-sealed type of differential pressure transmitters

- If the liquid fill is for high-temperature high-vacuum, the viscosity of the liquid fill will rise as the measured temperature and ambient temperature fall, and the response speed of the transmitter will slow down. Instrument the device such that the ambient temperature of the capillary tubes and main unit is always at least 10 °C.
- When measuring the sealed tank level, attach the transmitter in a location which is at least 10 cm lower than the location of the tank nozzle. If it is not possible to attach it at least 10 cm lower, look for an attachment location in accordance with the item described next.

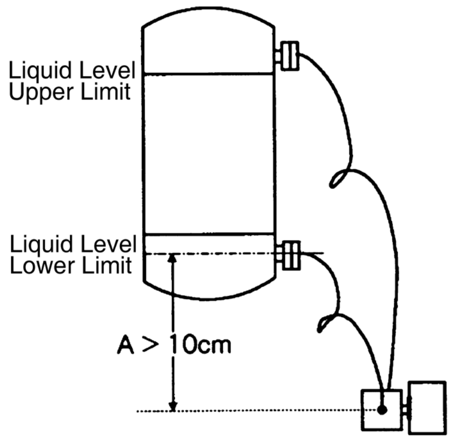


Figure 2-3. Attachment Location for Sealed Tank Level Measurement
(Figure 2-3 is the differential pressure remote case)

(iv) Considering locations at which to attach to the sealed tank

When attaching the transmitter to a location that is higher than the lower flange of the sealed tank, the following conditions must be satisfied. When considering locations, assume that the tank is empty.

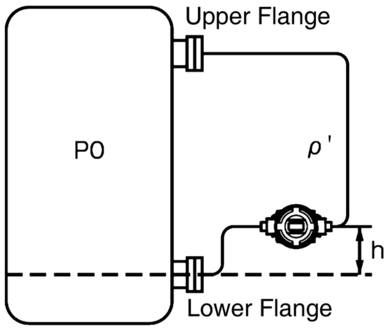


Figure 2-4. Considering Sealed Tank Attachment Locations

P0: Tank internal pressure (absolute pressure: kPa abs)
ρ': Specific gravity of sealed liquid in capillary tube section
h: Height from tank lower flange to transmitter

If the transmitter is attached as in Figure 2-4, the pressure received by the diaphragm surface of the lower flange of the transmitter body includes not only the internal pressure of the tank but also the pressure of being pulled by the water head pressure of the sealed liquid in the capillary tube section. For the pressure received by this diaphragm surface, any pressure not lower than the allowable pressure low limit P (kPa abs) of the transmitter body is acceptable, but particular care must be exercised in applications in which the internal pressure of the tank is at the vacuum level.
The attachment conditions are as follows.

$$P0 + \left(\frac{-\rho' h}{102}\right) \geq P$$

$$h \leq \frac{(P0 - P) \times 102}{\rho'}$$

1 kPa = 102 mm H_2O

Table 2-1. Allowable Pressure Low Limit Example

	Sealed Liquid Specific Gravity ρ'	**Allowable Pressure Low Limit P (kPa abs)**	**Contact Liquid Temperature Range °C**
General-purpose	0.935	2	-40 to +40
For high-temperature	1.07	2	-5 to +90
For high-temperature vacuum	1.07	0.133	-5 to +100
For high-temperature high-vacuum	1.09	0.133	10 to +250
For oxygen, for chlorine	1.87	53	-5 to +40

Precautions for allowable pressure low limit

- If the contact liquid temperature range in Table 2-1 is exceeded, the allowable pressure low limit will change as well, so refer to the specifications and calculate the value.
- If the contact liquid ambient temperature range with which the allowable pressure low limit was calculated is narrower than the ambient temperature range during normal operation, take steps to ensure that the ambient temperature range of the installation area falls within this contact liquid ambient temperature range.

(v) Calculation example: case in which general-purpose sealed liquid, remote seal type transmitter JTE is used in a vacuum application

Liquid Temperature:	25 °C
Allowable pressure low limit (P):	2 kPa abs. (15 mm Hg abs.)
Sealed Liquid Specific Gravity (ρ'):	0.935
Tank internal pressure (P0):	3 kPa abs. (low limit)

In order to satisfy the transmitter specifications, substituting into

$$h \leq \frac{(P0 - P) \times 102}{\rho'} \quad \text{yields}$$

$$h \leq \frac{(3 - 2) \times 102}{0.935} = 109 \text{ mm}$$

Accordingly, the transmitter can be attached at a location up to 109 mm above the tank lower flange.

Precaution regarding negative pressure: If the above conditions are not satisfied, the diaphragm surface will be pulled by negative pressure exceeding the usage range, resulting in the sealed liquid reaching saturation vapor pressure and causing bubbles to form. If the negative pressure becomes even greater, the diaphragm may undergo buckling and become damaged. Recognizing that it may not necessarily be clear to customers what values to use in installation location calculations, we recommend that the transmitter body be installed at least 100 mm lower than the lower flange.

2-2-4 Connecting the Wetted Part of a Flange Type or Remote Seal Type to the Process

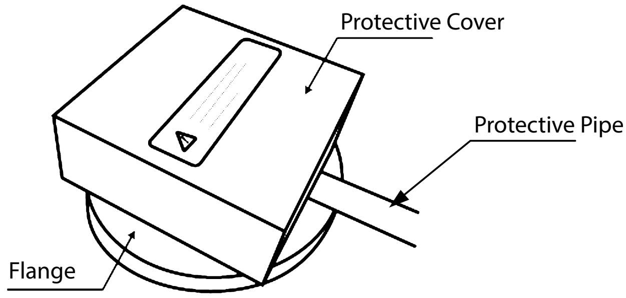
⚠Warning

When installing the product, make sure that the gaskets do not stick out at the connections with the process (connections between adapter flanges and connecting pipes and flanges). Also be careful not to forget to close vent and drain plugs. There is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution

During transport, grasp the flanges and the protective pipes. Grasping the capillary tubes, letting the flanges hang down, etc., may result in the capillary tubes slipping out of your hands and the flanges falling, possibly causing injury.

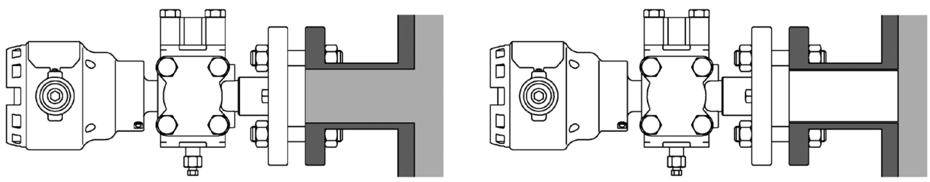
A cover is attached to the diaphragm to protect the surface that connects to the wetted part. Remove it when attaching to the process. It is not a gasket.



Example: Remote Sealing

(1) Precautions When Attaching a Flange Type (JTC) Transmitter

Referring to Figure 2-5., attach the flange to the process.



(Standard Mount Type) (Protruding Type)

Figure 2-5. Attaching Flange Type Transmitter to Tank

- Have on hand the parts necessary for attachment to the process side flange (bolts, nuts, gaskets). Select these based on the diameter, pressure rating, usage temperature, etc.
- To prevent leaks, tighten the bolts equally firmly.
  In actual practice, to tighten bolts with an appropriate torque, various factors should be taken into account, such as the bolts' material, the type and dimensions of the gasket, the type and pressure of measured fluid, and the shape of the companion flange. Approximate tightening torques are shown below.

(2) Precautions When Attaching the Pressure-Receiving Portion of a Remote Seal Type (JTE/JTH/JTS) Transmitter

- For the JTE model, in order to lessen the effects of temperature differences in the surroundings, bundle together the high pressure side and low pressure side capillary tubes. In addition, fasten the capillary tubes so that they do not move around due to wind, vibration, etc. Tie up and fasten excess capillary tubes. When doing so, be careful not to bend the tubes excessively beyond their bend radius.
- For JTH and JTS models, fasten the flange and capillary tubes securely in a location where ambient temperature variation is low and there is no vibration.
- Attach the process side flange using mounting bolts and gaskets. To prevent leaks, tighten the bolts equally firmly. See page 2-6 for tightening torque reference values.
- Prepare a flange gasket which is appropriate for the process flange side. When using semi-metallic or rubber gaskets, select ones which are shaped so as to not come into contact with the diaphragm of the transmitter.
- Attach the FEP protective film as per section 2-2-5.

* Precautions when selecting 3B flush mount type gaskets
As shown in Figure 2-6, the diaphragm diameter is 95 mm, so if a commercially available 3B gasket is used, it will come into contact with the diaphragm and may cause malfunctions. Select appropriate materials based on the fluid, the working pressure, the temperature, etc., and also be careful of the inside diameter.

- Be careful of the inside diameter of the gasket to be used. The commercial 3B gasket inside diameter (80-90 mm) is smaller than that of the diaphragm.

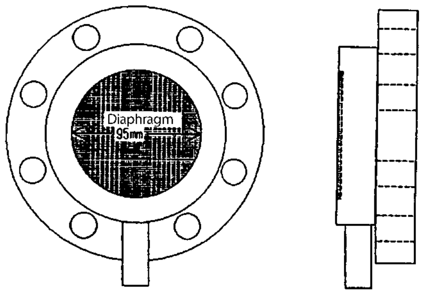


Figure 2-6.   3B Flash Mount Type Diaphragm Diameter

Outer dimension   : 134 mm
Inside diameter   : 98 mm $^{+2}_{-0}$ Thickness: 2 mm

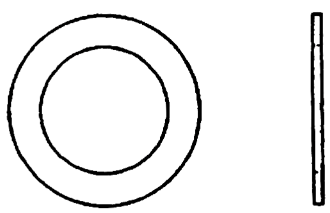


Figure 2-7.   Gasket Selection Example (Dimensions)

- When a gasket wears out, select a new one that does not come into contact with the diaphragm. If the gasket is made of soft material, it may become deformed when it is fastened. In addition, the gasket can droop, become warped, etc., so attach the gasket such that its center lines up with the center of the diaphragm.

(3) Precautions When Handling Capillary Tubes

- When handling capillary tubes, be careful not to twist them.
- When unwinding a capillary tube, hold the flange portion and turn the tube such that it reverts to a big loop.
- Attach the capillary tube in such a way that it extends downward as much as possible.
- Do not turn the tube in such a way that it becomes twisted near the base.
- Secure the middle of the capillary tube to prevent vibration.

(4) Precautions When Attaching the Flange During Sealed Tank Level Measurement by a JTE Model Transmitter

- The setting range when attaching a transmitter high pressure (HP) flange to the upper portion of the tank is different from that when attaching one to the lower portion of the tank. (See section 3-10-2.)
- When attaching a transmitter high pressure (HP) flange to the lower portion of the tank, put a minus sign on the height value when setting the sealed liquid compensation function. (See section 3-10-2.)
- For the JTE930S model, be sure to attach the transmitter high pressure (HP) side to the upper portion of the tank.

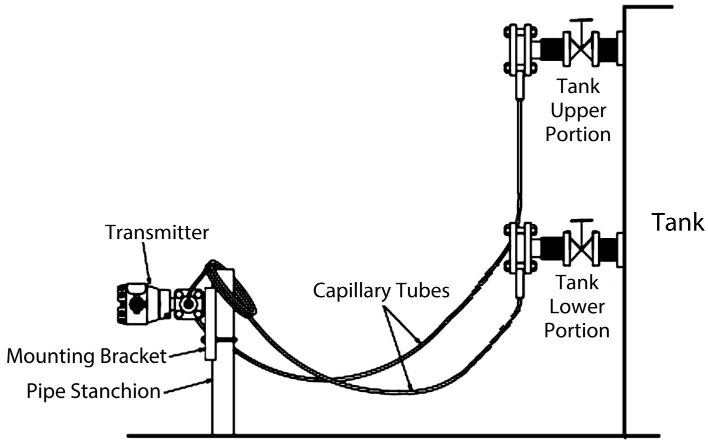


Figure 2-8. Attachment to Sealed Tank (JTE Model)

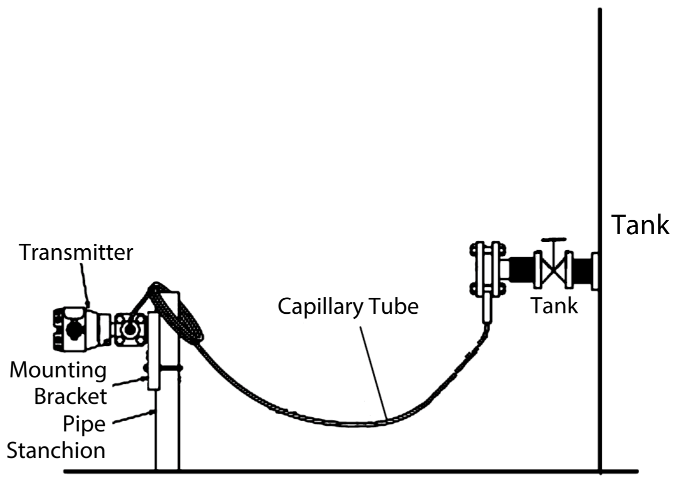


Figure 2-9. Attachment to Open Tank (JTH/JTS Model)

2-2-5 Precautions When Attaching FEP Protective Film

* The FEP protective film is optional. If this option is selected, a "Teflon Protective Film Attachment Manual" will be included, so refer to that document as well.

- Be careful not to tighten the FEP protective film excessively, as the film may become damaged.
- If the zero point shifts significantly when the pressure-receiving part is attached to the process side flange, it is conceivable that there is too much grease or that the gasket is misaligned, so check the attachment conditions for problems.

(1) 3B Flanges

When attaching the pressure-receiving part to the process side flange, follow the steps below immediately beforehand.

(1) Hold the diaphragm surface of the pressure-receiving part of the transmitter such that it faces upward.

(2) Apply about 15g of Daiflon grease (about one-third of a tube) to the diaphragm surface, and spread it across the entire surface with your finger. The average thickness of the grease on the diaphragm will be about 2mm.

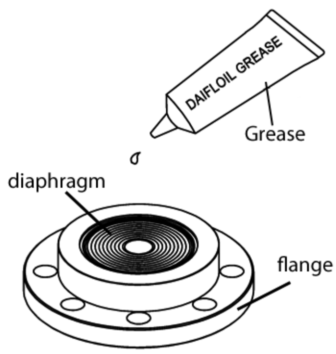


Figure 2-10. Application of Grease

Also be careful of the following during attachment.

- When applying the grease, do not apply excessive force that might deform the diaphragm.
- Make sure that no air (bubbles) are left in the grease.

(3) Fit the FEP protective film onto the diaphragm gasket surface.

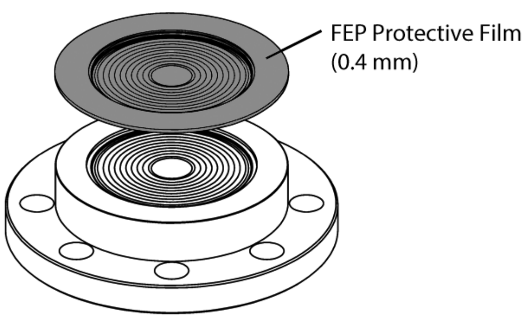


Figure 2-11. Attachment of FEP Protective Film

(4) Press the film outward from the center of the diaphragm such that the grease sticks out from the periphery. Press slowly so no air remains between the diaphragm and the FEP protective film. Press the grease out until there is almost none left on the surfaces around the gasket. After pressing out 5-7 g of grease, the thickness of the grease on the diaphragm surface will be about 0.5 mm. When doing this, be careful not to apply excessive force that would cause deformation.

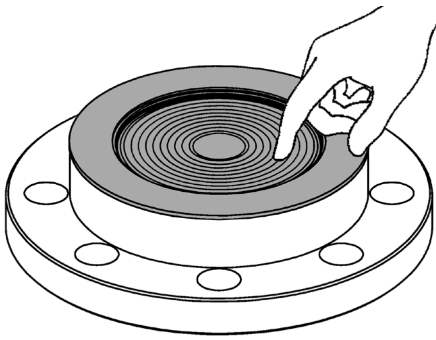


Figure 2-12. Removal of Excess Grease

(5) Place the gasket against the flange of the pressure-receiving part, and attach it to the process flange. For information regarding the tightening torque for the bolts and nuts, see Table 2-2.

(6) If work is impeded due to zero point fluctuation, use a communicator or the like to acquire data from before and after fastening the flange, and check that the fluctuation is on the order of ±0.1 kPa. If the fluctuation width is large, detach the pressure-receiving part from the process, and check how the FEP protective film is attached to confirm that there are no abnormalities.

(2) 1-1/2B, 2B Flanges

When attaching the pressure-receiving part to the process side flange, follow the steps below immediately beforehand.

(1) Hold the diaphragm surface of the pressure-receiving part of the transmitter such that it faces upward.

(2) Apply about 10 g of Daiflon grease (about one-fourth of a tube) to the diaphragm surface and the surfaces around the flange gasket, and spread it evenly on the gasket surface with your finger so that it reaches a thickness of about 0.5 mm (Figure 2-13).
Also be careful of the following during attachment.

- When applying the grease, do not apply excessive force that might deform the diaphragm.
- Make sure that no air (bubbles) are left in the grease.

(3) Fit the FEP protective film onto the diaphragm surface. When doing this, lift one side and fit the film gently from the opposite side so that no air remains. (See Figure 2-14.)
Also be careful of the following during attachment.

- Make the FEP protective film fit closely onto the metallic diaphragm.
- Make sure that the wave portion of the FEP protective film does not bulge out.

(4) After attachment, confirm that no air remains between the diaphragm and the FEP protective film. If air remains, it may affect measurements. In this case, press the air out with your finger outward from the center of the diaphragm (Figure 2-15).

(5) Place the gasket against the flange of the pressure-receiving part, and attach it to the process flange. The tightening torque for the bolts and nuts is shown in Table 2-2. During bolt tightening, apply an equal amount of tightening torque to each bolt.

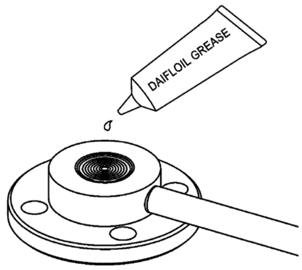


Figure 2-13. Grease Application

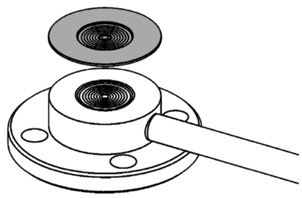


Figure 2-14. FEP Protective Film Attachment

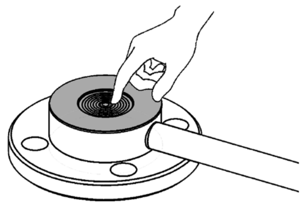


Figure 2-15. Excess Grease Removal

Table 2-2. Tightening Torque (Reference Values)

Flange Rating	**Tightening Torque (N·m)**
JIS10k 40A	20
JIS10k 50A	30
JIS10k 80A	45
ANSI/JPI 3B	45
ANSI/JPI 150# 2B	28
ANSI/JPI 150# 1-1/2B	20

2-2-6 Fit-Tank Attachment (JTE Model)

Fit-Tank is a mounting kit (adapters, tube clamps) for remote seal type transmitters. It enables tank level instrumentation to be carried out easily. Using Fit-Tank alleviates the need to attach the transmitter body to a stanchion. In addition, Azbil's proprietary sealed liquid temperature compensation feature and capillary tubes, which are included standard with the remote seal type transmitter, can be wired in a methodical manner, and satisfactory temperature characteristics can be attained.

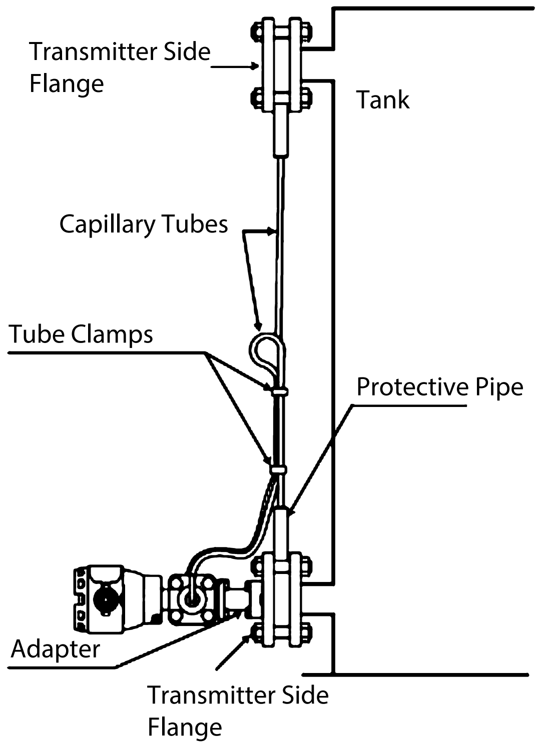


Figure 2-16. Fit-Tank Installation Example

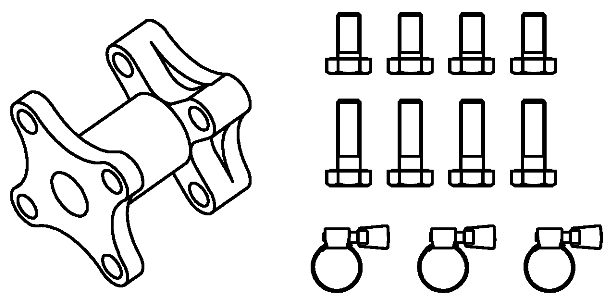


Figure 2-17. Fit-Tank Attachment Kit

(1) Compatible Models

JTE929S general-purpose sealed liquid
Cannot be combined with high-temperature model, high-temperature vacuum model, or high-temperature high-vacuum model.

(2) Attachment Overview

(i) Attachment dimensions

Figure 2-18 shows the adapter assembly attached to the process side, and Figure 2-19 shows the appearance and length of the adapter in the attachment kit.

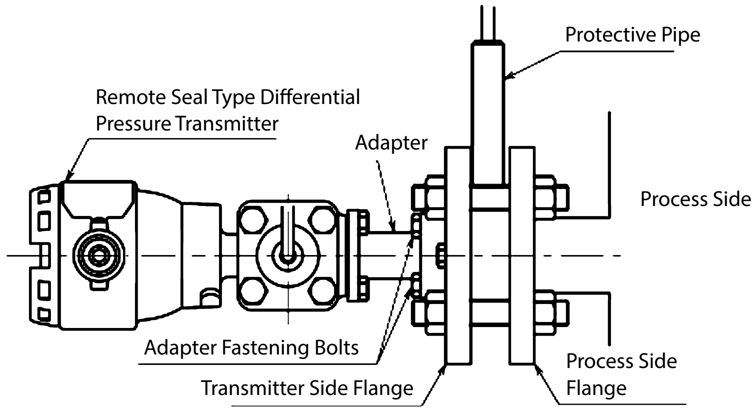


Figure 2-18.   Adapter Assembly

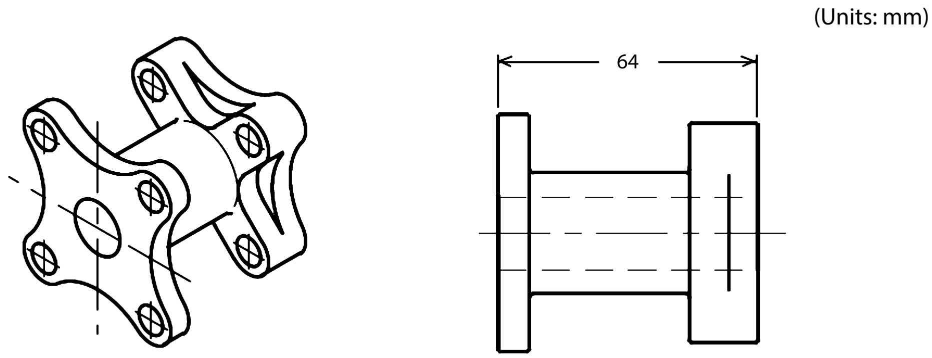


Figure 2-19.   Adapter Appearance

(ii) Attachment location

Refer to the important notes regarding general-purpose installation conditions in section 2-1-1.

(iii) Attachment method

(1) Check that the adapter is attached to the transmitter.
    Confirm that the adapter is firmly attached to the transmitter with four bolts.

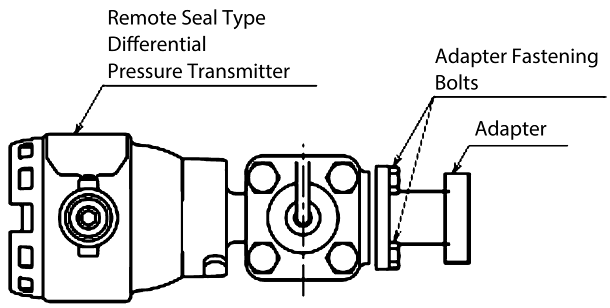


Figure 2-20.   Adapter Attachment

(2) Attachment of the transmitter side flange only to the process side flange
First, attach the desired transmitter side flange to the process side flange. For information regarding flange attachment, see section 2-2-4. The transmitter can be attached to either the high pressure or low pressure flange.

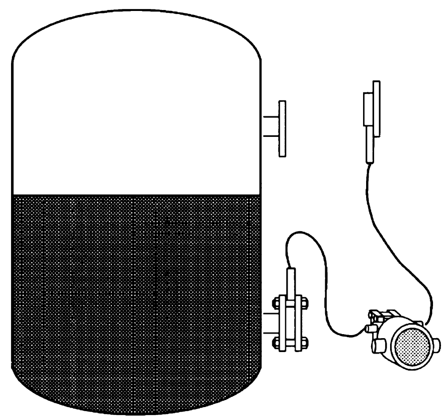


Figure 2-21. Process Side Flange Attachment 1

(3) Attachment transmitter-adapter assembly to the flange
Using four fastening bolts, securely fasten the transmitter, which was attached to the adapter in (1), to the transmitter side flange which was attached in (2).

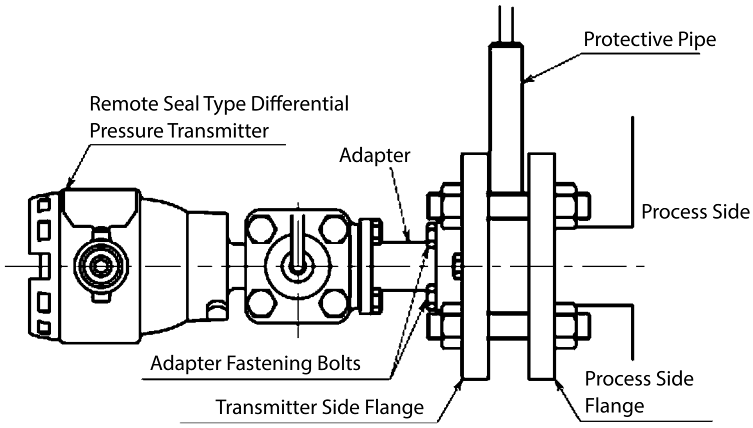
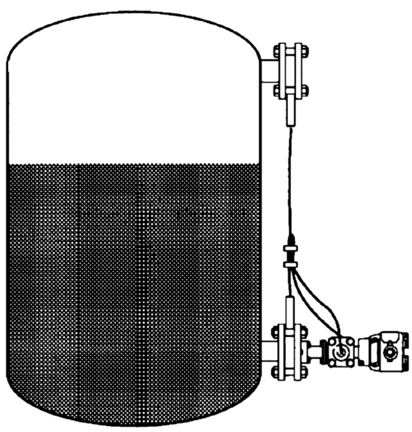


Figure 2-22. Attachment to the Transmitter Side Flange

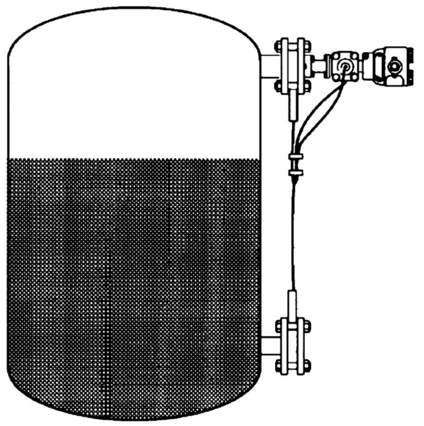
⚠ Caution

❗	If a capillary tube, bent back as shown in Figure 2-24, is placed higher than the lower flange of the process, the tank internal pressure must be at least as high as the atmospheric pressure. Accordingly, if the tank internal pressure becomes lower than the atmospheric pressure, the bent-back capillary tube must be lower than the lower flange of the process.
❗	If the capillaries extend upward relative to the horizontal plane, be sure to use capillary tubes with an olefin coating. If the capillary tubes do not have an olefin coating, there is a risk that rainwater will accumulate inside the protective pipe of the extended portion of the capillaries, causing corrosion.

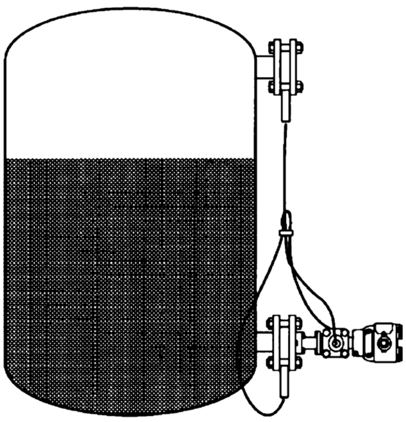
(3) Attachment Examples for Different Process Conditions



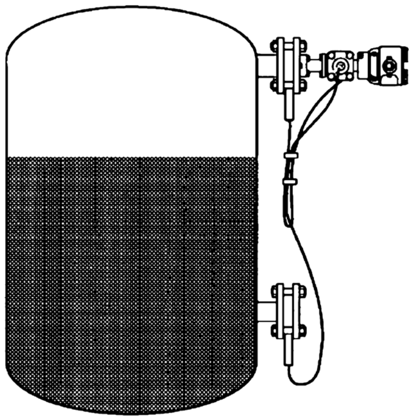
Tank Internal Pressure: Atmospheric Pressure,
Tank Lower Portion Attachment
With Capillary Tube Olefin Coating



Tank Internal Pressure: Atmospheric Pressure,
Tank Upper Portion Attachment
With Capillary Tube Olefin Coating



Tank Internal Pressure: Atmospheric Pressure,
Tank Lower Portion Attachment
With Capillary Tube Olefin Coating



Tank Internal Pressure: Atmospheric Pressure,
Tank Upper Portion Attachment
With Capillary Tube Olefin Coating

Figure 2-23. Attachment Example (1)

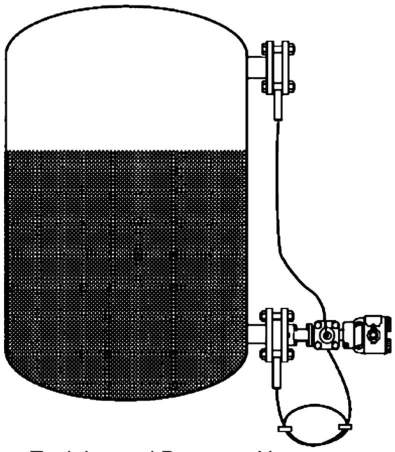


Figure 2-24. Attachment Example (2)

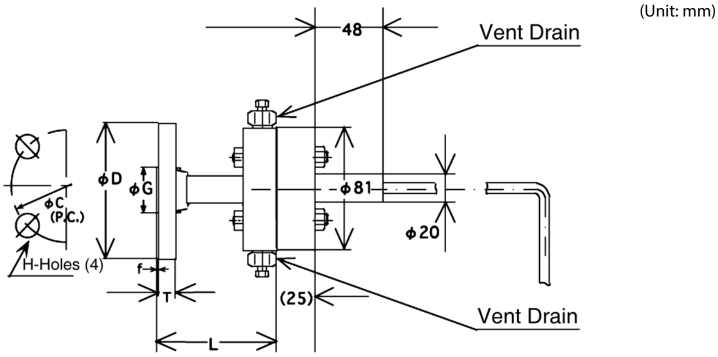
* For attachment to a sealed tank, see section 2-2-3(2) "(iv) Considering locations at which to attach to the sealed tank"

2-2-7 1/2B Remote Attachment (JTE/JTH Model)

(1) Attachment Overview

(i) Attachment dimensions

Figure 2-25 shows an assembly dimensions diagram.



Flange Rating	ϕ D	ϕ G	T	f	ϕ C	ϕ H	L
JIS 10K-15A	95	51	12	1	70	15	84
JIS 20K-15A	95	51	14	1	70	15	84
JIS 30K-15A	115	55	18	1	80	19	79
ANSI150-1/2B	89	35.1	11.5	1.6	60.5	16	86
ANSI300-1/2B	95	35.1	14.5	1.6	66.5	16	92
JPI150-1/2B	89	35.1	11.5	1.6	60.5	16	86
JPI300-1/2B	95	35.1	14.5	1.6	66.5	16	92
JIS 10K-20A	100	56	14	1	75	15	90
JIS 20K-20A	100	56	16	1	75	15	90
JIS 30K-20A	120	60	18	1	85	19	84
ANSI150-3/4B	99	42.9	13	1.6	69.8	16	90
ANSI300-3/4B	117	42.9	16	1.6	82.6	19	99
JPI150-3/4B	99	42.9	13	1.6	69.8	16	90
JPI300-3/4B	117	42.9	16	1.6	82.6	19	99

Figure 2-25. 1/2B Remote Adapter Assembly Diagram and Dimensions

(ii) Attachment method

(1) 1/2B remote adapter attachment check

Confirm that the pressure-receiving parts at the ends of the capillary tubes and the adapter are securely fastened together using four sets of bolts and nuts. If they are not fastened together, or if they are loose, fasten them together securely. When doing so, check the state of the anti-stick grease, and apply grease as necessary to prevent sticking. In addition, remove any foreign materials, as these may also cause sticking.

Table 2-3. Tightening Torque

Bolt/Nut Material	Bolt/Nut Tightening Torque (N·m)	
	Adapter Flange Material SCS14A/SUSF316	Adapter Flange Material PVC
SUS304	10±1	7±0.5
SUS630	20±1	-
Carbon Steel	20±1	7±0.5

(2) Attachment to process side flanges

Figure 2-26 shows an example of attachment to the tank. For information regarding flange attachment, see section 2-2-4. The minimum bending diameter of the capillary tubes should be about 5 cm. For information regarding capillary tube handling, see section 2-2-4. In addition, depending on the properties of the measured fluid, the fluid may in some cases solidify in the adapter and impede measurement. In such cases, keep the area around the adapter sufficiently warm so that the measured fluid does not solidify.

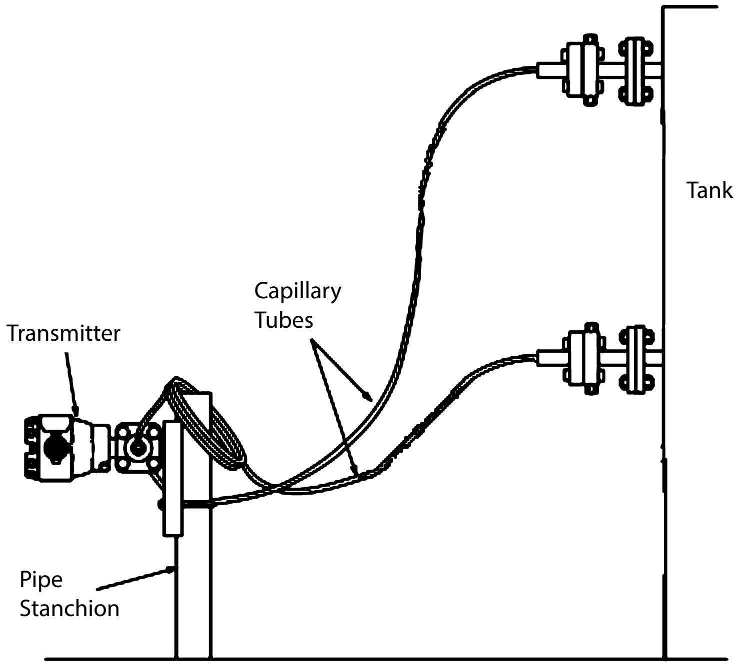


Figure 2-26.   Instrumentation example for the Tank

2-2-8 Installation of the Flushing Ring (Model DV) to a Flanged Transmitter (Models JTE, JTH, JTS, and JTC)

(1) Function and structure

This chapter describes the function and configuration of the optional flushing ring for the remote seal type and flange type transmitters. If you are a first-time user of the flushing ring, read this section to understand the basics.

(i) Function of the flushing ring

By sandwiching the flushing ring between the flanged connection type transmitter and the mating process flange, the vent/drain valve can be accessed without removing the process flange during adjustment and maintenance..

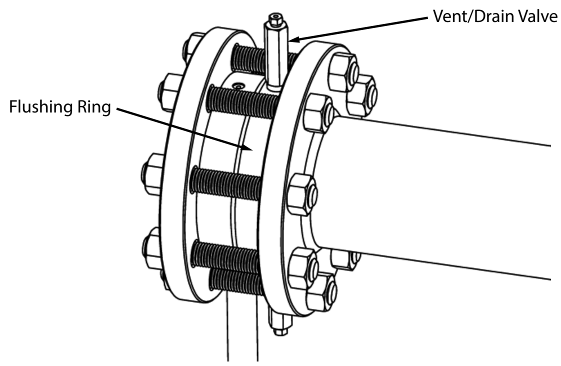


Figure 2-27. Example of Typical Flushing Ring

(ii) Name and composition of each part

The flushing ring consists of a ring, a vent/drain plug, and a vent/drain bushing. Figure 2-28 shows the structure and name of each part.

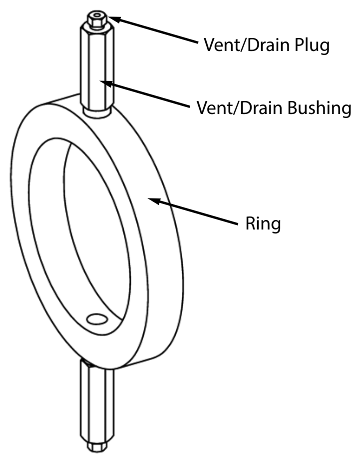


Figure 2-28. Flushing Ring Components

- Ring
  Used by sandwiching it between the diaphragm base of the transmitter and the mating process flange.
- Vent/drain plug, vent/drain bushing
  Used when removing drain or venting pressure. (See Figure 2-28 for details)

(2) Installing Instructions

This section explains the installation of the flushing ring, piping method and other important matters. In order to properly use the flushing ring, install it according to the conditions described below.

(i) Installation site selection

Choose the location of the flushing ring according to the following conditions.

- If there is a possibility of the process fluid to freeze, take heat insulation measures.
- Select a location with the least impact and vibration.
- Avoid installing in a corrosive atmosphere.

(ii) Installation dimensions

Refer to the dimensional drawing in the specification sheet or approval drawing for the dimensions of the flushing ring.

(iii) Installation procedure

⚠Warning	
⃠	Do not use this device for fluids such as toxic gas that may result in harmful physical risks due to minute leaks.
❗	During installation, make sure that the gasket does not stick out at the connection with the process. There is a risk that the process fluid will leak out and may result in burns or other injuries.
❗	Close the vent/drain plug during operation. There is a risk that the process fluid will leak out and may result in burns or other injuries.
❗	If the process fluid contains toxic substances, take safety measures such as wearing goggles and masks to prevent contact with the skin and eyes and to prevent inhalation.

⚠Caution	
❗	Use both hands to when carrying this instrument. If dropped, it may cause injuries or may damage the instrument.
❗	The protection cover for the sealing surface is not a gasket. Failing to remove it before installing may result in leakage of the process fluid.

Install the transmitter and flushing ring according to Figure 2-29.

- Be sure to install the flushing ring so that the vent/drain plugs are in a vertical position.
- Prepare the correct size parts (threaded rods, nuts, gaskets) according to the process flange. Consider the port diameter, pressure rating, operating temperature, etc. when selecting.
- Tighten the nuts evenly and firmly to prevent leakage.

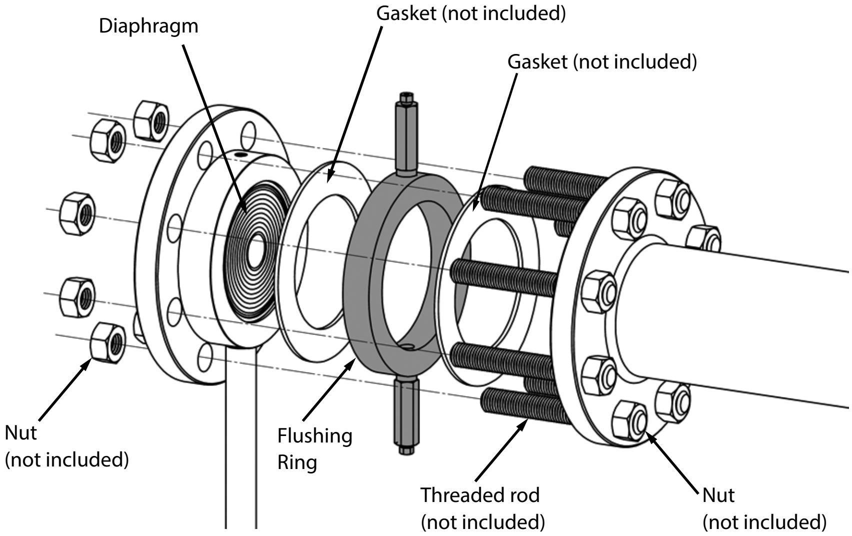


Figure 2-29. Example of flushing ring installation

(3) Precautions When Using the Vent/Drain Plug

The vent/drain valve consists of the vent/drain plug and vent/drain bushing. Here are some precautions when using this valve.

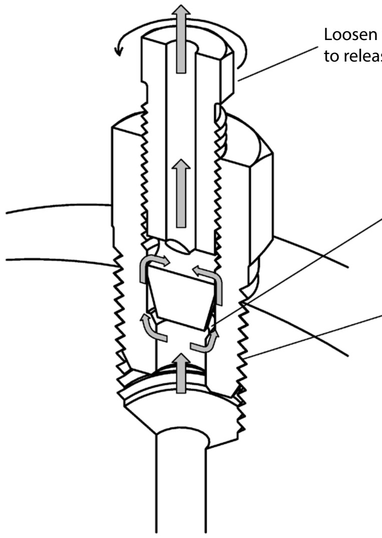


Figure 2-30. Detailed view of vent/drain plug and vent/drain bushing

⚠Caution
When loosening the vent plug, be aware of the direction in which the process fluid will be released. Do not look in and put your head close.
After removing the internal pressure, be sure to re-tighten the vent/drain plug. Forgetting to do so will result in process fluid leakage.
Regularly check the vent/drain plug and vent/drain bushing for leaks.

2-3 Piping

2-3-1 Flow Rate Measurement Piping (JTD Model)

⚠Warning

When doing the piping work, ensure that the connections between the connecting pipe parts and the transmitter and three-way manifold valve are able to maintain a reliable seal. If sealing is inadequate, there is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

(1) Piping

(i) Introduction

The piping method differs depending on the device installation location and the method of attaching to the pipeline. A method in which a three-way manifold valve (and an extension pipe, if necessary) is connected will now be described as a general piping method.
For the JTD model, there are high pressure side and low pressure side pipe connections, so be careful not to reverse them.
The three-way manifold valve and extension pipes are sold separately.

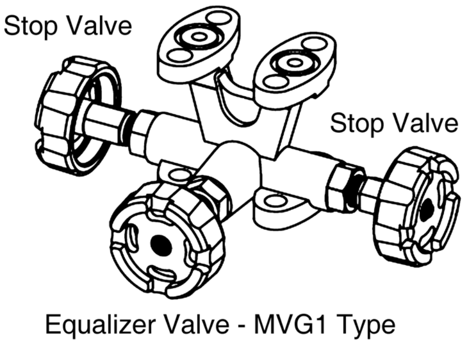


Figure 2-31. Three-Way Manifold Valve

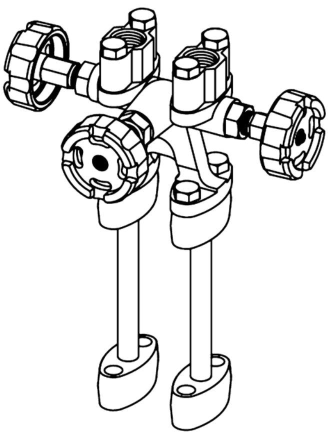


Figure 2-32. Extension Pipes

(ii) High pressure side display on this device

An "H" is displayed on the high pressure side of the main unit of this device to indicate high pressure, so be sure to check this during piping in order to avoid mistakes. The side without a mark is the low pressure side.

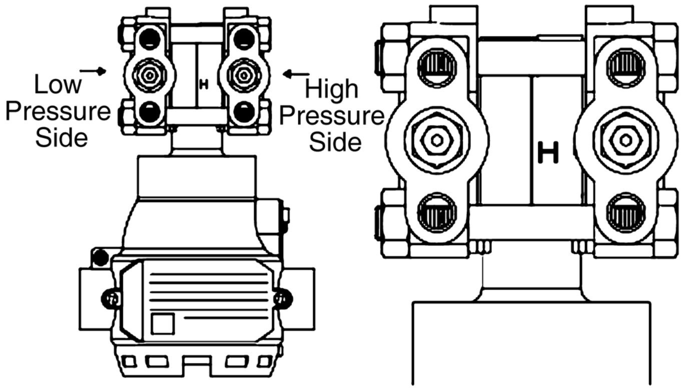


Figure 2-33.   Mark on High Pressure Side of Main Unit

(iii) Selection of pipes to use

For connecting pipes from the process, select pipe schedule numbers and nominal thicknesses in accordance with process side selection criteria (conditions such as process pressure). Diameter 1/2B, schedule number 80 steel pipes are one example of connecting pipes which are commonly used.

(iv) Required parts example

When doing the piping work, refer to the piping example diagram, and have the following parts ready. Select the rating, material, etc., of each part based on process side selection standards.

- Three-Way Manifold Valve
- Pipes
- Master Valves
- Unions or Flanges
- T-Joints
- Drain Valves
- Gas Vent Plugs
- Condenser (only for connecting valves for vapor flow rate measurement)

(v) Adapter flange

When doing the piping work, follow the table below for tightening torque when using an adapter flange. Note that the bolts that fasten the adapter flange are loose when shipped.

Table 2-4. Adapter Flange Tightening Torque

Material / Bolt Size	Tightening Torque (N·m)
Carbon Steel	20±2
SUS304/316	10±1

(2) Liquid or Gas Flow Rate Measurement Piping

(i) Example of recommended piping for liquid flow rate measurement

A typical piping example in which the device is lower than the differential pressure output port on the process pipe.
Be sure to implement the following items.

- Depending on the measured fluid, create an incline in the differential pressure output pipes so that drains, vents, etc., will clear.

  Meaning of incline symbol ⊿ in the diagram: Low position ⊿ High position

- Install gas vent plugs at locations where gas in connecting pipes exits.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

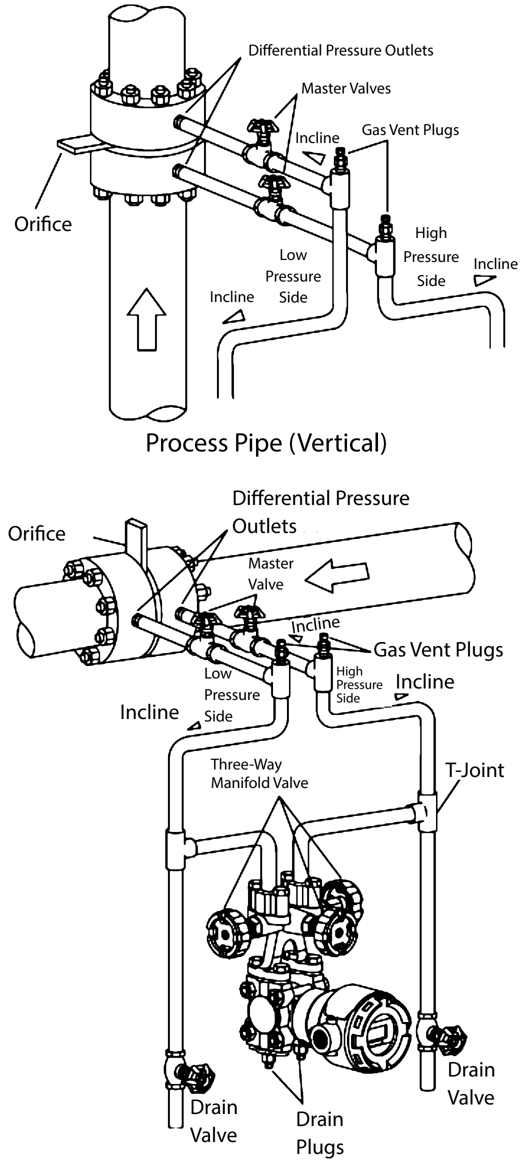


Figure 2-34. Example of Piping for Liquid Flow Rate Measurement

(ii) Recommended piping, example 2

A typical piping example in which the device is higher than the differential pressure output port of the process pipe is shown below.
Be sure to implement the following items.

- Depending on the measured fluid, create an incline of at least 1/10 in the differential pressure output pipes so that drains, vents, etc., will clear.

  Meaning of incline symbol ⊿ in the diagram: Low position ⊿ High position

- Install gas vent plugs at locations where gas in connecting pipes exits.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

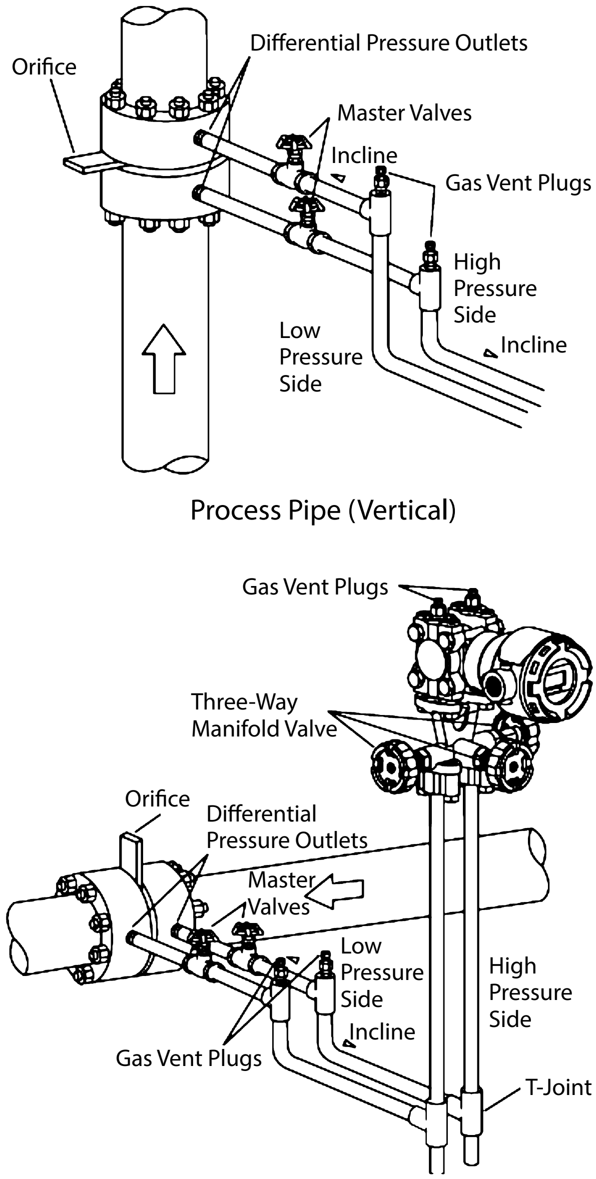


Figure 2-35.   Example of Piping for Gas Flow Rate Measurement

(3) Vapor Flow Rate Measurement Piping

(i) Recommended piping example

A typical piping example is illustrated below. With this vapor flow rate measurement piping, the device is installed lower than the differential pressure output port.
Be sure to implement the following items.

- Depending on the measured fluid, create an incline of at least 1/10 in the differential pressure output pipes so that drains will clear.

  Meaning of incline symbol ⊿ in the diagram: [Low position] ⊿ [High position]

- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.
- If the process has a vertical pipe, installing the condensers different heights as shown in the diagram prevents zero drift in the differential pressure gauge, which otherwise would occur readily. Incidentally, in this case it is not possible to perform zero adjustment using the three-way manifold valve.

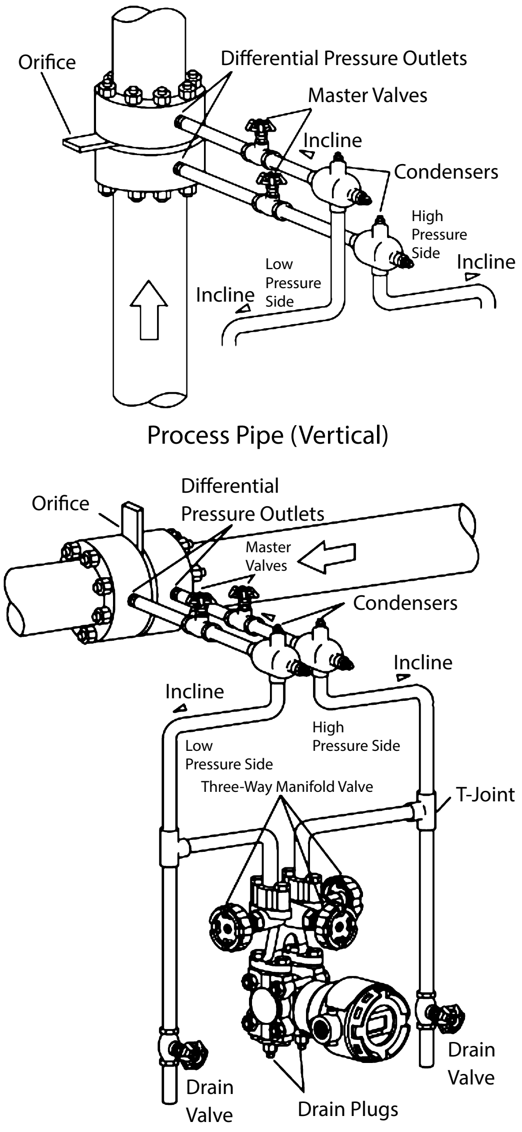


Figure 2-36. Vapor Flow Rate Measurement Piping Example

2-3-2 Pressure Measurement Piping (JTD/JTG/JTA Model)

⚠Warning

When doing the piping work, ensure that the connections between the connecting pipe parts and the transmitter and three-way manifold valve are able to maintain a reliable seal. If sealing is inadequate, there is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

(1) Piping

(i) Introduction

For the JTD model, connect the high pressure side to the process pipe, and open the low pressure side to the atmosphere. In this case, in order to prevent rainwater from entering, use a vertical downward-facing opening to the atmosphere. For the JTG and JTA models, connect the low pressure side to the process pipe.

(ii) High pressure side mark on this device

An “H” is displayed on the high pressure side of the main unit of this device to indicate high pressure, so be sure to check this during piping in order to avoid mistakes. The side without a mark is the low pressure side.

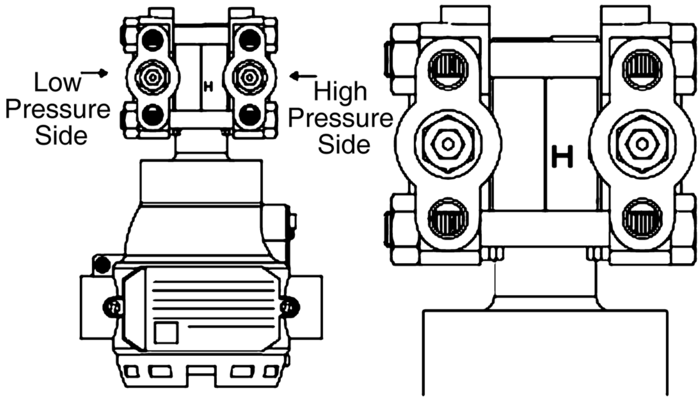


Figure 2-37.   Mark on High Pressure Side of Main Unit

(iii) Selection of pipes

For connecting pipes from the process, select pipe schedule numbers and nominal thicknesses in accordance with process side selection criteria (conditions such as process pressure). Diameter 1/2B, schedule number 80 steel pipes are one example of connecting pipes which are commonly used.

(iv) Required parts example

When doing the piping work, refer to the piping example diagrams, and have the following parts ready. Select the rating, material, etc., of each part based on process side selection standards.

- Pipes
- A master valve, and a manual master valve if necessary
- Unions or Flanges
- T-Joints
- Drain Valve
- Gas Vent Plugs

(2) Pressure Measurement Piping

(i) Recommended piping example

A typical pressure measurement piping example is illustrated below.
Be sure to implement the following items.

- Depending on the measured fluid, create an incline in the differential pressure output pipes so that drains, vents, etc., will clear.

  Meaning of incline symbol ⊿ in the diagram: Low position ⊿ High position

- Install gas vent plugs at locations where gas in connecting pipes exits.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

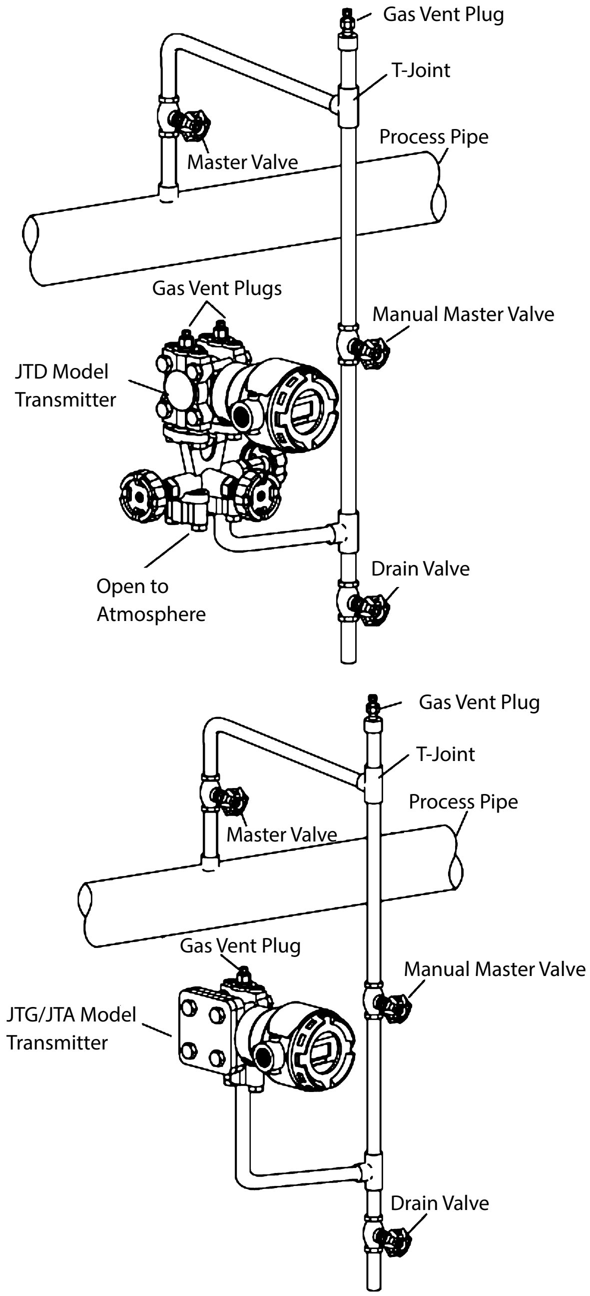


Figure 2-38.   Gas Pressure Measurement Piping

(ii) Piping method

The piping method differs depending on the state of the measured fluid, indicator location, pipeline, etc. A typical piping example is illustrated below. Run the piping as shown below.

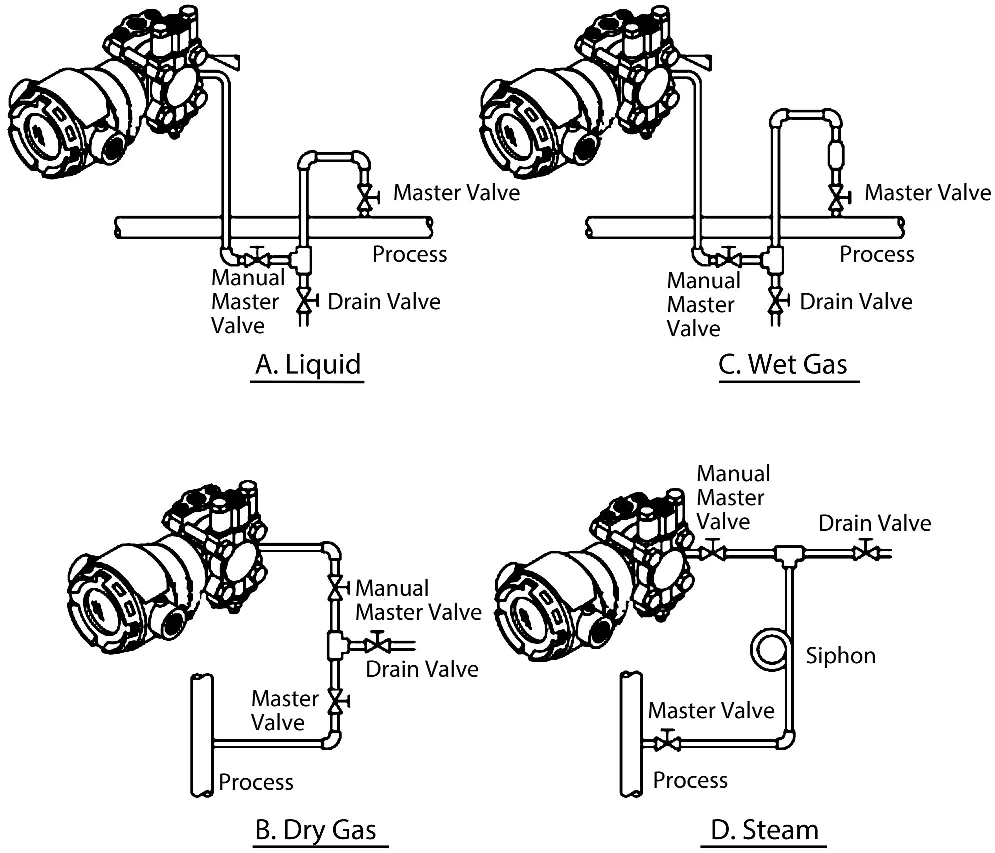


Figure 2-39. Pressure Measurement Piping Example

(iii) Auxiliary equipment

(1) Oil sealing and air purging
If it is not possible to guide the measured fluid directly to this device due to suspension, high viscosity, high temperature, corrosiveness, etc., use sealing or purging. For information regarding sealing and purging methods, please consult with the relevant personnel at our company.

(2) Throttle valves for pulsation flow prevention
If there is high-speed pulsation flow in the process fluid, or high levels of pressure fluctuation, fluctuations can be suppressed by installing a throttle or the like in the connecting pipe.

2-3-3 Liquid Level Measurement Piping (JTD/JTG Model)

⚠Warning

When doing the piping work, ensure that the connections between the connecting pipe parts and the transmitter and three-way manifold valve are able to maintain a reliable seal. If sealing is inadequate, there is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

(1) Piping

(i) Introduction

The method of measuring the liquid level in the tank using a JTD model transmitter differs depending on whether the tank is open or sealed. In addition, if the tank is sealed, the piping method also differs depending on whether the gas seal method (dry leg) or the liquid seal method (wet leg) is used. Measuring the liquid level in the tank using a JTG model transmitter is in general performed on an open tank.

(ii) High pressure side mark on this device

An "H" is displayed on the high pressure side of the main unit of this device to indicate high pressure, so be sure to check this during piping in order to avoid mistakes. The side without a mark is the low pressure side.

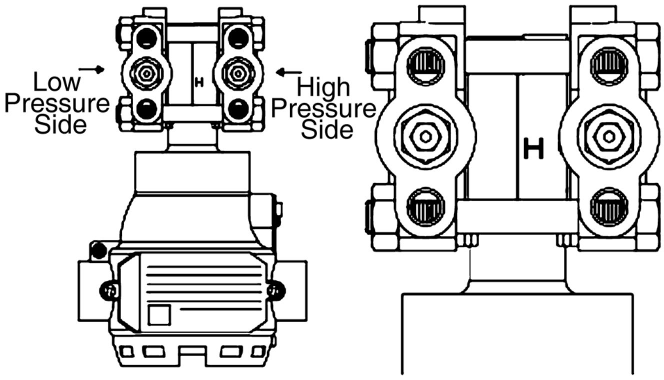


Figure 2-40. Mark on High Pressure Side of Main Unit

(iii) Caution

In the range that appears on the nameplate at the time of shipping, if the amount of suppression is more than 1/2 the span, the positions of H and L switch. In that case, H will be on the left side, and the H mark will be on the rear side. **In this case, do the process piping so as to connect the high pressure to the side without the H stamp.**

Example: When range is -50 to +20 kPa

Suppression quantity 50 kPa

Span 70 kPa

$$50 > \frac{70}{2} = 35$$ is the result,

so the amount of suppression is higher, and thus the high pressure side will be on the left side.

(iv) Selection of pipes

For connecting pipes from the process, select pipe schedule numbers and nominal thicknesses in accordance with process side selection criteria (conditions such as process pressure). Diameter 1/2B, schedule number 80 steel pipes are one example of connecting pipes which are commonly used.

(v) Required parts example

When doing the piping work, refer to the piping example diagrams, and have the following parts on hand. Select the rating, material, etc., of each part based on process side selection standards.

- Three-Way Manifold Valve
- Pipes
- Master Valve
- Unions or Flanges
- T-Joints
- Drain Valve
- Gas Vent Plugs
- Seal Pot (only for sealed tank, wet leg)

(2) Open Tank Piping

(i) Recommended piping example

A typical open tank liquid level piping example is illustrated below.
Be sure to implement the following items.

- Connect the high pressure side of the device to the lower portion of the tank, and open the low pressure side to the atmosphere.
- Install the device in a location that is lower than the minimum level of the liquid to be measured.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

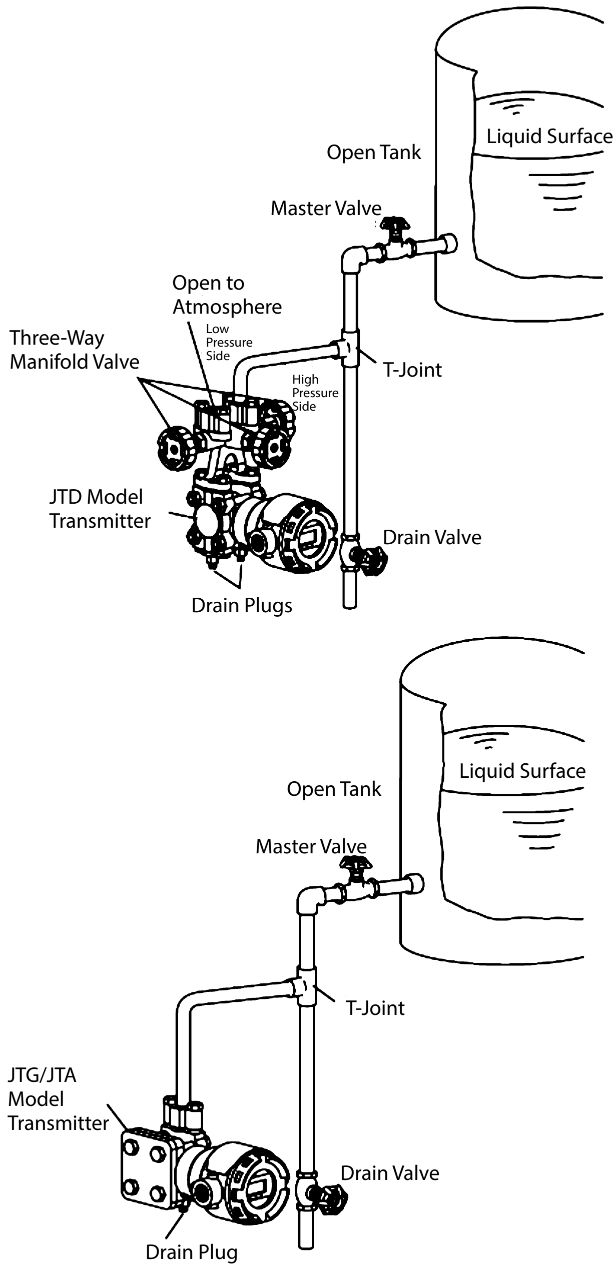


Figure 2-41. Liquid Level Measurement (Open Tank) Piping Example

(3) Sealed Tank Piping

(i) Dry leg recommended piping example

A typical sealed tank dry leg liquid level piping example is illustrated below.
Be sure to implement the following items.

- Connect the high pressure side of the device to the lower portion of the tank, and connect the low pressure side to the tank's gas seal pipe.
- Install the device in a location that is lower than the minimum level of the liquid to be measured.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

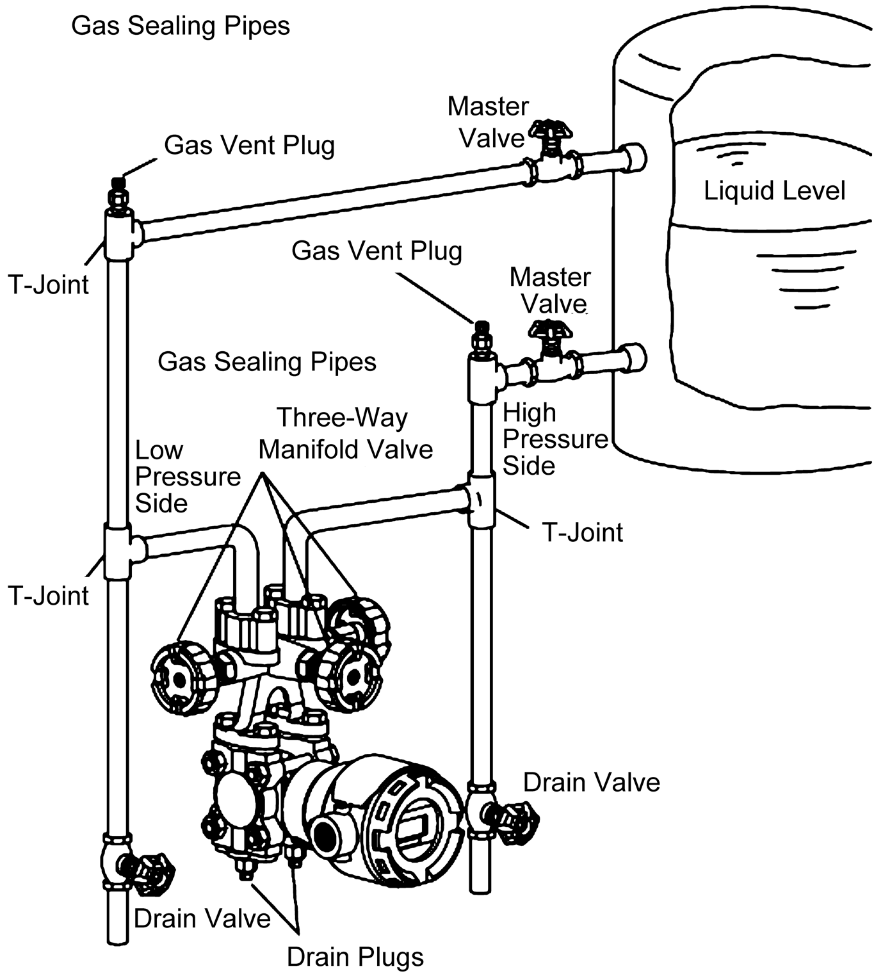


Figure 2-42. Liquid Level Measurement (Sealed Tank, Dry Leg) Piping Example

(ii) Wet leg recommended piping example

A typical sealed tank wet leg liquid level piping example is illustrated below.
Be sure to implement the following items.

- Connect the high pressure side of the device to the tank's liquid seal piping, and connect the low pressure side to the lower portion of the tank.
- Install the device in a location that is lower than the minimum level of the liquid to be measured.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the transmitter, etc.
- For the purpose of connecting pipe maintenance, use T-joints to attach drain valves.

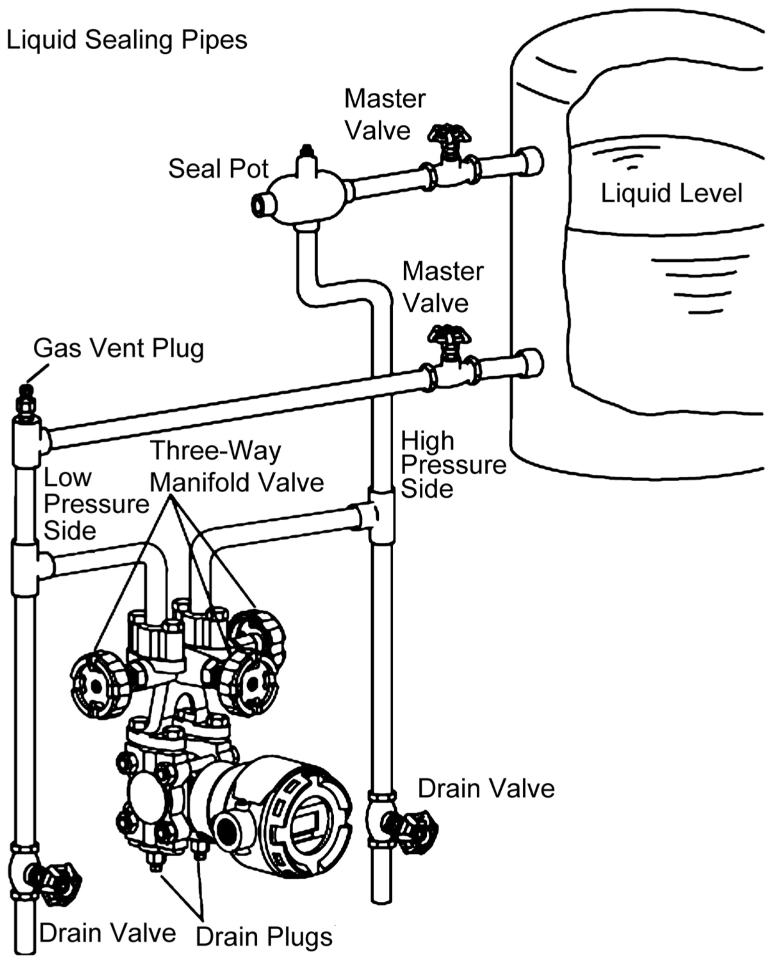


Figure 2-43.   Liquid Level Measurement (Sealed Tank, Wet Leg) Piping Example

2-3-4 Liquid Level Measurement Piping (JTC Model)

⚠Warning

When doing the piping work, ensure that the connections between the connecting pipe parts and the transmitter and three-way manifold valve are able to maintain a reliable seal. If sealing is inadequate, there is a danger that the measured fluid will leak out and cause scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

(1) Piping

(i) Introduction

The method for measuring the liquid level in the tank using a JTC model transmitter differs depending on whether the tank is open or sealed. In addition, for sealed tanks, the method will be the gas seal method (dry leg). For information on attaching this product to a process, see section 2-2-4. The piping method will now be described.

(ii) Selection of pipes

For connecting pipes from the process, select pipe schedule numbers and nominal thicknesses in accordance with process side selection criteria (conditions such as process pressure). Diameter 1/2B, schedule number 80 steel pipes are one example of connecting pipes which are commonly used.

(iii) Required parts example

When doing the piping work, refer to the piping example diagrams, and have the following parts on hand. Select the rating, material, etc., of each part based on process side selection standards.

- Pipes
- Master Valve
- Unions or Flanges
- T-Joints
- Drain Valve
- Gas Vent Plugs

(2) Open Tank Piping

(i) Recommended piping example

A typical open tank liquid level piping example is illustrated below.
Since the high pressure side is attached directly to the nozzle on the lower portion of the tank, a connecting pipe will normally not be necessary.

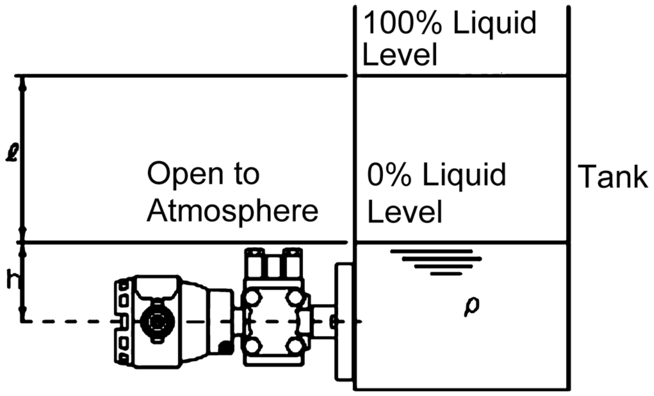


Figure 2-44. Liquid Level Measurement (Open Tank) Piping Example

(3) Sealed Tank Piping

(ii) Recommended piping example

A typical sealed tank (dry leg) liquid level piping example is illustrated below.
Be sure to implement the following items.

- Connect the high pressure side of the device to the lower portion of the tank, and connect the low pressure side to the tank's gas seal pipe.
- After doing the piping work, confirm that there are no pressure leaks in the connecting pipes, the transmitter, etc.

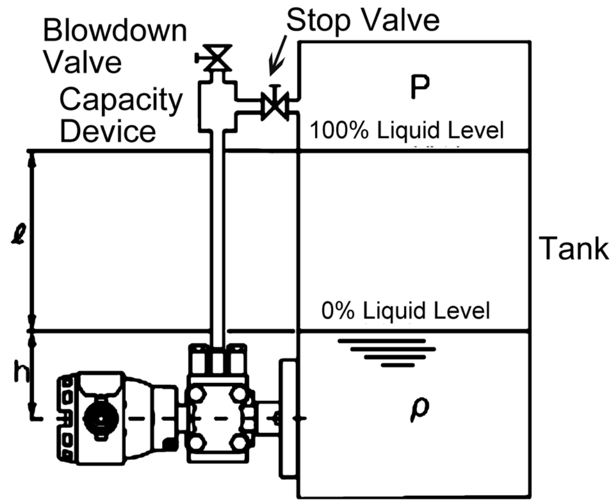


Figure 2-45. Liquid Level Measurement (Sealed Tank, Dry Leg) Piping Example

2-4 Electrical Wiring

2-4-1 General Wiring

(1) Introduction

Wiring which is not subject to explosion-proofing standards will now be described. When working with explosion-proof wiring, in addition to the description here, see section 2-4-2, "Explosion-Proof Wiring."

(2) Wiring

When wiring, refer to the following diagram.

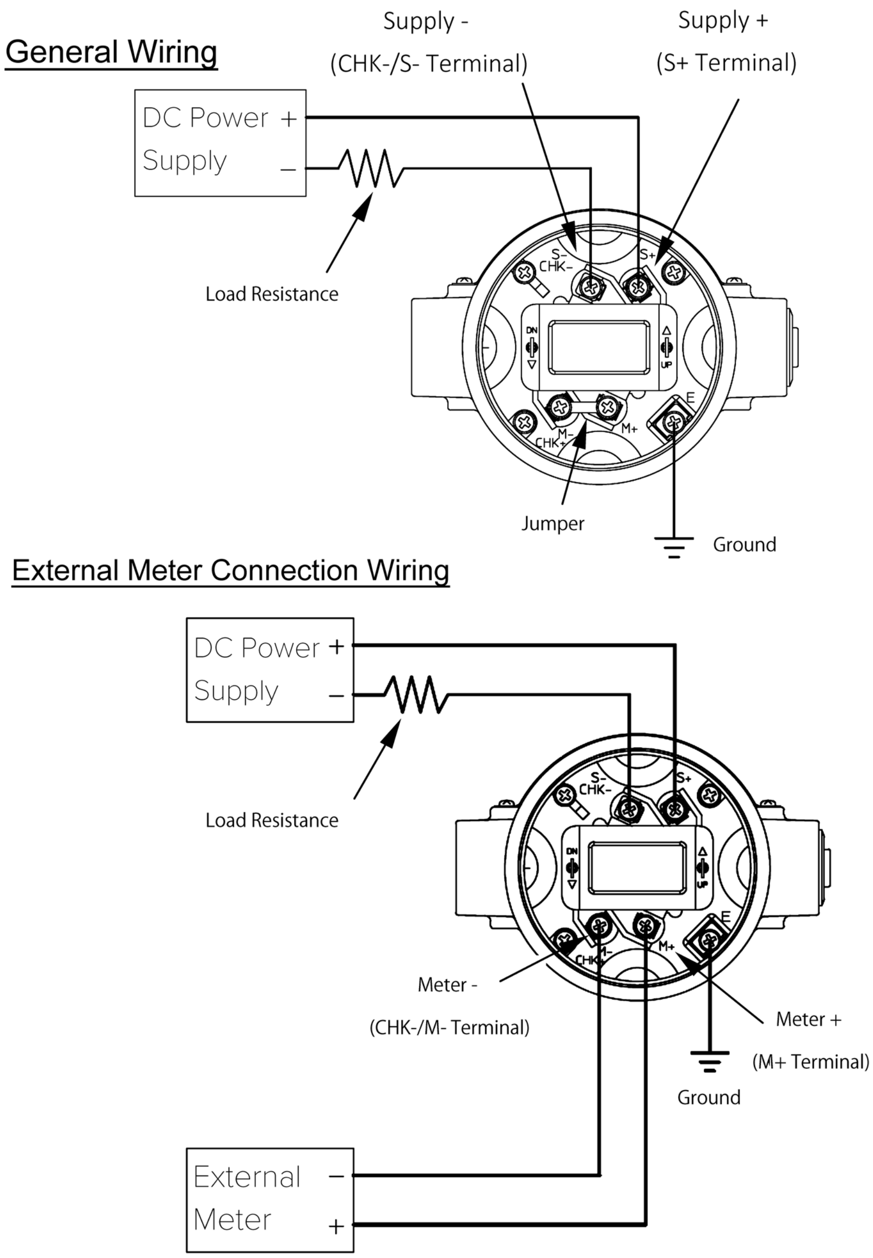


Figure 2-46. Wiring

Note: If an external indicator with a high load resistance greater than 10 ohms is used, optional accessories are necessary.

(3) Caution

For communication using SFN, HART, etc., external load resistance of at least 250 Ω is required. If the receiver side load resistance is less than 250 Ω, insert a loop with the necessary resistance. Also, when performing external meter wiring, remove the jumper.

(4) Pipes and Cable Glands for Wiring

Run the cable to the transmitter case as follows.

- Attach a conduit pipe or cable gland to conduits for electrical wiring for the device. Follow these instructions when performing wiring.
- In order to prevent rainwater from entering the device, waterproof the connectors using sealant material or the like. In addition, select cable glands that ensure waterproofing and dustproofing.
- Use elbow pipes as necessary to change the direction of the electrical wiring.

(5) Grounding

There are grounding points on the terminal block inside the device, as well as on the outside of the device. Ground the device using any of these.

- Ground terminals provide D class grounding (grounding resistance of 100 Ω or less).
- For explosion-proof models, grounding work is absolutely necessary.
- Precautions if there is welding work near the transmitter
  Ground welding machines and welding power transformers directly; do not ground them to the stanchion pipe to which the transmitter is attached. This device may be affected by welding current.
- Do not allow external grounding wires to come into direct contact with the case. Insert terminals between flat washers.

(6) Power Supply and External Load Resistance

The relationship between the power supply voltage and external load resistance used with this device must be held within the range shown in the diagram below. External load resistance is the total resistance connected to the output terminals of the device, such as resistance from cables configured into a loop, and internal resistance from instruments connected at intermediate locations.

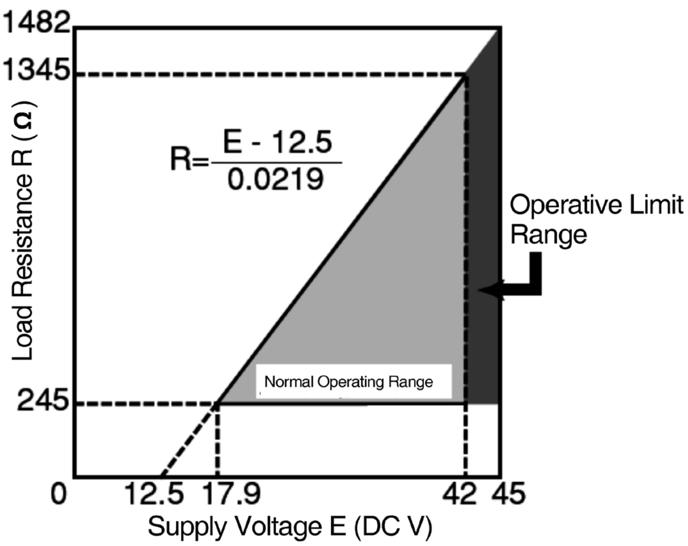
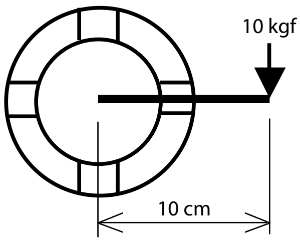


Figure 2-47. Relationship between Supply Voltage and External Load Resistance

(7) How to Open and Close the Case Cover

Take note of the following points when opening and closing the case cover:
The product is manufactured to ensure air tightness by eliminating any gap between the case cover and the transmitter case.
Case cover tightening torque reference value: 10 to 15 N· m



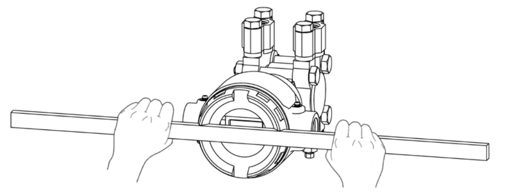
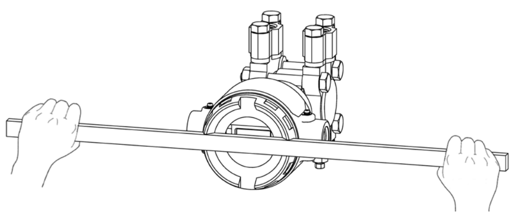
A diagram for 10 N·m pressure (≈ 100 kgf/cm)

Applying a force of 10 kgf at a location 10 cm away from the center of the case cover will result in approximately 10 N·m.

Exercise care not to apply excessive force when opening or closing the case cover.
Tightening the case cover with excessive torque may result in the following problems:

- The case cover will be difficult to open.
- Other parts of the instrument may be damaged. (For example, the joint between the transmitter case and the main unit may loosen, the aluminum transmitter case may break, etc.)
- Tightening the case cover with excessive force by hooking a tool in the grooves may cause the tool to slip, resulting in injury.
- Tightening the case cover with excessive force by hooking a tool in the grooves may cause the tool to slip, possibly scraping the coating off the case cover.

By opening or closing the case cover with a long tool (bar) placed in the grooves, a large torque can be generated by a small force. If a long tool is used, hold it close to the case cover when turning it.

	Hold the tool close to the case cover and turn it.
	Turning the tool while holding it far from the case cover will produce an excessively large torque with little force because of the extra leverage. Do not do this under any circumstances.

2-4-2 Wiring for Explosion-Proof Models

(1) Guidelines

When wiring for TIIS flameproof models, in addition to the descriptions below, see the descriptions in section "2-4-1 General Wiring" For details, see “Factory Explosion-Proof Equipment Guide for Users” and “Factory Electrical Equipment Explosion-Proofing Guidelines - Technical Guidelines conforming to International Standards 2008” by the Research Institute of Industrial Safety.

(2) Caution

Pay particular attention to the following items when performing wiring work.

- If the TIIS special explosion-proofing specifications are selected as specifications for this device, a pressure-resistant packing cable gland will be included. The certification testing was passed with this as part of the transmitter case. Accordingly, note that explosion-proofing certification will not be guaranteed if wiring is done using something other than the included cable gland.
- The case cover of the transmitter cannot be opened when in an explosive atmosphere.

(3) Locking

This product has a locking structure. Before wiring, first unlock the transmitter case cover using an M3 hexagonal wrench. After wiring, fasten the case cover sufficiently, and lock it. For explosion-proof models, locking the case cover on the transmitter case is an absolute requirement. A hexagonal wrench for locking is included.

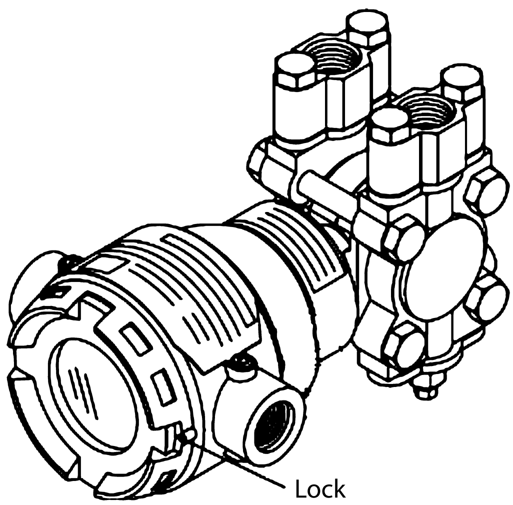


Figure 2-48.   Transmitter Case Locking

(4) External Wiring Work

When wiring this device, use either the pressure-resistant packing cable gland shown in the following diagram (optional) or the conduit fitting. Leave sufficient space for this connection. In addition, if the usage temperature of the device exceeds 50 °C, use cables for wiring that have a maximum temperature tolerance of at least 70 °C.

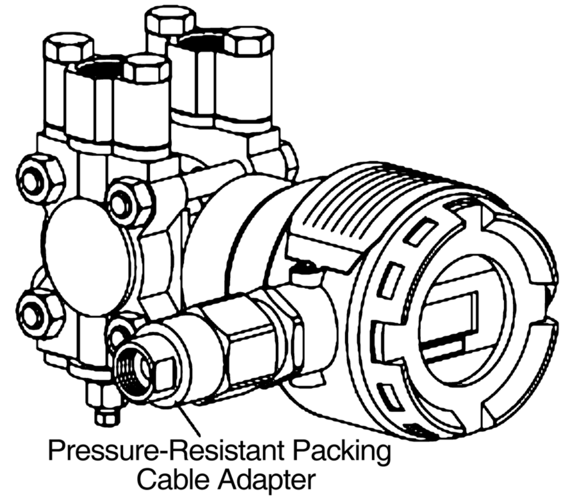


Figure 2-49. Pressure-Resistant Packing Cable Gland

2-5 Changing the Position of the Process Connection Port

2-5-1 Changing the Height of the Process Connection Port (JTD/JTG/JTA/JTC Model)

The process connection port on the main unit cover of the JTD, JTG, JTA, and JTC models will be in the position for the selected model (upper area or lower area), but its position can be changed. Changing the position of the process connection port from the lower area to the upper area will now be described.

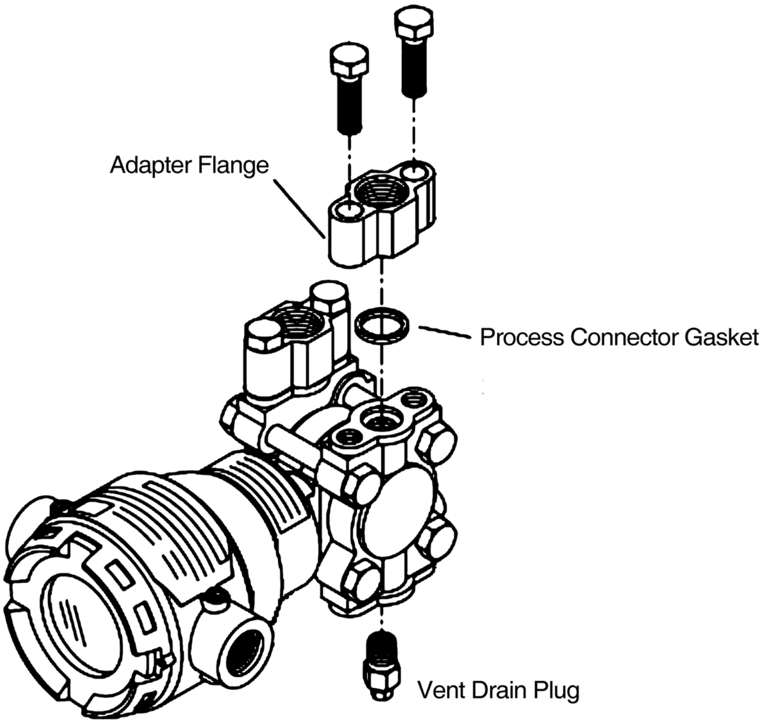


Figure 2-50.   Changing Vertical Position of Process Connection Port

◆ Procedure ◆

(1) Remove the four bolts that fasten the adapter flanges on the high pressure side and low pressure side.

(2) Remove the two vent/drain plugs on the high pressure side and low pressure side.

(3) Using the bolts, fasten the two adapter flanges to the upper portion of the device.
At this point, be sure not to forget about the process connector gasket.
Tighten the bolts in accordance with the following prescribed torques.

Prescribed torque:	SNB7/SUS630	20±1 N·m
	SUS304	10±0.5 N·m

(4) Wrap sealing tape around the threaded portion of the two vent/drain plugs, and spray them with a lubricant.

(5) Fasten the vent/drain plugs to the lower portion of the device.
Tighten the plugs in accordance with the prescribed torques.

Prescribed torque: 5±0.3 N·m

Move the process connection port from the upper area to the lower area using an analogous procedure.

Chapter 3 Starting and Stopping this Device

⚠Caution
If the transmitter uses SFN communication while the process is in the automatic control state, the output may fluctuate, and the device may enter a dangerous operating state. Before performing this operation, be sure to switch the control loop of the process to manual control.

In this chapter, the following items will be described.

- Connecting a Communicator (CommStaff, HART Communicator, etc.) to this Device
- Verifying Settings such as the Required Tag Number, the Output Format of this Device, etc., during Receiving Inspection
- Preparations before Measurement
- Starting and Stopping Measurement
- Items Necessary when Stopping this Device for Maintenance and Replacement

For information regarding communicator usage, see the operation manual for the relevant device.

Field Communication Software CommStaff User's Manual:	CM2-CFS100-2001
Field Communication Software CommStaff Instruction Manual: Advanced Transmitter (HART Version 5) Edition	CM2-CFS100-2003
Field Communication Software CommStaff Instruction Manual: Advanced Transmitter (HART Version 7) Edition	CM2-CFS100-2013
Supplement Manual for HART Communication Option: Advanced Transmitter (HART Version 5)	CM2-GTX000-2002
HART Communicator Operation Manual: Advanced Transmitter (HART Version 7)	CM2-GTX000-2003

Before connecting to this device, be sure to read the operation manual carefully.

3-1 Operation Preparations

3-1-1 Communicator Connection

The figure below shows the wiring when connecting a communicator to this device.
For SFN/DE communication using CommStaff, be sure to connect the communication cables to the terminals of this device as shown below.

Red wire: Supply + (S+) terminal
Black wire: Supply - (S-) terminal

* For communication with the communicator, external load resistance of at least 250 Ω is required. If the receiver side load resistance is less than 250 Ω, insert a loop with the necessary resistance.

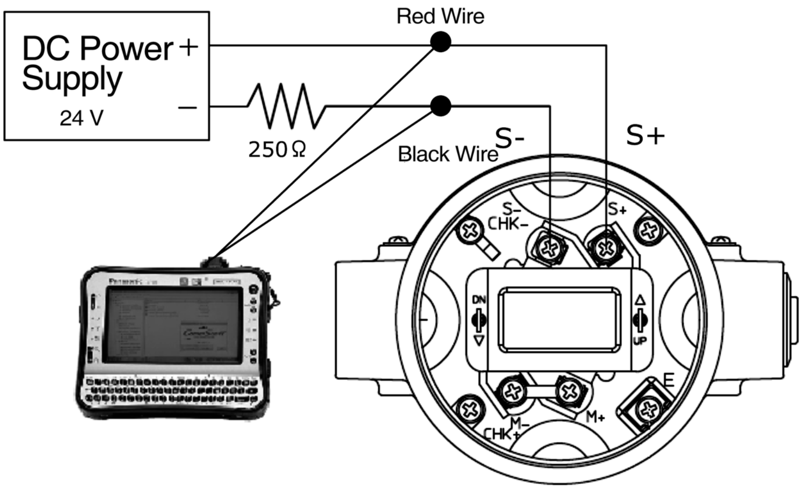


Figure 3-1. Communicator Connection

3-1-2 Settings Confirmation

Confirm that the settings required for operation are set correctly.

(1) Tag Number Setting

Confirm that it is the tag number specified in advance. When changing the tag number, confirm that the specifications for this device are compatible with the installation location.

(2) Output Format Settings

⚠Warning	
!	In order to detach the terminal block with integrated indicator devices, refer to Chapter 4 and exercise sufficient care when opening the case cover. When using the product in a hazardous area, do not open its case cover. There is a risk of explosion, etc.

⚠Caution	
!	Take sufficient care when specifying the output formats. In particular, if the fail-safe setting and the hardware write protection setting are specified incorrectly, the device can enter a dangerous operating state.
!	Take sufficient care when when changing the hardware write protection setting. Removing write protection makes it possible for the settings of this device to be changed erroneously, and as a result, for the device to enter a dangerous operating state.

- Output format
  Enables selection of “Linear / Square Root.”
- Cutoff
  Output will be cut off when the flow rate is low. Sets the threshold value for that cutoff.
- Dropout
  Selects whether to make the output zero or make it linear during output cutoff.
- Flow rate mode
  Selects whether to take the square root in the positive direction only or in both directions.
- Burnout direction
  Indicates the behavior of the output during major failures. Specified using switch S2 in Figure 3-2.

Hi (H side):	Output swings to the high limit (21.6 mA).
Low (L side):	Output swings to the low limit (3.6 mA). If optional specifications (special burnout) are selected, the low limit will be 3.2 mA.
None:	Output continues.

- Burnout On/Off
  Enables selection of burnout On/Off. Specified using switch S3 in Figure 3-2.

On (E side):	Device behaves according to burnout direction setting.
Off (D side):	Burnout direction setting is ignored, and the device continues to output measurement results.

- Output limit setting
  Except during burnout, the output current can be restricted to limit values which set the output current range.

Table 3-1. Setting Range for Output Limits

	Lower Limit Current	Upper Limit Current	B/O DOWN	B/O UP
Electricity Specification	3.6mA	21.6mA	3.2mA or less	21.6mA or greater

Note: Setting range for variable saturation point of output.

12mA ≤ Upper output limit ≤ 21.6mA

3.6mA ≤ Lower output limit <12mA

- Constant current output
  In constant current mode, output is held constant between 4 and 20 mA. This can be used for loop tests and the like.
- Write Protection
  This is a function for protecting the device's settings. When this function is enabled, the device's settings cannot be changed. There are two types of write protection: hardware-based protection and software-based protection.

[Hardware Write Protection]

By sliding a switch (S1) on the electronics module, this hardware write protection can be switched ON and OFF. ("OFF" does not appear on the board.) See Figure 3-3.

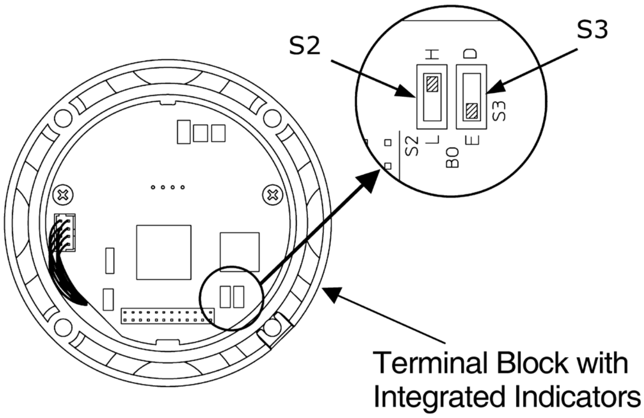


Figure 3-2. Burnout Setting Switches

Note: For information on the limits, see Table 3-1. If the output current is less than the limit, HART communication may not be available.

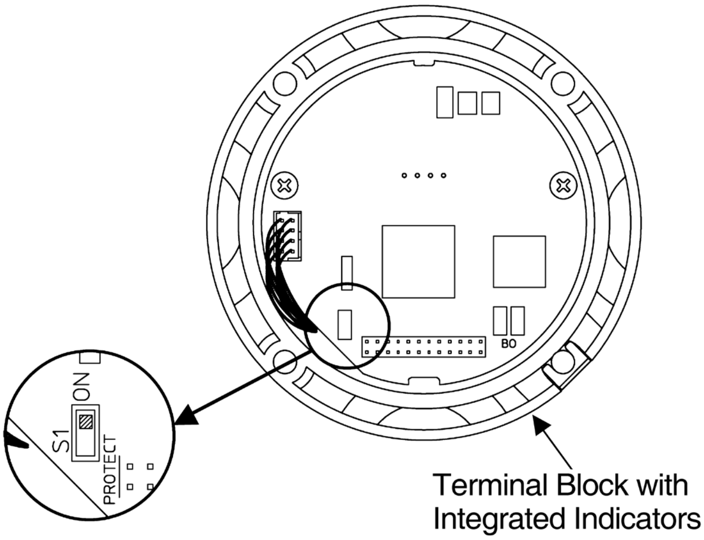


Figure 3-3. Hardware Write Protection Setting Switch

[Software Write Protection]

For information regarding software write protection, see the operation manual for the communicator.

CommStaff	Section 2-1, “Menu List”
HART Communicator	Section 2-3, “Device Menu Tree”

(3) Indicator Settings

The settings for display format (linear / square root) and display units (% / real pressure/ engineering unit scale) of the indicators can be checked. “Real pressure” displays actual measured values in the selected pressure units.

“Engineering unit scale” displays values for flow rate, level, etc., in the specified scale and units. If engineering unit scale is set, EULO (value at 0% output) and EUHI (value as 100% output) are set as well. With engineering unit scale, units can be selected or, alternatively, arbitrarily defined units can be displayed.

(4) Damping Time Constant Setting

The values which can be specified for the damping time are as follows.

During SFN communication:

0, 0.16, 0.32, 0.48, 1, 2, 4, 8, 16, 32 (unit: seconds)

During HART communication:

Specify a value (to two decimal places) in the 0.00–120.00 second range.

Note: Transmitter responsiveness varies with each model. When replacing an instrument, adjust the damping time constant as necessary so that it is appropriate for the instrumentation loop.

3-2 Measurement Using the JTD Model

3-2-1 Flow Rate Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning

When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution

Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.

In terms of piping, before commencing operation of this device as shown below, the differential pressure outlet valves (master valves), drain valves, gas vent plugs (see Figures 2-30 and 2-31) and the stop valve of the three-way manifold valve must be closed on both the high pressure and low pressure sides. In addition, check that the equalizer valve of the three-way manifold valve is open.

(ii) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

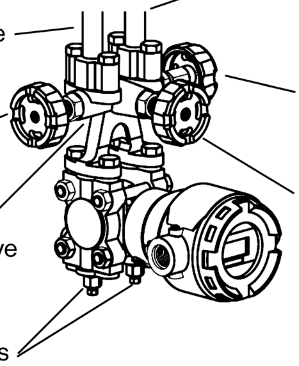
◆ Procedure ◆

(1) Open the high and low pressure side master valves (see Figures 2-30 and 2-31), and introduce process fluid into the connecting pipe. If the process temperature is high at this point, wait until the connecting pipe cools down.

(2) Fill the pressure-receiving part of the device with process fluid.

(1) Gradually open the stop valve on the high pressure side. When it is filled with process fluid, close the valve.

(2) Gradually open the stop valve on the high pressure side. When it is filled with process fluid, close the valve.



(3) Set the differential pressure applied to the device to zero.
Gradually open the equalizer valve. Next, gradually open the high pressure side stop valve, and introduce process pressure into the pressure-receiving part of the device. The device will attain a state (the equalized pressure state) in which equal pressure will be applied to the high pressure side and low pressure side of the device.

(4) Check that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the device itself, etc.

(iii) Zero point check and calibration

◆ Procedure ◆

(1) Check that, in the previous operation, the equalized pressure state was attained.

(2) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

Note: Have the required equipment on hand before starting zero-point calibration.

(2) Starting Operation

(i) Applying process pressure

In the following procedure, valves are operated to apply the differential pressure of the process to this device, and then the measurement value is checked using the communicator.

◆ Procedure ◆

(1) Check that the valves of the three-way manifold valve are in the following state.

(1) High pressure side stop valve: fully open

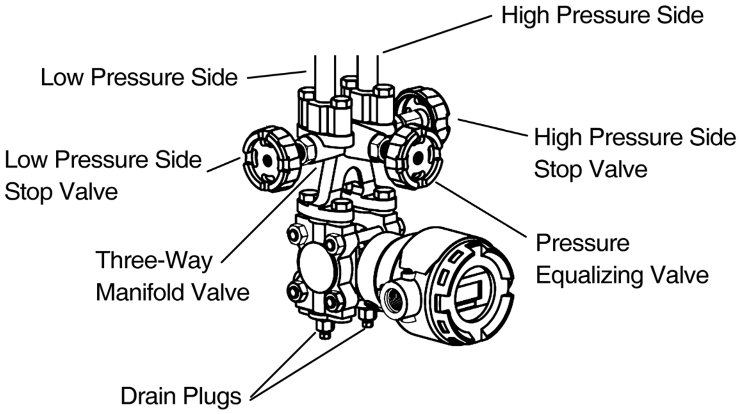
(2) Low pressure side stop valve: fully closed

(3) Equalizer valve: fully open

(2) Introduce process pressure into the low pressure side.

(1) Close the equalizer valve.

(2) Gradually open the low pressure side stop valve.



(ii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output, the displayed values, etc., do not match the process conditions, recheck the setting range and the like. If this does not solve the problem, carry out the troubleshooting in Chapter 4, or contact us.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

Note: Transmitter responsiveness varies with each model. When replacing an instrument, adjust the damping time constant as necessary so that it is appropriate for the instrumentation loop.

(iii) Cautions following confirmation of readings

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

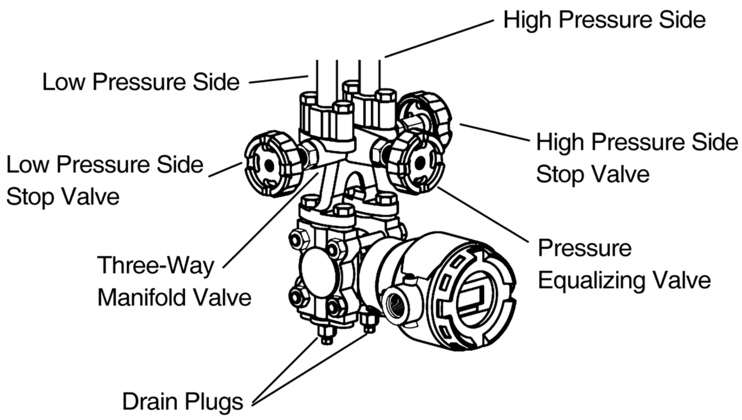
(1) Turn off the power to the device.

(2) Operate the valves of the three-way manifold valve in the following order.

(1) Close the low pressure side stop valve.

(2) Open the equalizer valve.

(3) Close the high pressure side stop valve.



(3) Close the high and low pressure side master valves (see Figures 2-30 and 2-31).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.
- Leave the equalizer valve open. If it is left closed, output of other than zero can occur when the power is turned on to restart operation.

3-2-2 Pressure Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning
When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution
Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.
In terms of piping, before commencing operation of this device as shown below, check that the pressure outlet valves (master valves), manual master valve, drain valves, and gas vent plugs (see Figure 2-36) are closed.

(ii) Zero point check and calibration

◆ Procedure ◆

(1) Open the high-pressure side gas vent plug, and open the pressure-receiving part to the atmosphere. If any process fluid remains in the pressure-receiving part, remove it completely, exercising care not to damage the diaphragm. If any process fluid remains, it will not be possible to calibrate the zero point correctly.
Also, check that the low pressure side is open to the atmosphere.

(2) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

(3) After finishing calibration and checking, close the high-pressure side gas vent plug.

(iii) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

◆ Procedure ◆

(1) Fill the pressure-receiving part of the device with process fluid.

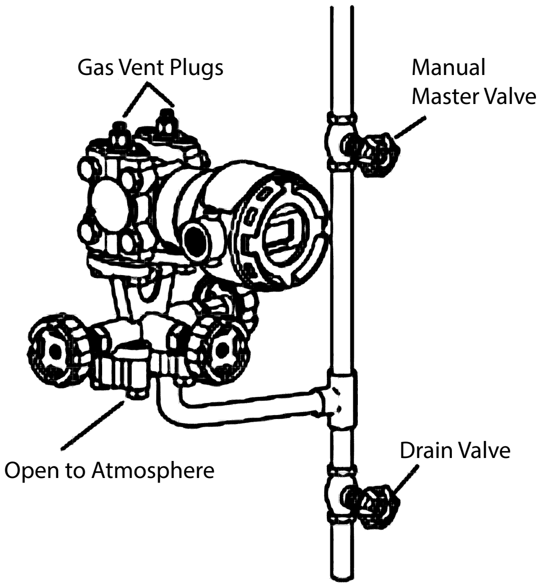
(1) Open the master valves (see Figure 2-36), and introduce process fluid into the connecting pipe. If the process temperature is high at this point, wait until the connecting pipe cools down.

(2) Gradually open the manual master valve, and introduce process pressure into the pressure-receiving part of the device.

(2) Vent the air from the device.

(1) Gradually open the high pressure side gas vent plug to remove the air from the main unit.

(2) When the air has been removed, close the gas vent plug and the manual master valve.



(3) Check that there are no pressure leaks in the connecting pipes, the device itself, etc.

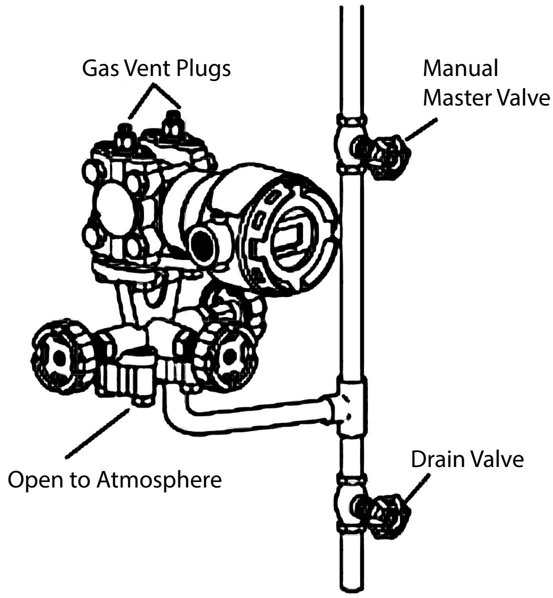
(2) Starting Operation

(i) Applying process pressure

In the following procedure, valves are operated to apply the pressure of the process to this device, and then the measured values are checked using the communicator.

◆ Procedure ◆

(1) Gradually open the manual master valve.



(ii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output and the displayed values do not match the process conditions,
  - Check the setting range
  - Check the location at which the flange is attached to the process
  - Recalibrate

  If there is still no improvement, carry out the troubleshooting in Chapter 4.
- If the measurement output and display do not stabilize, adjust the damping time constant.

(iii) Cautions following checking of measured values

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

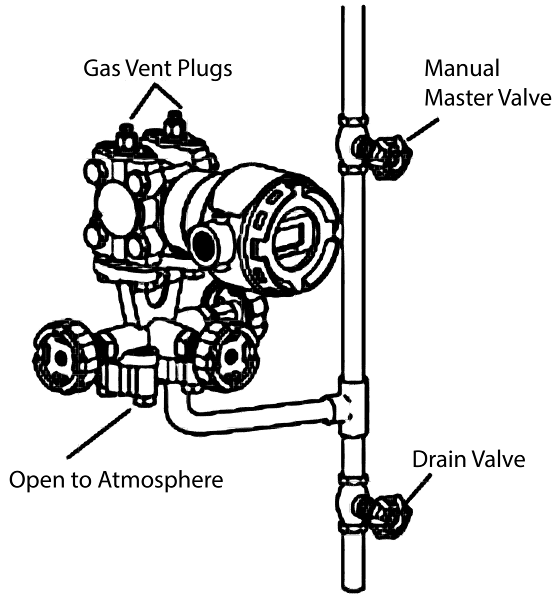
(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

(1) Turn off the power to the device.

(2) Close the manual master valve.



(3) Close the master valve (See Figure 2-36).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.
- Leave the equalizer valve open. If it is left closed, output of other than zero can occur when the power is turned on to restart operation.

3-2-3 Open Tank and Sealed Tank (Dry Leg) Liquid Level Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning	
❗	When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution	
❗	Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.
❗	In terms of piping, before commencing operation of this device as shown below, the master valves, drain valves, drain plugs, gas vent plugs, and the stop valve of the three-way manifold valve must be closed on both the high pressure and low pressure sides. In addition, check that the equalizer valve of the three-way manifold valve is open (see Figures 2-37 and 2-38).

(ii) Calculating the setting range

To find the setting range based on calculation, see section 3-10.

(iii) Zero point check and calibration

◆ Procedure ◆

(1) Open the high pressure side and low pressure side gas vent plugs, drain plugs, and stop valves of the three-way manifold valve, and open the pressure-receiving part to the atmosphere. At this time, if fluid remains in the pressure-receiving part, remove it, being careful not to damage the diaphragm.

(2) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

(3) After finishing calibration and checking, close the high-pressure side and low-pressure side gas vent plugs, the high-pressure side drain plug, the high-pressure side stop valve for the three-way manifold valve, and the equalizer valve.

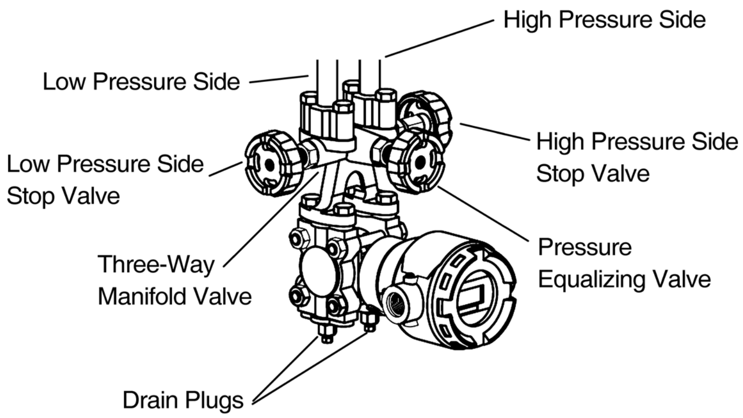
(iv) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

◆ Procedure ◆

(1) (1) Open the master valves (see Figure 2-39), and introduce process fluid into the connecting pipe. If the process temperature is high at this point, wait until the connecting pipe cools down.

(2) Gradually open the high pressure side stop valve, and fill with process fluid. When full, close the high pressure side stop valve.



(2) Check that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the device itself, etc.

(2) Starting Operation

(i) Applying process pressure

In the following procedure, valves are operated to apply the differential pressure of the process to this device, and then the measured values are checked using the communicator.

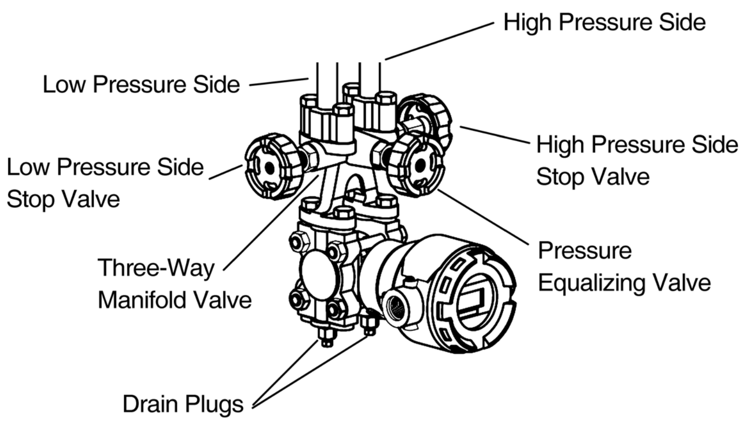
◆ Procedure ◆

(1) Check that the valves of the three-way manifold valve are in the following state.

(1) High pressure side stop valve: fully closed

(2) Low pressure side stop valve: fully open

(3) Equalizer valve: fully closed



(2) Gradually open the high pressure side stop valve, and introduce process pressure.

(ii) Zero point adjustment during operation

When performing zero point adjustment during operation, see section 3-7.

(iii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output, the displayed values, etc., do not match the process conditions, recheck the setting range and the like. If this does not solve the problem, carry out the troubleshooting in Chapter 4, or contact us.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(iv) Cautions following confirmation of readings

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

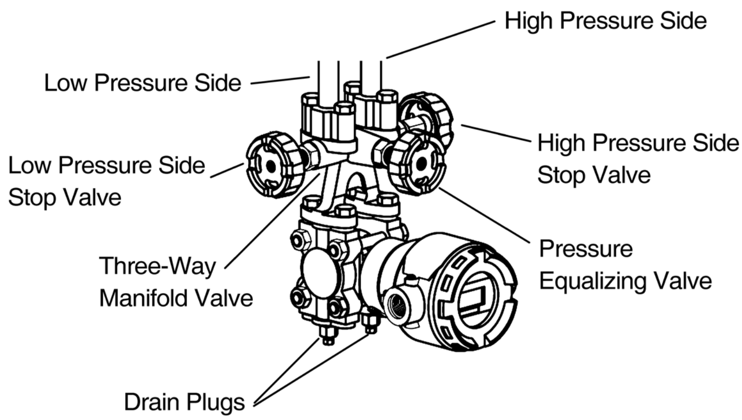
(1) Turn off the power to the device.

(2) Operate the valves of the three-way manifold valve in the following order.

(1) Close the low pressure side stop valve.

(2) Open the equalizer valve.

(3) Close the high pressure side stop valve.



(3) Close the master valve (See Figure 2-41).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.
- Leave the equalizer valve open. If it is left closed, output of other than zero can occur when the power is turned on to restart operation.

3-2-4 Sealed Tank (Wet Leg) Liquid Level Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning

!	When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution

!	Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.
!	In terms of piping, before commencing operation of this device as shown below, the master valves, drain valves, gas vent plugs, and the stop valve of the three-way manifold valve must be closed on both the high pressure and low pressure sides. In addition, check that the equalizer valve of the three-way manifold valve is in the open state. (See Figure 2-41)

(ii) Calculating the setting range

To find the setting range based on calculation, see section 3-10.

(iii) Zero point check and calibration

◆ Procedure ◆

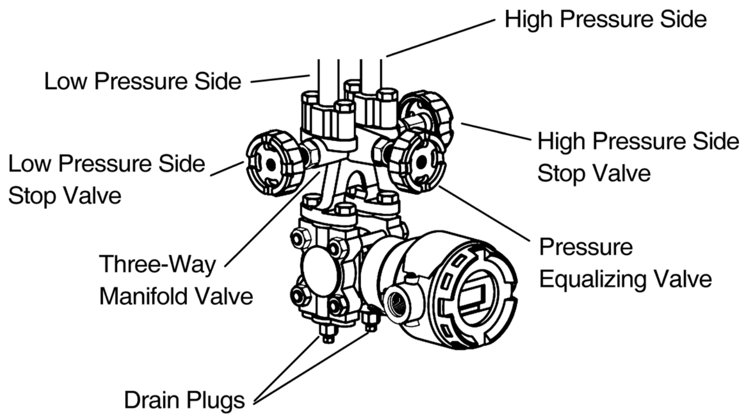
(1) Inject sealing liquid through the seal pot, and fill the connecting pipe with sealing liquid.

(2) Gradually open the high pressure side and low pressure side stop valves of the three-way manifold valve and then the drain plugs, and fill the pressure-receiving part of the device with sealing liquid.

(3) After sealing liquid flows out from the high pressure side and low pressure side drain plugs, close the drain plugs and then close the high pressure side and low pressure side stop valves. The device will attain a state (of equalized pressure) in which equal pressure will be applied to the high pressure side and low pressure side of the device.

(4) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

(5) After finishing calibration and checking, first close the equalizer valve, and then open the low-pressure side stop valve and drain plug, and remove the sealing liquid on the low-pressure side. Finally, close the low-pressure side stop valve and drain plug.



(iv) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

◆ Procedure ◆

(1) Open the high and low pressure side master valves (see Figure 2-41), and introduce process pressure into the connecting pipe. If the process temperature is high at this point, wait until the connecting pipe cools down.

(2) Gradually open the high pressure side and low pressure side stop valves of the three-way manifold valve, introduce process fluid into the pressure-receiving part of the device, and when introduction of the fluid is complete, close the high pressure side and low pressure side stop valves.

(3) Check that there are no pressure leaks in the connecting pipes, the three-way manifold valve, the device itself, etc.

(2) Starting Operation

(i) Applying process pressure

In the following procedure, valves are operated to apply the differential pressure of the process to this device, and then the measured values are checked using the communicator.

◆ Procedure ◆

(1) Check that the valves of the three-way manifold valve are in the following state.

(1) High pressure side stop valve: fully closed

(2) Low pressure side stop valve: fully closed

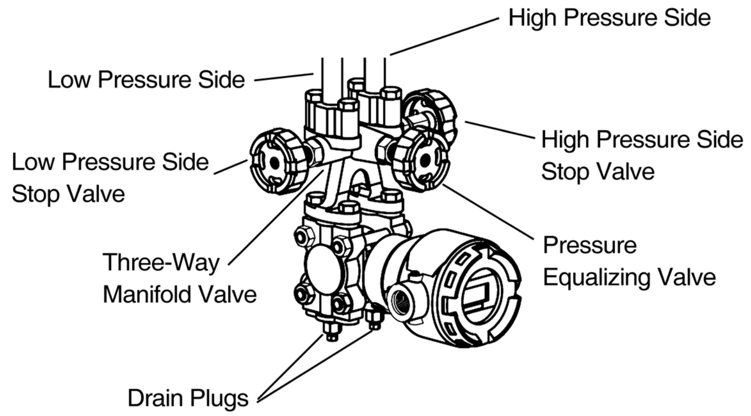
(3) Equalizer valve: fully closed

(2) Fill the liquid seal pipes with sealing liquid.

(3) Introduce process pressure.

(1) Gradually open the high pressure side stop valve.

(2) Gradually open the low pressure side stop valve.



(ii) Zero point adjustment during measurement

When performing zero point adjustment during operation, see section 3-9.

(iii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output, the displayed values, etc., do not match the process conditions, recheck the setting range and the like. If this does not solve the problem, carry out the troubleshooting in Chapter 4, or contact us.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(iv) Cautions following confirmation of readings

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

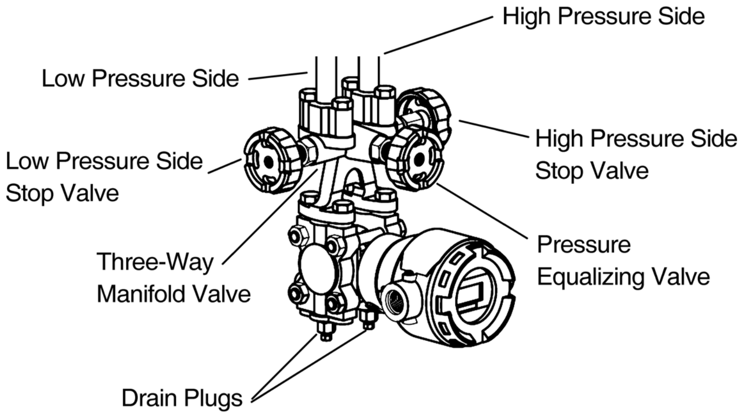
(1) Turn off the power to the device.

(2) Operate the valves of the three-way manifold valve in the following order.

(1) Close the low pressure side stop valve.

(2) Open the equalizer valve.

(3) Close the high pressure side stop valve.



(3) Close the master valve (See Figure 2-41).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.
- Leave the equalizer valve open. If it is left closed, output of other than zero can occur when the power is turned on to restart operation.

3-3 Measurement Using the JTG/JTA Model

3-3-1 Pressure Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning

When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution

Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.

In terms of piping, before commencing operation of this device as shown below, check that the master valves, manual master valve, drain valves, gas vent plugs (see Figure 2-35) are closed.

(ii) Zero point check and calibration

◆ Procedure ◆

(1) Open the device-side gas vent plug, and open the pressure-receiving part to the atmosphere. At this time, if fluid remains in the pressure-receiving part, remove it, being careful not to damage the diaphragm.

(2) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

(3) After finishing calibration and checking, close the gas vent plug.

(iii) Cautions regarding the absolute pressure gauge

The JTA model is an absolute pressure gauge. Do not perform zero point calibration. If it is necessary to adjust the zero point on an absolute pressure gauge, please contact us.

(iii) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

◆ Procedure ◆

(1) Fill the pressure-receiving part of the device with process fluid.

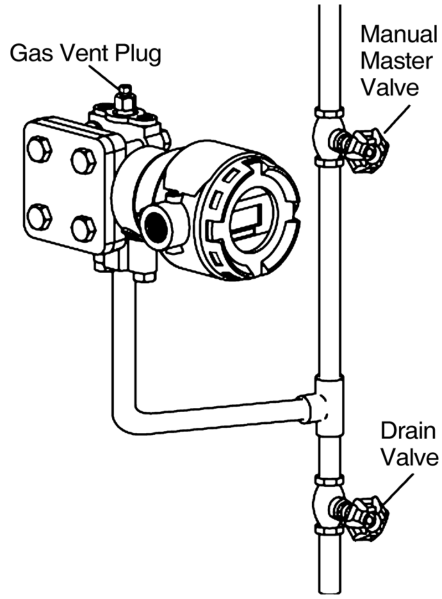
(1) Open the master valves (see Figure 2-35), and introduce process fluid into the connecting pipe. If the process temperature is high at this point, wait until the connecting pipe cools down.

(2) Gradually open the manual master valve, and introduce process pressure into the pressure-receiving part of the device.

(2) Vent the air from the device.

(1) Gradually open the device-side gas vent plug to remove the air from the main unit.

(2) When the air has been removed, close the plug and the manual master valve.



(3) Check that there are no pressure leaks in the connecting pipes, the device itself, etc.

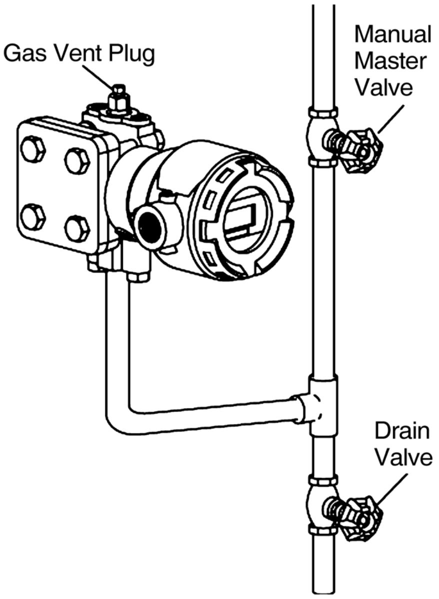
(2) Starting Operation

(i) Applying process pressure

In the following procedure, valves are operated to apply the pressure of the process to this device, and then the measured values are checked using the communicator.

◆ Procedure ◆

(1) Gradually open the manual master valve.



(ii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output, the displayed values, etc., do not match the process conditions, recheck the setting range and the like. If this does not solve the problem, carry out the troubleshooting in Chapter 4, or contact us.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(iii) Cautions following confirmation of readings

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

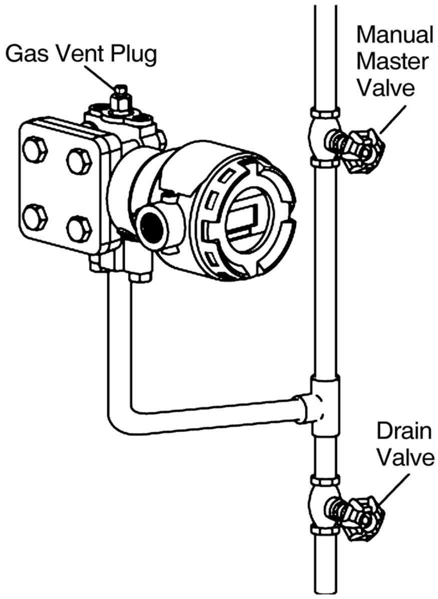
(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

(1) Turn off the power to the device.

(2) Close the manual master valve.



(3) Close the master valve (see Figure 2-35).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.

3-3-2 Liquid Level Measurement

(1) Preparing for Operation

(i) Important points

⚠Warning
When clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the process fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.

⚠Caution
Check that the process is in manual control mode. If it is in automatic control mode, be sure to switch it to manual control mode before starting work.
In terms of piping, before commencing operation of this device as shown below, check that the master valves, manual master valve, drain valves, drain plugs (see Figure 2-39) are closed.

(ii) Calculating the setting range

To find the setting range based on calculation, see section 3-10.

(iii) Zero point checking and calibration

◆ Procedure ◆

(1) Open the drain plugs, and open the pressure-receiving part to the atmosphere. At this time, if fluid remains in the pressure-receiving part, remove it, being careful not to damage the diaphragm.

(2) Using the communicator, check the device output. If the output is not zero, calibrate the zero point. For information regarding the zero point calibration procedure, see the operation manual for the communicator.

(3) After finishing calibration and checking, close the drain plugs.

(iv) Cautions regarding the absolute pressure gauge

The JTA model is an absolute pressure gauge. Do not perform zero point adjustment. If it is necessary to adjust the zero point on an absolute pressure gauge, please contact us.

(v) Introducing process pressure and checking for leaks

In the following procedure, process pressure is introduced into the pressure-receiving part of this device.

◆ Procedure ◆

(1) Open the master valves (see Figure 2-39), and introduce process fluid into the connecting pipe. If the process temperature is high at this point, gradually introduce process pressure such that the usage range of the pressure-receiving part of the device is not exceeded.

(2) Close the master valve.

(3) Check that there are no pressure leaks in the connecting pipes, the device itself, etc.

(2) Starting Operation

(i) Applying process pressure

Next, the valves is operated to apply the pressure of the process to this device, and then the measured values are checked using the communicator.

◆ Procedure ◆

(1) Gradually open the master valve (see Figure 2-39).

(ii) Zero point adjustment during measurement

When performing zero point adjustment during operation, see section 3-9.

(iii) Checking measured values

- Using the communicator, check the measured values.
- After checking , disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output, the displayed values, etc., do not match the process conditions, recheck the setting range and the like. If this does not solve the problem, carry out the troubleshooting in Chapter 4, or contact us.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(iv) Cautions following confirmation of readings

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

To stop operation of the device, carry out the following procedure.

◆ Procedure ◆

(1) Turn off the power to the device.

(2) Close the master valve (see Figure 2-39).

(ii) Cautions for stopping device operation

- If operation will be stopped for a long period of time, remove the process fluid from inside the connecting pipes and the pressure-receiving part of the device. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.

3-4 Measurement Using the JTC Model

3-4-1 Liquid Level Measurement

(1) Preparing for Operation

(i) Checking the minimum liquid level (zero position) and zero point input during input equalization

The zero position liquid level is taken to be the center of the seal diaphragm on the surface of the process connection flange of the device (see Figures 3-4 and 3-5). As a result, the measurement range H extends from the center of the transmitter flange to the height of the usage range. However, when performing the zero point check, lower the liquid level to below the bottom of the seal diaphragm. In addition, for a sealed tank wet leg, remove the sealing liquid. That is, check the zero point after putting the diaphragms on the high pressure side and the low pressure side into an equalized pressure state. For information regarding the method of checking, see the operation manual for the communicator.

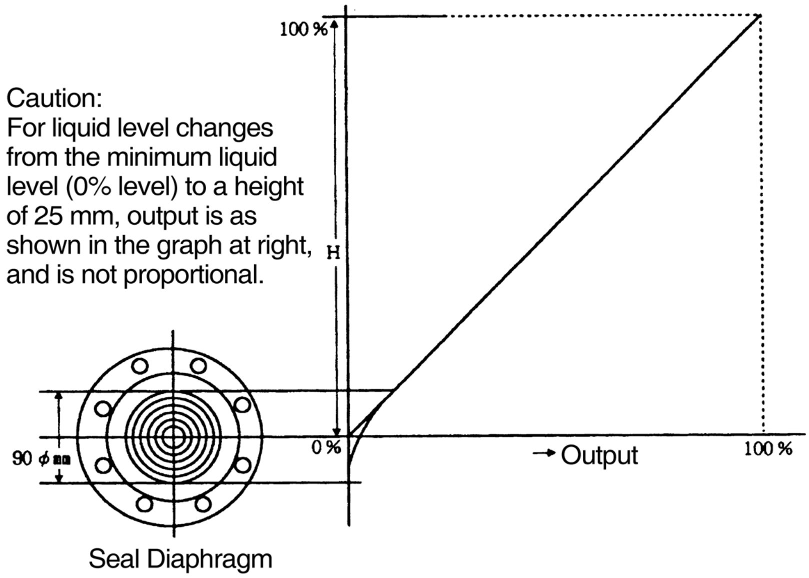


Figure 3-4. Minimum Liquid Level Characteristics

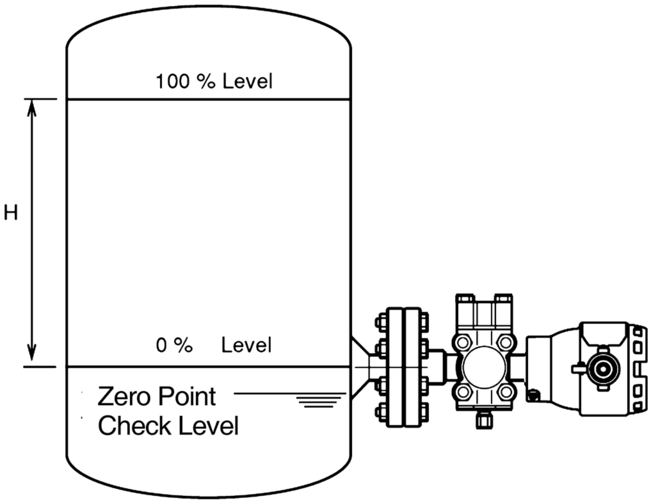


Figure 3-5. Zero Position Determination

(ii) Zero adjustment

Zero adjustment of this device can be performed by communicating with the device using a communicator, or via external zero adjustment (optional function, see section 3-9).

1. If the liquid level in the tank can be set to the minimum value (0%) of the measurement range

    (1) Using a communicator
    Section 3-7, "Zero adjustment based on actual level during liquid level measurement," and Section 3-8, "Zero adjustment based on range-equivalent input pressure" are the sections to which to refer.

    (2) Using external zero adjustment (optional)
    Section 3-9, "External zero adjustment (optional function)," is the section to which to refer.

2. If the liquid level in the tank cannot be set to the minimum value (0%) of the measurement range

    (1) Using a communicator
    Section 3-7, "Zero adjustment based on actual level during liquid level measurement," is the section to which to refer.

    (2) Using external zero adjustment (optional function)
    Section 3-9, "External zero adjustment (optional function)," is the section to which to refer.

(2) Starting Operation

After zero adjustment as described in the previous section, the device can be operated. Proceed to check its measurements .

(i) Checking measured values

- Using the communicator, check the measured values.
- After checking, disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output and the displayed values do not match the process conditions,
  - Check the setting range
  - Check of the location at which the flange is attached to the process
  - Recalibrate

  If there is still no improvement, carry out the troubleshooting in Chapter 4.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(ii) Cautions following checking of measured values

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

Turn off the power to the device.

(ii) Cautions for stopping device operation

If operation will be stopped for a long period of time, remove the flange portions of the device, clean the diaphragm with a soft brush and some solvent, and store it. When doing so, be careful not to deform or scratch the diaphragm. In addition, remove the process fluid from inside the connecting pipes and the device's pressure-receiving part as well. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.

3-5 Measurement Using the JTE Model

At the start of operation, make adjustments while the process is in its actual state.

3-5-1 Liquid Level Measurement

(1) Preparing for Operation

(i) Checking the minimum liquid level (zero position) and zero point input during input equalization

The zero position liquid level is taken to be the center of the seal diaphragm on the surface of the process connection flange of the device (see Figures 3-6 and 3-7). As a result, the measurement range H extends from the center of the transmitter flange to the height of the usage range. However, when performing the zero point check, lower the liquid level to a point below the bottom of the seal diaphragm. The device must be in a state in which head pressure is not being applied by the process fluid. That is, check the zero point after putting the diaphragms on the high pressure side and the low pressure side into an equalized pressure state in the tank. For information regarding the method of checking, see the operation manual for the communicator.

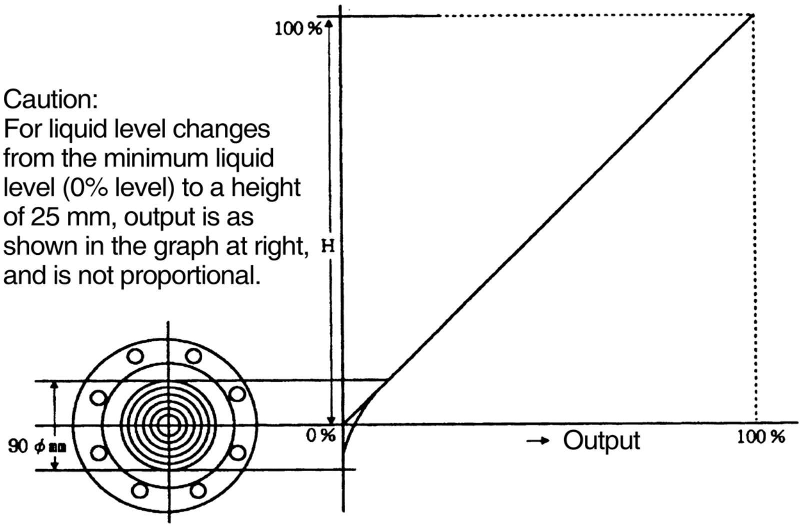


Figure 3-6. Minimum Liquid Level Characteristics

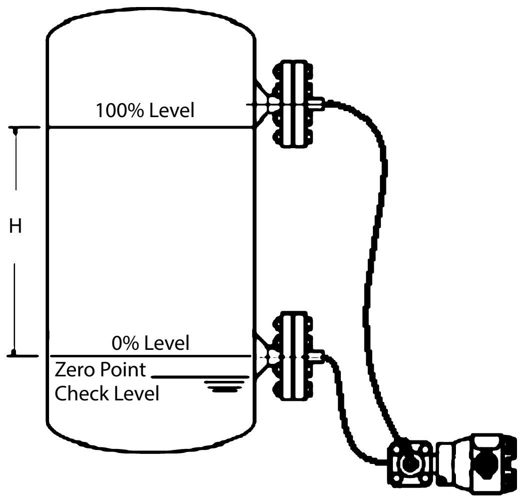


Figure 3-7. Zero Position Determination

(ii) Zero adjustment

Zero adjustment of this device can be performed by communicating with the device using a communicator, or via external zero adjustment (optional function, see section 3-9).

(1) If the liquid level in the tank can be set to the minimum value (0%) of the measurement range

(1) Using a communicator
Section 3-7, “Zero adjustment based on actual level during liquid level measurement,” Section 3-8, “Zero adjustment based on range-equivalent input pressure,” are the sections to which to refer.

(2) Using external zero adjustment (optional function)
Section 3-9, “External zero adjustment (optional function),” is the section to which to refer.

(2) If the liquid level in the tank cannot be set to the minimum value (0%) of the measurement range

(1) Using a communicator
Section 3-7, “Zero adjustment based on actual level during liquid level measurement,” is the section to which to refer.

(2) Using external zero adjustment (optional function)
Section 3-9, “External zero adjustment (optional function),”is the section to which to refer.

(2) Starting Operation

After zero adjustment as described in the previous section, the device can be operated. Proceed to check its measurements.

(i) Checking measured values

- Using the communicator, check the measured values.
- After checking, disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output and the displayed values do not match the process conditions,
  - Check the setting range
  - Check of the location at which the flange is attached to the process
  - Recalibrate

  If there is still no improvement, carry out the troubleshooting in Chapter 4.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(ii) Cautions following checking of measured values

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

Turn off the power to the device.

(ii) Cautions for stopping device operation

When stopping operation for a long period of time, remove the flange portions of the device, clean the diaphragm with a soft brush and some solvent, and store it. When doing so, be careful not to deform or scratch the diaphragm. In addition, remove the process fluid from inside the connecting pipes and the device's pressure-receiving part as well. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.

3-5-2 Flow Rate Measurement

(1) Cautions During Flow Rate Measurement

Given the structure of the remote seal model pressure-receiving part, there may in cases in which the equalizer valve, stop valves, etc., cannot be attached, so be sure to complete the zero point check before injecting fluid into the main pipe. In addition, if there are differential pressure flange outlets on the vertical pipe, the high pressure side flange and the low pressure side flange will be positioned at different heights. In this case, determine the zero point using the lower range value (LRV) setting.

3-6 Measurement Using the JTH/JTS Model

At the start of operation, make adjustments while the process is in its actual state.

3-6-1 Liquid Level and Pressure Measurement

(1) Preparing for Operation

(i) Checking the minimum liquid level (zero position) and zero point input during input equalization

The zero position liquid level is taken to be the center of the seal diaphragm on the surface of the process connection flange of the device (see Figures 3-8 and 3-9). As a result, the measurement range H extends from the center of the transmitter flange to the height of the usage range. However, when performing the zero point check, lower the liquid level to a point below the bottom of the seal diaphragm.

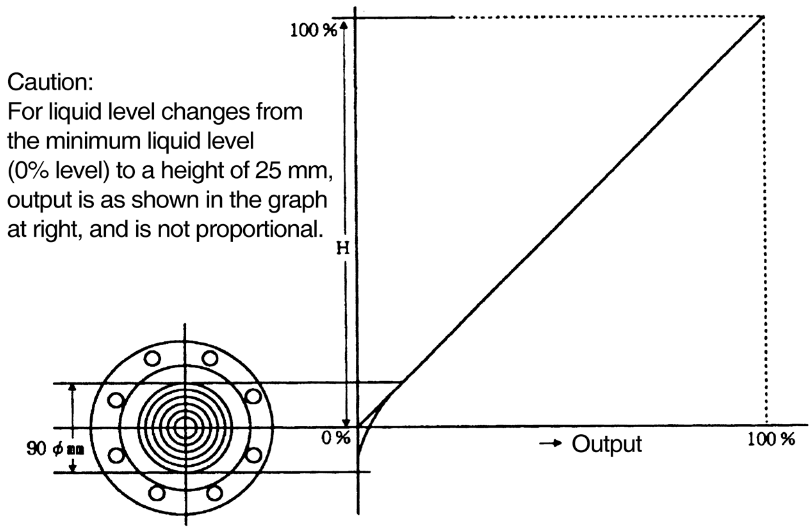


Figure 3-8. Minimum Liquid Level Characteristics

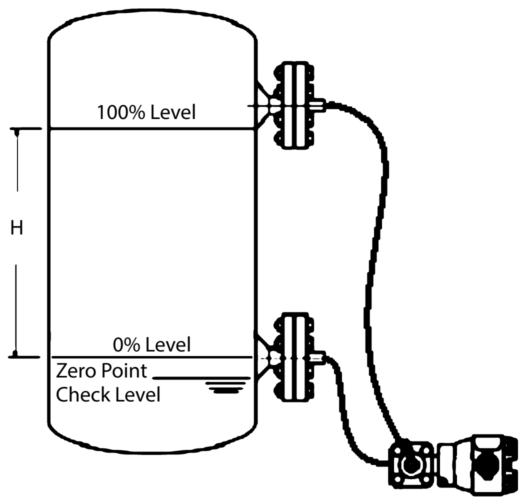


Figure 3-9. Zero Position Determination

(ii) Zero adjustment

Zero adjustment of this device can be performed by communicating with the device using a communicator, or via external zero adjustment (optional function, see section 3-9).

(1) If the liquid level in the tank can be set to the minimum value (0%) of the measurement range

(1) Using a communicator
Section 3-7, "Zero adjustment based on actual level during liquid level measurement,"
Section 3-8, "Zero adjustment based on range-equivalent input pressure,"
are the sections to which to refer.

(2) Using external zero adjustment (optional function)
Section 3-9, "External zero adjustment (optional function),"
is the section to which to refer.

(2) If the liquid level in the tank cannot be set to the minimum value (0%) of the measurement range

(1) Using a communicator
Section 3-7, "Zero adjustment based on actual level during liquid level measurement,"
is the section to which to refer.

(2) Using external zero adjustment (optional function)
Section 3-9, "External zero adjustment (optional function),"
is the section to which to refer.

(2) Starting Operation

After zero adjustment as described in the previous section, the device can be operated. Proceed to check its measurements.

(i) Checking measured values

- Using the communicator, check the measured values.
- After checking, disconnect the communication cable, attach the device's case cover, and switch the process to normal operation.
- If the analog signal output and the displayed values do not match the process conditions,
  - Check the setting range
  - Check of the location at which the flange is attached to the process
  - Recalibrate

  If there is still no improvement, carry out the troubleshooting in Chapter 4.
- If the measurement output and display do not stabilize, refer to Chapter 4 and adjust the damping time constant.

(ii) Cautions following checking of measured values

After checking the measured values, confirm that the device's case cover is securely closed. If it is not securely closed, rainwater and the like can enter the device and cause damage to the terminals, electronics modules, etc., located inside.

(3) Stopping Operation

(i) Stopping operation of the device

Turn off the power to the device.

(ii) Cautions for stopping device operation

When stopping operation for a long period of time, remove the flange portions of the device, clean the diaphragm with a soft brush and some solvent, and store it. When doing so, be careful not to deform or scratch the diaphragm. In addition, remove the process fluid from inside the connecting pipes and the device's pressure-receiving part as well. The process fluid might, for example, adhere to the surface of the diaphragm and impede measurement when operation resumes.

3-7 Zero Adjustment Based on Actual Level During Liquid Level Measurement

To adjust the zero point while they liquid level is being measured, without actually draining the liquid to the zero level, it is possible to make adjustment using an output value correlated with the actual level as measured by a level gauge (etc.). In conjunction with this operation manual, see the operation manuals for the respective communicators.

CommStaff Operation Manual: Section 3-3
HART Communicator Operation Manual: Section 3-2-3

3-8 Zero/Span Adjustment Based on Range-Equivalent Input Pressure

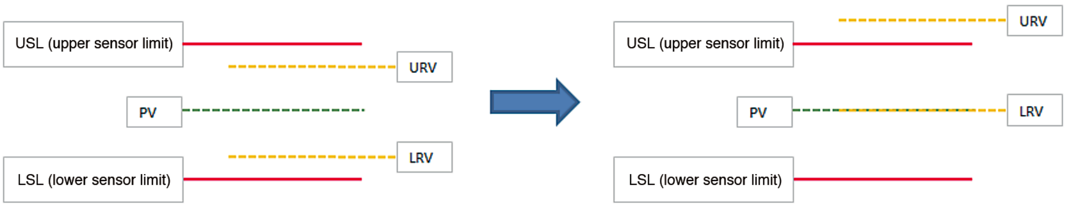
By applying the pressure corresponding to the desired range to the transmitter, the lower range value (LRV, the input pressure during 0% output) and upper range value (the input pressure during 100% output) can be set to values that correspond to the actual pressure. The lower range value and upper range value are automatically set using the desired liquid level or input pressure, and the zero/span adjustment can be completed. In conjunction with this operation manual, see the operation manuals for the respective communicators.

CommStaff Operation Manual: Section 3-2
HART Communicator Operation Manual: Section 3-2-3

(1) Notes for Zero Adjustment

When performing zero adjustment in a case where the upper range value will exceed the upper sensor limit (USL), note that there are differences in behavior between HART 5 and HART 7.

- HART5
  The present liquid level or input pressure is set as the lower range value. The upper range value is set while maintaining the span unchanged.



- HART7
  The present liquid level or input pressure is set as the lower range value. The upper range value is cut off at the upper sensor limit. Since the new upper range value may not be appropriate, change it as necessary.

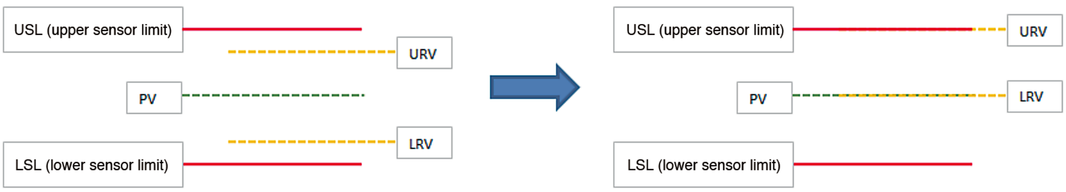


Table 3-2. Setting Range for Each Model Number

model JT	LSL	USL
910	-1kPa	1kPa
920	-100kPa	100kPa
930, 931, 940	-100kPa	700kPa
960, 961, 980	-0.1MPa	14MPa

3-9 External Zero Adjustment (Optional Function)

(1) Introduction

When equipped with the external zero adjustment function, this device enables zero adjustment to be performed on-site even if a communicator is not used.

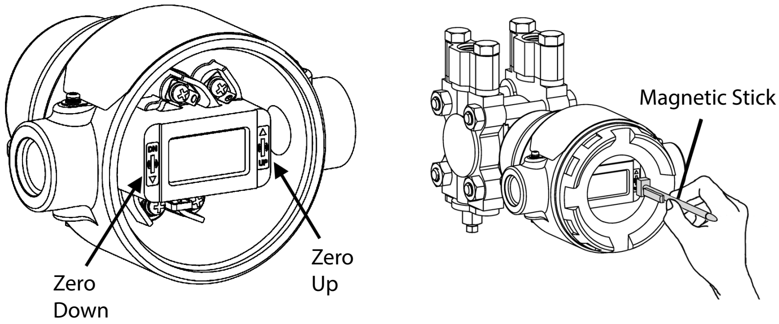


Figure 3-10. External Zero Adjustment

* External zero adjustment can be performed with the case cover attached. Fasten the case cover securely, without any gaps between the device and the case.

(2) External Zero Adjustment Procedure

! Handling Precautions:

- The procedure differs depending on the version of the software. The software version is indicated on the nameplate on the transmitter.

Note: If there is communication with the device from a communicator, etc., during external zero adjustment, zero adjustment has priority. Therefore, changing of settings by the communicator will be limited.

(i) Procedure for software versions earlier than 6.0

(1) Accurately apply the differential pressure that will serve as the reference for 0 % of the range to the transmitter. In addition, check that there are no leaks.

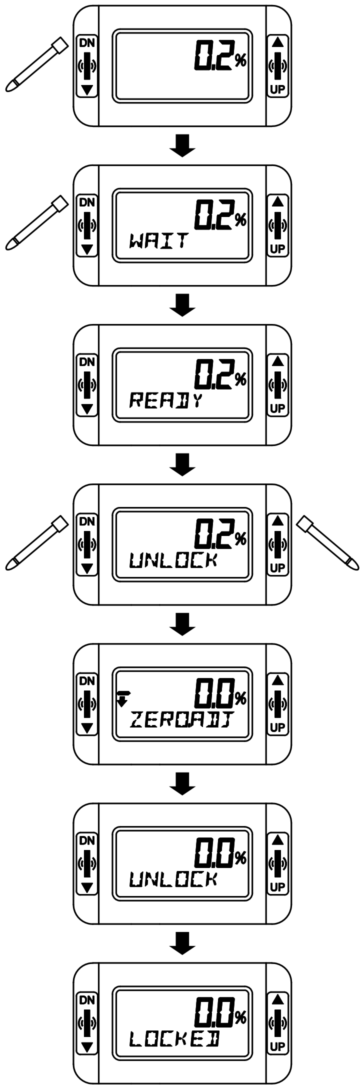
(2) Touch “UP” or “DN” on the glass window with the magnetic stick for 2 seconds or more. “ZERO ADJ” will be displayed, and the zero point can be adjusted.

(3) If the output of the transmitter is less than 4 mA, keep touching “UP” with the magnetic stick until the output reaches 4 mA. If the output of the transmitter is more than 4 mA, touch “DN” with the magnetic stick. When the output is reduced to 4 mA, remove the stick from the window to complete zero point adjustment

(4) In adjustment for liquid level measurement, it is not necessary to actually drain the liquid to the 0 % level. The output value (%) of the transmitter can be adjusted to the liquid level (%) measured by a level gauge or the like.

(ii) Procedure for software version 6.0 or later

(1) Accurately apply the differential pressure that will serve as the reference for 0 % of the range to the transmitter. In addition, check that there are no leaks.
(2) Touch “DN” on the glass window with the magnetic stick.
(3) When “WAIT” followed by “READY” is displayed, remove the stick from the window. When “UNLOCK” is displayed, the external zero point adjustment function is enabled. With “UNLOCK” displayed, if there is no operation with the magnetic stick for 45 seconds or more, the external zero/span adjustment function will be automatically disabled.
(4) With “UNLOCK” displayed, touch “UP” or “DN” on the glass window with the magnetic stick for 2 seconds or more.“ZERO.ADJ” will be displayed, and the zero point can be adjusted.
(5) If the output of the transmitter is less than 4 mA, keep touching “UP” with the magnetic stick until the output reaches 4 mA. If the output of the transmitter is more than 4 mA, touch “DN” with the magnetic stick. When the output is reduced to 4 mA, remove the stick from the window to complete zero point adjustment.
(6) In adjustment for liquid level measurement, it is not necessary to actually drain the liquid to the 0 % level. The output value (%) of the transmitter can be adjusted to the liquid level (%) measured by a level gauge or the like.



Touch “DN” with the magnetic stick.

Wait for 3 seconds.

Remove the magnetic stick.

Touch “DN” or “UP” again with the magnetic stick for 2 seconds or more.

When zero point adjustment is complete, remove the magnetic stick.

With “UNLOCK” displayed, if there is no operation with the magnetic stick for 45 seconds or more,

“LOCKED” is displayed for 3 seconds, after which the external adjustment function is disabled.

3-10 Calculating the Setting Range During Liquid Level Measurement

3-10-1 Open Tank and Sealed Tank (Dry Leg or Remote Seal) Setting Range

(1) Calculation Example Using the JTD Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant 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 the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the high pressure side output port
d: Distance between the high pressure side output port and the transmitter

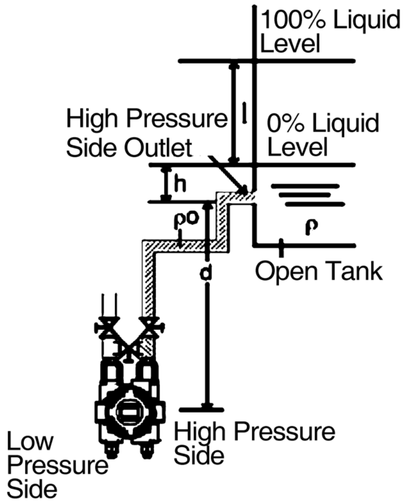


Figure 3-11.   Open Tank

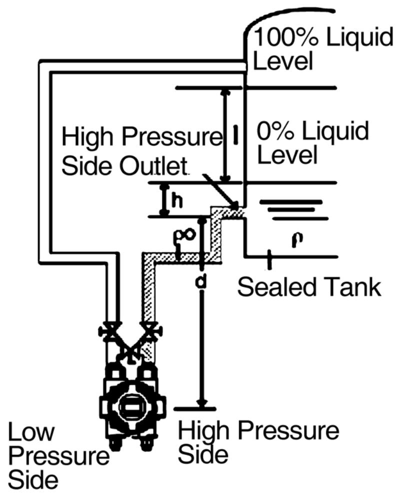


Figure 3-12.   Sealed Tank (Dry Leg)

0% liquid level differential pressure

Lower range value (LRV) = $h\times\rho + d\times\rho_0$

100% liquid level differential pressure

Upper range value (URV) = $l\times\rho + h\times\rho + d\times\rho_0$
$= (l + h)\times\rho + d\times\rho_0$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 1.0
l: 1500 mm
h: 250 mm
d: 500 mm

would result in:
0% liquid level differential pressure
LRV = $250\times0.9 + 500\times1.0$ = 725 mm H_2O = 7.110 kPa
100% liquid level differential pressure
URV = $\{(1500 + 250)\times0.9\} + 500\times1.0$ = 2075 mm H_2O = 20.35 kPa
Accordingly,
Low limit (LRV): 7.110 kPa
High limit (URV): 20.35 kPa
is the resulting range.

(2) Calculation Example Using the JTG Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant 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 the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the high pressure side output port
d: Distance between the high pressure side output port and the transmitter

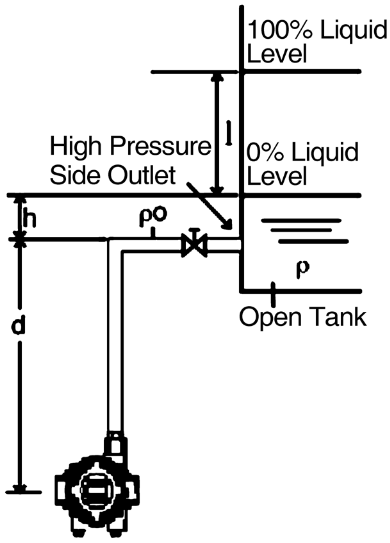


Figure 3-13. Open Tank

0% liquid level differential pressure

$$LRV = h \times \rho + d \times \rho_0$$

100% liquid level differential pressure

$$URV = l \times \rho + h \times \rho + d \times \rho_0$$
$$= (l + h) \times \rho + d \times \rho_0$$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 1.0
l: 1500 mm
h: 250 mm
d: 500 mm

would result in:

0% liquid level differential pressure

LRV = 250×0.9 + 500×1.0 = 725 mm H_2O = 7.110 kPa

100% liquid level differential pressure

URV = {(1500 + 250)×0.9} + 500×1.0 = 2075 mm H_2O = 20.35 kPa

Accordingly,

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

is the resulting range.

(3) Calculation Example Using the JTC Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

ρ: Specific gravity of liquid in tank
l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the high pressure side output port

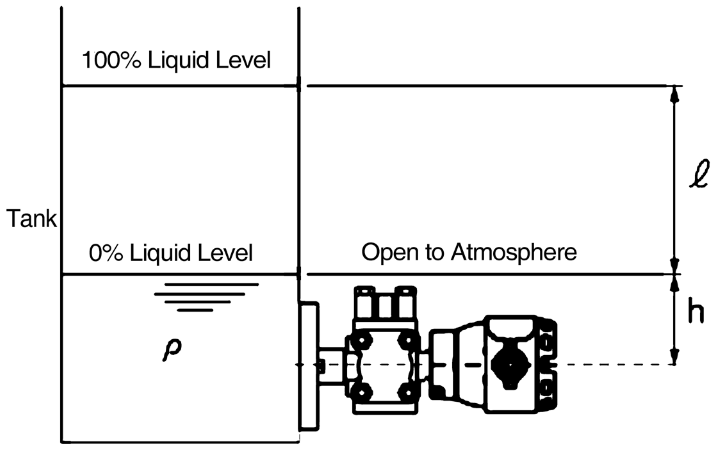


Figure 3-14. Open Tank

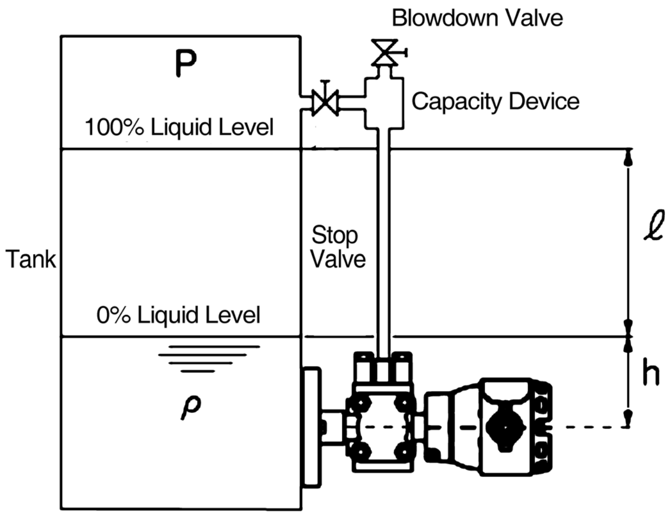


Figure 3-15. Sealed Tank (Dry Leg)

0% liquid level differential pressure

$LRV = h \times \rho$

100% liquid level differential pressure

$URV = l \times \rho + h \times \rho$
$= (l + h) \times \rho$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
l: 1500 mm
h: 250 mm

would result in:

0% liquid level differential pressure

LRV = 250×0.9 = 225 mm H_2O = 2.206 kPa

100% liquid level differential pressure

UR = (1500 + 250)×0.9 = 1575 mm H_2O = 15.45 kPa

Accordingly,

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

is the resulting range.

(4) Calculation Example Using the JTE Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

- ρ: Specific gravity of liquid in tank
- ρ_0: Specific gravity of sealed liquid
- l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
- h: Distance between the 0% liquid level and the high pressure side output port
- d: Distance between the high pressure side output port and the transmitter

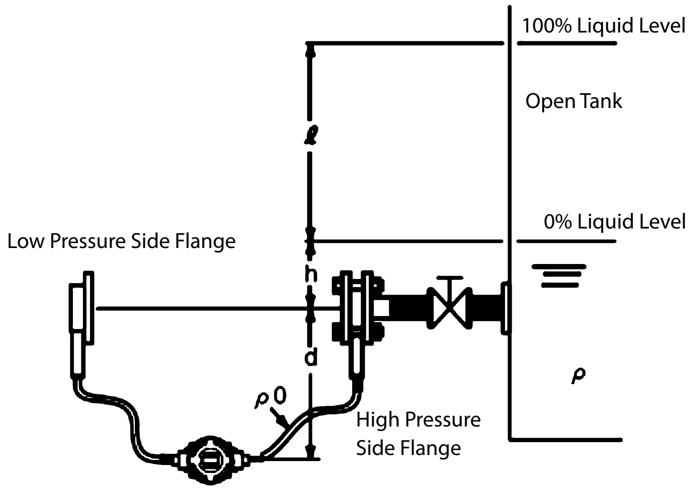


Figure 3-16. Open Tank

* Here, attach the low pressure side flange at the same height as the high pressure side flange.

0% liquid level differential pressure

$$LRV = h\times\rho + d\times\rho_0 - d\times\rho_0$$

100% liquid level differential pressure

$$URV = l\times\rho + h\times\rho$$
$$= (l+h)\times\rho + d\times\rho_0 - d\times\rho_0$$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 0.935 (general-purpose remote)
l: 1500 mm
h: 250 mm
d: 500 mm

would result in:

0% liquid level differential pressure

LRV = 250×0.9 = 225 mm H_2O = 2.206 kPa

100% liquid level differential pressure

URV = (1500 + 250)×0.9 = 1575 mm H_2O = 15.45 kPa

Accordingly,

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

is the resulting range.

(5) Calculation Example Using the JTH Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

- ρ: Specific gravity of liquid in tank
- ρ_0: Specific gravity of sealed liquid
- l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
- h: Distance between the 0% liquid level and the high pressure side output port
- d: Distance between the high pressure side output port and the transmitter

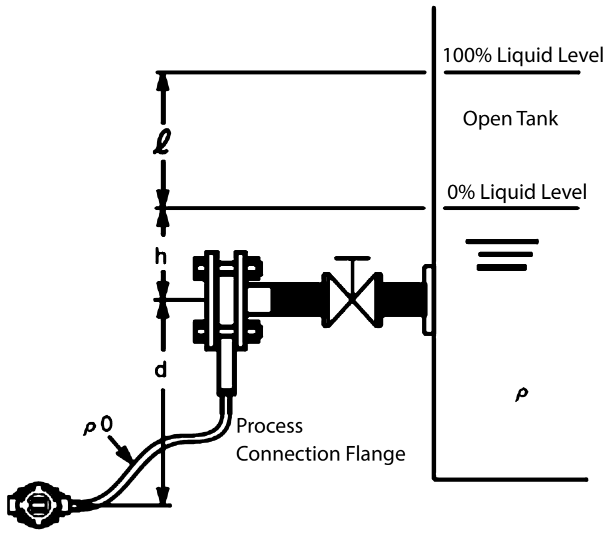


Figure 3-17.   Open Tank

0% liquid level differential pressure

$LRV = h \times \rho + d \times \rho_0$

100% liquid level differential pressure

$URV = l \times \rho + h \times \rho$

$= (l + h) \times \rho + d \times \rho_0$

Accordingly,

Low limit (LRV): $h\rho + d \times \rho_0$

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

is the range to set.

Calculation example:

ρ: 0.9

ρ_0: 1.0

l: 1500 mm

h: 250 mm

d: 500 mm

would result in:

0% liquid level differential pressure

LRV = 250×0.9 + 500×1.0 = 725 mm H_2O = 7.110 kPa

100% liquid level differential pressure

URV = {(1500 + 250)×0.9} + 500×1.0 = 2075 mm H_2O = 20.35 kPa

Accordingly,

Low limit (LRV): 7.110 kPa

High limit (URV): 20.35 kPa

is the resulting range.

3-10-2 Sealed Tank (Wet Leg or Remote Seal) Setting Range

(1) Calculation Example Using the JTD Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

ρ: Specific gravity of liquid in tank
ρ_0: Specific gravity of sealing liquid
l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the transmitter
d: Distance between the high pressure side output port and the transmitter

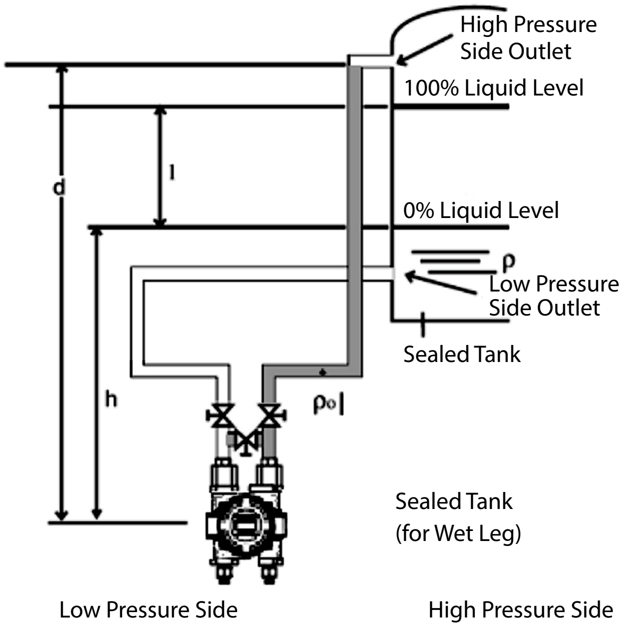


Figure 3-18. Sealed Tank (Wet Leg)

0% liquid level differential pressure

$$LRV = d\times\rho_0 - h\times\rho$$

100% liquid level differential pressure

$$URV = d\times\rho_0 - l\times\rho + h\times\rho$$
$$= d\times\rho_0 - (l+h)\times\rho$$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 1.0
l: 1500 mm
h: 250 mm
d: 2000 mm

would result in:

0% liquid level differential pressure

LRV = (2000×1.0) - (250×0.9) = 1775 mm H_2O = 17.41 kPa

100% liquid level differential pressure

URV = (2000×1.0) - (1500 + 250)×0.9 = 425 mm H_2O = 4.168 kPa

Accordingly,

Low limit (LRV): 17.41 kPa
High limit (URV): 4.168 kPa

is the resulting range.

(2) Calculation Example Using the JTC Model

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

ρ: Specific gravity of liquid in tank
ρ_0: Specific gravity of sealing liquid
l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the high pressure side output port
d: Distance between the seal pot side output port and the transmitter

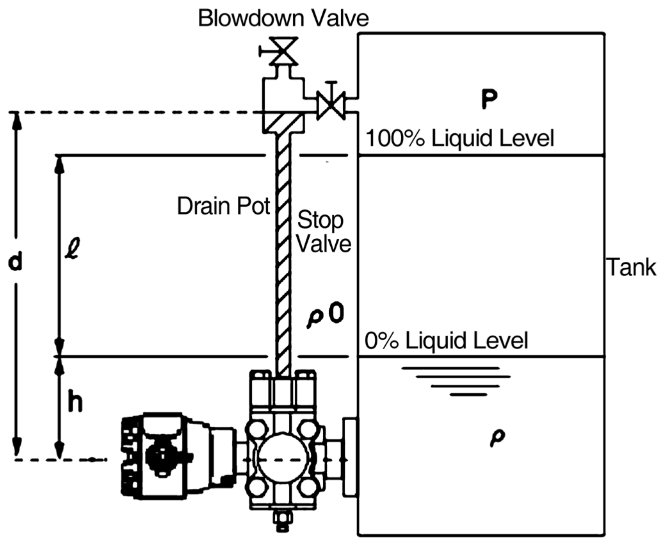


Figure 3-19. Sealed Tank (Wet Leg)

0% liquid level differential pressure

$LRV = h\times\rho - d\times\rho_0$

100% liquid level differential pressure

$URV = l\times\rho - h\times\rho$

$= (l+h)\times\rho - d\times\rho_0$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 1.0
l: 1500 mm
h: 250 mm
d: 2000 mm

would result in:

0% liquid level differential pressure

LRV = (250×0.9) - (2000×1.0) = -1775 mm H_2O = -17.41 kPa

100% liquid level differential pressure

URV = (1500 + 250)×0.9 - (2000×1.0)
= -425 mm H_2O = -4.168 kPa

Accordingly,

Low limit (LRV): -17.41 kPa

High limit (URV): -4.168 kPa

is the resulting range.

(3) Calculation Example Using the JTE Model

In some cases the high pressure flange is attached to the upper portion of the tank, and in some cases the high pressure flange is attached to the lower portion of the tank.

(i) If the high pressure side flange is attached to the upper portion of the tank

Calculation of the setting range is described below.
In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

ρ: Specific gravity of liquid in tank
ρ_0: Specific gravity of sealed liquid
l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the low pressure side mounting flange
d: Distance between the flanges

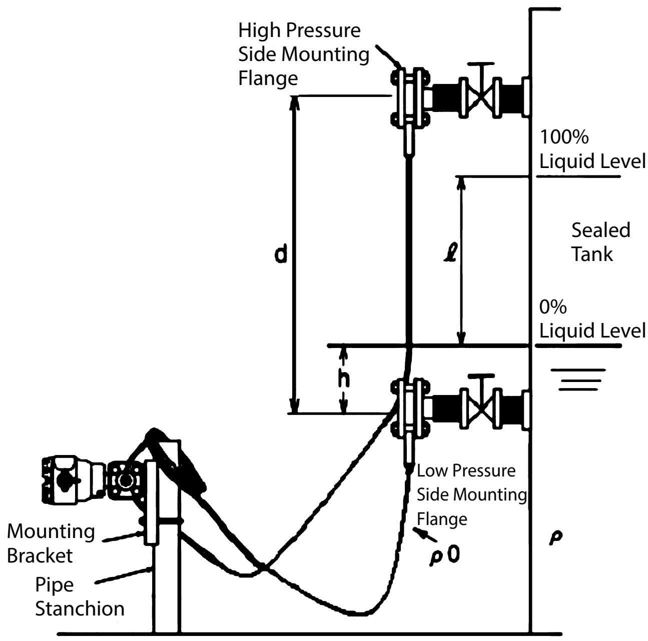


Figure 3-20. Sealed Tank (Wet Leg)

0% liquid level differential pressure

$LRV = d \times \rho_0 - h \times \rho$

100% liquid level differential pressure

$URV = d \times \rho_0 - l \times \rho - h \times \rho$

$= d \times \rho_0 - (l + h) \times \rho$

Accordingly,

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 0.935 (general-purpose remote)
l: 1500 mm
h: 250 mm
d: 2000 mm

would result in:

0% liquid level differential pressure

LRV = (2000×0.935) - (250×0.9) = 1645 mm H_2O = 16.13 kPa

100% liquid level differential pressure

URV = (2000×0.935) - (1500 + 250)×0.9
= 295 mm H_2O = 2.893 kPa

Accordingly,

Low limit (LRV): 16.13 kPa
High limit (URV): 2.893 kPa

is the resulting range.

(ii) If the high pressure side flange is attached to the lower portion of the tank

This connection is possible with the JTE929S.
In addition, if the sealed liquid temperature compensation function is enabled, affix a minus sign (-) to the height setting.

In this calculation, density and distance are represented by the following symbols. In addition, density is assumed to be constant during liquid level measurement.

ρ: Specific gravity of liquid in tank
ρ_0: Specific gravity of sealed liquid
l: Distance between the 100% liquid level and the 0% liquid level (measurement range)
h: Distance between the 0% liquid level and the high pressure side mounting flange
d: Distance between the flanges

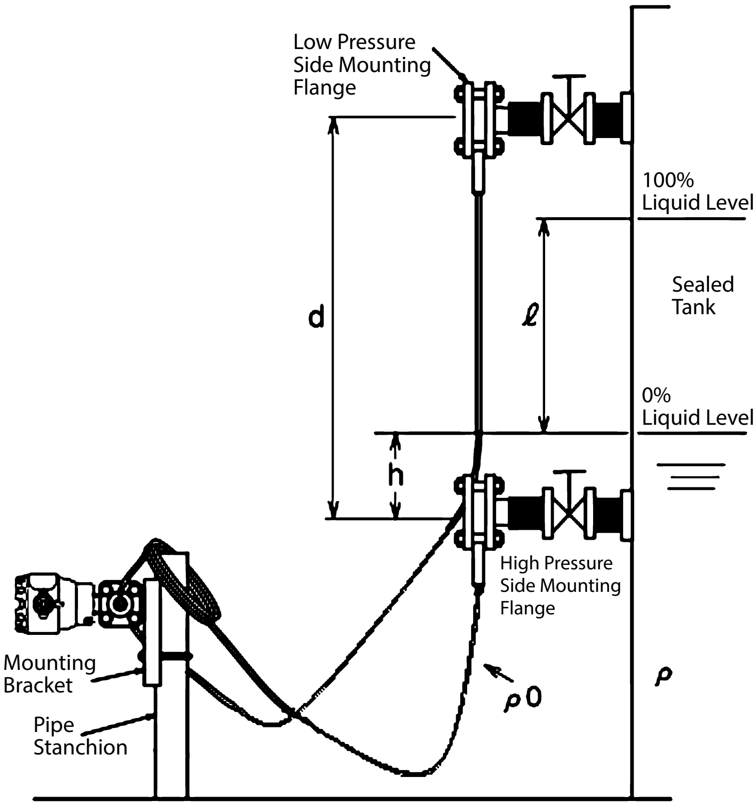


Figure 3-21. Sealed Tank (Wet Leg)

0% liquid level differential pressure

$LRV = h\times\rho - d\times\rho_0$

100% liquid level differential pressure

$URV = l\times\rho + h\times\rho - d\times\rho_0$

$= (l+h)\times\rho - d\times\rho_0$

Accordingly,

Low limit (LRV): $h\rho - d\rho_0$

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

is the range to set.

Calculation example:

ρ: 0.9
ρ_0: 0.935 (general-purpose remote)
l: 1500 mm
h: 250 mm
d: 2000 mm

would result in:

0% liquid level differential pressure

LRV = (250×0.9) - (2000×0.935)
= -1645 mm H_2O = -16.13 kPa

100% liquid level differential pressure

URV = (1500 + 250)×0.9 - (2000×0.935)
= -295 mm H_2O = -2.893 kPa

Accordingly,

Low limit (LRV): -16.13 kPa
High limit (URV): -2.893 kPa

is the resulting range.

3-11 Advanced Diagnostics (optional)

The advanced diagnostics include the pressure frequency index, the standard deviation, and calculation of the out-of-range pressure event count.

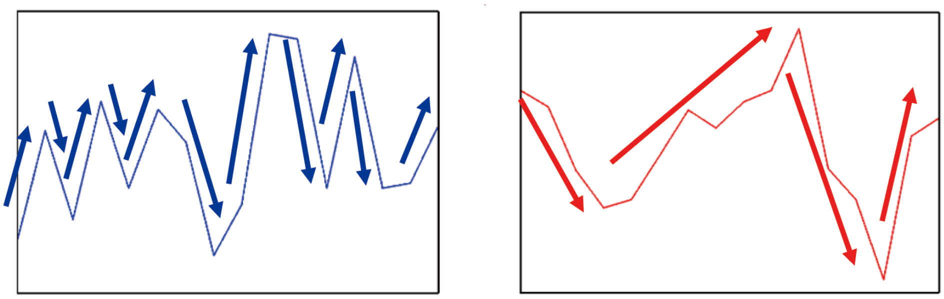
The diagnosis also determines whether the pressure frequency index, standard deviation, and the out-of-range pressure event count exceed the threshold values. Users can check alarms on the self-diagnostics status screen in the communicator if the results exceed a threshold. Alarms can also be checked on the built-in indicator of the transmitter.

3-11-1 Pressure Frequency Index

The pressure frequency index quantifies how often the input pressure goes up and down (fluctuation) with a number between 0 and 1. The index is calculated from data on the number of fluctuations during a time period of several minutes. It is possible to detect a change in process conditions by monitoring changes in this value. For example, the pressure frequency index can be used for diagnosis of clogged connecting pipes.

For information about diagnosis of clogged connecting pipes, see Appendix B.

In the practical example shown below, a change in the number of fluctuations of the input pressure when the process is operating normally and when conditions have changed can be easily seen.



normal conditions　　changed conditions

(1) Points to note

When using the pressure frequency index, note the following:
The pressure frequency index changes depending on a combination of factors. Thus, it may be difficult to detect a single abnormality or phenomenon by this index alone.

If the process is in an abnormal state from the beginning, it is not possible to detect a change caused by abnormal conditions. Carry out the steps described below in (3), “Preparation,” under normal conditions.

Even if an unexpected abnormality occurs, the pressure frequency index does not necessarily change immediately. This is because it takes a few minutes to calculate the frequency of the pressure fluctuation with a high level of accuracy. If an abnormality occurs briefly and conditions quickly return to normal, the change in the index will be small, and an alarm may not be activated.

If the transmitter is installed in an environment subject to excessive vibration, the pressure frequency index will be affected. As a result, an error may not be detected or there may be a false alarm. If the pressure frequency index is used to diagnose clogging of connecting pipes, problems may not be detected correctly, depending on the process conditions.

(2) Pressure Frequency Index-Related Parameters

Pressure frequency index-related parameters are shown below. For details on the attributes, see (4) below, “Checking the Settings.”

Pressure Frequency Index	Pressure frequency index
Press Freq Index Max	Maximum value of the pressure frequency index
Press Freq Index Min	Minimum value of the pressure frequency index
Reset Press Freq Index	Resetting the pressure frequency index
Press Freq Index Alarm Use	Operating mode of the pressure frequency index diagnostic alarm
Press Freq Index High Limit	Upper limit of the pressure frequency index (Diagnostic alarm threshold—high limit)
Press Freq Index Low Limit	Lower limit of the pressure frequency index (Diagnostic alarm threshold—low limit)
Press Freq Index Sensor Selection	Sensor selection
Press Freq Calc PV High Limit	Upper limit of pressure value filter
Press Freq Calc PV Low Limit	Lower limit of pressure value filter
Press Freq Filter Constant	Pressure frequency filter constant

(3) Preparation

First, it is necessary to monitor the process under normal conditions. The process should be monitored for time periods ranging from several hours to one day (the amount of time required for each condition to occur, if there is a significant change in the operating conditions).

The way to monitor the process under normal conditions is to monitor trends in the pressure frequency index. If that is not possible, an easier way is to obtain the maximum and minimum values of the pressure frequency index.

(i) Monitoring of trends in the pressure frequency index

See the CommStaff Operation Manual (HART 7).

(ii) Obtaining the maximum and minimum values of the pressure frequency index

Follow the procedure below to obtain the maximum and minimum values of the pressure frequency index.

Reset the pressure frequency index and its maximum and minimum values when the process is stable under normal conditions. Recording of the maximum and minimum values then begins anew .

To reset, execute Reset Press Freq Index.

This resets the pressure frequency index and its maximum and minimum values.

Note that resetting prevents these parameters from obtaining correct values until a new pressure frequency index is calculated.

Once the set amount of time has elapsed, observe the value of the following two variables.

Press Freq Index Max	Maximum value of the pressure frequency index
Press Freq Index Min	Minimum value of the pressure frequency index

(4) Checking the Settings

For information about setting the following descriptive parameters, see the operating manual for the relevant communicator.

(i) Setting the alarm

Based on the results from the Preparation section, set the variables for the upper and lower limits of the pressure frequency index.

Press Freq Index High Limit:	The setting range is between 0.0 and 1.0.
Press Freq Index Low Limit:	The setting range is between 0.0 and 1.0.

Next, set the operating mode of the pressure frequency index diagnostic alarm. Press Freq Index Alarm Use: The possible settings are shown below.

Disabled:	Alarm is not used.
Enabled (High):	Upper limit only
Enabled (Low):	Lower limit only
Enabled (High and Low):	Upper and lower limits

(ii) Alarm detection

If a pressure frequency index alarm is detected, it is reported as the appropriate self-diagnostic status. See section "4-4 Troubleshooting"

(iii) Sensor Selection and P Sampling Interval

The sensor and pressure sensor sampling interval can be set. Press Freq Index Sensor Selection: The possible settings are shown below.

For a differential pressure (DP) gauge

DP, 120ms	factory default
DP, 240ms	
DP, 360ms	
SP, 360ms	

For a pressure gauge (GP) or absolute pressure gauge (AP)

DP, 120ms	factory default
DP, 240ms	
DP, 360ms	

- Sensor selection

  For a differential pressure gauge, an SP sensor can be selected in addition to a DP sensor. If an SP sensor is selected, fluctuations in static pressure can be detected. Using the static pressure fluctuations allows the monitoring of the state of the process or application in a perspective different from that of differential pressure fluctuations.

  For example, when the pressure frequency index is used to detect clogged connecting pipes, a change in the pressure fluctuation frequency caused by clogging on one side may appear more quickly in the static pressure than in the differential pressure. Therefore, the SP sensor has the potential to detect clogging faster.

  The pressure frequency index is calculated based on the data from the SP sensor, provided that the pressure to be measured is sufficiently high and the SP sensor is capable of detecting pressure fluctuations.

- P Sampling Interval
  Select the sampling interval for the differential pressure and pressure value that is used to calculate the pressure frequency index value when [DP Sensor] is selected for [Sensor Selection]. The options are 120, 240, and 360 ms.

  The shorter the fluctuation detection cycle is, the higher the upper limit on detectable frequencies becomes. However, a short fluctuation detection interval results in the lower limit being raised. A longer fluctuation detection cycle lowers the upper limit on detectable frequencies but allows the detection of lower frequencies.

  To detect phenomena resulting from high frequencies, as in the case of clogging of connecting pipes, it is generally better if the fluctuation detection cycle is as short as possible. However, if the original pressure fluctuation frequency is low, it may go out of the range of detectable frequencies, making it difficult to detect fluctuation. Therefore, when setting the sampling interval, it is necessary to take into consideration the pressure fluctuation frequency under normal conditions and the frequency domain in which abnormalities occur.

(iv) Filter adjustments

The pressure frequency index is intended to detect abnormalities in a process. However, if the pressure and flow rate naturally change slowly over a period of 40 seconds to five minutes (low-frequency fluctuation), the index may fall to a low value even if the process is normal. Since such fluctuation in pressure and flow rate can occur in a normal process, a fall in the index may wrongly suggest an abnormality, or it may not be possible to correctly detect actual abnormalities.

To prevent false recognition of abnormalities resulting from a reduction in the index value, high pass filtering is performed to remove the low-frequency component before the number of fluctuations is counted.

The strength of the filter (filter coefficient) can be set.

Press Freq Filter Constant: The possible setting range is between 0.0 and 1.0.
The factory default is 0.0.

Increase the filter coefficient to remove more low-frequency components, and decrease the coefficient for the opposite effect. Note that increasing the coefficient decreases the filter's ability to detect abnormalities.

3-11-2 Standard Deviation

This function calculates the standard deviation of the input pressure. It can be used for diagnostic processes that detect a change in process conditions.

(1) Equation

The following equation is used to calculate the standard deviation (s).

$$s^2 = \frac{1}{n}\sum_{i=1}^{n} x_i^2 - (\bar{x})^2 = \overline{x^2} - (\bar{x})^2$$

s: Standard deviation
x: Input pressure
n: Number of samples

(2) Parameters Related to the Standard Deviation

Standard deviation-related parameters are shown below. For details on the attributes, see (4) below, “Checking the Settings.”

Standard Deviation	Standard deviation
Standard Deviation	Maximum amount of standard deviation
Standard Deviation	Minimum amount of standard deviation
Average Pressure	Average pressure
Standard Deviation Unit	The unit of measurement for standard deviation
Reset Standard Deviation	Reset of the standard deviation and average
Standard Deviation Sample Count	Number of samples used for calculation
Standard Deviation Alarm Use	Operating mode of the standard deviation alarm
Standard Deviation High Limit	Upper limit of standard deviation (alarm threshold—high limit)
Standard Deviation Low Limit	Lower limit of standard deviation (alarm threshold—low limit)

(3) Preparation

First, it is necessary to monitor the process under normal conditions. The process should be monitored for a time period of one to several hours (the amount of time required for each condition to occur, if there is a significant change in the operating conditions).

The way to monitor the process under normal conditions is to monitor trends in the standard deviation. If that is not possible, an easier way is to obtain the maximum and minimum standard deviation.

(i) Monitoring trends in standard deviation

To monitor trends in the standard deviation, see the CommStaff Operation Manual (HART 7).

(ii) Obtaining the maximum and minimum standard deviation

Follow the procedure below to obtain the maximum and minimum standard deviation.

Reset the standard deviation and its maximum and minimum values when the process is stable under normal conditions. Recording of the maximum and minimum values then begins anew . To reset, execute Reset Standard Deviation. This resets the standard deviation, its maximum and minimum values, and the average pressure.

Once the set amount of time has elapsed, observe the value of the following two variables.

Standard Deviation Max	Maximum amount of standard deviation
Standard Deviation Min	Minimum amount of standard deviation

(4) Checking the Settings

For information about setting the following descriptive parameters, see the operating manual for the relevant communicator.

(i) Setting the alarm

Based on the results from the Preparation section, set the variables for the upper and lower limits of standard deviation.

Standard Deviation High Limit:	The possible setting range is 0 and above.
Standard Deviation Low Limit:	The possible setting range is 0 and above.

Next, set the operating mode of the standard deviation alarm.

Standard Deviation Alarm Use:	The possible settings are shown below.	
	Disabled:	Alarm is not used.
	Enabled (High):	Upper limit only
	Enabled (Low):	Lower limit only
	Enabled (High and Low):	Upper and lower limits

(ii) Alarm detection

If a standard deviation alarm is detected, it is reported as the appropriate self-diagnostic status. See section "4-4 Troubleshooting"

(iii) Number of samples

The number of samples of pressure used to calculate the standard deviation is set at 1,000 at the factory. The sampling interval is approximately 60 ms ; the standard deviation is calculated once every 60 seconds (approx.).

To change the number of samples, use the following parameter:
Standard Deviation Sample Count: Can be set in a range from 1,000 (approx. 1 minute) to 60,000 (approx. 1 hour).

3-11-3 Out-of-Range Pressure Event Count

The number of times the process pressure exceeds a preset threshold pressure (high or low limit) is counted. If the out-of-range pressure event count is greater than the alarm threshold, an alarm is issued.

(1) Parameters Related to the Out-of-Range Pressure Event Count

The parameters related to the out-of-range pressure event count are shown below. For details on the attributes, see the CommStaff Operating Manual (HART 7).

OOR Pressure Count	Out-of-range pressure event count
Reset OOR Pressure Count	Resetting of the out-of-range pressure event count
Normal Pressure High Limit	Upper limit of normal pressure for the out-of-range pressure event count
Normal Pressure Low Limit	Lower limit of normal pressure for the out-of-range pressure event count
OOR Count Alarm Use	Operating mode of the out-of-range pressure event count alarm
OOR Count Alarm Threshold	Threshold of the out-of-range pressure event count alarm

(2) Preparation

To reset an already generated out-of-range pressure event count, execute Reset OOR Pressure Count.

(3) Checking the Settings

For information about setting the following descriptive parameters, see the operating manual for the relevant communicator.

(i) Setting the alarm

Set the following parameters for the alarm threshold of the out-of-range pressure event count.
OOR Count Alarm Threshold: The possible setting range is 100,000 or less.
Next, set the operating mode of the out-of-range pressure event count alarm.

OOR Count Alarm Use: The possible settings are shown below.
Disabled: Alarm is not used.
Enabled: Alarm is used.

(ii) Alarm detection

If an out-of-range pressure event count alarm is detected, it is reported as the appropriate self-diagnostic status. See section "4-4 Troubleshooting"

(iii) Threshold pressure

Set the following for the out-of-range pressure event count threshold pressure (high and low limits).

Normal Pressure High Limit: −1.5*URL to 1.5*URL
Normal Pressure Low Limit: −1.5*URL to 1.5*URL

Chapter 4 Maintenance and Troubleshooting of this Device

This chapter describes this device's data storage, assembly and disassembly, output checking, calibration methods, and countermeasures if problems occur.

4-1 Assembly and Disassembly of this Device

4-1-1 Cautions During Assembly and Disassembly

⚠Warning	
❗	When detaching this product from the process for maintenance and the like, clear vents and drains in order to remove residual pressure and residues in the measurement target. In addition, when clearing vents and drains, check the direction in which material will come out in order to avoid any contact with the human body. There is a danger of scalding and other harmful health effects. If the measured fluid is harmful to the human body, take safety measures such as wearing goggles or a mask so that it does not adhere to the skin or the eyes, become inhaled, etc.
❗	Particular care must be exercised due to the fact that, for pressure-resistant, explosion-proof transmitters, the pressure-resistant, explosion-proof performance specifications may be lost as a result of corrosion, deformation, or scratching of the case or case cover, or damage to the threaded portions or connecting surfaces.
❗	Do not open the case cover in the hazardous areas described in 2-1-2 when the device is powered up.
❗	For pressure-resistant, explosion-proof model transmitters, the pressure-resistant, explosion-proof performance specifications are ensured by locking the case cover. Fasten the case cover completely, and be sure to lock it.
❗	Replace damaged seal gaskets. If this product is operated in a damaged state, it will not be possible to ensure sufficient performance of the seals, and there is a danger that the measured fluid will spurt out, possibly resulting in scalding and other harmful health effects.
❗	Use genuine parts as replacements. In particular, for gaskets, adapter flanges, and the like, parts from other manufactures may in some cases fit into place, but they cannot ensure pressure resistance and airtightness. The result may be leakage of the measured fluid, with possible harmful effects on human health.
❗	Be sufficiently careful of residues from measured fluids which are left behind in the product. If materials which affect the human body are contained in these residues, harmful effects on human health could result. When performing maintenance on a product which has been uninstalled, first clean the pressure-receiving parts adequately.
❗	If evidence of corrosion is observed in pressure-bearing parts such as through bolts, nuts, and pressure-release rings, replace them. Parts whose pressure-resistance has decreased can break and thus are dangerous. There is also a risk of physical injuries such as bruises and lacerations caused by broken parts.
❗	When loosening through bolts and nuts to remove the device, hold the drain ring assembly to prevent it from falling off. If it falls because sufficient care is not taken, it can cause injuries or product damage.

4-1-2 Attaching and Detaching the Case Cover

This product has a locking structure. When detaching the case cover, first loosen the lock using a standard hexagonal wrench. When attaching the case cover, first screw on the case cover tightly, and then fasten the lock using the hexagonal wrench.
When attaching the case cover, first screw on the case cover tightly, and then fasten the lock using the hexagonal wrench. For information on how to install the case cover, see section 2-4-1 (7).

⚠Caution

After detaching the case cover, be careful that dust, rainwater, etc., do not enter the inside of the transmitter case.

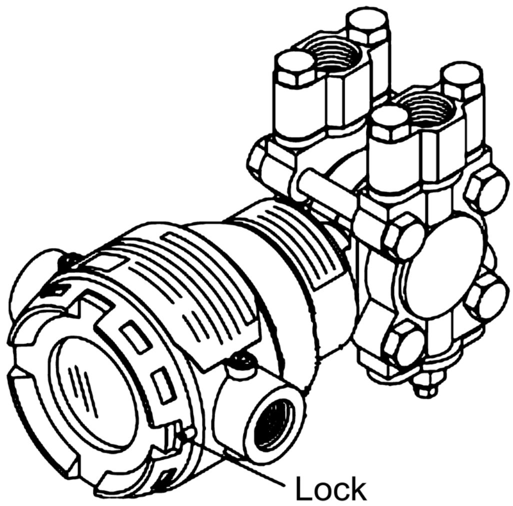


Figure 4-1.   Locking the Device

4-1-3 Attaching and Detaching the Main Unit Cover (JTD, JTG, JTA, and JTC)

(1) Detachment

When detaching the main unit cover, remove the four sets of nuts and bolts shown in the diagram below.

⚠Caution
After detaching the main unit cover, be careful not to scratch the diaphragm.

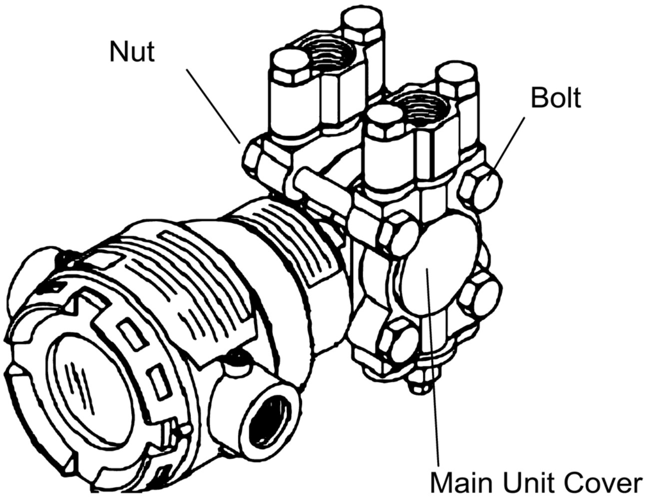


Figure 4-2. Nuts and Bolts Fastening the Main Unit Cover

(2) Attachment

When attaching the main unit cover, fasten the bolts to the appropriate tightening torque below. If the seal gaskets are damaged, replace them with new ones.

Table 4-1. Cover Bolt and Nut Tightening Torques (N·m)

Model Number	Process Wetted Material	Bolt/ Nut Material	Bolt and Nut Tightening Torques (N·m)		
			Main Unit Cover Material SCS14A		Main Unit Cover Material PVC
			When Using New Gaskets	When Reusing Gaskets	When Reusing Main Unit Cover in Gen'l
JTD910S	SUS316	SUS304	15±1	10±1	-
JTD920S JTD930S	SUS316 ASTMB575	SNB7	22±2	17±1	10±1
		SUS630	22±2	17±1	-
		SUS304	15±1	10±1	10±1
JTD920S JTD930S JTD960S	Tantalum SUS316L	SNB7	22±2	17±1	10±1
		SUS630	-	-	-
		SUS304	15±1	10±1	10±1
JTD921S JTD931S JTD961S	SUS316	SNB7	90±20	90±20	-
		SUS630	90±20	90±20	-
		SUS304	55±10	55±10	-
JTG940S JTG960S	SUS316 ASTMB575 Tantalum SUS316L	SNB7	22±2	17±1	10±1
		SUS630	22±2	17±1	-
		SUS304	15±1	10±1	10±1
JTG980S	SUS316 ASTMB575	SNB7	90±20	90±20	-
		SUS630	90±20	90±20	-
		SUS304	55±10	55±10	-
JTA922S JTA940S	SUS316 ASTMB575 Tantalum SUS316L	SNB7	22±2	17±1	-
		SUS630	22±2	17±1	-
		SUS304	15±1	10±1	-
JTC929S JTC940S	SUS316	SNB7	22±2	17±1	-
		SUS630	22±2	17±1	-
		SUS304	15±1	10±1	-

Table 4-2. Adapter Flange Bolt and Nut Tightening Torque

Bolt and Nut Material	Bolt and Nut Tightening Torques (N·m)	
	Adapter Flange Material SCS14A	Adapter Flange Material PVC
Carbon Steel	20±1	7±0.5
SUS630	20±1	-
SUS304	10±0.5	7±0.5

4-1-4 Cleaning the Device

(1) Introduction

In order to maintain the performance specifications of the transmitter, it is necessary to thoroughly clean the transmitter and pipes. If, for example, sediment accumulates in the pressure chamber of the transmitter, it can cause measurement errors.

(2) Cleaning the Main Unit (JTD,JTG,JTA and JTC)

(i) Procedure

(1) Remove the bolts and nuts, and detach the main unit cover.

(2) Clean the diaphragm, the inside of the main unit cover, etc., using a soft brush and solvent. When doing so, be careful not to deform or scratch the diaphragm.

(3) During re-assembly, replace cover gaskets with new ones as necessary.

(4) Fasten bolts and nuts to the prescribed fastening torque (Table 4-1).

When measuring and stopping operation of a device in a cold area in which there is a risk that water (etc.) may freeze, remove the water from the main unit. Loosen the drain plugs.

(3) Cleaning Remote Seal Models

There is no need for routine maintenance and inspection. If the flanges are removed for maintenance, clean the diaphragm with a soft brush and solvent. When doing so, be careful not to deform or scratch the diaphragm.

(4) Cleaning the Drain Ring Assembly and 1/2B Remote Adapter

If sediment has accumulated in the vent/drain plugs, the process fluid may not be sufficiently vented/drained. Using a soft brush and solvent, clean the drain ring assembly and 1/2B remote adapter. When doing so, exercise care not to deform or scratch the gasket surfaces and the thread seal. When measuring and stopping operation of a device in a cold area in which there is a risk that water and/or other objects or substances may freeze, loosen the drain plugs to remove the water from the vents and drains.

4-1-5 Replacement of Electronics Module

The electronics module on the indicator-integrated terminal block can be replaced. Use the following procedure.

- Replacement Procedure
  Use the following procedure to replace the electronics module.

⚠Caution	
⃠	The electronic components on the electronics module are susceptible to damage from electrostatic discharge. Avoid touching them with your hands. If you need to touch them, bring your body's electrical potential to the same potential as that of the electronic components before touching them.
❗	Place the removed electronics module into a conductive bag to protect it from damage due to electrostatic discharge.

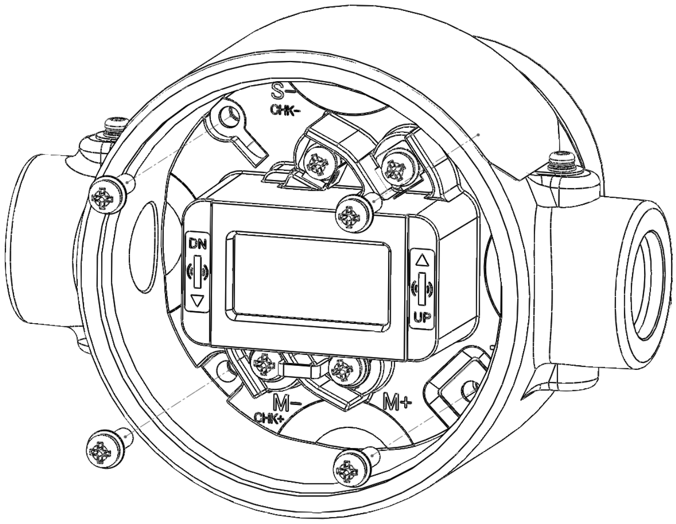
◆ Dismount terminal board assembly ◆

(1) Turn off the transmitter.

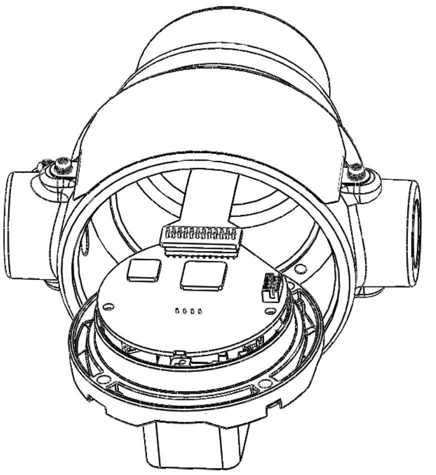
(2) Dismount transmitter case cover.

(3) Disconnect signal cables from the terminals. Disconnect the conduit pipe from the case. Pull out the signal cables from the case.

(4) Remove the 4 screws that fix the indicator/terminal board assembly.



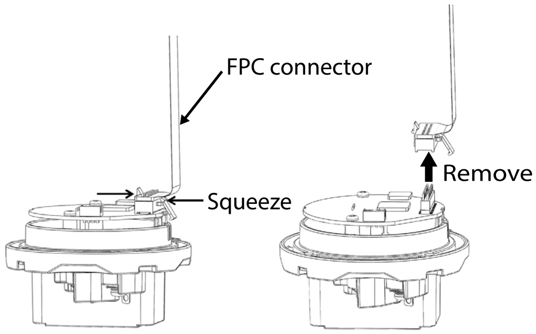
(5) Pull out toward you, the indicator/terminal board assembly.



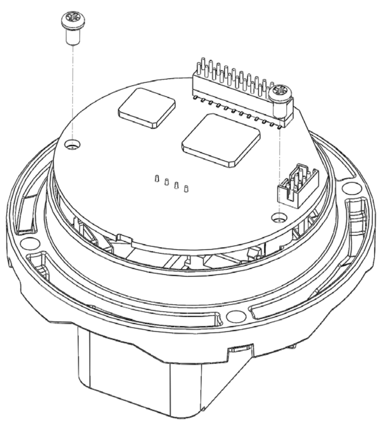
⚠Caution

Hold both ends of the display unit with fingers. Pull out gently and without any sideways movement, the assembly.
The flexible cable may be destroyed if pulled with too much force.

(6) Remove the FPC connector with the connector cover to separate the indicator/terminal board assembly from the body. Remove the connector cover with pinching the protrusion of the cover.



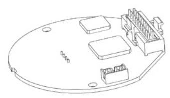
(7) Remove the LCD cable connector from the assembly with an indicator/terminal board assembly and remove the 2 screws that fix the electronics module.



(8) Remove the electronics module from the indicator/terminal board assembly.

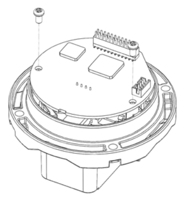
◆ Mount terminal board assembly ◆

(1) Remove the connector cover from the FPC connector. Assemble the connector cover to a new electronics module.

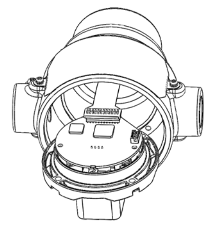


(2) Assemble the electronics module to the indicator/terminal board assembly.

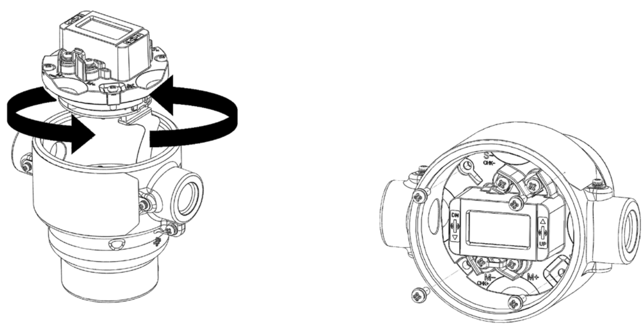
(3) Fix the electronics module with the 2 screws and connect the LCD connector to the electronics module.
Tightening torque: 0.6±0.1N·m



(4) Assemble the FPC connector to the electronics module.



(5) Mount the indicator/terminal board assembly with 2 rotations not to damage the flexible printed circuit board (FPC).



⚠Caution
"S+" and "S-" terminals should be in the upper side.

(6) Fix the indicator/terminal board assembly with 4 screws.
Tightening torque: 1.2±0.1N·m

(7) Assemble the case cover to the body. Always lock the cover.

⚠Caution
Tighten the cover firmly. Any looseness may result in water ingress. Refer to 4-2-1.

4-2 Calibration of the Setting Range and Output Signal

This section describes calibration work which is performed at our company and at designated service stations. Since precise reference input devices and measuring instruments are necessary, this is not work that will typically be carried out by users, but it is described in case it absolutely must be performed.
As shown below, there are two types of calibration.

- Setting range calibration (input calibration) using a reference input device
- Output signal calibration

4-2-1 Setting Range Calibration Using a Reference Input Device

(1) Preparation

The method for calibrating the lower range value (LRV) and upper range value (URV) of the setting range by inputting a reference pressure into the device is described below. First calibrate the lower range value, and then the upper range value.

(2) Device to Use

For this calibration, have the following devices available. The required performance specifications for each device are provided for reference. It is desirable for the uncertainty of the measuring device to be at least four times the accuracy of the transmitter to be calibrated.

- Standard pressure generator: One that can generate pressures in the measurement range of the device
  Accuracy: ±0.025% rdg.
- Power supply: 24 V DC
- Precision resistor: 250 Ω ± 0.005%
- Voltmeter: 10 V DC range ± 0.02% + 1 digit
- Communicator: CommStaff, HART communicator

(3) Caution

The accuracy of this device after calibration depends on the performance specifications of the device used here.

(4) Calibration Conditions

Perform real pressure calibration under the following environmental conditions.

- Perform calibration in a windless test chamber. If there is a wind, pressure will be applied to the pressure-receiving part on the side that is open to the atmosphere, which may exert an effect on calibration accuracy.
- Standard operating temperature of 23 °C, humidity of 65%. Provided that there is no rapid fluctuation, there will not be any significant effects even if the temperature is in the 15 to 35 °C range, or if humidity is in the 45 to 75% range.

(5) Wiring and Piping During Calibration

In general, the following wiring and piping should be employed.

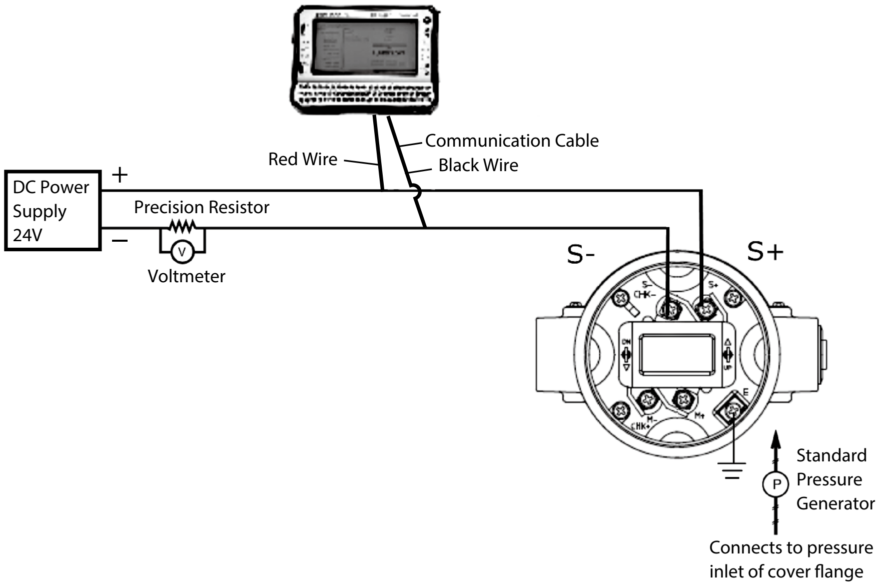


Figure 4-3. Wiring and piping during Calibration

(6) Checking the Setting Range

See the operation manuals for the respective communicators.

CommStaff Instruction Manual	(HART5) Section 2-6 / (HART7) Section 1-3
HART Communicator Operation Manual	(HART5) Section 3-2-1 / (HART7) Section 3-2-1

(7) Measurement Range Calibration Procedure

See the operation manuals for the respective communicators.

CommStaff Instruction Manual	(HART5) Section 4-2 / (HART7) Section 3-2
HART Communicator Operation Manual	(HART5) Section 3-2-8 / (HART7) Section 3-3-2

4-2-2 Output Signal Calibration

(1) Preparation

In normal circumstances, output signal calibration (D/A converter adjustment) is not necessary and should not be done. If performing this operation cannot be avoided, have the following devices on hand.

(2) Required Equipment

- Precision ammeter: 0.03% FS
- Precision resistor: 250 Ω ± 0.005%
- Communicator: CommStaff, HART communicator

(3) Wiring for Calibration

When wiring, refer to the following diagram. In order to check that connections are correct and that the device and communicator are communicating, do the connection testing described in Section 3-1-1.

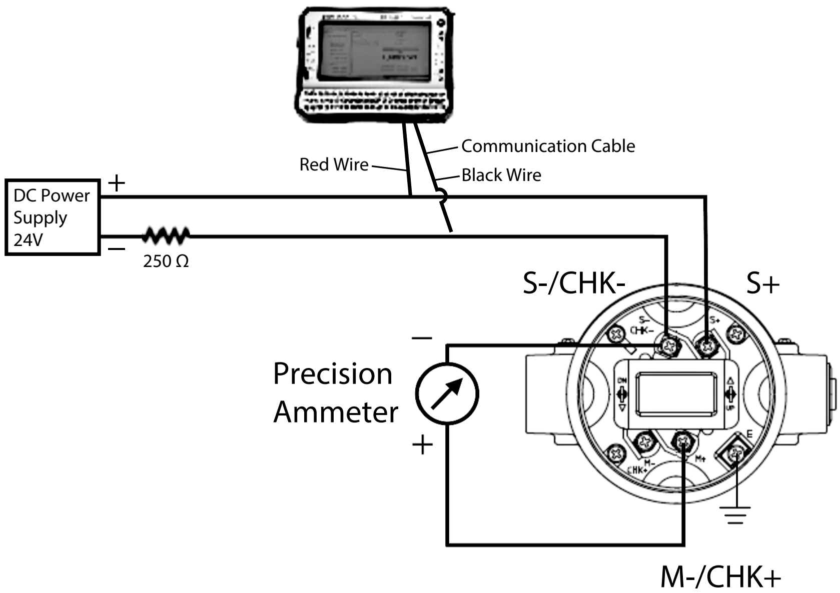


Figure 4-4. Wiring

(4) Output Signal Calibration Procedure

See the operation manuals for the respective communicators.

CommStaff Instruction Manual	(HART5) Section 4-1 / (HART7) Section 3-1
HART Communicator Operation Manual	(HART5) Section 3-2-8 / (HART7) Section 3-3-2

4-3 Calibration Value Restoration and History Functions

The functions described here require connection with a communicator.

> **⚠Caution**
>
> If the transmitter uses SFN communication while the process is in the automatic control state, the output may fluctuate, and the device may enter a dangerous operating state. Before performing this operation, be sure to switch the control loop of the process to manual control.

4-3-1 Restoring the Factory Calibration Value

This function reverts the transmitter's calibration value to the state at the time of factory shipping. If calibration has been performed using an erroneous value, the factory value can be restored.

Field Communication Software (Model CFS100) Instruction Manual
(HART5) Section 4-3 / (HART7) Section 3-3

HART Communicator Operation Manual
(HART5) Section 3-2-8 / (HART7) Section 3-3-2-1

4-3-2 Diagnostics History Display

Displays the diagnostic results stored in the transmitter. It enables errors which occurred in the past to be checked. For information regarding the contents of the diagnostic messages, see Table 4-3.

Field Communication Software (Model CFS100) Instruction Manual
(HART5) Section 4-5 / (HART7) Section 3-5

HART Communicator Operation Manual
(HART5) Section 3-3-2 / (HART7) Section 3-4-2

Table 4-3.

HART5

	Diagnostics Display Message	Description
Critical Status	Analog/Digital Conversion Fault	An error occurred during analog-to-digital conversion.
	Sensor Characteristic Data Fault	An error was detected in the sensor characteristic data.
	Suspect Input	Input data error
	CPU Fault	CPU operation failure
	NVM Fault	Nonvolatile memory error
	RAM Fault	RAM failure
	ROM Fault	ROM failure
	Output Circuit Fault	Output circuit failure
Internal Data Inconsistency	Invalid Database	Configuration data and/or calibration data is invalid.
Non-Critical Status	Meter Body Over Temperature	Meter body is too hot.
	Excess Zero Correct	The zero Calibration Value exceeds the limit for accurate measurement.
	Excess Span Correct	The span Calibration Value exceeds the limit for accurate measurement.
	Meter Body Overload or Fault	Indicates whether the present output level is higher than the Output Alarm High Limit setting.
	Correct Reset	Clears the calibration data.
	External Zero/Span Adjustment Fault	The zero Calibration Value exceeds the limit for accurate measurement.
	Output Alarm Deected	The output is going over upper/lower limit of output alarm.
	Sensor Temp. Alarm Detected	The sensor temperature is going over upper/lower limit of sensor temp. alarm.

Table 4-3.

HART7

	Diagnostics Display Message	Description
Failure	Analog/Digital Conversion Failure	An error occurred during analog-to-digital conversion.
	Sensor Characteristic Data Failure	An error was detected in the sensor characteristic data.
	Suspect Input	Input data error
	CPU Failure	CPU operation failure
	NVM Failure	Nonvolatile memory error
	RAM Failure	RAM failure
	ROM Failure	ROM failure
	Output Circuit Failure	Output circuit failure
	Invalid Database	Configuration data and/or calibration data is invalid.
Out of Specification	Meter Body Over Temperature	Meter body is too hot.
	Meter Body Overload or Failure	The input pressure is more than two times the upper range limit for the device. Or,-Device error
	High Output Alarm	Indicates whether the present output level is higher than the Output Alarm High Limit setting.
	Low Output Alarm	Indicates whether the present output level is lower than the Output Alarm Low Limit setting.
	High Sensor Temp. Alarm	Indicates whether the present sensor temperature is higher than the Sensor Temp. Alarm High Limit setting.
	Low Sensor Temp. Alarm	Indicates whether the present sensor temperature is lower than the Sensor Temp. Alarm Low Limit setting.
Maintenance Required	External Zero/Span Adjustment Failure	An error occurred during external adjustment of the zero point or span.
	Excess Zero Calibration Value	The zero Calibration Value exceeds the limit for accurate measurement.
	Excess Span Calibration Value	The span Calibration Value exceeds the limit for accurate measurement.
	Not Calibrated	Clears the calibration data.
	Pressure Frequency Index Alarm	Check Process and/or Impulse Line.
	Standard Deviation Alarm	Check Process Conditions.
	Out-of-Range Count Alarm	Check Operating Conditions.

4-3-3 Zero Calibration Internal Data

This concerns the zero point calibration data saved in the transmitter. The function saves zero point calibration data, which can be read using a communicator. By viewing shifts in the zero calibration value, the transmitter maintenance interval and replacement period can be estimated

Field Communication Software (Model CFS100) Instruction Manual
(HART5) Section 4-6 / (HART7) Section 3-6

HART Communicator Operation Manual
(HART5) No display capability on HART communicator / (HART7) Section 3-4-3

4-4 Troubleshooting

If the transmitter does not operate, or if it operates erroneously, check the items in Tables 4-4 and 4-5. If the situation does not improve even after performing these checks, stop using the device immediately, turn off the power, and contact one of our branch offices, sales offices, or distributors.

Table 4-4. Troubleshooting

Phenomenon	Countermeasures
Nothing is displayed on the display	· Confirm that the correct power supply voltage is being applied. · Confirm that the power supply is connected.
Output is fixed at 0	· Confirm that the device's settings are correct. · Confirm that the flow rate is not in the low-flow cutoff range. · Confirm that there are no clogs in the connecting pipes. · Confirm that the manifold valve, stop valves, etc., are in the correct open and closed states.
Output is shifted	· Confirm that fluid is not leaking from the pipes. · Confirm that fluid is not flowing in reverse. · Confirm that the respective directions of the high pressure side and low pressure side connections are correct. · Confirm that the transmitter is not tilted significantly.

In addition to the above, check the following.

- Self-diagnostics results using the communicator (Table 4-5)
- Whether there are leaks in the pipe connectors
- Whether the product side bolt fasteners are loose
- Whether any pipes are loose or disconnected
- Whether the power supply voltage, load resistance, etc., are in accordance with the specifications
- Whether the pressure and temperature are in accordance with the specifications
- Whether there are any strong sources of magnetism or electrical noise nearby

Table 4-5.

HART5

	Indicator Display	Diagnostics Display Message	Description	Countermeasures
Critical Status	Err.01 A-D CNV	Analog/Digital Conversion Fault	An error occurred during analog-to-digital conversion.	There is a problem with the sensor. Contact customer service.
	Err.02 PROM	Sensor Characteristic Data Fault	An error was detected in the sensor characteristic data.	
	Err.03 INPUT	Suspect Input	Input data error	
	Err.04 CPU	CPU Fault	CPU operation failure	There is a problem with the printed circuit board. Contact customer service.
	Err.05 NVM	NVM Fault	Nonvolatile memory error	
	Err.06 RAM	RAM Fault	RAM failure	
	Err.07 ROM	ROM Fault	ROM failure	
	Err.08 OUTPUT	Output Circuit Fault	Output circuit failure	
Internal Data Inconsistency	Err.09 CONFIG	Invalid Database	Configuration data and/or calibration data is invalid.	

Table 4-5.

HART5

	Indicator Display	Diagnostics Display Message	Description	Countermeasures
Non-Critical Status	AL.20 M/B. TEMP	Meter Body Over Temperature	Meter body is too hot.	Change the installation so that the temperature of the meter body falls within the specified range. Alternatively, check that the temperature of the process fluid is not abnormal.
	AL.21 ZERO. CAL	Excess Zero Correct	The zero Calibration Value exceeds the limit for accurate measurement.	Check that the input pressure is appropriate for the calibration value, and calibrate again.
	AL.22 SPAN. CAL	Excess Span Correct	The span Calibration Value exceeds the limit for accurate measurement.	
	OUTPUT% OUTMODE	In Output Mode	The device is operating in Output Mode.	Exit from output mode
	AL.24 OVRLOAD	Meter Body Overload or Fault	The input pressure is more than two times the upper range limit for the device. Or, Device error	Exit from failure alarm simulation mode
	AL.26 NO.CALIB	Correct Reset	Clears the calibration data.	Restart the calibration value at the time of shipping, or calibrate the high and low limits of the setting range.
	AL.28 SWITCH	External Zero/Span Adjustment Fault	An error occurred during external adjustment of the zero point or span.	There is a problem with the external zero adjustment switch or the printed circuit board. Contact customer service.
	[blank] F/A SIM	Failure Alarm Simulation Mode	The device is operating in Failure Alarm Simulation Mode.	Exit from failure alarm simulation mode
	AL.51 OUT%.AL	Output Alarm Deected	The output is going over upper/lower limit of output alarm.	Check the output value
	AL.52 TEMP.AL	Sensor Temp. Alarm Detected	The sensor temperature is going over upper/lower limit of sensor temp. alarm.	Check the sensor temperature.

Table 4-5.

HART7

	Indicator Display	Diagnostics Display Message	Description	Countermeasures
Failure	Err.01 A-D CNV	Analog/Digital Conversion Failure	An error occurred during analog-to-digital conversion.	There is a problem with the sensor. Contact customer service.
	Err.02 PROM	Sensor Characteristic Data Failure	An error was detected in the sensor characteristic data.	
	Err.03 INPUT	Suspect Input	Input data error	
	Err.04 CPU	CPU Failure	CPU operation failure	There is a problem with the printed circuit board. Contact customer service.
	Err.05 NVM	NVM Failure	Nonvolatile memory error	
	Err.06 RAM	RAM Failure	RAM failure	
	Err.07 ROM	ROM Failure	ROM failure	
	Err.08 OUTPUT	Output Circuit Failure	Output circuit failure	
	Err.09 CONFIG	Invalid Database	Configuration data and/or calibration data is invalid.	
Function Check	OUTPUT% OUTMODE	In Output Mode	The device is operating in Output Mode.	Exit from output mode
	[blank] F/A SIM	Failure Alarm Simulation Mode	The device is operating in Failure Alarm Simulation Mode.	Exit from failure alarm simulation mode
Out of Specification	AL.20 M/B. TEMP	Meter Body Over Temperature	Meter Body Over Temperature	Change the installation so that the temperature of the meter body falls within the specified range. Alternatively, check that the temperature of the process fluid is not abnormal.
	AL.24 OVRLOAD	Meter Body Overload or Failure	Meter Body Overload or Failure	- Confirm that the input pressure is within the specified range. - If the input pressure is high, either lower the input pressure or, If neccesary, calibrate using a device with a large range.
	AL.53 OUT%.HI	High Output Alarm	High Output Alarm	Check the output value
	AL.54 OUT%.LO	Low Output Alarm	Low Output Alarm	
	AL.55 TEMP.HI	High Sensor Temp. Alarm	High Sensor Temp. Alarm	Check the sensor temperature.
	AL.56 TEMP.LO	Low Sensor Temp. Alarm	Low Sensor Temp. Alarm	

Table 4-5.

HART7

	Indicator Display	Diagnostics Display Message	Description	Countermeasures
Maintenance Required	AL.28 SWITCH	External Zero/Span Adjustment Failure	External Zero/Span Adjustment Failure	There is a problem with the external zero adjustment switch or the printed circuit board. Contact customer service.
	AL.21 ZERO. CAL	Excess Zero Calibration Value	Excess Zero Calibration Value	Check that the input pressure is appropriate for the calibration value, and calibrate again.
	AL.22 SPAN. CAL	Excess Span Calibration Value	Excess Span Calibration Value	
	AL.26 NO.CALIB	Not Calibrated	Not Calibrated	Restart the calibration value at the time of shipping, or calibrate the high and low limits of the setting range.
	AL.61 PRESS.FQ	Pressure Frequency Index Alarm	Pressure Frequency Index Alarm	Check operating conditions
	AL.62 STD.DEV	Standard Deviation Alarm	Standard Deviation Alarm	
	AL.63 OOR.CNT	Out-of-Range Count Alarm	Out-of-Range Count Alarm	

4-5 Insulation Resistance Test and Withstand Voltage Test

(i) Cautions regarding the insulation resistance test and withstand voltage test

As a rule, do not perform the insulation resistance test and withstand voltage test. These tests may damage the built-in lightning arrester for surge current absorption. If these tests absolutely must be carried out, following the specified procedure closely.

(ii) Test procedure

(1) Detach the device's exterior wiring

(2) Short the respective + and - SUPPLY terminals.

(3) Perform the tests in between each of these shorted circuits and the ground terminals.

(4) Applied voltage and decision criteria are as follows. In order to prevent damage to the pressure transmitter, do not apply voltages higher than the values shown below.

(iii) Decision criteria

Test	Decision Criteria
Insulation resistance test	2×10^{7} Ω or higher at test voltage 25 V DC (25 °C, 60% RH or higher)
Withstand voltage test	50 V AC, 1 min., set current at 2 mA

Appendix A

A1 Diagnosis of clogging in the connecting pipe using the pressure frequency index

This appendix describes judgment of an abnormal state, setup procedures, and operation check procedures when the pressure frequency index is used to diagnose clogging in the connecting pipe. For general matters concerning the pressure frequency index, see section "3-11-1 Pressure Frequency Index"

Section A1 of appendix A describes the principle behind the diagnosis of clogging in the connecting pipe. Read this section first.
Sections A2–4 describe how to configure the diagnostic functions by transmitter and application type.

- When measuring the pressure using a pressure gauge, see section A2.
- When measuring the differential pressure and flow rate using the differential pressure gauge, see section A3.
- When measuring the level, see section A4.

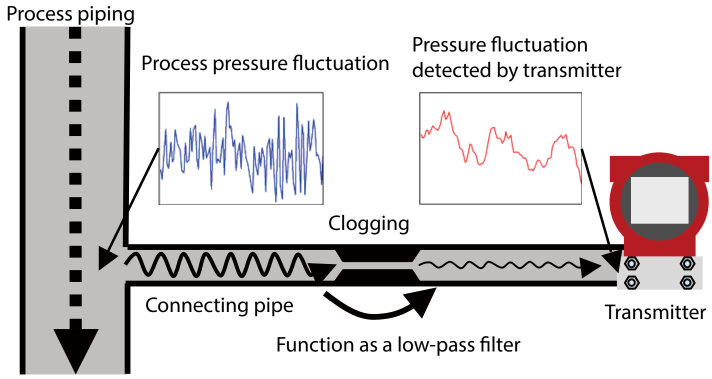
Section A5 provides a supplemental description of parameters related to the diagnosis of clogging.

A1-1 Principle

The pressure of a flowing fluid fluctuates irregularly and frequently. The pressure frequency index shows the number of fluctuations that have been detected. A large index number means that the vertical oscillation is fast and that there are many high-frequency fluctuations. A small index shows that the vertical oscillation is slow and that there are relatively few high-frequency fluctuations.

There are many causes of fluctuation. First, the pressure that generates the flow fluctuates. The magnitude of this fluctuation may vary depending on the pressure and flow velocity, but fluctuation always occurs when the fluid flows. This fluctuation is the most important factor in the diagnosis of clogging in the connecting pipe. Also, pressure fluctuation occurs due to pumps, compressors, or agitators. This fluctuation may also be used to diagnose clogging, depending on its cycle and frequency.

Pressure fluctuation is transmitted to the differential pressure and pneumatic pressure transmitter through the connecting pipe. When the connecting pipe is operating normally, fluctuation in the process is directly transmitted to the transmitter, since there are no obstructions halfway. On the other hand, if the connecting pipe is clogged, the clogging and piping system function as a low-pass filter for pressure fluctuation. This is caused by the fact that the clogging obstructs the fluid flow, and the pressure levels at both ends of the clogged portion cannot be equalized within a short period of time. Therefore, even when the process pressure includes high frequency fluctuations, it is difficult for them to be transmitted past the clog.



The pressure frequency index, based on the number of times the pressure rises and falls, indicates the frequency of pressure fluctuation. Clogging in the connecting pipe functions as a low-pass filter that attenuates the high-frequency components of fluctuation, thereby decreasing the index number. Because of this mechanism, clogging in the connecting pipe can be diagnosed from the pressure frequency index.

In the case of differential pressure, the diagnosis of clogging is more complex, because the difference between two pressure fluctuations must be calculated. However, the principle is the same: the phenomenon in which the piping system and clogging in the connecting pipe function as a low-pass filter is utilized.

A2 Configuration using a pressure gauge

A2-1 Clogging and the pressure frequency index

The pressure frequency index varies depending on clogging in the connecting pipe. Generally, the pressure frequency index becomes smaller as clogging progresses. Normally, the pressure frequency index does not become larger.

A2-2 Points to note regarding the diagnosis of clogging

When the pressure frequency index is used to diagnose clogging in the connecting pipe, observe the cautions shown below.

If the fluctuation is very small or its frequency is low, clogging cannot be diagnosed. This is because the pressure must include a sufficient number of fluctuations for the pressure frequency index to be calculated accurately. Specific examples are listed below.

- There is no fluid flow, or flow velocity is very slow.
- Fluid viscosity is high.

Variation in the pressure frequency index does not always mean that clogging in the connecting pipe has occurred. The index may vary due to other factors, such as the following.

- A change in the operating conditions of the pump, compressor, etc. (ON/OFF, number of units, RPM, etc.)
- Air bubbles entering the process piping or connecting pipe
- A change in the viscosity of the process fluid
- Flow velocity variation caused by valve hunting

Note that whether or not the cause is clogging can be inferred by comparing the pressure frequency index and the standard deviation with their values when conditions are normal. If the standard deviation increases at the same time that the pressure frequency index decreases, it is probable that, rather than a decrease in high-frequency fluctuation due to clogging, there has been an increase in low-frequency fluctuation due to some other cause.

Depending on the material that causes clogging, it is possible that variation in the index will be too small for an alarm to be activated. For example, if the clog is made of something like gravel, where there are gaps, the pressure fluctuation can be transmitted through the gaps, and there will not be much change in the index.

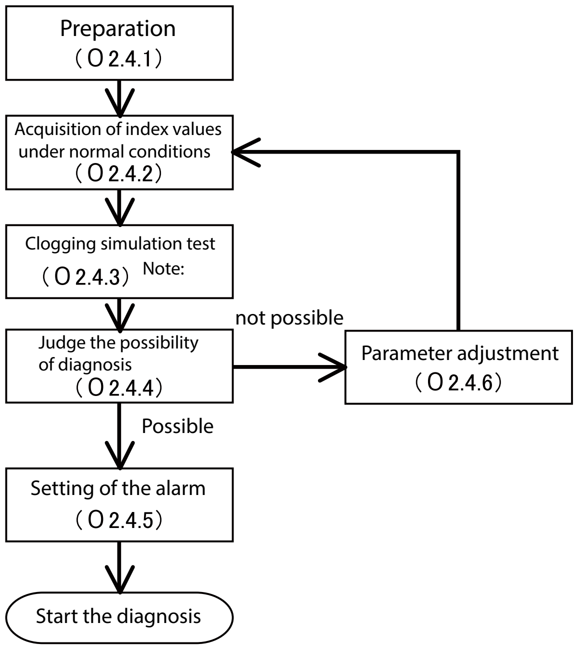
If the frequency of pressure fluctuation is abnormal from the beginning, as is a case where the connecting pipe was clogged from the start, it may not be possible to diagnose the clogging. Do the setup procedures (A2–4) when the connecting pipe is operating normally.

Even if clogging occurs suddenly, the pressure frequency index will not change immediately. This is because it takes a few minutes to calculate the frequency of the pressure fluctuation with a high level of accuracy.

If the transmitter is installed in an environment subject to heavy vibration, the pressure frequency index may be affected, preventing correct diagnosis.

A2-3 Parameter configuration procedures

To diagnose clogging in the connecting pipe using the pressure frequency index, parameters must be set. Use the configuration procedure below.



Preparation (see section A2-4-1): Initialize the parameters in preparation for obtaining the index values.
Acquisition of index values under normal conditions (see section A2-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.
Clogging simulation test (see section A2-4-3): Operate the valve of the connecting pipe to simulate a clog and obtain index values.

If you cannot conduct the clogging simulation test, skip sections A2-4-3 to A2-4-6, and then read section A2-4-7.

Judging the possibility of diagnosis (see section A2-4-4): Determine whether or not you can differentiate between a normal state and a simulated clogged state by comparing their index values.
Setting the alarm (see section A2-4-5): If diagnosis is judged to be possible, adjust the parameters shown below to set an alarm based on the collected index values. When the configuration process is complete, the diagnosis can begin.

Press Freq Index Alarm Use
Press Freq Index Low Limit

Parameter adjustment (see section A2-4-6): If distinguishing the two states is not possible, analyze the cause, adjust the parameters shown below, and then return to “Acquisition of index values under normal conditions.”

Press Freq Index Sensor Selection
Press Freq Filter Constant
Press Freq Calc PV High Limit
Press Freq Calc PV Low Limit

The procedures stated in “Acquisition of index values under normal conditions” and “Clogging simulation test” refer to the following parameters and process variables.

Pressure Frequency Index
Press Freq Index Max
Press Freq Index Min
Standard Deviation
Standard Deviation Max
Standard Deviation Min

The standard deviation values are not directly used to diagnose clogging, but it may be necessary to refer to them during parameter adjustment. Therefore, it is recommended that they be collected at the same time as the pressure frequency indexes.

A2-4 Configuration procedures

This section describes the configuration procedures in order.

A2-4-1 Preparation

Before starting configuration, initialize the parameters.

◆Procedure◆

(1) Set Press Freq Index Sensor Selection to “DP, 120 ms.”

(2) Set Press Freq Filter Constant to “0.15.”

(3) Set Press Freq Calc PV High Limit to “Upper Range Value.”

(4) Set Press Freq Calc PV Low Limit to “Lower Range Value.”

(5) Set Press Freq Index Alarm Use to “Disabled” (operation off).

A2-4-2 Acquisition of index values under normal operating conditions

Obtain the index value under normal operating conditions without clogging in the connecting pipe. The collected pressure frequency index and standard deviation values are used to judge the possibility of diagnosis and to adjust the parameters in later steps.

◆Procedure◆

(1) Check that the connecting pipe is operating normally. When a valve such as a manifold valve is attached to the connecting pipe, check that the pressure can be measured.

(2) Execute Reset Press Freq Index and Reset Standard Deviation. Note that after Reset Press Freq Index is executed, the correct values for Pressure Frequency Index, Press Freq Index Min, and Press Freq Index Max cannot be obtained for a short period of time. After Reset Press Freq Index has been executed, wait until the first index calculation is completed.

(3) Wait for at least 30 minutes, and if possible one hour.

(4) Obtain the pressure frequency index and its minimum and maximum values, and the PV, and record them.

(5) Obtain the values of Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions, perform the steps above under as many conditions as possible and collect the data. The reason for this is that the pressure frequency index value may vary depending on the operating conditions, even when the process state is normal. Covering as many conditions as possible will enable judging of the possibility of diagnosis and parameter adjustment to be carried out more reliably.

A2-4-3 Clogging simulation test

If a valve such as a stop valve is connected to the connecting pipe, the valve can be utilized to conduct the clogging simulation test. The pressure frequency index and standard deviation values that are collected in the clogging simulation state are used to judge the possibility of diagnosis and to adjust the parameters in later steps.

⚠Caution

When the valve of the connecting pipe is closed completely, the transmitter cannot measure the correct value. In addition, even when the valve is not closed completely, the delay before the process variable follows a change in pressure may be long. (This symptom is the same as when the damping time constant of the transmitter is made larger.) When conducting the clogging simulation test, exercise great care so that the test does not interfere with process safety or control.

◆Procedure◆

(1) Close the valve of the connecting pipe either completely or so that it is slightly open (with a small amount of fluid flow).

(2) Execute Reset Press Freq Index and Reset Standard Deviation.

(3) Wait 20 minutes or more.

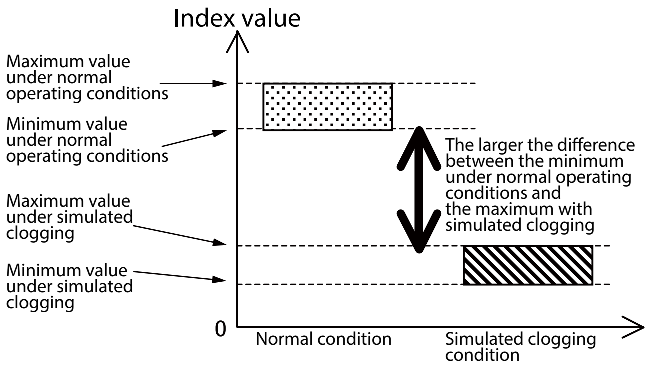
(4) Record the values for Pressure Frequency Index, Press Freq Index Min, Press Freq Index Max, and the PV.

(5) Obtain the values for Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions and the index value under normal operating conditions varies depending on the operating conditions, it is recommended that the steps described above be repeated under each operating condition.
In the clogging simulation test, the valve of the connecting pipe needs to be sufficiently closed. The reason for this is that the low-pass filter effect due to clogging as described in “Principle” above does not occur if the flow path resistance caused by clogging (resistance to fluid flow) is not sufficiently high.

A2-4-4 Judging the possibility of diagnosis

Whether or not clogging can be diagnosed can be judged according to the index and its maximum and minimum values collected under normal operating conditions (section A2-4-2) and under a simulated clogged condition (section A2-4-3).

Judgment criteria	
• The maximum index value with simulated clogging is smaller than the minimum index value under normal operating conditions. • The difference between the minimum under normal operating conditions and the maximum with simulated clogging is equivalent to or larger than the difference between the minimum and maximum under normal operating conditions.  	Diagnosis is possible.
The above conditions are not satisfied.	Diagnosis is not possible or difficult.

The minimum condition for diagnosis is that the maximum with simulated clogging is smaller than the minimum under normal conditions. If this condition is not satisfied, the index value may decrease to the value with simulated clogging even when the connecting pipe is operating normally. Therefore, the conditions are not suitable for diagnosis. In cases where the index value under normal conditions varies depending on the operating conditions, judgment should be based on the values when the minimum index value is at its smallest.
The larger the difference between the minimum under normal operating conditions and the maximum with simulated clogging, the easier diagnosis is. Therefore, this value is important.
A reference for judging whether diagnosis is possible is that this difference is equivalent to or larger than the difference between the minimum value and maximum value under normal operating conditions. If this difference is less than half of the difference between the minimum and maximum under normal conditions, diagnosis will probably be difficult. The reason for this is that the index will be close to its value with clogging even under normal conditions, so it will be difficult to distinguish between normal and abnormal states. In this case, conditions are probably inappropriate for diagnosis.

If diagnosis is judged to be possible, go on to section A2-4-5 and set the diagnostic alarm.
If diagnosis is judged to be not possible, go to section A2-4-6 and consider parameter adjustment.

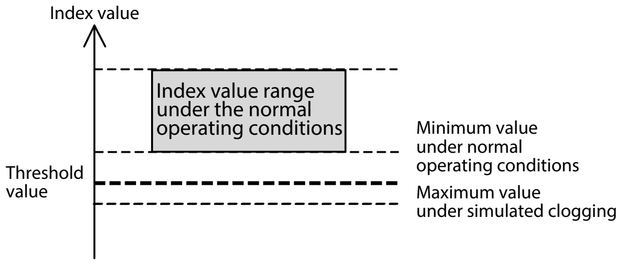
[CAUTION] The position of a clog may affect the amount of variation of the pressure frequency index. In particular, if the fluid is a compressible fluid or gas, the effect can be significant. In such a case, if clogging is closer to the process side, the amount of variation will be greater. Therefore, when the position where clogging actually occurs is closer to the transmitter than the position of the simulated clogging, changes in the index value will be small or almost zero in comparison to those in the simulation test. Likewise, when the position where clogging actually occurs is closer to the process as compared to the position of the simulated clog, changes in the index will be greater than in the simulation test.

A2-4-5 Setting of the diagnosis alarm

If diagnosis is judged to be possible, set the alarm. If you do not want to activate the alarm, omit the steps in this section.

[CAUTION] The procedures described in this document do not guarantee the detection of clogging or the elimination of false indications. The pressure frequency index may change due to causes other than clogging, and may also depend on the degree of clogging or the material of the clog. Adjusting the settings should be done with the realization that there is no threshold value setting that can eliminate misinformation and securely detect clogging only.

First, determine the alarm threshold value. This threshold should be between the minimum index value under normal conditions and the maximum with simulated clogging. If the threshold is put close to the minimum under normal operating conditions, the alarm will be activated earlier, but the possibility of a false alarm is also higher. Put the threshold at a certain distance away from the minimum under normal operating conditions, leaving a margin.



After determining the threshold value, follow the steps below to set the alarm and start the diagnosis.

◆Procedure◆

(1) Execute Reset Press Freq Index.

(2) Set Press Freq Index Low Limit to the determined threshold value.

(3) Set Press Freq Index Alarm Use “Enabled (Low)” (lower limit only).

With these settings, when the index value is outside the normal range and approaches the value with simulated clogging, the alarm is activated.

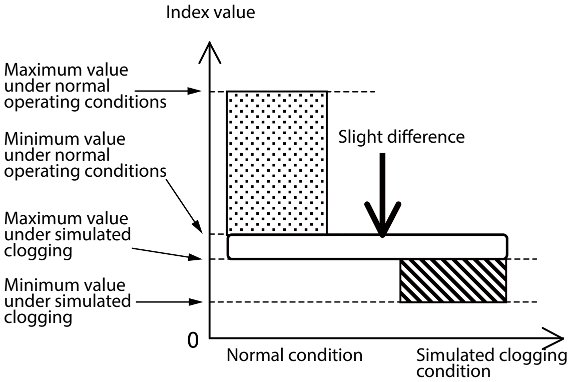
A2-4-6 Parameter adjustment

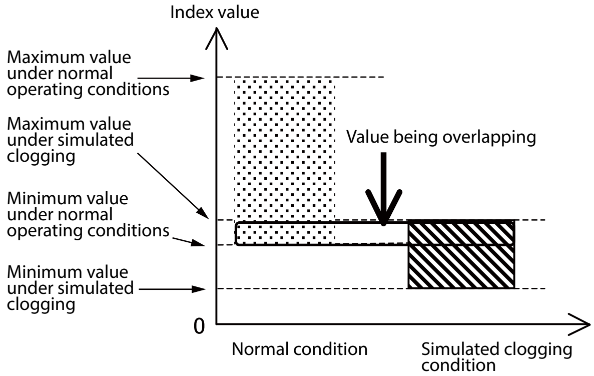
If diagnosis is judged to be not possible, the data collected under normal operating conditions (section A2-4-2) and when there is simulated clogging (section A2-4-3) can be analyzed and the parameters adjusted.
The reason why diagnosis cannot be performed is that the index value—even under normal operating conditions—is similar to or smaller than that when there is clogging, so the normal and clogged states cannot be distinguished. There are two primary causes leading for this situation.

- A large amount of variation of the index under normal conditions
- A small variation of the index when there is clogging

This situation may be improved by adjusting the parameters of the pressure frequency index diagnosis. The following describes the two cases.

(A) Variation of the index under normal operating conditions is large.
In this case, although the value of the index is small with simulated clogging, variation in the index is large under normal conditions, so the index value can be close to or equivalent to its value with clogging even when there is no clogging, as shown in the figure below.



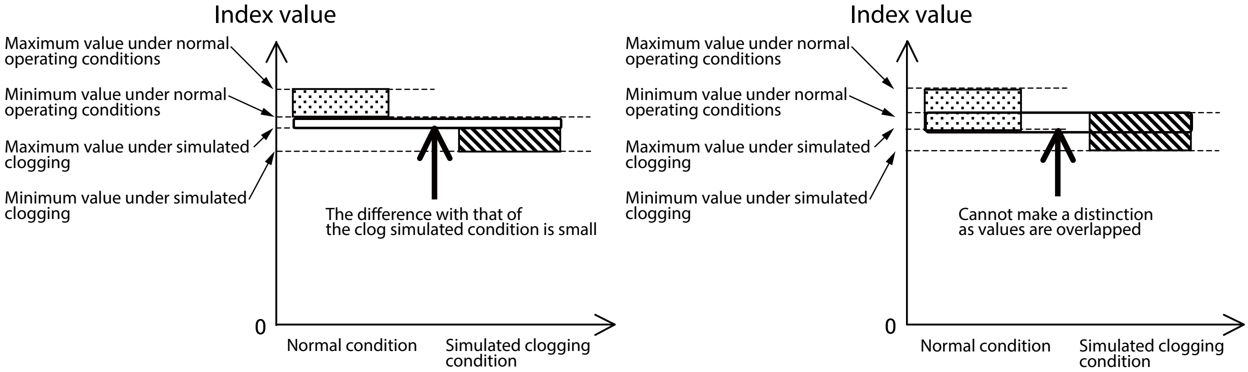


In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

Guidelines for parameter adjustment	
The index value sometimes decreases significantly under normal operating conditions. At this time, the process variable changes or the standard deviation becomes large.	Increase the Press Freq Filter Constant in steps of 0.02–0.05.
The index value under normal operating conditions changes significantly depending on the operating conditions.	Check whether the operating conditions are related to the process variable. If there is a PV range where the difference between the maximum index value and the minimum is relatively small, or a PV range where the minimum under normal conditions is not small, set Press Freq Calc PV High Limit and Press Freq Calc PV Low Limit to the values of this range. When these parameters are used, diagnosis should be carried out only when pressure is applied, and should be stopped when no pressure is applied.

(B) The variation of the index when there is a clog is small.

In this case, although variation in the index is relatively small under normal operating conditions, the value of the index is almost the same as with simulated clogging, as shown in the figure below. In this case, the index value under normal operating conditions is similar to that with clogging, or the index value is almost the same even when clogging occurs. In either case, it is necessary to examine the cause and to minimize this effect. Use the following guidelines for adjustment.



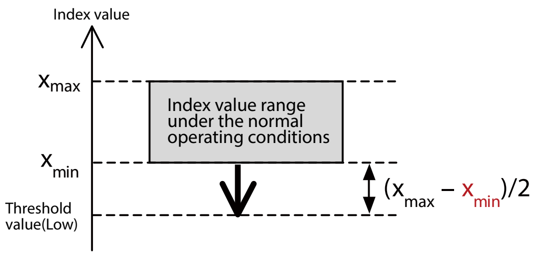
Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
Since the process variable fluctuates and there is always low-frequency pressure fluctuation, the value of the index is small even under normal operating conditions. The standard deviation is relatively large.	Increase the Press Freq Filter Constant in steps of 0.02–0.05.
The PV does not change and the standard deviation is also small. The frequency of the original pressure fluctuation is low and the index value is small. (The reference index value is 0.1 or less under normal operating conditions.) Fluid viscosity is high.	Change the Press Freq Index Sensor Selection. If the present value is “DP, 120 ms”, set it to “DP, 240 ms,” and if the present value is “DP, 240 ms,” set it to “DP, 360 ms.”
The magnitude and frequency of the original pressure fluctuation are acceptable. (The reference index value is 0.2 or more under normal operating conditions.) However, the value is almost the same when there is clogging.	Decrease the Press Freq Filter Constant in steps of 0.02–0.05.

A2-4-7 Clogging simulation test cannot be conducted.

When the clogging simulation test cannot be conducted, only the index value data under normal operating conditions (index values collected in section A2-4-2) can be used to determine the threshold value.

When many index values can be collected, calculate the average value (μ) and standard deviation (σ), and determine the threshold value based on μ ± nσ. To eliminate misinformation, a value from 4 to 6 is recommended for n.

The threshold value can also be determined using the maximum (xmax) and minimum (xmin) index values. For example, the threshold value should be set to a value that is no more than (xmax–xmin)/2 from the minimum value, as shown in the figure below.



Note that the threshold value determined using only the index value data under normal operating conditions is not always appropriate. The index value may become smaller than the threshold value due to causes other than clogging, or the index value may not become smaller than the threshold value even when clogging occurs. Observe changes in the index value for a short period after the threshold value has been determined, and then check that the index value does not become smaller than the threshold value under normal operating conditions, and that the difference between the correct value range and threshold value is not large. Revise the threshold value when necessary.

A3 Setting using a differential pressure gauge

A3-1 Clogging and pressure frequency index

The pressure frequency index may vary depending on clogging in the connecting pipe. The pressure frequency index may either become smaller or larger due to clogging in the connecting pipe. In differential pressure measurement, there is a connecting pipe on both the high pressure and low pressure sides. When both pipes are clogged over a certain level, the pressure frequency index will decrease. However, the index will increase or not change significantly as clogging progresses. The reason for this is explained below.

In differential pressure measurement, the fluctuation in the differential pressure is used to calculate the pressure frequency index (excluding the case where static pressure sensor is selected in the Press Freq Index Sensor Selection). Differential pressure fluctuation is a combination of the fluctuation on the high pressure side and the fluctuation on the low pressure side. Therefore, when there are common components in the fluctuation on both sides, under normal conditions they cancel each other out and the detected fluctuation becomes smaller than the original common component. In such a case, if the balance between the fluctuation on the two sides changes, the components that canceled each other out under normal operating conditions expand, and the fluctuation becomes larger than under normal operating conditions. Therefore, when there is a certain difference in the amount of clogging between the high and low pressure sides, that is, when one side only is clogged, the pressure frequency index will be larger than under normal operating conditions. In addition, depending on the relationship between the cause of increase in the index and the cause of decrease in the index, the index value may not change even when clogging occurs. Note that when both connecting pipes are clogged over a certain level, the cause of decrease in the index will become stronger, so that the index value eventually will become small as clogging progresses.

A3-2 Points to note regarding the diagnosis of clogging

When the pressure frequency index is used to diagnose clogging in the connecting pipe, observe the cautions below.
When the fluctuation is very small or when the fluctuation frequency is low, clogging cannot be diagnosed. The reason for this is that the pressure or differential pressure needs to include a sufficient number of fluctuations to calculate the pressure frequency index accurately. Specific examples are listed below.

- There is no fluid flow, or flow velocity is very slow.
- Fluid viscosity is high.

Variation in the pressure frequency index does not always mean that clogging in the connecting pipe has occurred. The index may vary due to other factors, such as the following.

- A change in the operating conditions of the pump, compressor, etc. (ON/OFF, number of units, RPM, etc.)
- Air bubbles entering the process piping or connecting pipe.
- A change in the viscosity of the process fluid
- Flow velocity variation caused by valve hunting

Note that whether or not the cause is clogging can be inferred by comparing the pressure frequency index and the standard deviation with their values when conditions are normal. If the standard deviation increases at the same time that the pressure frequency index decreases, it is probable that, rather than a decrease in high-frequency fluctuation due to clogging, there has been an increase in low-frequency fluctuation due to some other cause.

Whether or not the status in which only one side of the connecting pipe is clogged is detected may vary depending on the various conditions such as fluid conditions or characteristics of the differential pressure generation mechanism (orifice, etc.). To understand whether or not detection is possible beforehand, it is strongly recommended that it is checked beforehand according to the clogging simulation test stated in section A3-4-3.

Depending on materials that cause clogging, even when clogging occurs, variations in index are small and no alarm is activated. For example, it is understood that when there are clearances, even when a clogged state due to gravel exists, the pressure fluctuation is transmitted through the clearances, and changes in index become small.

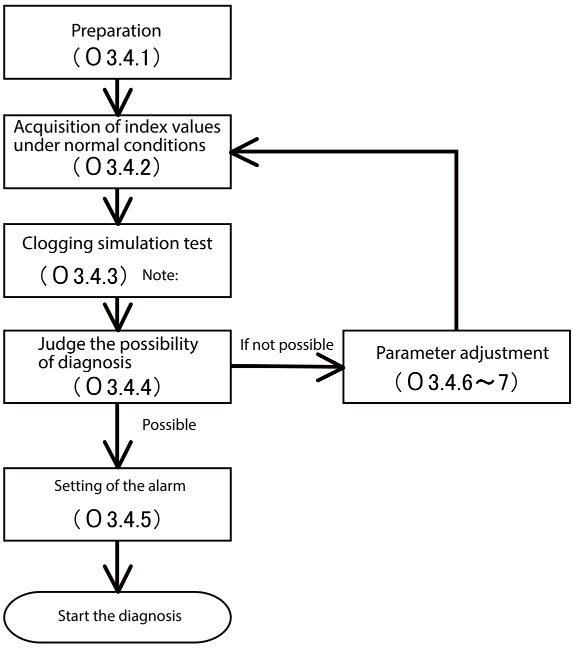
If the frequency of pressure fluctuation is abnormal from the beginning, as is a case where the connecting pipe was clogged from the start, it may not be possible to diagnose the clogging. Do the setup procedures (section A3-4) when the connecting pipe is operating normally.

Even if clogging occurs suddenly, the pressure frequency index will not change immediately. This is because it takes a few minutes to calculate the frequency of the pressure fluctuation with a high level of accuracy.

If the transmitter is installed in an environment subject to heavy vibration, the pressure frequency index may be affected, preventing correct diagnosis.

A3-3 Parameter configuration procedures

To diagnose clogging in the connecting pipe using the pressure frequency index, parameters must be set. Use the configuration procedure below.



Preparation (see section A3-4-1): Initialize the parameters in preparation for obtaining the index values.
Acquisition of index values under normal conditions (see section A3-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.
Clogging simulation test (see section A3-4-3): Operate the valve of the connecting pipe to simulate a clog and obtain index values. Do a both-side clogging simulation test that simulates clogging on both the high and low pressure sides, and a one-side clogging simulation test that simulates clogging on one side only.

Note: If you cannot conduct the clogging simulation test, skip sections A3-4-3 to A3-4-7, and go to section A3-4-8.

Judging the possibility of diagnosis (see section A3-4-4): Determine whether or not you can differentiate between a normal state and a simulated clogged state by comparing their index values.
Setting the alarm (see section A3-4-5): If diagnosis is judged to be possible, adjust the parameters shown below to set an alarm based on the collected index values. When the configuration process is complete, the diagnosis can begin.

Press Freq Index Alarm Use
Press Freq Index Low Limit
Press Freq Index High Limit

Parameter adjustment (see section A3-4-6 and 7): If distinguishing the two states is not possible, analyze the cause, adjust the parameters shown below, and then return to "Acquisition of index values under normal conditions."

Press Freq Index Sensor Selection
Press Freq Filter Constant
Press Freq Calc PV High Limit
Press Freq Calc PV Low Limit

The procedures stated in "Acquisition of index values under normal conditions" and "Clogging simulation test" refer to the following parameters and process variables.

Pressure Frequency Index
Press Freq Index Max
Press Freq Index Min
Standard Deviation
Standard Deviation Max
Standard Deviation Min

The standard deviation values are not directly used to diagnose clogging, but it may be necessary to refer to them during parameter adjustment. Therefore, it is recommended that they be collected at the same time as the pressure frequency indexes.

A3-4 Configuration procedures

This section describes the configuration procedures in order.

A3-4-1 Preparation

Before starting configuration, initialize the parameters.

◆Procedure◆

(1) Set Press Freq Index Sensor Selection to “DP, 120 ms.”
(2) Set Press Freq Filter Constant to “0.15.”
(3) Set Press Freq Calc PV High Limit to “Upper Range Value.”
(4) Set Press Freq Calc PV Low Limit to “Lower Range Value.”
(5) Set Press Freq Index Alarm Use to “Disabled” (operation off).

A3-4-2 Acquisition of the index values under normal operating conditions

Obtain the index value under normal operating conditions without clogging in the connecting pipe. The collected pressure frequency index and standard deviation values are used to judge the possibility of diagnosis and to adjust the parameters in later steps.

◆Procedure◆

(1) Check that the connecting pipe is operating normally. When a valve such as a manifold valve is attached to the connecting pipe, check that the pressure can be measured.

(2) Execute Reset Press Freq Index and Reset Standard Deviation. Note that after Reset Press Freq Index is executed, the correct values for Pressure Frequency Index, Press Freq Index Min, and Press Freq Index Max cannot be obtained for a short period. After Reset Press Freq Index has been executed, wait until the first index calculation is completed.

(3) Wait for at least 30 minutes, and if possible one hour.

(4) Obtain the values of Pressure Frequency Index, Press Freq Index Min, Press Freq Index Max, and the process variable, and record them.

(5) Obtain the values of Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions, perform the steps above under as many conditions as possible and collect the data. The reason for this is that the pressure frequency index value may vary depending on the operating conditions, even when the process state is normal. Covering as many conditions as possible will enable judging of the possibility of diagnosis and parameter adjustment to be carried out more reliably.

A3-4-3 Clogging simulation test

If a valve such as a manifold valve is connected to the connecting pipe, the valve can be utilized to conduct the clogging simulation test. The pressure frequency index and standard deviation values that are collected in the clogging simulation state are used to judge the possibility of diagnosis and to adjust the parameters in later steps.
Three kinds of clogging simulation test are conducted. The both-side clogging simulation test, in which valves on both the high pressure and low pressure sides are closed, and the one-side clogging simulation test, in which the valve on one side only is closed, are conducted. Two kinds of one-side clogging simulation test are conducted, one where the high pressure side is closed, and the other where the low pressure side is closed.

⚠Caution

When the valve of the connecting pipe is closed completely, the transmitter cannot measure the correct value. In addition, even when the valve is not closed completely, the delay before the process variable follows a change in pressure may be long. (This symptom is the same as when the damping time constant of the transmitter is made larger.) When conducting the clogging simulation test, exercise great care so that the test does not interfere with process safety or control.

◆Procedure◆

(1) Close the valve of the connecting pipe either completely or so that it is slightly open (with a small amount of fluid flow).

- For the both-side clogging simulation test, close the valves of the connecting pipes on both the high and low pressure sides.
- For the one-side clogging simulation test (high pressure side), open the valve of the connecting pipe on the high pressure side and close only the valve on the low pressure side.
- For the one-side clogging simulation test (low pressure side), close the valve of the connecting pipe on the high pressure side and open the valve on the low pressure side.

(2) Execute Reset Press Freq Index and Reset Standard Deviation.

(3) Wait 20 minutes or more.

(4) Record the values for Pressure Frequency Index, Press Freq Index Min, Press Freq Index Max, and the PV.

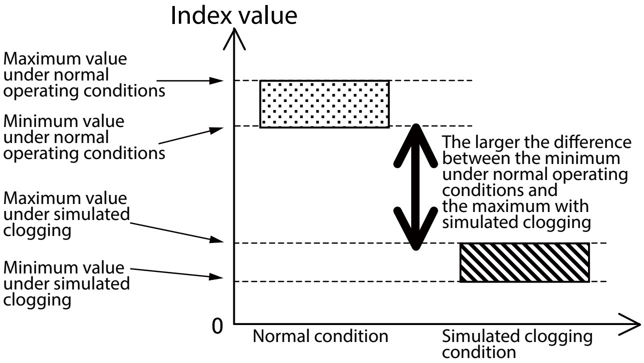
(5) Obtain the values for Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions and the index value under normal operating conditions varies depending on the operating conditions, it is recommended that the steps described above be repeated under each operating condition.
In the clogging simulation test, the valve of the connecting pipe needs to be sufficiently closed. The reason for this is that the low-pass filter effect due to clogging as described in “Principle” above does not occur if the flow path resistance caused by clogging (resistance to fluid flow) is not sufficiently high.

A3-4-4 Judging the possibility of diagnosis

Whether or not clogging can be diagnosed can be judged according to the index and its maximum and minimum values collected under normal operating conditions (section A3-4-2) and under a simulated clogged condition (section A3-4-3)

(A) Judging the possibility of both-side clogging diagnosis

<table>
<tr><th colspan="2">Judgment criteria</th></tr>
<tr><td>• The maximum index value with simulated clogging(both side) is smaller than the minimum index value under normal operating conditions.
• The difference between the minimum under normal operating conditions and the maximum with simulated clogging is equivalent to or larger than the difference between the minimum and maximum under normal operating conditions.

</td><td>Diagnosis is possible</td></tr>
<tr><td>The above conditions are not satisfied.</td><td>Diagnosis is not possible or difficult</td></tr>
</table>

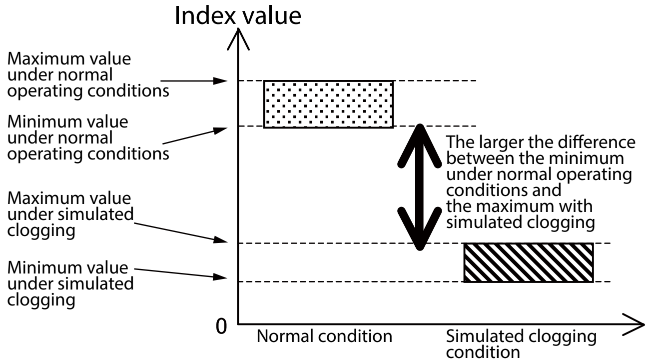
The minimum condition for diagnosis is that the maximum with simulated clogging is smaller than the minimum under normal conditions. If this condition is not satisfied, the index value may decrease to the value with simulated clogging even when the connecting pipe is operating normally. Therefore, the conditions are not suitable for diagnosis. In cases where the index value under normal conditions varies depending on the operating conditions, judgment should be based on the values when the minimum index value is at its smallest.
The larger the difference between the minimum under normal operating conditions and the maximum with simulated clogging, the easier diagnosis is. Therefore, this value is important.
A reference for judging whether diagnosis is possible is that this difference is equivalent to or larger than the difference between the minimum value and maximum value under normal operating conditions. If this difference is less than half of the difference between the minimum and maximum under normal conditions, diagnosis will probably be difficult. The reason for this is that the index will be close to its value with clogging even under normal conditions, so it will be difficult to distinguish between normal and abnormal states. In this case, conditions are probably inappropriate for diagnosis.
If diagnosis is judged to be possible, go on to the next step and judge the possibility of one-side clogging diagnosis.
If diagnosis is judged to be not possible, go to section A3-4-6 and consider parameter adjustment.

(B) Judging the possibility of one-side clogging diagnosis

<table>
<tr><th colspan="2">Judgment criteria</th></tr>
<tr><td>

• The maximum value in either the one-side clogging simulation state on the high pressure or low pressure side is smaller than the minimum value under normal operating conditions.

• The difference between the minimum under normal operating conditions and the maximum with simulated clogging is equivalent to or larger than the difference between the minimum and maximum under normal operating conditions.

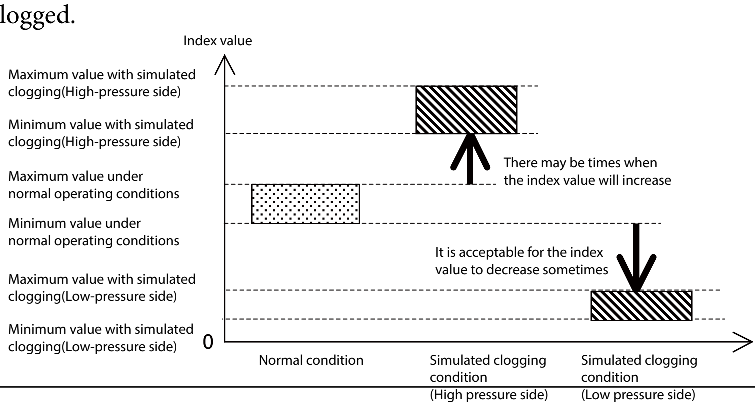


</td><td>Diagnosis is possible (Case A)</td></tr>
<tr><td>

• With simulated one-side clogging, the minimum index value on either the high or low pressure side, or on both sides, is larger than the maximum value under normal operating conditions.

• The difference between the index value under normal operating conditions and the index value with simulated clogging is equivalent to or larger than the difference between the minimum and maximum values under normal operating conditions.

The following diagram is an example of such case. There may be times when the index value will increase no matter which one of them gets clogged.



</td><td>Diagnosis is possible (Case B)</td></tr>
<tr><td>• The above conditions are not satisfied.</td><td>Diagnosis is not possible or difficult.</td></tr>
</table>

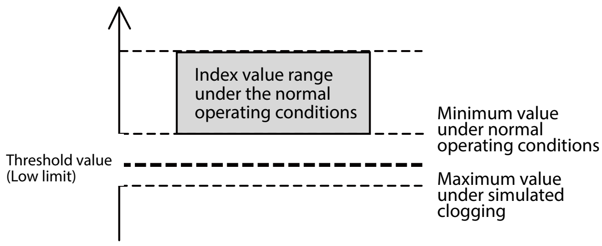
If the diagnosis is judged to be possible, go to section A3-4-5 and set the diagnostic alarm.
If only the one-side diagnosis is judged to be not possible, go to section A3-4-7 and change the settings to enable easier detection of one-side clogging, or set only both-side clogging for the diagnosis target, and then set the diagnosis alarm as described in section A3-4-5.

A3-4-5 Setting the diagnosis alarm

When diagnosis is judged to be possible, set the alarm. If you do not want to activate the alarm, omit the steps in this section.

[CAUTION] The procedures described in this document do not guarantee the detection of clogging or the elimination of false indications. The pressure frequency index may change due to causes other than clogging, and may also depend on the degree of clogging or the material of the clog. Adjusting the settings should be done with the realization that there is no threshold value setting that can eliminate misinformation and securely detect clogging only.

(A) When using both-side clogging diagnosis only, or when judging case A in section A3-4-4
First, determine the alarm threshold value. Determine only the lower limit value. This threshold should be between the minimum index value under normal conditions and the maximum with simulated clogging. If the threshold is put close to the minimum under normal operating conditions, the alarm will be activated earlier, but the possibility of a false alarm is also higher. Put the threshold at a certain distance away from the minimum under normal operating conditions, leaving a margin.



After determining the threshold value, follow the steps below to set the alarm and start the diagnosis.

◆Procedure◆

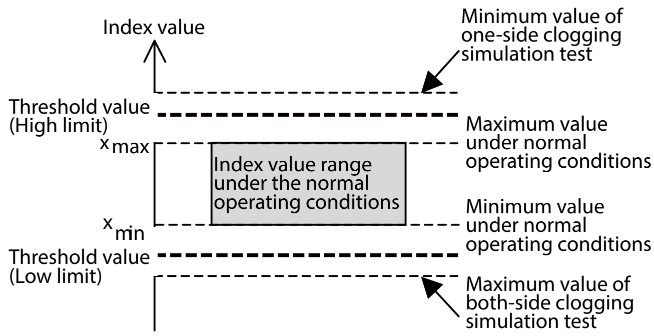
(1) Execute Reset Press Freq Index.

(2) Set Press Freq Index Low Limit to the determined threshold value (lower limit).

(3) Set Press Freq Index Alarm Use "Enabled (Low)" (lower limit only).

With these settings, when the index value is outside the normal range and approaches the value with simulated clogging, the alarm is activated.

(B) When judging case B in section A3-4-4
First, determine both the upper limit and lower limit of the alarm threshold value. The threshold value (upper limit) should be put between the maximum value under normal operating conditions and the minimum value that increases the value of the index in the one-side clogging simulation. The threshold value (lower limit) should be put between the minimum value under normal operating conditions and the maximum value in the both-side clogging simulation. If the threshold is put close to the minimum value or maximum value under normal operating conditions, the alarm will be activated earlier, but the possibility of a false alarm is also higher. Put the threshold at a certain distance away from the minimum or maximum values under normal operating conditions, leaving a margin.



After determining the threshold value, follow the steps below to set the alarm and start the diagnosis.

◆Procedure◆

(1) Execute Reset Press Freq Index.

(2) Set Press Freq Index Low Limit to the determined threshold value (lower limit).

(3) Set Press Freq Index High Limit to the determined threshold value (upper limit).

(4) Set Press Freq Index Alarm Use “Enabled (High and Low)” (upper and lower limits).

With these settings, when the index value is outside the normal range and approaches the value with simulated clogging, the alarm is activated.

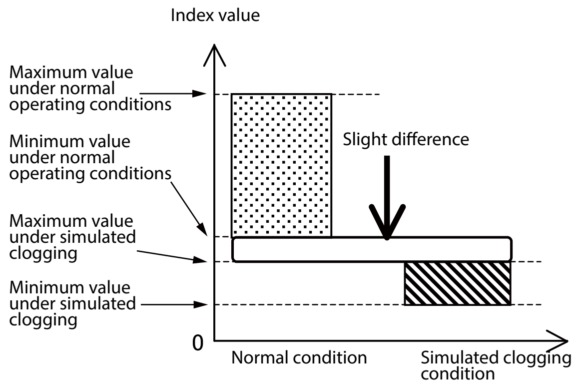
A3-4-6 Parameter adjustment (for both-side clogging diagnosis)

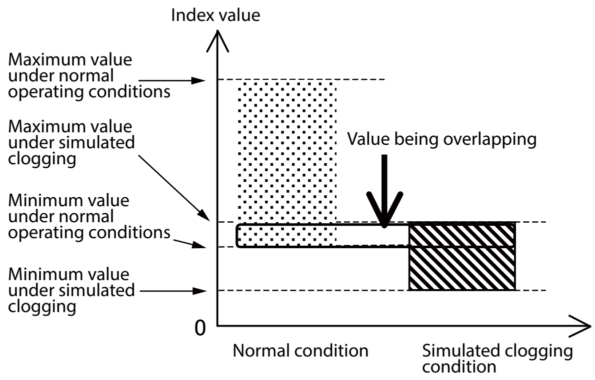
If both-side clogging diagnosis is judged to be not possible, the data that is collected under normal operating conditions (section A3-4-2) and when there is simulated clogging (section A3-4-3) can be analyzed and the parameters adjusted. The reason why diagnosis cannot be performed is that the index value—even under normal operating conditions—is similar to or smaller than that when there is clogging, so the normal and clogged states cannot be distinguished. There are two primary causes leading for this situation.

- A large amount of variation of the index under normal conditions
- A small variation of the index when there is clogging

This situation may be improved by adjusting the parameters of the pressure frequency index diagnosis. The following describes the two cases.

(A) Variation of the index under normal operating conditions is large.
In this case, although the value of the index is small with simulated clogging, variation in the index is large under normal conditions, so the index value can be close to or equivalent to its value with clogging even when there is no clogging, as shown in the figure below.



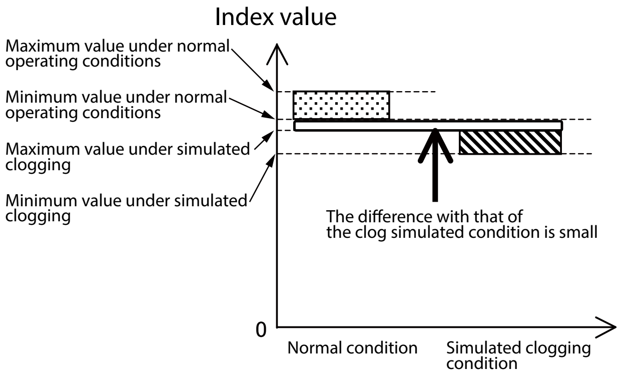


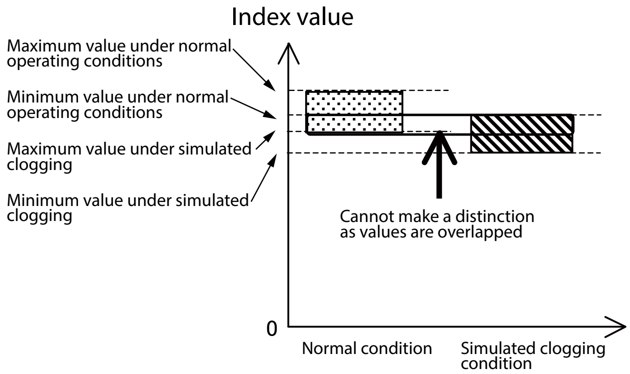
In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
The index value sometimes decreases significantly under normal operating conditions. At this time, the process variable changes or the standard deviation becomes large.	Decrease the Press Freq Filter Constant in steps of 0.02–0.05.
The index value under normal operating conditions changes significantly depending on the operating conditions.	Check whether the operating conditions are related to the process variable. If there is a PV range where the difference between the maximum index value and the minimum is relatively small, or a PV range where the minimum under normal conditions is not small, set Press Freq Calc PV High Limit and Press Freq Calc PV Low Limit to the values of this range. When these parameters are used, diagnosis should be carried out only when there is a flow, and should be stopped when the flow is stopped. By doing so, diagnosis can be done reliably even if the fluid flow is intermittent.

(B) The variation of the index when there is a clog is small.

In this case, although variation in the index is relatively small under normal operating conditions, the value of the index is almost the same as with simulated clogging, as shown in the figure below.





In this case, the index value under normal operating conditions is similar to that with clogging, or the index value is almost the same even when clogging occurs. In either case, it is necessary to examine the cause and to minimize this effect. Use the following guidelines for adjustment.

Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
Since the process variable fluctuates and there is always low-frequency pressure fluctuation, the value of the index is small even under normal operating conditions. The standard deviation is relatively large.	Decrease the Press Freq Filter Constant in steps of 0.02–0.05.
The PV does not change and the standard deviation is also small. The frequency of the original pressure fluctuation is low and the index value is small. (The reference index value is 0.1 or less under normal operating conditions.) Fluid viscosity is high.	Change the Press Freq Index Sensor Selection. If the present value is "DP, 120 ms", set it to "DP, 240 ms," and if the present value is "DP, 240 ms," set it to "DP, 360 ms." **Note:** This adjustment can be performed only when DP is selected for the Press Freq Index Sensor Selection.
The magnitude and frequency of the original pressure fluctuation are acceptable. (The reference index value is 0.2 or more under normal operating conditions.) However, the value is almost the same when there is clogging.	Decrease the Press Freq Filter Constant in steps of 0.02–0.05.

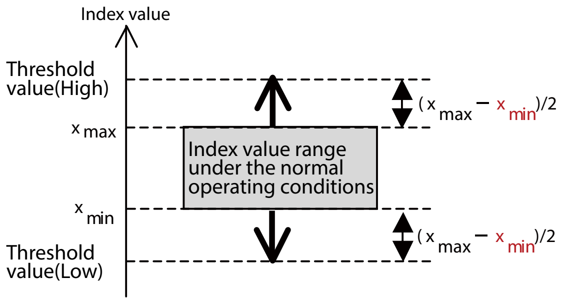
A3-4-7 Parameter adjustment (for single side clog diagnosis)

If both-side clogging can be diagnosed but not one-side clogging, changing the Press Freq Index Sensor Selection to "SP, 360 ms" may make diagnosis possible. However, this change lowers the performance of both-side clogging diagnosis. Furthermore, changing the parameter does not necessarily ensure the reliable diagnosis of one-side clogging. Be sure you understand these points before changing the parameter.

After the parameter has been changed, return to section A3-4-1, and obtain the index value under normal operating conditions again. Since the data collected so far cannot be used, follow sections A3-4-1 to 4 again to collect the data. If both-side clogging cannot be diagnosed after the parameter has been changed, and the possibility of diagnosing one-side clogging has not changed, change the setting back to its previous value. Then set the diagnosis alarm for the case where only both-side clogging is diagnosed, referring to section A3-4-5.

A3-4-8 Clogging simulation test cannot be conducted.

When the clogging simulation test cannot be conducted, only the index value data under normal operating conditions (index values collected in section A3-4-2) can be used to determine the threshold value. When many index values can be collected, calculate the average value (μ) and standard deviation (σ), and determine the threshold value based on μ ± nσ. To eliminate misinformation, a value from 4 to 6 is recommended for n.
If only the maximum (xmax) and minimum (xmin) index values are known, the threshold value can also be determined using these values. For example, the threshold value should be set to a value that is no more than (xmax−xmin)/2 from the minimum value, as shown in the figure below.



Note that the threshold value determined only using the index value data under normal operating conditions is not always appropriate. The index value may reach the threshold value due to causes other than clogging, or the index value may not change to the threshold value even when clogging occurs. Observe changes in the index value for a short period after the threshold value has been determined, and then check that the index value does not exceed the threshold value under normal operating conditions, and that the difference between the correct value range and threshold value is not large. Revise the threshold value when necessary. Also, if the clogging simulation test is not conducted, it is difficult to predict the behavior of the index when one side is clogged. Therefore, even when the threshold value is set to the Press Freq Index High Limit, it is not relevant for clogging diagnosis.

A4 Setting using a level meter

A4-1 Clogging and the pressure frequency index

The pressure frequency index varies depending on clogging in the connecting pipe. Generally, the pressure frequency index becomes smaller as clogging progresses. Normally, the pressure frequency index does not become larger.

A4-2 Points to note regarding the diagnosis of clogging

When the pressure frequency index is used to diagnose clogging in the connecting pipe, observe the cautions shown below.
If the fluctuation is very small or its frequency is low, clogging cannot be diagnosed. This is because the pressure and differential pressure need to include sufficient perturbation in order to calculate the pressure frequency index with high accuracy. The following is a list of specific examples.

- There is no fluid flow, or flow velocity is very slow.
- Fluid viscosity is high.
- There is no fluctuation source due to the fact that no fluid is flowing in or out to/from the tank or the fluid is not agitated.

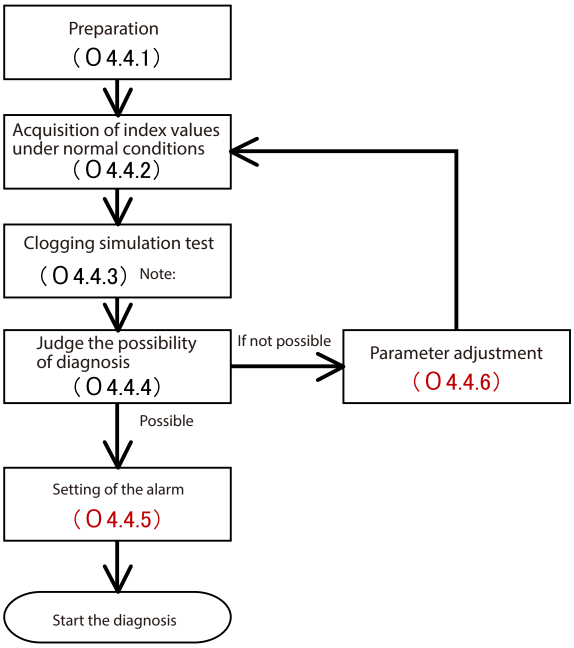
Variation in the pressure frequency index does not always mean that clogging in the connecting pipe has occurred. The index may vary due to other factors, such as the following.

- A change in the operating conditions of the pump, compressor, agitator, etc. (ON/OFF, number of units, RPM, etc.)
- A change in the viscosity of the process fluid

Depending on the material that causes clogging, it is possible that variation in the index will be too small for an alarm to be activated. For example, if the clog is made of something like gravel, where there are gaps, the pressure fluctuation can be transmitted through the gaps, and there will not be much change in the index.
If the frequency of pressure fluctuation is abnormal from the beginning, as is a case where the connecting pipe was clogged from the start, it may not be possible to diagnose the clogging. Do the setup procedures (A4–4) when the connecting pipe is operating normally.
Even if clogging occurs suddenly, the pressure frequency index will not change immediately. This is because it takes a few minutes to calculate the frequency of the pressure fluctuation with a high level of accuracy.
If the transmitter is installed in an environment subject to heavy vibration, the pressure frequency index may be affected, preventing correct diagnosis.

A4-3 Parameter configuration procedures

To diagnose clogging in the connecting pipe using the pressure frequency index, parameters must be set. Use the configuration procedure below.



Preparation (see section A4-4-1): Initialize the parameters in preparation for obtaining the index values.
Acquisition of index values under normal conditions (see section A4-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.
Clogging simulation test (see section A4-4-3): Operate the valve of the connecting pipe to simulate a clog and obtain index values.

Note: If you cannot conduct the clogging simulation test, skip sections A4-4-3 to A4-4-6, and then read section A4-4-7.

Judging the possibility of diagnosis (see section A4-4-4): Determine whether or not you can differentiate between a normal state and a simulated clogged state by comparing their index values.
Setting the alarm (see section A4-4-5): If diagnosis is judged to be possible, adjust the parameters shown below to set an alarm based on the collected index values. When the configuration process is complete, the diagnosis can begin.

Press Freq Index Alarm Use
Press Freq Index Low Limit

Parameter adjustment (see section A4-4-6): If distinguishing the two states is not possible, analyze the cause, adjust the parameters shown below, and then return to “Acquisition of index values under normal conditions.”

Press Freq Index Sensor Selection
Press Freq Filter Constant
Press Freq Calc PV High Limit
Press Freq Calc PV Low Limit

The procedures stated in "Acquisition of index values under normal conditions" and "Clogging simulation test" refer to the following parameters and process variables.

Pressure Frequency Index
Press Freq Index Max
Press Freq Index Min
Standard Deviation
Standard Deviation Max
Standard Deviation Min
Press Freq Calc PV High Limit
Press Freq Calc PV Low Limit

The standard deviation values are not directly used to diagnose clogging, but it may be necessary to refer to them during parameter adjustment. Therefore, it is recommended that they be collected at the same time as the pressure frequency indexes.

A4-4 Configuration procedures

This section describes the configuration procedures in order.

A4-4-1 Preparation

Before starting configuration, initialize the parameters.

◆Procedure◆

(1) Set Press Freq Index Sensor Selection to "DP, 120 ms."

(2) Set Press Freq Filter Constant to "0.15."

(3) Set Press Freq Calc PV High Limit to "Upper Range Value."

(4) Set Press Freq Calc PV Low Limit to "Lower Range Value."

(5) Set Press Freq Index Alarm Use to "Disabled" (operation off).

A4-4-2 Acquisition of the index values under normal operating conditions

Obtain the index value under normal operating conditions without clogging in the connecting pipe. The collected pressure frequency index and standard deviation values are used to judge the possibility of diagnosis and to adjust the parameters in later steps.

◆Procedure◆

(1) Check that the connecting pipe is operating normally. When a valve such as a manifold valve is attached to the connecting pipe, check that the pressure can be measured.

(2) Execute Reset Press Freq Index and Reset Standard Deviation. Note that after Reset Press Freq Index is executed, the correct values for Pressure Frequency Index, Press Freq Index Min, and Press Freq Index Max cannot be obtained for a short period of time. After Reset Press Freq Index has been executed, wait until the first index calculation is completed.

(3) Wait for at least 30 minutes, and if possible one hour.

(4) Obtain the values for Pressure Frequency Index, Press Freq Index Min, Press Freq Index Max, and the process variable, and record them.

(5) Obtain the values of Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions, perform the steps above under as many conditions as possible and collect the data. The reason for this is that the pressure frequency index value may vary depending on the operating conditions, even when the process state is normal. Covering as many conditions as possible will enable judging of the possibility of diagnosis and parameter adjustment to be carried out more reliably.

A4-4-3 Clogging simulation test

If a valve such as a stop valve is connected to the connecting pipe, the valve can be utilized to conduct the clogging simulation test. The pressure frequency index and standard deviation values that are collected in the clogging simulation state are used to judge the possibility of diagnosis and to adjust the parameters in later steps.

⚠Caution

When the valve of the connecting pipe is closed completely, the transmitter cannot measure the correct value. In addition, even when the valve is not closed completely, the delay before the process variable follows changes in pressure may be long. (This symptom is the same as when the damping time constant of the transmitter is made larger.) When conducting the clogging simulation test, exercise great care so that the test does not interfere with process safety or control.

◆Procedure◆

(1) Close the valve of the connecting pipe either completely or so that it is slightly open (with a small amount of fluid flow).

(2) Execute Reset Press Freq Index and Reset Standard Deviation.

(3) Wait 20 minutes or more.

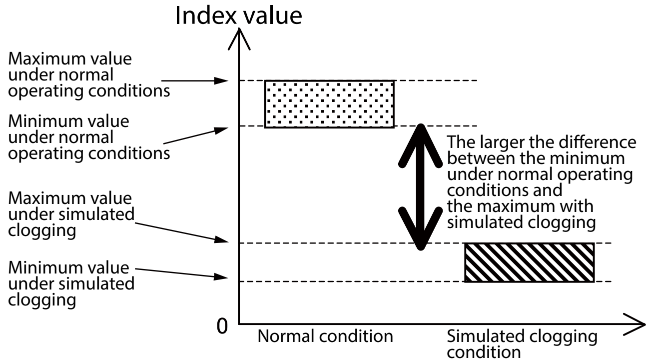
(4) Record the values for Pressure Frequency Index, Press Freq Index Min, Press Freq Index Max, and the PV.

(5) Obtain the values for Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

If there are multiple operating conditions and the index value under normal operating conditions varies depending on the operating conditions, it is recommended that the steps described above be repeated under each operating condition.
In the clogging simulation test, the valve of the connecting pipe needs to be sufficiently closed. The reason for this is that the low-pass filter effect due to clogging as described in “Principle” above does not occur if the flow path resistance caused by clogging (resistance to fluid flow) is not sufficiently high.

A4-4-4 Judging the possibility of diagnosis

Whether or not clogging can be diagnosed can be judged according to the index and its maximum and minimum values collected under normal operating conditions (section A4-4-2) and under a simulated clogged condition (section A4-4-3).

<table>
<tr><th colspan="2">Judgment criteria</th></tr>
<tr><td>The upper range limit of the clog simulated condition is smaller than the lower range value during normal condition.
The difference between the minimum under normal operating conditions and the maximum with simulated clogging is equivalent to or larger than the difference between the minimum and maximum under normal operating conditions.

</td><td>Diagnosis is possible.</td></tr>
<tr><td>The above conditions are not satisfied.</td><td>Diagnosis is not possible or difficult.</td></tr>
</table>

The minimum condition for diagnosis is that the maximum with simulated clogging is smaller than the minimum under normal conditions. If this condition is not satisfied, the index value may decrease to the value with simulated clogging even when the connecting pipe is operating normally. Therefore, the conditions are not suitable for diagnosis. In cases where the index value under normal conditions varies depending on the operating conditions, judgment should be based on the values when the minimum index value is at its smallest.
The larger the difference between the minimum under normal operating conditions and the maximum with simulated clogging, the easier diagnosis is. Therefore, this value is important.
A reference for judging whether diagnosis is possible is that this difference is equivalent to or larger than the difference between the minimum value and maximum value under normal operating conditions. If this difference is less than half of the difference between the minimum and maximum under normal conditions, diagnosis will probably be difficult. The reason for this is that the index will be close to its value with clogging even under normal conditions, so it will be difficult to distinguish between normal and abnormal states. In this case, conditions are probably inappropriate for diagnosis.
If diagnosis is judged to be possible, go on to section A4-4-5 and set the diagnostic alarm. If diagnosis is judged to be not possible, go to section A4-4-6 and consider parameter adjustment.

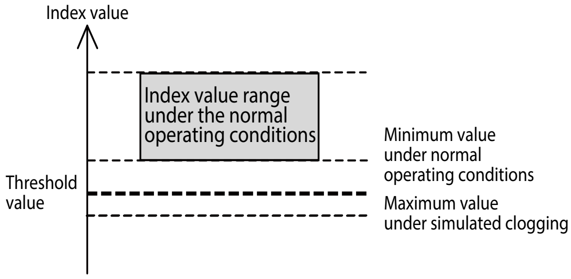
[CAUTION] The position of a clog may affect the amount of variation of the pressure frequency index. In particular, if the fluid is a compressible fluid, the effect can be significant.
In such a case, if clogging is closer to the process side, the amount of variation will be greater. Therefore, when the position where clogging actually occurs is closer to the transmitter than the position of the simulated clogging, changes in the index value will be small or almost zero in comparison to those in the simulation test. Likewise, when the position where clogging actually occurs is closer to the process as compared to the position of the simulated clog, changes in the index will be greater than in the simulation test.

A4-4-5 Setting of the diagnosis alarm

If diagnosis is judged to be possible, set the alarm. If you do not want to activate the alarm, omit the steps in this section.

[CAUTION] The procedures described in this document do not guarantee the detection of clogging or the elimination of false indications. The pressure frequency index may change due to causes other than clogging, and may also depend on the degree of clogging or the material of the clog. Adjusting the settings should be done with the realization that there is no threshold value setting that can eliminate misinformation and securely detect clogging only.

First, determine the alarm threshold value. This threshold should be between the minimum index value under normal conditions and the maximum with simulated clogging. If the threshold is put close to the minimum under normal operating conditions, the alarm will be activated earlier, but the possibility of a false alarm is also higher. Put the threshold at a certain distance away from the minimum under normal operating conditions, leaving a margin.



After determining the threshold value, follow the steps below to set the alarm and start the diagnosis.

◆Procedure◆

(1) Execute Reset Press Freq Index.

(2) Set Press Freq Index Low Limit to the determined threshold value.

(3) Set Press Freq Index Alarm Use “Enabled (Low)” (lower limit only).

With these settings, when the index value is outside the normal range and approaches the value with simulated clogging, the alarm is activated.

A4-4-6 Parameter adjustment

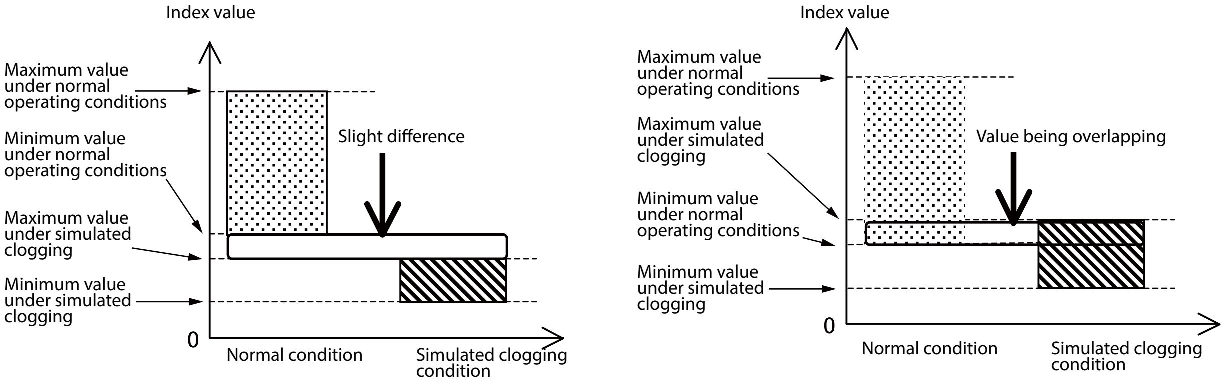
If diagnosis is judged to be not possible, the data collected under normal operating conditions (section A4-4-2) and when there is simulated clogging (section A4-4-3) can be analyzed and the parameters adjusted. The reason why diagnosis cannot be performed is that the index value—even under normal operating conditions—is similar to or smaller than that when there is clogging, so the normal and clogged states cannot be distinguished. There are two primary causes leading for this situation.

- A large amount of variation of the index under normal conditions
- A small variation of the index when there is clogging

This situation may be improved by adjusting the parameters of the pressure frequency index diagnosis. The following describes the two cases.

(A) Variation of the index under normal operating conditions is large.

In this case, although the value of the index is small with simulated clogging, variation in the index is large under normal conditions, so the index value can be close to or equivalent to its value with clogging even when there is no clogging, as shown in the figure below.

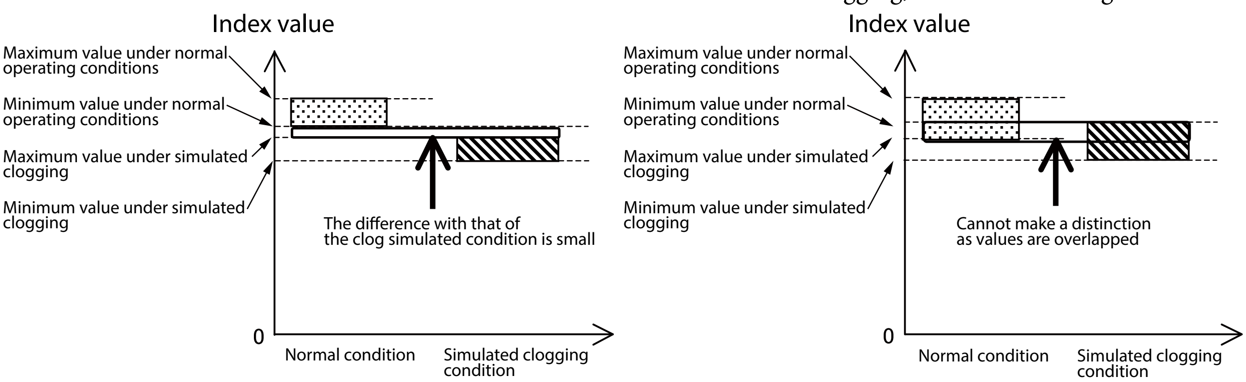


In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
The index value sometimes decreases significantly under normal operating conditions. At this time, the process variable changes or the standard deviation becomes large.	Increase the Press Freq Filter Constant in steps of 0.02–0.05.
The index value under normal operating conditions changes significantly depending on the operating conditions.	Check whether the operating conditions are related to the process variable. If there is a PV range where the difference between the maximum index value and the minimum is relatively small, or a PV range where the minimum under normal conditions is not small, set Press Freq Calc PV High Limit and Press Freq Calc PV Low Limit to the values of this range. If you use this parameter, you can conduct the diagnosis only when there's level, and stop the diagnosis when there is not.

(B) The variation of the index when there is a clog is small.

In this case, although variation in the index is relatively small under normal operating conditions, the value of the index is almost the same as with simulated clogging, as shown in the figure below.

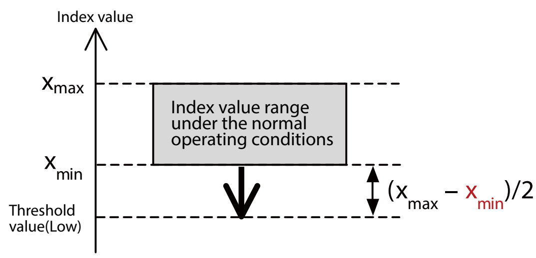


In this case, the index value under normal operating conditions is similar to that with clogging, or the index value is almost the same even when clogging occurs. In either case, it is necessary to examine the cause and to minimize this effect. Use the following guidelines for adjustment.

Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
Since the process variable fluctuates and there is always low-frequency pressure fluctuation, the value of the index is small even under normal operating conditions. The standard deviation is relatively large.	Increase the Press Freq Filter Constant in steps of 0.02–0.05.
The PV does not change and the standard deviation is also small. The frequency of the original pressure fluctuation is low and the index value is small. (The reference index value is 0.1 or less under normal operating conditions.) Fluid viscosity is high.	Change the Press Freq Index Sensor Selection. If the present value is “DP, 120 ms”, set it to “DP, 240 ms,” and if the present value is “DP, 240 ms,” set it to “DP, 360 ms.”
The magnitude and frequency of the original pressure fluctuation are acceptable. (The reference index value is 0.2 or more under normal operating conditions.) However, the value is almost the same when there is clogging.	Decrease the Press Freq Filter Constant in steps of 0.02–0.05.

A4-4-7 Clogging simulation test cannot be conducted.

When the clogging simulation test cannot be conducted, only the index value data under normal operating conditions (index values collected in section A4-4-2) can be used to determine the threshold value. When many index values can be collected, calculate the average value (μ) and standard deviation (σ), and determine the threshold value based on $\mu \pm n\sigma$. To eliminate misinformation, a value from 4 to 6 is recommended for n. The threshold value can also be determined using the maximum (xmax) and minimum (xmin) index values. For example, the threshold value should be set to a value that is no more than (xmax−xmin)/2 from the minimum value, as shown in the figure below.



Note that the threshold value determined using only the index value data under normal operating conditions is not always appropriate. The index value may become smaller than the threshold value due to causes other than clogging, or the index value may not become smaller than the threshold value even when clogging occurs. Observe changes in the index value for a short period after the threshold value has been determined, and then check that the index value does not become smaller than the threshold value under normal operating conditions, and that the difference between the correct value range and threshold value is not large. Revise the threshold value when necessary.

A5 Supplemental description of parameters

This section describes the parameters related to pressure frequency index diagnosis and their effect on clogging diagnosis.
The following description is intended to provide information for users who want to know the function of each parameter in detail. For the general configuration procedures, see sections A2 to 4.

A5-1 Pressure frequency filter constant

The Press Freq Filter Constant determines the strength of the high pass filter used to suppress decreases in the pressure frequency index due to causes other than clogging of the connecting pipes. The default setting at the time of shipment from the factory is “0,” meaning that the filter is not used. However, if the pressure frequency index is used for clogging diagnosis, setting the filter constant to cut out low-frequency fluctuations is recommended. In particular, when SP is selected for Press Freq Index Sensor Selection, setting the filter constant is strongly recommended. For clogging diagnosis, the generally recommended filter constant value range is 0.12 to 0.18.
The larger this parameter, the stronger the filtering effect. In this case, it will be difficult for the index value to become small for a reason other than clogging. However, if the filtering is too severe, it is difficult to detect changes in frequency that occur when the connecting pipe is clogged, so diagnosis performance deteriorates. The smaller the parameter, the smaller the filtering effect. In this case, there is little deterioration of diagnosis performance using the filter. However, if filtering is too weak, the value of the index can easily become small for reasons other than clogging. As a result, false alarms can occur.
When low-frequency fluctuation is very large (as a rough guideline, when the width of low-frequency fluctuation is more than 10 times greater than the standard deviation under normal operating conditions), it is difficult to eliminate this effect even when the filter is used.
The Fcut (Hz) and Tcu (t s) (inverse value of cutoff frequency) of this filter are as follows. c is the filter constant. Ts is the sampling interval selected in the Press Freq Index Sensor Selection, and it is any of 0.12 (s), 0.24 (s), and 0.36 (s).

$$Fcut = \frac{1}{2\pi Ts} \cos^{-1}\left(1 - \frac{c^2}{2\,(c+1)}\right)$$

$$Tcut = \frac{2\pi Ts}{\cos^{-1}\left(1 - \frac{c^2}{2\,(c+1)}\right)}$$

A5-2 Sensor selection

One of the following can be selected for Press Freq Index Sensor Selection.

DP, 120ms	factory default
DP, 240ms	
DP, 360ms	
SP, 360ms	only with a differential pressure gauge

A5-2-1 P sampling interval

When DP is selected for Press Freq Index Sensor Selection, 120, 240, or 360 ms can be selected for the P sampling interval. Normally, a shorter sampling interval is advantageous for clogging diagnosis. The reason for this is that changes in pressure fluctuation caused by clogging become apparent at higher frequencies. (For details, see the “Principle” section.) The sampling interval must be short for perception of changes in high frequency. Generally, the shorter the sampling interval, the better the performance of clogging diagnosis. However, with a shorter sampling interval, low frequencies are difficult to measure. Therefore, if the frequency of the pressure fluctuation is low initially, lengthening the sampling interval will make diagnosis easier.

A5-2-2 Sensor type

DP and SP are the available sensor selections for a differential pressure gauge. The reason for this is that it allows different sensors to be used for the index calculation. When DP is selected, the differential pressure sensor is used. When SP is selected, the static pressure sensor is used. Therefore, the diagnosis characteristics may change.
The following are the features of clogging diagnosis when DP is selected.

- The flow rate or magnitude of the pressure fluctuation necessary for diagnosis is smaller than for SP.
- Since a sampling interval of 120 ms can be selected, the sensitivity for clogging detection is high. The index update frequency is also high.
- It may not be possible to detect one-side clogging.

The following are the features of clogging diagnosis when SP is selected.

- The pressure fluctuation necessary for diagnosis is larger than for DP. Therefore, diagnosis may be possible with DP but not possible with SP.
- The sampling interval is fixed at 360 ms. The sensitivity for clogging detection decreases and the index update frequency is low in comparison to DP with 120 or 240 ms selected.
- It is possible that one-side clogging that cannot be detected or that is difficult to detect with DP can be detected with SP.

The advantage of selecting SP is that its one-side clogging detection capability is different from that of DP. However, selecting SP does not ensure one-side clogging detection. When the clogging simulation test cannot be conducted or when one-side clogging cannot be detected with SP, select DP. In these cases there is no advantage in selecting SP.

Appendix B

The following are the range settings at the time of factory shipping during coarse adjustment.
If a range specification is received from the customer, the product ships with the specified range.

Type	SI units	LRV	URV
JTD910 _	Pa	0	500
JTD920 _	kPa	0	50
JTD921 _	kPa	0	50
JTD930 _	kPa	0	350
JTD931 _	kPa	0	350
JTD960 _	MPa	0	7
JTD961 _	MPa	0	7
JTC929 _	kPa	0	50
JTC940 _	MPa	0	0.7
JTE929 _	kPa	0	50
JTE930 _	kPa	0	350
JTG940 _	MPa	0	2
JTG960 _	MPa	0	7
JTG980 _	MPa	0	20
JTH920 _	kPa	0	50
JTH940 _	kPa	0	700
JTH960 _	MPa	0	2
JTH980 _	MPa	0	20
JTA922 _	kPa abs	0	13
JTA940 _	MPa abs	0	2
JTS922 _	kPa abs	0	13
JTS940 _	MPa abs	0	0.7

Damping time constant at time of factory shipping*

Type	Adjustment span (X) according to damping time constant		
	4 s	2 s	1 s
JTD910 _	-	0.1 kPa ≤ X < 2 kPa	-
JTD920 _	5 kPa ≤ X < 2.5 kPa	2.5 kPa ≤ X < 5 kPa	5 kPa ≤ X
JTD921 _	0.75 kPa ≤ X < 2.5 kPa	2.5 kPa ≤ X < 5 kPa	5 kPa ≤ X
JTD930 _	35 kPa ≤ X < 45 kPa	45 kPa ≤ X < 90 kPa	90 kPa ≤ X
JTD931 _	35 kPa ≤ X < 45 kPa	45 kPa ≤ X < 90 kPa	90 kPa ≤ X
JTD960 _	0.25 MPa ≤ X < 0.7 MPa	0.7 MPa ≤ X < 1.4 MPa	1.4 MPa ≤ X
JTD961 _	0.25 MPa ≤ X < 0.7 MPa	0.7 MPa ≤ X < 1.4 MPa	1.4 MPa ≤ X
JTC929 _	-	2.5 kPa ≤ X < 5 kPa	5 kPa ≤ X
JTC940 _	70 kPa ≤ X < 80 kPa	80 kPa ≤ X < 210 kPa	210 kPa ≤ X
JTE929 _	-	2.5 kPa ≤ X < 5 kPa	5 kPa ≤ X
JTE930 _	35 kPa ≤ X < 45 kPa	45 kPa ≤ X < 90 kPa	90 kPa ≤ X
JTG940 _	17.5 kPa ≤ X < 80 kPa	80 kPa ≤ X < 210 kPa	210 kPa ≤ X
JTG960 _	-	0.7 MPa ≤ X < 1.4 MPa	1.4 MPa ≤ X
JTG980 _	-	0.7 MPa ≤ X < 1 MPa	1 MPa ≤ X
JTH920 _	-	2.5 kPa ≤ X < 5 kPa	5 kPa ≤ X
JTH940 _	35 kPa ≤ X < 80 kPa	80 kPa ≤ X < 210 kPa	210 kPa ≤ X
JTH960 _	-	0.7 MPa ≤ X < 1.4 MPa	1.4 MPa ≤ X
JTH980 _	-	0.7 MPa ≤ X < 1 MPa	1 MPa ≤ X
JTA922 _	-	4 kPa abs ≤ X < 5 kPa abs	5 kPa abs ≤ X
JTA940 _	35 kPa abs ≤ X < 80 kPa abs	80 kPa abs ≤ X < 210 kPa abs	210 kPa abs ≤ X
JTS922 _	-	4 kPa abs ≤ X < 5 kPa abs	5 kPa abs ≤ X
JTS940 _	35 kPa abs ≤ X < 80 kPa abs	80 kPa abs ≤ X < 210 kPa abs	210 kPa abs ≤ X

*If a specification is received from the customer, the product ships with the separately specified value.

Appendix C

Safety **Azbil Corporation**

ATEX Intrinsic safety and Dust Certifications (English)

1. Marking information

1.1 Intrinsic safety and Dust

CE 0344 Ex DEKRA 14ATEX0140 X

II 1 G Ex ia IIC T4 Ga; Ui = 30 V; Ii = 93 mA; Pi = 1 W; Ci = 5 nF; Li = 0

II 1 D Ex ia IIIC T105 °C Da

-30 °C ≤ Ta ≤ +60 °C; $T_{PROCESS}$ = 105 °C; IP66 / IP67

CE Ex DEKRA 15ATEX0078

II 3 G Ex ic IIC T4 Gc; Ui = 30 V; Ci = 5 nF; Li = 0

-30 °C ≤ Ta ≤ +60 °C; $T_{PROCESS}$ = 110 °C; IP66 / IP67

2. Applicable standards

EN 60079-0:2012 + A11

EN 60079-11:2012

3. Instruction for safe use

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC 60529, suitable cable entries must be used and correctly installed. Unused openings must be closed with a suitable stopping plug.

3.2 Thread type of entry

When Model No. is given with JTx9xxx-x … x-yx … x-x …

If y=X, 2, or 3, the thread type of entries is G1/2, or

If y=A, the thread type of entries is 1/2NPT.

4. Special conditions for safe use of intrinsic safety Ex ia (X certificate)

If the enclosure of the transmitter is aluminium, and if it is mounted in an area where the use of EPL Ga equipment is required, it must be installed such that, even in the event of rare incidents, ignition sources due to impact and friction sparks are excluded.

For the use in the area where an EPL Da apparatus is required, electrostatic discharge shall be avoided.

Manual No.CM2-ATS100-2001

Safety **Azbil Corporation**

IECEx Intrinsic safety and Dust Certifications (English)

1. Marking information

1.1 Intrinsic safety and Dust

IECEx DEK 14.0091X

Ex ia IIC T4 Ga; Ui = 30 V; Ii = 93 mA; Pi = 1 W; Ci = 5 nF; Li = 0

Ex ia IIIC T105 °C Da;

-30 °C ≤ Ta ≤ +60 °C; $T_{PROCESS}$ = 105 °C; IP66 / IP67

Ex ic IIC T4 Gc; Ui = 30 V; Ci = 5 nF; Li = 0

-30 °C ≤ Ta ≤ +60 °C; $T_{PROCESS}$ = 110 °C; IP66 / IP67

2. Applicable standards

IEC 60079-0:2011

IEC 60079-11:2011

3. Instruction for safe use

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC 60529, suitable cable entries must be used and correctly installed. Unused openings must be closed with a suitable stopping plug.

3.2 Thread type of entry

When Model No. is given with JTx9xxx-x … x-yx … x-x …

If y=X, 2, or 3, the thread type of entries is G1/2, or

If y=A, the thread type of entries is 1/2NPT.

4. Special conditions for safe use of intrinsic safety Ex ia (X certificate)

If the enclosure of the transmitter is aluminium, and if it is mounted in an area where the use of EPL Ga equipment is required, it must be installed such that, even in the event of rare incidents, ignition sources due to impact and friction sparks are excluded.

For the use in the area where an EPL Da apparatus is required, electrostatic discharge shall be avoided.

Manual No.CM2-ATS100-2001

Terms and Conditions

We would like to express our appreciation for your purchase and use of Azbil Corporation's products.

You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

1. Warranty period and warranty scope

1.1 Warranty period

Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

1.2 Warranty scope

In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

(1) Failure caused by your improper use of azbil product (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
(2) Failure caused for other reasons than Azbil Corporation's product;
(3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
(4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
(5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
(6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

2. Ascertainment of suitability

You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

(1) Regulations and standards or laws that your Equipment is to comply with.
(2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
(3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use
Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down. You are required to provide your Equipment with safety design such as fool-proof design,*1 and fail-safe design*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance,*3 fault tolerance,*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

*1. A design that is safe even if the user makes an error.
*2. A design that is safe even if the device fails.
*3. Avoidance of device failure by using highly reliable components, etc.
*4. The use of redundancy.

3. Precautions and restrictions on application

3.1 Restrictions on application

Please follow the table below for use in nuclear power or radiation-related equipment.

	Nuclear power quality*5 required	Nuclear power quality*5 not required
Within a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Cannot be used (except for limit switches for nuclear power*7)
Outside a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Can be used

*5. Nuclear power quality: compliance with JEAG 4121 required
*6. Radiation controlled area: an area governed by the requirements of article 3 of "Rules on the Prevention of Harm from Ionizing Radiation," article 2 2 4 of "Regulations on Installation and Operation of Nuclear Reactors for Practical Power Generation," article 4 of "Determining the Quantity, etc., of Radiation-Emitting Isotopes,"etc.
*7. Limit switch for nuclear power: a limit switch designed, manufactured and sold according to IEEE 382 and JEAG 4121.

Any Azbil Corporation's products shall not be used for/with medical equipment.

The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product. However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

3.2 Precautions on application

you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below. Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

(1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals
(2) For use of specific purposes, such as:
    * Nuclear energy/radiation related facilities
      [When used outside a radiation controlled area and where nuclear power quality is not required]
      [When the limit switch for nuclear power is used]
    * Machinery or equipment for space/sea bottom
    * Transportation equipment
      [Railway, aircraft, vessels, vehicle equipment, etc.]
    * Antidisaster/crime-prevention equipment
    * Burning appliances
    * Electrothermal equipment
    * Amusement facilities
    * Facilities/applications associated directly with billing
(3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
(4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
(5) Machinery or equipment that may affect human lives, human bodies or properties
(6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

4. Precautions against long-term use

Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification. Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.

5. Recommendation for renewal

Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations.

In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used. Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc. as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals. System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts. For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.

6. Other precautions

Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.

7. Changes to specifications

Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason. For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.

8. Discontinuance of the supply of products/parts

Please note that the production of any Azbil Corporation's product may be discontinued without notice. After manufacturing is discontinued, we may not be able to provide replacement products even within the warranty period.

For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.

9. Scope of services

Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

(1) Installation, adjustment, guidance, and attendance at a test run
(2) Maintenance, inspection, adjustment, and repair
(3) Technical guidance and technical education
(4) Special test or special inspection of a product under the conditions specified by you

Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.

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