Advanced Transmitter Electronic Differential Pressure/ Pressure Transmitter

Model GTX_ _ _

User's Manual

Azbil Corporation

NOTICE

While the information in this manual is presented in good faith and believed to be accurate, Azbil Corporation disclaims any implied warranty of merchantability or fitness for a particular purpose and makes no express warranty except as may be stated in its written agreement with and for its customer.

In no event shall Azbil Corporation be liable to anyone for any indirect, special or consequential damages. This information and specifications in this document are subject to change without notice.

This product has been designed, developed, and manufactured for general-purpose and explosion-proof applications in machinery and equipment. Never use this product in applications where human life may be put at risk, or in radiation-controlled areas for nuclear applications.

Especially when this product is used in applications where safety is critical, such as safety devices for plant worker protection, direct control of transportation equipment, or aeronautical or aerospace equipment, special care should be taken to implement a fail-safe and redundant design concept as well as a periodic maintenance program.

For details on system design, application design, instructions on use, suitable applications, etc., contact the azbil Group. In no event is Azbil Corporation liable to anyone for any indirect, special, or consequential damages as a result of using this product.

HART® is a registered trademark of the FieldComm Group.

Warranty

The conditions for warranty of this product are shown below.

Within the warranty period, if the product has some defect for which Azbil Corporation is responsible, the company will repair the product or provide a replacement.

1. Warranty period

   The warranty period is one (1) year from the date of delivery of the product to the location specified by the customer.

   However, if the product is repaired for a fee, the warranty period is 3 months from the date of delivery of the repaired product.

2. Exemptions

   The following cases are exempted from the warranty.

   (1) A problem caused by incorrect handling, modification, or repair made by any person other than Azbil Corporation or a subcontractor commissioned by the company.

   (2) A problem caused by handling, use, or storage that exceeds the operating conditions stated in the user's manual, specifications sheet, or delivery specification sheet.

   (3) A problem caused by corrosion of wetted surfaces.

   (4) Other problems for which Azbil Corporation is not responsible.

3. Other

   (1) In the case of a warranty contract with Azbil Corporation other than this warranty, the contract has priority over this warranty.

   (2) Whether product repair is free of charge depends on the results of inspection by Azbil Corporation.

Safety

Instructions

Preface

Correct installation and periodic maintenance are essential to the safe use of your differential pressure transmitters.
Read the safety instructions provided in this manual carefully and understand them fully before starting installation, operation, and maintenance work.

Inspection

On delivery, make sure that the specifications are correct and check for any damage that may have occurred during transportation. This equipment was tested under a strict quality control program before shipment. If you find any problem in the quality specifications, please contact an Azbil Corp. representative immediately, providing the model name and serial number.
The name plate is mounted on the neck of the enclosure.

Precautions

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

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

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

To ensure safe operation, be sure to observe the safety instructions provided on the next page.
Azbil Corporation will assume no responsibility, or offer any guarantee for any failure resulting from violation of these safety instructions.

Handling Precautions for This Product

Installation Precautions

⚠ WARNING

- Some models of the transmitter have a mass of 10 kg or more because of differences in specifications. For your safety when transporting or installing the transmitter, use a dolly or two or more people. Carelessly lifting the transmitter and accidentally dropping it can cause injury or damage.
- When installing the transmitter, ensure that gaskets do not protrude from connecting points into the process (such as adapter flange connection points and connecting pipes and flanges). Failure to do so may cause a leak of process fluid, resulting in harm from burns, etc. In addition, if the process fluid contains toxic substances, take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation.
- Use the transmitter within the operating ranges stated in the specifications (for explosion-proofing, pressure rating, temperature, humidity, voltage, vibration, shock, mounting direction, atmosphere, etc.). Using the transmitter outside the operating conditions may cause device failure or fire, resulting in a harmful physical risk of burning or the like.
- To ensure safety, installation and connection work should be carried out only by technicians skilled in instrumentation and electrical work. In areas where there is an explosion hazard., installation and wiring must conform to guidelines for explosion-proof electrical installations in general industrial use.

⚠ CAUTION

- When using the U-bolt to fix the optional bracket to a 2″ pipe, note that the U bolt may be damaged if tightened with excessive force.
- After installation, do not use the transmitter as a foothold or put your weight on it. Doing so may cause damage.
- Be careful not to hit the glass indicator with tools etc. This could break the glass and cause injury.
- Carefully follow the instructions for grounding given in the user's manual. Improper grounding may affect output or violate explosion-proof guidelines.
- Impact to transmitter can damage sensor module.

Wiring Precautions

⚠WARNING

To avoid shocks, do not perform electrical wiring work with wet hands or with live wires.

⚠CAUTION

- Do wiring work properly in conformance with the specifications. Wiring mistakes may result in malfunction or irreparable damage to the instrument.
- Use a power supply that conforms to the specifications. Use of an improper power supply may result in malfunction or irreparable damage to the instrument.
- Use a power supply with overcurrent protection for this instrument.

Maintenance Precautions

⚠WARNING

- Before removing this product from the process equipment for purposes of maintenance, vent the residual pressure and discharge the residual fluid. When discharging the residual pressure and fluid, check the direction of the vent or drain to prevent injury by the process fluid. Failure to do so may result in burns or other injuries. If the process fluid contains toxic substances, take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation.
- When the device is being used in an explosion-proof area, do not open the cover. Opening the cover may cause an explosion.
- If a sealing gasket is broken, replace it with a new one. If the device runs with a broken sealing gasket, since the degree of sealing is not sufficient, the process fluid may spurt out, resulting in burns or other injuries.

CAUTION

- Do not disassemble or modify this device. Doing so may result in device failure or electric shock. Explosion-proof equipment cannot be inspected or disassembled in areas where there is an explosion hazard. In addition, the use of modified explosion-proof equipment is prohibited.
- If this device is used with a high-temperature fluid, be careful not to touch the device accidentally. Since this product can become extremely hot, contact with it may result in burns.
- If this device is no longer needed, dispose of it appropriately as industrial waste, in accordance with local regulations. Do not reuse all or a part of the device.

Precautions for Using Communication Devices

CAUTION

When using a communication device such as a transceiver, cell phone, PHS phone, or pager near this device, observe the precautions below. Otherwise, depending on the transmission frequency, this device may not function properly.

- Determine beforehand the minimum distance at which the communication device will not affect the operation of this device, and maintain a separation greater than that distance.
- Make sure the cover of its transmitter section of this device is closed before using the communication device.

Precautions for Communication

CAUTION

If transmitter output is reduced to 3.2 mA or less because of burnout, etc., communication with a HART communicator may not be possible. Try turning off the power, rebooting, and restarting communication.

Cautions to Disposal of 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.

Safety Manual

⚠ Warning
If the Q1, "Safety Transmitter" option is selected, before the transmitter is used in a safety instrumented system, be sure to follow the instructions below.

1. Application

This document is applicable for safety requirements that conform to the IEC 61508: 2010 international standard.

2.Model of safety transmitter

Q1 in options code is necessary to select the certified safety transmitter.
The model code configuration of Model GTX consists of the following four sections, separated by a hyphen mark.
Regular shape transmitters (Type selection [X] = D, G, or A)
GTX xx[X] (Type Selections) -xxxxxxx (Specific Selections) – xxxxxxx (Common Selections) - (Options) Q1 (Options)
Flange mounted transmitters (Type selection [X] = F or W)
GTX xx[X] (Type Selections) -xxxxxxxxxxxx (Specific Selections) -xxxxxxx (Common Selections) - (Options) Q1 (Options)
Remote diaphragm sealed transmitters (Type selection [X]= R, U, or S)
GTX xx[X] (Type Selections) - xxxxxxxxxx (Specific Selections) - xxxxxxx (Common Selections) - (Options) Q1 (Options)

1. Type Selection (3 digits)
2. Specific Selection (7digits, 12 digits, or 10 digits, depending on the shape of transmitter)
3. Common Selection (7 digits)
4. Options (Sum of all chosen option codes which are 2 digits each)

3. Safety function specifications

Item	Specification
Mode of operation	Low demand mode
Safety integrity level	SIL 2 (HFT 0), SIL 3 (HFT 1)
Device Type	Type B

3.1 Output related to safety

The safety-related output from the transmitter is a 4–20 mA analog output signal. For all functions related to safety requirements, the output is an analog signal. Contact output or a digital output signal cannot be used in a safety instrumented system.

3.2 Output when the state is normal

The ordinary output is a 3.6 to 21.6 mA analog signal, including 0 % or lower, and 100 % or higher.
If NAMUR NE43 option is selected, the signal range is 3.8 mA to 20.5 mA.

3.3 Output when the state is abnormal

3.3.1 Output signal when the state is abnormal (burnout)

When the state is abnormal, the output signal goes off-scale in the upper or lower direction, depending on the burnout setting.

In the cases below, the output signal may go off-scale in the low direction regardless of the burnout setting.

- Watchdog timer reset
- Internal voltage error
- Output circuit error

When self-diagnosis judges that a major failure has occurred, the transmitter's output signal is less than 3.6 mA or more than 21.6 mA.

3.3.2 LCD indication when the state is abnormal

When the state is abnormal, specific error messages are displayed on the LCD.

For details of the messages, see the table in chapter 5, "Troubleshooting."

3.4 Startup

The safety output signal becomes effective within 2 seconds after transmitter startup.

3.5 Accuracy

Standard accuracy for safety is ±2 % or ±4 %, depending on the model number. Depending on the conditions of use, the accuracy in actual use will differ.

3.6 Diagnosis time

The transmitter's self-diagnosis results are detected within 5 minutes after an error occurs. A burnout signal will be output within 5 seconds after the error is detected.

4. Settings related to safety

After the transmitter is installed, the following parameters must be set before use.

- Burnout direction
- Write-protect switch*

* When the transmitter is used as a part of a safety instrumented system, communication using a communicator is prohibited when the state is normal.

5. Restrictions

5.1 Restrictions on environment

To maintain long-term product performance and reliability, install the transmitter in an environment with the characteristics below.

1. Ambient temperature

1-1. Have as little ambient temperature gradient and variation as possible.

1-2. If the transmitter is affected by heat from the process, take countermeasures such as wrapping it with insulation or installing it in a ventilated place.

1-3. If there is a possibility that the process fluid will freeze, be careful not to freeze it by adiabatic treatment.

2. Environment

Pollution degree: 2

Indoor/outdoor use

Avoid using the transmitter in a corrosive atmosphere as much as possible.

When installing, follow the conditions for explosion-proof equipment and intrinsic safety.

3. Shock and vibration

Install where shock and vibration is minimal.

5.2 Restrictions on application

For the items below, the transmitter's output does not meet the requirements for a safety instrumented system.

- Change of settings
- Turning off write protection
- Multi-drop
- Simulation mode (loop test, B/O simulation)
- Test of safety functions

In a safety instrumented system, a substitute device is required to ensure safety during setup or maintenance of the transmitter.

6. Maintenance

6.1. Maintenance

Make sure that an engineer with technical knowledge does the maintenance work.

Maintenance needs to be done on a regular basis. Proof tests (tests to check operation) are an effective method of maintenance for detecting hidden problems.

6.2 Proof tests

See below for a proof test. With this test you can detect 59 % of DU failures.

A. Bypass the PLC or take appropriate measures to avoid tripping the sensor shutoff.

B. Use the communicator to check the results of diagnosis.

C. Switch to burnout simulation mode with the communicator.

D. In simulation mode, check that indication goes beyond the burnout upper limit.

E. In simulation mode, check that indication goes beyond the burnout lower limit.

F. Quit simulation mode.

G. Remove the bypass circuit from the PLC.

In addition to the above test, by doing the following test, 99 % of DU failures can be detected.

H. Apply pressure so that the output signal is 0 %, 20 %, 40 %, 60 %, 80 %, 100 % and verify the output signal.

7. Safety-related parameters

λ_{dd} [h-1]	481
λ_{du} [h-1]	222
λ_s [h-1]	363
HFT	0-SIL2, 1-SIL3
MTTR	72 h
PFD_{avg} (PTI = 1 year)	1.02×10^{-3}
PFD_{avg} (PTI = 5 years)	4.9×10^{-3}
Diagnosis time	< 5 min

8. Functional safety software (S/W)

The following shows valid S/W versions for safety transmitter.

S/W Ver.	Date of Release
Ver.2.9	Sep. 2012
Ver.6.3	Jan. 2019

9. Abbreviations

SIS: Safety instrumented system
SIL: Safety integrity level
HFT: Hardware fault tolerance
PFD: Probability of failure on demand
PLC: Programmable logic controller
B/O: Burnout (output signal when state is abnormal)
DU: Dangerous undetected

Safety Precautions

1. Checking products

When receiving a purchased product, check the appearance and confirm that the product is not damaged.
If the product specifications are customized, accessories other than standard accessories may be included in the product.

2. Checking specifications

The model number, which indicates the product's specifications, is written on the metal nameplate attached to the transmitter. Check that there is no difference between the specifications indicated by the model number and the specifications that were ordered.

3. Transport

To protect the transmitter from damage during transport, it is recommended that the product be moved to the installation location while still packaged.

4. Storage environment

4-1. Storage location
Keep the product in a place not affected by vibration, impact, or rain water.
4-2. If possible, we recommend storing the product packed as it was originally shipped.
4-3. When storing a transmitter that has been used, check that there is no fluid on the liquid-contacting parts of the transmitter, and wash it before storing.

5. Installation and operation

Before applying pressure to the transmitter, observe the following rules.
5-1. The adapter flange attachment bolt is loose at the time of shipment from the factory. When installing, tighten it to the specified torque.
5-2. Do not subject the product to pressure beyond the rated pressure.
5-3. Do not loosen the bolts or excessively tighten them while pressure is applied to the transmitter.

6. Electrical components

6-1. This product contains CMOS electrical components. There is a danger that the functions of CMOS components will be damaged by static electricity. Never touch electrical components or circuits with your bare hands.
6-2. If you need to touch something, be sure to remove static electricity from yourself beforehand.
6-3. If the printed wiring board (PWB) is removed, keep it in an antistatic bag.

7. Inquiries

Azbil Corporation
Advanced Automation Company
1-12-2 Kawana, Fujisawa, Kanagawa Prefecture
251-8522

PED Conformity (2014/68/EU)

The maximum pressures applicable under the Sound Engineering Practice (SEP) section of the Pressure Equipment Directive depend on the type of fluid measured, as shown in the table below.

Measured fluid	Group*	Pressure	Applicable models
Gas	1	200 bar (20 MPa)	All models except GTX32D, 42D, 72D, 82G
	2	1,000 bar (100 MPa)	All models
Liquid	1	500 bar (50 MPa)	All models
	2	1,000 bar (100 MPa)	All models

*Note : Group 1 comprises fluids defines as: explosive, extremely flammable, highly flammable, flammable, very toxic, toxic and oxidizing.
Group 2 comprises all other fluids not refer to group 1

Any transmitter model having a maximum working pressure that is higher than the pressure corresponding to its group does not conform to SEP.
Models GTX32D, 42D, 72D and 82G conform to PED according to Module A.

Explosion protected Models

FM Explosionproof / Dust-ignition proof Approval

1. Marking Information

FM18US0129X
Explosionproof for Use in Class I, Division 1, Groups A, B, C and D T5;
Dust-ignitionproof for Use in Class II and III, Division 1, Groups E, F and G T5; -40°C≤Tamb≤+85°C;
Flameproof for Use in Class I, Zone 0/1, AEx db IIC T5 Ga/Gb; -30°C≤Tamb≤+80°C; -30°C≤Tprocess≤100°C;
Hazardous (Classified) locations Indoor / Outdoor Type 4X, IP67

2. Applicable Standards

- FM Class 3600: 2018, Electrical Equipment for Use In Hazardous (Classified) Locations - General Requirements
- FM Class 3615: 2018, Explosionproof Electrical Equipment General Requirements
- FM Class 3810: 2018, Electrical Equipment for Measurement, Control and Laboratory Use
- ANSI/ISA 60079-0: 2013, Explosive Atmospheres - Part 0: Equipment - General Requirements
- ANSI/ISA 60079-1: 2015, Explosive Atmospheres - Part 1: Equipment Protection by Flameproof Enclosures "d"
- ANSI/ISA 60079-26: 2017, Explosive Atmospheres - Part 26: Equipment with equipment protection level (EPL) Ga
- ANSI/IEC 60529: 2004, Degrees of Protection Provided by Enclosures (IP Code)
- ANSI/NEMA 250: 1991 Enclosures for Electrical Equipment (1000 Volts Maximum)

3. Instruction for Safe Use

Installations shall comply with the relevant requirements of ANSI/ NFPA70 National Electrical Code® and the manufacturer's instructions.

4. Specific Conditions of Use

4.1 The enclosure of the Model GTX is made of aluminum, so if it mounted in Zone 0, it must be installed in such a way that, even in the event of rare incidents, ignition CM2-GTX100-2001 rev12 Explosion Protected Models sources due to impact of friction sparks are excluded.
4.2 See Table 1 for the material of the barrier diaphragm. The barrier diaphragm shall not be subjected to environmental conditions which might adversely affect the partition wall, for example corrosion.
4.3 Repairs of flameproof joints are allowed only by manufacturer.
4.4 The equipment must be returned to the manufacturer in case of failure.
4.5 The wetted parts with process fluid are suitable for use in Zone 0 and other parts are suitable for use in Zone 1.
4.6 This product is specified for vibrating as follows.
- For all models other than the direct mount type

Frequency 5-60Hz / 0.21mm amplitude
Frequency 60-500 Hz / 2g

- For the direct mount type with stainless steel enclosures
  Frequency 10-60Hz / 0.15mm amplitude
  Frequency 60-500 Hz / 2g
- For the direct mount type with enclosure material other than stainless steel
  Frequency 10-60Hz / 0.21mm amplitude
  Frequency 60-2000 Hz / 3g

Table 1. Identifying Diaphragm Material from Model Code

	Standard Mount Type Note 1	Remote Sealed Type Note 2	Flange Mount Type Note 3
Code ■	GTX _ _ D/G/A - _ _ _ ■	GTX _ _ R/U/S - _ _ ■	GTX _ _ F/W - _ _ _ ■
A, D	SUS316L	SUS316L	SUS316L / SUS316L
B, L, M	ASTM B575	ASTM B575	ASTM B575 / SUS316L
C, N, P	Tantalum	Tantalum	Tantalum / SUS316L
E, Q, R	Monel	Monel	Monel / SUS316L
F, S, T	Titanium	Titanium	Titanium / SUS316L
G, U, V	Nickel	Nickel	Nickel / SUS316L
H	Zirconium	Zirconium	Zirconium / SUS316L
J	Platinum	Platinum	Platinum / SUS316L
K	SUS304L	SUS304L	SUS304L / SUS316L
1	-	-	ASTM B575 / ASTM B575
2	-	-	Tantalum / Tantalum
3	-	-	SUS316L / SUS316L
4	-	-	Monel / Monel
5	-	-	Titanium / Titamiun

Note 1. Refers to diaphragm material of both the high and low pressure sides for differential pressure model (GTX _ _ D), and diaphragm material of just the measured pressure side for gauge and absolute pressure models (GTX _ _ G/A).

Note 2. Refers to diaphragm material of both the high and low pressure sides for differential pressure model (GTX _ _ R), and diaphragm material of just the measured pressure side for gauge and absolute pressure models (GTX _ _ U/S).

Note 3. Refers to the combination of diaphragm material of the flanged side and reference side. (Flanged side / Reference side).

FM Intrinsically safe, Nonincendive and Suitable Approval

1. Marking Information

FM18US0256X
Intrinsically Safe for use in Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F and G; Class III, Division 1; T4 -40°C < Tamb < +60°C;
Class I, Zone 0, AEx ia IIC;T4 Ga -30°C < Tamb < +60°C; Tprocess = 105°C
Hazardous (Classified) Locations; Indoor/Outdoor Enclosure TYPE 4X, IP67;
For entity parameters see control drawings 80395278, 80395279, and 80395280.
Nonincendive, with Nonincendive Field Wiring Parameters, for use in Class I, Division 2, Groups A, B, C and D, T4; Class I, Zone 2, Group IIC, T4;
Suitable for Class II & III, Division 2, Groups E, F and G, T4; -40°C < Tamb < +60°C;
Hazardous (Classified) Locations; Indoor/Outdoor Enclosure TYPE 4X, IP67;
For Nonincendive Field Wiring parameters see 80395494.

2. Applicable Standards

- FM Class 3600: 2018 Electrical Equipment for Use in Hazardous (Classified) Locations - General Requirements
- FM Class 3610: 2018 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II & III, Division 1, Hazardous (Classified) Locations
- FM Class 3611: 2016 Nonincendive Electrical Equipment for Use in Class I & II, Division 2, and Class III, Divisions 1 & 2, Hazardous (Classified) Locations
- FM Class 3810: 2005 Electrical Equipment for Measurement, Control and Laboratory Use
- ANSI/ISA-60079-0: 2013 Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations - Part 0: General Requirements
- - ANSI/ISA-60079-11: 2014 Electrical Apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations - Part 11: Intrinsic Safety "i"
- ANSI/ISA-61010-1-2012 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
- ANSI/IEC 60529:2004 Degrees of Protection Provided by Enclosures (IP Code)
- ANSI/NEMA 250:1991 Enclosures for Electrical Equipment (1,000 Volts Maximum)

3. Instruction for Safe Use

3.1 Installations shall comply with the relevant requirements of the ANSI/NFPA 70 National Electrical Code®.

3.2 Installations shall comply with the latest edition of the manufacturer's instruction manual. IS models shall be installed in accordance with the control drawings 80395278, 80395279, and 80395280, and NI models shall be installed in accordance with the control drawing 80395494.

3.3 The intrinsically safe associated apparatus must be FM Approvals approved.

3.4 Control room equipment connected to the associated apparatus should not use or generate more than 250 Vrms or Vdc.

3.5 See ANSI/ISA RP12.06.01, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations, for guidance on the installation of intrinsically safe apparatus and systems.

3.6 Tampering and replacement with non-factory components may adversely affect the safe use of the system.

3.7 Insertion or withdrawal of removable electrical connectors is to be accomplished only when the area is known to be free of flammable vapors.

3.8 For ambient temperatures below -10°C (+14°F) and above +60°C (+140°F) use field wiring suitable for both minimum and maximum ambient temperatures.

3.9 Use copper, copper-clad aluminum or aluminum conductors only.

3.10 The recommended tightening torque for field wiring terminals is 0.8 N·m (7 in.·lb) or greater, as specified.

3.11 A dust-tight conduit seal shall be used when installed in Class II & III environments.

3.12 WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY

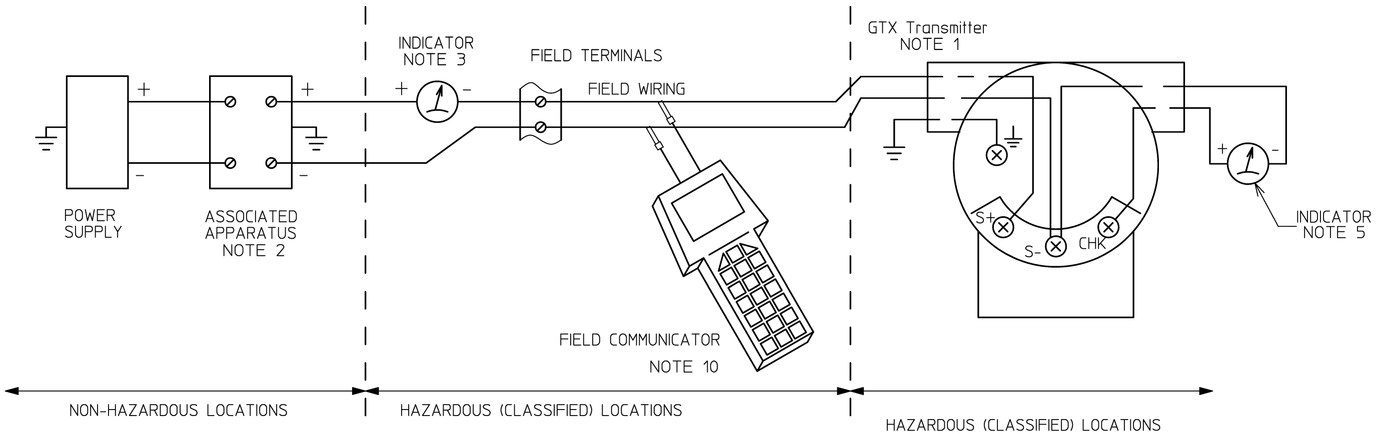
3.13 WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR DIVISIONS 1 & 2 AND ZONES 0, 1 & 2

3.14 WARNING - DO NOT DISCONNECT EQUIPMENT UNLESS AREA IS KNOWN TO BE NONHAZARDOUS

3.15 WARNING - FOR CONNECTION ONLY TO NON-FLAMMABLE PROCESSES.

3.16 For use the in the area where EPL “Ga” apparatus is required, electrostatic discharge shall be avoided

GTX□□□-□□□□□□□□□□□□□□□□□□
└→OPTION : F2, F5, C2, C6, or FA



HAZARDOUS (CLASSIFIED) LOCATIONS
IS FOR CL I, II, III, DIV 1, GPs A, B, C, D, E, F & G, T4 : -40°C ≤ Tamb ≤ +60°C
IS AEx/Ex ia T4 Ga for CL I, Zone 0, GP IIC : -30°C < Tamb < +60°C : Max Process Temperature 105°C

NOTES : 1. ENTITY PARAMETERS OF GTX Transmitter
Vmax=30V, Imax=100mA, Pi=1W, Ci =10nF, Li= 0.5mH

2. INTERCONNECTION IS ALLOWED BETWEEN GTX TRANSMITTER AND FM/cFM ENTITY APPROVED ASSOCIATED APPARATUS. THE ASSOCIATED APPARATUS SHOULD BE INSTALLED ACCORDING TO THE MANUFACTURER'S INSTRUCTION.
THE FM/cFM APPROVED ASSOCIATED APPARATUS INCLUDES ANY FM/cFM ENTITY APPROVED SINGLE OR DUAL BARRIER.

3. FM/cFM APPROVED INDICATOR SHALL CONTAIN THE FOLLOWING PARAMETERS : Li=60 μH, MAX Ci=0F, INTERNAL RESISTANCE=36Ω MAX. THE INDICATOR SHALL HAVE A SUITABLE FM/cFM APPROVAL FOR THE HAZARDOUS AREA.

4. THE TRANSMITTER MAY BE MOUNTED WITHIN A CLASS I, DIVISION 2 AND CLASS I, ZONE2 HAZARDOUS (CLASSIFIED) LOCATION WITHOUT THE FM/cFM APPROVED ASSOCIATED APPARATUS IF THE POWER SUPPLY RATINGS DO NOT EXCEED THE MAXIMUM VOLTAGE, CURRENT AND POWER SPECIFIED FOR THE TRANSMITTER.
THE INSTALLATION AND WIRING ARE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (ANSI/NFPA70)

5. FM/cFM APPROVED INTRISICALLY SAFE INDICATOR.

6. TO DETERMINE PROPER MATCHING OF I.S. EQUIPMENT AND THE MAXIMUM WIRING LENGTH USE, THE FOLLOWING FORMULAS SHALL BE SATISFIED :

Voc or Vt ≤ Vmax,
Isc or It ≤ Imax,
Ca ≥ Σ Ci + Cw (WIRING)
La ≥ Σ Li + Lw (WIRING)
Ca : MAXIMUM ALLOWED CAPACITANCE OF THE LOOP
La : MAXIMUM ALLOWED INDUCTANCE OF THE LOOP

7. DUST-TIGHT CONDUIT SEAL SHOULD BE USED WHEN INSTALLED IN CLASS II AND CLASS III ENVIRONMENTS.

8. INTRINSICALLY SAFE INSTALLATION SHOULD BE IN ACCORDANCE WITH ANSI/ISA RP12.6 "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRICAL CODE (ANSI/NFPA70).

9. INSTALLATION OF ALL FM/cFM APPROVED EQUIPMENTS SHALL BE IN ACCORDANCE TO THE MANUFACTURERS INSTALLATION DRAWINGS WHEN INSTALLING THE EQUIPMENT.

NOTE
THIS DRAWING MUST NOT BE CHANGED WITHOUT PRIOR AUTHORIZATION FROM FM APPROVALS

改番 REV.	来 RECORD	歴 DATE	担当 BY	照査 CHK.

名称 TITLE GTX Transmitter
INSTALLATION
DRAWING 1/3
FM/cFM I.S.

図番 DWG.NO. 80395278 | 改番 REV. 03 | シート SHT. | A3

80395279 DWG.NO.

REV.	RECORD	DATE	BY	CHK.

NOTES:

10. A FM/cFM APPROVED FIELD COMMUNICATOR MAY BE CONNECTED AT ANY POINT IN THE LOOP BETWEEN THE FM/cFM ENTITY APPROVED ASSOCIATED APPARATUS AND THE TRANSMITTER.
    EXAMPLE OF ENTITY PARAMETERS OF THE COMMUNICATOR:
    475 FIELD COMMUNICATOR
    Vmax.=30V, Imax.=200mA, Pi=1W
    Voc=1.9V, Isc=32μA
    Ci=0, Li=0

    THE MAXIMUM ALLOWABLE CONNECTED INDUCTANCE (La) AND CAPACITANCE (Ca) OF THE LOOP MUST BE CONSIDERED WHEN USING THE COMMUNICATOR. (SEE SHEETS 3)

11. AEx/Ex ib IS SUITABLE ONLY FOR CLASS I, ZONE 1 HAZARDOUS (CLASSIFIED) LOCATIONS AND IS NOT SUITABLE FOR CLASS I, ZONE 0 or CLASS I, DIVISION1 HAZARDOUS (CLASSIFIED) LOCATIONS.

12. THE POWER SUPPLY CONNECTED TO THE ASSOCIATED APPARATUS MUST NOT USE OR GENERATE MORE THAN 250 Vrms OR Vdc.

CONSIDERATION OF AN INTRINSICALLY SAFE LOOP BASED ON ENTITY PARAMETERS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN SUCH COMBINATION.

BASICALLY, THE MAXIMUM UNPROTECTED CAPACITANCE (Ci) AND INDUCTANCE (Li) OF THE INTRINSICALLY SAFE APPARATUS, INCLUDING INTERCONNECTING WIRING PARAMETERS (Lw, Cw), MUST BE EQUAL TO OR LESS THAN THE CAPACITANCE (Ca) AND INDUCTANCE (La) WHICH CAN BE SAFELY CONNECTED TO THE ASSOCIATED APPARATUS. ALSO, THE MAXIMUM OUTPUT PARAMETERS (Voc, Isc, Po) OF THE ASSOCIATED APPARATUS MUST BE EQUAL TO OR LESS THAN THE MAXIMUM ENTITY PARAMETERS (Vmax, Imax, Pmax) OF THE INTRINSICALLY SAFE APPARATUS.

IF THE HHT IS CONNECTED TO THE INTRINSICALLY SAFE LOOP.
FURTHER CONSIDERATION MUST BE TAKEN AS SHOW BY THE FOLLOWING EXAMPLES.

TITLE	GTX Transmitter INSTALLATION DRAWING 2/3
	FM/cFM I.S.
DWG.NO.	80395279
REV.	02
SHT.	/

A3

80395280

DWG.NO.

EXAMPLE 1. La

MAXIMUM OUTPUT CURRENT (Isum) TO THE LOOP IN THE WORST SITUATION IS THE SUM OF THE DELIVERED CURRENT (Isc) BY THE BARRIER AND THAT (Isc) BY THE HHT. IF Isc OF THE BARRIER IS 93mA.

Isum = 93mA + 0.032mA = 93.032mA.

THEN, BY APPLYING 100mA (THE NEXT HIGHER VALUE OF THE RESULTING Isum) TO THE RIGHT TABLE, La FOR GROUP A/B IS DETERMINED : La=4.00mH.

THE ABOVE OBTAINED La VALUE MUST SATISFY THE BELOW RELATIONSHIP.

La ≧ Li (TRANSMITTER) + Lw (WIRING) + Li (HHT).

ACCORDINGLY, THE WIRING INDUCTANCE NEVER EXCEEDS THE VALUE La - Li (TRANSMITTER) - Li (HHT), i.e. IF Li OF TRANSMITTER IS 0.308mH,

Lw ≦ 4.00mH - 0.308mH - 0 = 3.692mH

NOTE : IF THE ABOVE Lw VALUE IS SMALLER THAN THE INDUCTANCE OF A CABLE, ANOTHER BARRIER WITH A SMALLER Isc VALUE SHOULD BE SELECTED.

EXAMPLE 2. Ca

MAXIMUM OUTPUT VOLTAGE (Vsum) TO THE LOOP IN THE WORST SITUATION IS THE SUM OF THE DELIVERED VOLTAGE (Voc) BY THE BARRIER AND THAT (Voc) BY THE HHT. IF Voc OF THE BARRIER IS 28V.

Vsum = 28V + 1.9V = 29.9V.

THEN, BY APPLYING 30V (THE NEXT HIGHER VALUE OF THE RESULTING Vsum) TO THE RIGHT TABLE, Ca FOR GROUP A/B IS DETERMINED : Ca=0.12 μF.
THE ABOVE OBTAINED Ca VALUE MUST SATISFY THE BELOW RELATIONSHIP.

Ca ≧ Ci (TRANSMITTER) + Cw (WIRING) + Ci (HHT).

ACCORDINGLY, THE WIRING CAPACITANCE NEVER EXCEEDS THE VALUE Ca - Ci (TRANSMITTER) - Ci (HHT), i.e. IF Ci OF TRANSMITTER IS 0.032 μF,

Cw ≦ 0.12 μF - 0.032 μF - 0 = 0.088 μF.

NOTE : IF THE ABOVE Cw VALUE IS SMALLER THAN THE CAPACITANCE OF A CABLE, ANOTHER BARRIER WITH A SMALLER Voc VALUE SHOULD BE SELECTED.

Isum = Isc (ASSOCIATED APPARATUS) + Isc(475 FIELD COMMUNICATOR)

Vsum = Voc (ASSOCIATED APPARATUS) + Voc (475 FIELD COMMUNICATOR)

Isum (MILLI AMPERES)	La (MILLI HENRYS) A/B	C	D
20	90.00	330.00	700.00
21	82.00	300.00	635.30
23	68.00	250.00	530.10
25	58.00	210.00	449.00
28	46.00	170.00	358.40
30	40.00	150.00	312.40
32	36.00	135.00	274.80
35	31.00	110.00	229.90
40	23.00	87.00	176.30
45	19.00	70.00	139.40
50	15.00	56.00	113.10
55	12.00	48.00	93.50
57	11.00	43.00	87.10
60	10.00	40.00	78.70
62	9.50	37.00	73.70
65	8.80	34.00	67.10
70	7.50	28.00	57.90
75	6.70	25.00	50.50
80	6.00	22.00	44.40
85	5.50	20.00	39.30
90	5.00	18.00	35.10
100	4.00	15.00	28.50
110	3.00	12.00	23.60
120	2.50	10.00	19.80
130	2.00	9.00	16.90
140	1.60	8.00	14.60
150	1.30	7.00	12.70
160	1.00	6.20	11.20
170	0.80	5.50	9.90
180	0.60	5.00	8.80
200	0.50	4.00	7.20
220	0.40	3.20	5.90

Vsum (VOLTS)	Ca (MICROFARADS) A/B	C	D
5	91.97	275.91	735.77
10	3.21	9.64	25.69
15	0.78	2.35	6.26
20	0.34	1.01	2.7
22	0.26	0.78	2.09
24	0.21	0.63	1.67
26	0.17	0.51	1.37
28	0.14	0.43	1.14
30	0.12	0.36	0.97
32	0.11	0.32	0.84
34	0.09	0.28	0.73
36	0.08	0.24	0.65
38	0.08	0.22	0.58
40	0.06	0.19	0.52
42	0.06	0.18	0.47

REV.	RECORD	DATE	BY	CHK.

TITLE GTX Transmitter INSTALLATION DRAWING 3/3 FM/cFM I.S.

DWG.NO. 80395280 REV. 02 SHT. A3

← Hazardous (Classified) Locations →

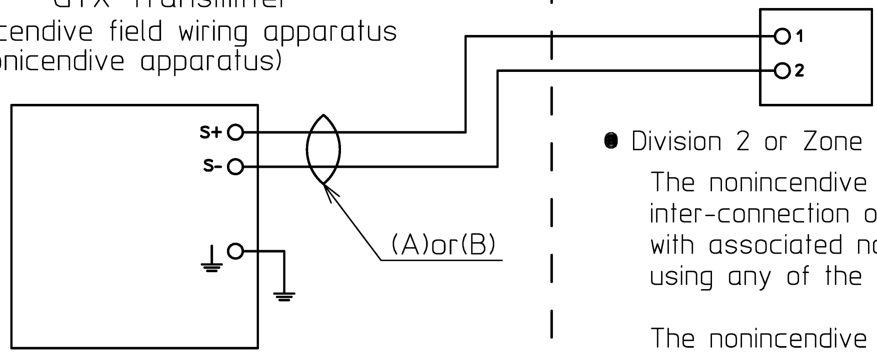
NI, with NIFW Parameters,
for CL I, DIV 2, GPs A, B, C & D, T4 ; CL I,
Zone2, GP IIC, T4 ; Suitable for CL II & III,
DIV 2, GPs E, F & G, T4 ; -40°C ≤ Tamb ≤ +60°C

← Non-Hazardous Locations →

改番 REV.	来 RECORD : 歴 DATE	担当 BY	照査 CHK.

Receiver
(Associated nonincendive
field wiring apparatus necessary
only for nonincendive field wiring)

GTX Transmitter
(Nonincendive field wiring apparatus
or Nonicendive apparatus)



- Division 2 or Zone 2 installation

  The nonincendive field wiring circuit concept allows the inter-connection of nonincendive field wiring apparatus, with associated nonincendive field wiring apparatus, using any of the wiring methods permitted for unclassified locations.

  The nonincendive field wiring is established under the following conditions:

  Vmax ≥ Voc or Vt,
  Ca ≥ Ci + Ccable,
  La ≥ Li + Lcable.

  NOTE: Imax need not be greater than Isc or It of the associated nonincendive field wiring apparatus because the converter provides the outputs with the current controlled circuit.

- (A) Nonincendive Field Wiring per NEC

  Terminals S+, S- :
  Vmax=30V
  Ci=10nF, Li=0.5mH

- (B) Wiring Methods for Div.2 locations except Nonincendive Field Wiring per NEC

- Associated nonincendive field wiring apparatus is not permitted to use or generate more than 250V r.m.s.

図番 DWG.NO. 80395494

名称 TITLE
GTX
Installation Drawing
FM/cFM NI / NIFW

図番 DWG.NO. 80395494 | 改番 REV. 02 | シート SHT. A4

cFM Explosionproof / Dust-ignition proof Approval

1. Marking Information

FM18CA0064X
Explosionproof for Use in Class I, Division 1, Groups B, C and D T5;
Dust-ignitionproof for Use in Class II and III, Division 1, Groups E, F and G T5; -40°CC≤Tamb≤+85°C;
Flameproof for Use in Class I, Zone 0/1, Ex db IIC T5 Ga/Gb; -30°C≤Tamb≤+80°C; -30°C≤Tprocess≤100°C;
Hazardous (Classified) locations Indoor / Outdoor Type 4X, IP67

2. Applicable Standards

- C22.2 No. 0-10(R2015) General requirements - Canadian electrical code, part II
- C22.2 No. 0.4-17 - Bonding of electrical equipment
- C22.2 No. 0.5-16 - Threaded conduit entries
- C22.2 No. 30-M1986(R2007) Explosion-Proof Enclosures for Use in Class I Hazardous Locations
- C22.2 No. 25-1966(R2009) Enclosures for Use in Class II Groups E, F, and G Hazardous Locations
- C22.2 No. 94-M91(R2006) Special Purpose Enclosures
- C22.2 No.61010-1-12 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
- C22.2 No.60079-0: 15 Explosive atmospheres - Part 0: Equipment - General requirements
- C22.2 No.60079-1: 16 Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
- C22.2 No.60079-26: 16 Explosive atmospheres - Part 26: Equipment with equipment protection level (EPL) Ga

3. Instruction for Safe Use

Installations shall comply with the relevant requirements of the CSA C22.1 Canadian Electrical Code and the manufacturers instructions.

4. Specific Conditions of Use

4.1 The enclosure of the Model GTX is made of aluminum, so if it mounted in an area where the use of EPL Ga apparatus is required, it must be installed in such a way that, even in the event of rare incidents, ignition sources due to impact of friction sparks are excluded.
4.2 See Table 1 for the material of the barrier diaphragm. The barrier diaphragm shall not be subjected to environmental conditions which might adversely affect the partition wall, for example corrosion.
4.3 Repairs of flameproof joints are allowed only by manufacturer.
4.4 The equipment must be returned to the manufacturer in case of failure.
4.5 The wetted parts with process fluid are suitable for EPL Ga and other parts are suitable for EPL Gb.
4.6 This product is specified for vibrating as follows.

- For all models other than the direct mount type
  Frequency 5-60Hz / 0.21mm amplitude
  Frequency 60-500 Hz / 2g
- For the direct mount type with stainless steel enclosures

Frequency 10-60Hz / 0.15mm amplitude

- Frequency 60-500 Hz / 2g
- For the direct mount type with enclosure material other than stainless steel
- Frequency 10-60Hz / 0.21mm amplitude
- Frequency 60-2000 Hz / 3g

Table 1. Identifying Diaphragm Material from Model Code

	Standard Mount Type Note 1	Remote Sealed Type Note 2	Flange Mount Type Note 3
Code ▪	GTX _ _ D/G/A - _ _ _ ▪	GTX _ _ R/U/S - _ _ ▪	GTX _ _ F/W - _ _ _ ▪
A, D	SUS316L	SUS316L	SUS316L / SUS316L
B, L, M	ASTM B575	ASTM B575	ASTM B575 / SUS316L
C, N, P	Tantalum	Tantalum	Tantalum / SUS316L
E, Q, R	Monel	Monel	Monel / SUS316L
F, S, T	Titanium	Titanium	Titanium / SUS316L
G, U, V	Nickel	Nickel	Nickel / SUS316L
H	Zirconium	Zirconium	Zirconium / SUS316L
J	Platinum	Platinum	Platinum / SUS316L
K	SUS304L	SUS304L	SUS304L / SUS316L
1	-	-	ASTM B575 / ASTM B575
2	-	-	Tantalum / Tantalum
3	-	-	SUS316L / SUS316L
4	-	-	Monel / Monel
5	-	-	Titanium / Titamiun

Note 1. Refers to diaphragm material of both the high and low pressure sides for differential pressure model (GTX _ _ D), and diaphragm material of just the measured pressure side for gauge and absolute pressure models (GTX _ _ G/A).

Note 2. Refers to diaphragm material of both the high and low pressure sides for differential pressure model (GTX _ _ R), and diaphragm material of just the measured pressure side for gauge and absolute pressure models (GTX _ _ U/S).

Note 3. Refers to the combination of diaphragm material of the flanged side and reference side. (Flanged side / Reference side).

cFM Intrinsically safe, Nonincendive and Suitable Approval

1. Marking Information

FM18CA0120X
Intrinsically Safe for use in Class I, Division 1, Groups A, B, C and D; Class II, Division 1, Groups E, F and G; Class III, Division 1; T4 -40°C < Tamb < +60°C;
Class I, Zone 0, Ex ia IIC;T4 Ga -30°C < Tamb < +60°C; Tprocess = 105°C
Hazardous (Classified) Locations; Indoor/Outdoor Enclosure TYPE 4X, IP67;
For entity parameters see control drawings 80395278, 80395279, and 80395280.
Nonincendive, with Nonincendive Field Wiring Parameters, for use in Class I, Division 2, Groups A, B, C and D; Class I, Zone 2, Group IIC,
Suitable for Class II & III, Division 2, Groups E, F and G, T4; -40°C < Tamb < +60°C;
Hazardous (Classified) Locations; Indoor/Outdoor Enclosure TYPE 4X, IP67;
For Nonincendive Field Wiring parameters see 80395494.

2. Applicable Standards

- C22.2 No. 0-10(R2015) General requirements - Canadian electrical code, part II
- C22.2 No. 94-M91(R2006) Special Purpose Enclosures
- C22.2 No.61010-1-12 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
- C22.2 No. 157-92(R2012) Intrinsically Safe and Non-incendive Equipment for Use in Hazardous Locations
- C22.2 No. 213-M1987(R2016), Non-incendive Electrical Equipment for Use in Class 1, Division 2 Hazardous Locations
- C22.2 60079-0: 15 Explosive atmospheres - Part 0: Equipment - General requirements
- C22.2 60079-11: 14 Explosive atmospheres - Part 11: Equipment protection by intrinsic safety “i”

3. Instruction for Safe Use

3.1 Installations shall comply with the relevant requirements of the CSA C22.1 Canadian Electrical Code

3.2 Installations shall comply with the latest edition of the manufacturer's instruction manual. IS models shall be installed in accordance with the control drawings 80395278, 80395279, and 80395280, and NI models shall be installed in accordance with the control drawing 80395494.

3.3 The intrinsically safe associated apparatus must be cFM Approvals approved.

3.4 Control room equipment connected to the associated apparatus should not use or generate more than 250 Vrms or Vdc.

3.5 Tampering and replacement with non-factory components may adversely affect the safe use of the system.

3.6 Insertion or withdrawal of removable electrical connectors is to be accomplished only when the area is known to be free of flammable vapors.

3.7 For ambient temperatures below -10°C (+14°F) and above +60°C (+140°F) use field wiring suitable for both minimum and maximum ambient temperatures.

3.8 Use copper, copper-clad aluminum or aluminum conductors only.

3.9 The recommended tightening torque for field wiring terminals is 0.8 N·m (7 in.·lb) or greater, as specified.

3.10 A dust-tight conduit seal shall be used when installed in Class II & III environments.

3.11 WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY

3.12 WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR DIVISIONS 1 & 2 AND ZONES 0, 1 & 2

3.13 WARNING - DO NOT DISCONNECT EQUIPMENT UNLESS AREA IS KNOWN TO BE NONHAZARDOUS

3.14 WARNING - FOR CONNECTION ONLY TO NON-FLAMMABLE PROCESSES.

3.15 For use the in the area where EPL “Ga” apparatus is required, electrostatic discharge shall be avoided.

ATEX Flameproof and Dust Certifications

1. Marking Information

CE 0344 KEMA 08ATEX0004X

II 1/2 G Ex db IIC T6 Ga/Gb	-30°C ≤ Tamb ≤ +75°C	-30°C ≤ Tprocess ≤ 85°C
II 1/2 G Ex db IIC T5 Ga/Gb	-30°C ≤ Tamb ≤ +80°C	-30°C ≤ Tprocess ≤ 100°C
II 1/2 G Ex db IIC T4 Ga/Gb	-30°C ≤ Tamb ≤ +80°C	-30°C ≤ Tprocess ≤ 110°C
II 2 D Ex tb IIIC T85°C Db	-30°C ≤ Tamb ≤ +75°C	-30°C ≤ Tprocess ≤ 85°C
II 2 D Ex tb IIIC T100°C Db	-30°C ≤ Tamb ≤ +75°C	-30°C ≤ Tprocess ≤ 100°C
II 2 D Ex tb IIIC T110°C Db	-30°C ≤ Tamb ≤ +75°C	-30°C ≤ Tprocess ≤ 110°C

IP66/IP67

2. Applicable Standards

- EN IEC 60079-0
- EN 60079-1
- EN 60079-26
- EN 60079-31

3. Installation Instruction

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC60529, suitable cable entries must be used and correctly installed. Unused openings must be closed with a suitable stopping plug.

3.2 Use supply wire suitable for 5 °C above surrounding ambient.

3.3 When Model No. is given with GTXxxx-x…x-yx…x-x…,
 if y=A, the thread type of the end of all entries is 1/2 NPT, or
 if y=B, the thread type of the end of all entries is M20.

3.4 The earthing wire and the cable lug shall be assembled, and the earthing wire secured close to the cable lug to prevent it from being pulled sideways. The tightening torque of the earthing secure is 1.2±0.1 N·m.

4. Special Conditions of Use

4.1 The enclosure of the Model GTX is made of aluminum, so if it mounted in an area where the use of 1G apparatus is required, it must be installed in such a way that, even in the event of rare incidents, ignition sources due to impact of friction sparks are excluded.

4.2 For the use in the area where EPL Db apparatus is required, electrostatic discharge shall be avoided.

4.3 See Table 4-1 in the clause 5.1.2 for the material of the barrier diaphragm.
The barrier diaphragm shall not be subjected environmental conditions which might adversely affect the partition wall, for example corrosion.

4.4 Repairs of flameproof joints are allowed only by manufacturer.

4.5 The equipment must be returned to the manufacturer in case of failure.

4.6 The wetted parts with process fluid are suitable for EPL Ga and other parts are suitable for EPL Gb.

4.7 This product is specified for vibrating as follows.
-For all models other than the direct mount type
 Frequency 5-60Hz / 0.21mm amplitude
 Frequency 60-500 Hz / 2g

- For the direct mount type with stainless steel enclosures
  Frequency 10-60Hz / 0.15mm amplitude
  Frequency 60-500 Hz / 2g
-For the direct mount type with enclosure material other than stainless steel
  Frequency 10-60Hz / 0.21mm amplitude
  Frequency 60-2000 Hz / 3g

ATEX Intrinsic safety

1. Marking Information

CE 0344 Ex KEMA 07ATEX0200X IP66/IP67

II 1 G Ex ia IIC T4 Ga -30°C ≤ Tamb ≤ +60°C Tprocess = 105°C
ELECTRICAL PARAMETERS: Ui = 30 V, Ii = 93 mA, Pi = 1 W, Ci = 5 nF, Li = 0.5 mH
II 2 D Ex ia IIIC T105°C Db -30°C ≤ Tamb ≤ +60°C Tprocess = 105°C
II 3 G Ex ic IIC T4 Gc -30°C ≤ Tamb ≤ +60°C Tprocess = 110°C
ELECTRICAL PARAMETERS: Ui = 30 V, Ci = 5 nF, Li = 0.5 mH

2. Applicable Standards

- EN IEC 60079-0
- EN 60079-11

3. Instruction for Safe Use

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC60529, 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 GTXxxx-x…x-yx…x-x…,
if y=A, the thread type of the end of all entries is 1/2 NPT, or
if y=B, the thread type of the end of all entries is M20.

4. Special Conditions of Use

Because the enclosure of Model GTX is made of aluminum, if it is mounted in an area where the use of 1G apparatus is required, it must be installed in such a way that, even in the event of rare incidents, ignition sources due to impact of friction sparks are excluded.

Precautions shall be taken to minimize the risk from propagating brush discharges at the painted surface in the presence of dust explosive atmospheres.

IECEx Flameproof and Dust Certifications

1. Marking Information

IECEx KEM 08.0001X
Ex db IIC T6 Ga/Gb -30°C ≤ Tamb ≤ +75°C -30°C ≤ Tprocess ≤ 85°C
Ex db IIC T5 Ga/Gb -30°C ≤ Tamb ≤ +80°C -30°C ≤ Tprocess ≤ 100°C
Ex db IIC T4 Ga/Gb -30°C ≤ Tamb ≤ +80°C -30°C ≤ Tprocess ≤ 110°C
Ex tb IIIC T85°C Db -30°C ≤ Tamb ≤ +75°C -30°C ≤ Tprocess ≤ 85°C
Ex tb IIIC T100°C Db -30°C ≤ Tamb ≤ +75°C -30°C ≤ Tprocess ≤ 100°C
Ex tb IIIC T110°C Db -30°C ≤ Tamb ≤ +75°C -30°C ≤ Tprocess ≤ 110°C
IP66/IP67

2. Applicable Standards

- IEC 60079-0: 2017
- IEC 60079-1: 2014
- IEC 60079-26: 2014
- IEC 60079-31: 2013

3. Installation Instruction

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC60529, suitable cable entries must be used and correctly installed. Unused openings must be closed with a suitable stopping plug.

3.2 Use supply wire suitable for 5 °C above surrounding ambient.

3.3 When Model No. is given with GTXxxx-x…x-yx…x-x…,
if y=A, the thread type of the end of all entries is 1/2 NPT, or
if y=B, the thread type of the end of all entries is M20

3.4 The earthing wire and the cable lug shall be assembled, and the earthing wire secured close to the cable lug to prevent it from being pulled sideways. The tightening torque of the earthing secure is 1.2±0.1 N·m.

4. Special Conditions of Use

4.1 The enclosure of the Model GTX is made of aluminum, so if it mounted in Zone 0, where the use of Ga apparatus is required, it must be installed in such a way that, even in the event of rare incidents, ignition sources due to impact of friction sparks are excluded.

4.2 For the use in the area where EPL Db apparatus is required, electrostatic discharge shall be avoided.

4.3 See Table 4-1 in the clause 5.1.2 for the material of the barrier diaphragm.
The barrier diaphragm shall not be subjected environmental conditions which might adversely affect the partition wall, for example corrosion.

4.4 Repairs of flameproof joints are allowed only by manufacturer.

4.5 The equipment must be returned to the manufacturer in case of failure.

4.6 The wetted parts with process fluid are suitable for EPL Ga and other parts are suitable for EPL Gb.

4.7 This product is specified for vibrating as follows.
- For all models other than the direct mount type
  Frequency 5-60Hz / 0.21mm amplitude
  Frequency 60-500 Hz / 2g
- For the direct mount type with stainless steel enclosures
  Frequency 10-60Hz / 0.15mm amplitude
  Frequency 60-500 Hz / 2g
- For the direct mount type with enclosure material other than stainless steel
  Frequency 10-60Hz / 0.21mm amplitude
  Frequency 60-2000 Hz / 3g

IECEx Intrinsic safety

1. Marking Information

IECEx KEM 07.0058X IP66/IP67
Ex ia IIC T4 Ga -30°C ≤ Tamb ≤ +60°C Tprocess = 105°C
ELECTRICAL PARAMETERS: Ui = 30 V, Ii = 93 mA, Pi = 1 W, Ci = 5 nF, Li = 0.5 mH
Ex ia IIIC T105°C Db -30°C ≤ Tamb ≤ +60°C Tprocess = 105°C
Ex ic IIC T4 Gc -30°C ≤ Tamb ≤ +60°C Tprocess = 110°C
ELECTRICAL PARAMETERS: Ui = 30 V, Ci = 5 nF, Li = 0.5 mH

2. Applicable Standards

- IEC 60079-0: 2017
- IEC 60079-11: 2011

3. Instruction for Safe Use

3.1 To maintain the degree of protection of at least IP66 in accordance with IEC60529, 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 GTXxxx-x…x-yx…x-x…,
if y=A, the thread type of the end of all entries is 1/2 NPT, or
if y=B, the thread type of the end of all entries is M20.

4. Special Conditions of Use

Because the enclosure of Model GTX is made of aluminum, if it is mounted in an area where the use of 1G apparatus is required, it must be installed in such a way that, even in the event of rare incidents, ignition sources due to impact of friction sparks are excluded.

Precautions shall be taken to minimize the risk from propagating brush discharges at the painted surface in the presence of dust explosive atmospheres.

NEPSI 隔爆外壳和防粉尘点燃外壳认证

1. 标志资讯

GYJ22.1837X
Ex db IIC T6 Gb -30 ℃≤ Tamb ≤ +75 ℃ Tprocess ≤ 80 ℃
Ex db IIC T5 Gb -30 ℃≤ Tamb ≤ +80 ℃ Tprocess ≤ 95 ℃
Ex db IIC T4 Gb -30 ℃≤ Tamb ≤ +80 ℃ Tprocess ≤ 110 ℃
Ex tb IIIC T85 ℃ Db -30 ℃≤ Tamb ≤ +75 ℃ Tprocess ≤ 85 ℃
Ex tb IIIC T100 ℃ Db -30 ℃≤ Tamb ≤ +80 ℃ Tprocess ≤ 95 ℃
Ex tb IIIC T115 ℃ Db -30 ℃≤ Tamb ≤ +80 ℃ Tprocess ≤ 110 ℃
IP66/IP67

2. 适用的标准

-GB/T 3836.1-2021
-GB/T 3836.2-2021
-GB/T 3836.31-2021

3. 产品安全使用特殊条件

防爆合格证号后缀 "X" 表明产品具有安全使用特殊条件， 具体内容如下：
1. 涉及安装、 维护、 维修时需咨询制造厂， 索取并参考带有隔爆面参数的文件。
2. 产品的温度组别、 使用环境温度范围及最高介质温度之间的关系见下表：

温度组别	使用环境温度范围	高介质温度
T6/T85 ℃	-30 ℃ ~ +75 ℃	80 ℃
T5/T100 ℃	-30 ℃ ~ +80 ℃	95 ℃
T4/T115 ℃	-30 ℃ ~ +80 ℃	110 ℃

4. 产品使用注意事项

1. 产品设有外接地端子， 用户在安装使用时应可靠接地。
2. 产品电缆引入口须配用经 NEPSI 认可的、 符合国家标准 GB/T 3836.1-2021、 GB/T 3836.2-2021 和 / 或 GB/T 3836.31-2021 标准规定的、 具有防爆等级为 Ex db ⅡC Gb 和 / 或 Ex tb ⅢC Db 的电缆引入装置， 方可用于爆炸性危险场所。 该电缆引入装置的螺纹规格为 1/2-14NPT 或 M20×1.5。 电缆引入装置的使用必须符合其使用说明书的要求， 冗余电缆引入口须采用封堵件有效密封。 电缆引入装置安装后， 须确保设备整体外壳防护等级不低于 IP66/IP67。
3. 现场使用和维护时， 必须遵循 "严禁带电开盖" 的原则。
4. 产品电气参数：
   电源 / 输出回路 （端子号 S+， S-）： 最大 42Vdc, 4-20mA （电流输出型）； 或最大 32Vdc， 18.5mA （现场总线型）；
   报警输出 （端子号 CHK/AL， GND）： 30Vdc， 30mA。
5. 用户不得自行更换该产品的零部件， 应会同产品制造商共同解决运行中出现的故障， 以杜绝损坏现象的发生。
6. 可燃性粉尘环境使用时， 需采取有效措施清洁产品外壳以避免粉尘堆积， 但严禁使用压缩空气吹扫。
7. 产品的安装、 使用和维护应同时遵守产品说明书及下列相关标准、 规范的要求：
   GB/T 3836.13–2021 爆炸性环境 第 13 部分： 设备的修理、 检修、 修复和改造
   GB/T 3836.15–2017 爆炸性环境 第 15 部分： 电气装置的设计、 选型和安装
   GB/T 3836.16–2017 爆炸性环境 第 16 部分： 电气装置的检查与维护
   GB 50257–2014 电气装置安装工程爆炸和火灾危险环境 电气装置施工及验收规范
   GB 15577–2018 粉尘防爆安全规程

NEPSI 本质安全认证

1. 标志资讯

GYJ22.1838X
Ex ia IIC T4 Ga -30 ℃ ≤ Tamb ≤ +60 ℃ Tprocess = 105 ℃ IP66 / IP67
Ex ic IIC T4 Gc -30 ℃ ≤ Tamb ≤ +60 ℃ Tprocess = 110 ℃ IP66 / IP67
Ex ia IIIC T105 ℃ Db -30 ℃ ≤ Tamb ≤ +60 ℃ Tprocess = 105 ℃ IP66 / IP67
ELECTRICAL PARAMETERS: Ui = 30 V, Ii = 93 mA, Pi = 1 W, Ci = 5 nF, Li = 0.5 mH

2. 适用的标准

-GB/T 3836.1-2021
-GB/T 3836.4-2021

3. 产品安全使用特殊条件

防爆合格证号后缀 “X” 表明产品具有安全使用特殊条件， 具体内容如下：

1. 当产品安装于要求 EPL Ga 级的场所时， 用户须采取有效措施防止产品外壳由于冲击或摩擦引起的点燃危险。
2. 产品最高允许介质温度、 使用环境温度范围与防爆标志的关系如下表所示：

防爆标志	使用环境温度范围	最高允许介质温度
Ex ia IIC T4 Ga	-30 ℃ ~ +60 ℃	105 ℃
Ex ic IIC T4 Gc	-30 ℃ ~ +60 ℃	110 ℃
Ex ia IIIC T105 ℃ Db	-30 ℃ ~ +60 ℃	105 ℃

4. 产品使用注意事项

1. 产品必须与经防爆认可的关联设备配套共同组成本安防爆系统方可使用于现场存在爆炸性气体混合物的危险场所。 其系统接线必须同时遵守智能压力变送器和所配关联设备的使用说明书要求， 接线端子不得接错。 产品本安电气参数如下：

最高输入电压	最大输入电流	最大输入功率	最大内部等效参数	
Ui (V)	Ii (mA)	Pi (W)	Ci (nF)	Li (mH)
30	93	1	5	0.5

2. 用户不得自行更换该产品的元器件及零部件， 应会同产品制造商共同解决运行中出现的故障， 以杜绝损坏现象的发生。
3. 产品的安装、 使用和维护应同时遵守产品说明书及下列相关标准、 规范的要求：
   GB/T 3836.13–2021 爆炸性环境 第 13 部分： 设备的修理、 检修、 修复和改造
   GB/T 3836.15–2017 爆炸性环境 第 15 部分： 电气装置的设计、 选型和安装
   GB/T 3836.16–2017 爆炸性环境 第 16 部分： 电气装置的检查与维护
   GB/T 3836.18–2017 爆炸性环境 第 18 部分： 本质安全电气系统
   GB 50257–2014 电气装置安装工程爆炸和火灾危险环境 电气装置施工及验收规范

CNS 耐壓安全認證

1. 防爆等級內容

型式檢定合格字號　　工電 (2015) 第 00113X 號
防爆規格標示
　Ex db IIC T5 Gb　-30℃ ≤ Tamb ≤ +80℃　Tprocess ≤ 100℃

2. 依據標準

CNS 3376-0 (2014)
IEC 60079-1 (2014)

3. 電氣規格

輸入 42 Vdc (最大)
輸出 4-20mA
IP66/IP67

4. 特殊條件

隔離膜不得處於可能會對分隔壁產生不利影響的環境條件下；
僅允許原製造廠維修耐壓防爆接合面；
本設備僅能由原製造商维修；
檢定範圍未包含電纜入口保護裝置， 應正確使用合格電纜接頭或盲塞以維持設備保護型式之完整性。
最高製程溫度不可超過 100 ℃， 以符合 T 5 之設備溫度等級 。

CNS 本質安全認證

1. 防爆等級內容

型式檢定合格字號　　工電 (2016) 第 00227X 號

防爆規格標示

Ex ia IIC T4 Ga	-30℃ ≤ Tamb ≤ +60℃	Tprocess ≤ 105℃	IP66/IP67
Ex ic IIC T4 Gc	-30℃ ≤ Tamb ≤ +60℃	Tprocess ≤ 110℃	IP66/IP67

2. 依據標準

IEC 60079-0 (2017)
IEC 60079-11 (2011)

3. 電氣規格

ia : Ui=30V、 Ii=93mA、 Pi=1W、 Ci=5nF、 Li=0.5mH
ic : Ui=30V、 Ci=5nF、 Li=0.5mH

4. 特殊條件

檢定範圍未包含電纜入口保護裝置， 應正確使用合格電纜接頭或盲塞以維持設備保護型式之完整性；
當使用 EPL Ga 的設備且外殼材質為鋁時， 安裝區域應避免設備外殼遭受摩擦與撞擊， 而產生足以造成引燃源的火花。

KCs 내압방폭 인증 (한국어)

1. 기호 정보

Ex d IIC T6 -30℃ ≤ Tamb ≤ +75℃ Tprocess ≤ 85℃ IP66/IP67
Ex d IIC T5 -30℃ ≤ Tamb ≤ +80℃ Tprocess ≤ 100℃ IP66/IP67
Ex d IIC T4 -30℃ ≤ Tamb ≤ +80℃ Tprocess ≤ 110℃ IP66/IP67
Ex tD A21 T85℃ -30℃ ≤ Tamb ≤ +75℃ Tprocess ≤ 85℃ IP66/67
Ex tD A21 T100℃ -30℃ ≤ Tamb ≤ +75℃ Tprocess ≤ 100℃ IP66/67
Ex tD A21 T110℃ -30℃ ≤ Tamb ≤ +75℃ Tprocess ≤ 110℃ IP66/67

2. 적용 가능한 표준

고용노동부 고시 제 2020-33 호

3. 설치 지침

3.1 IEC60529 에 따라 적어도 IP66 보호등급을 유지하려면 적절한 케이블 도입구를 사용하여 올바르게 장착해야 합니다 . 사용하지 않는 구멍은 적절한 블라인드 플러그로 막아야 합니다 .
3.2 5℃가 넘는 주위온도에 적합한 전원 케이블을 사용합니다 .
3.3 모델번호에 GTXxxx-x...x-yx...x-x...가 있는 경우 ,
y=A 이면 , 모든 도입구 단부의 나사 타입은 1/2 NPT,
y=B 이면 , 모든 도입구 단부의 나사 타입은 M20 입니다 .
3.4 접지선과 케이블 러그를 조립해야 하며 , 접지선은 옆으로 당겨지지 않도록 케이블 러그에 가까이 고정합니다 . 접지 고정의 조임 토크는 1.2 ± 0.1Nm 입니다 .

4. 특정 동작 조건

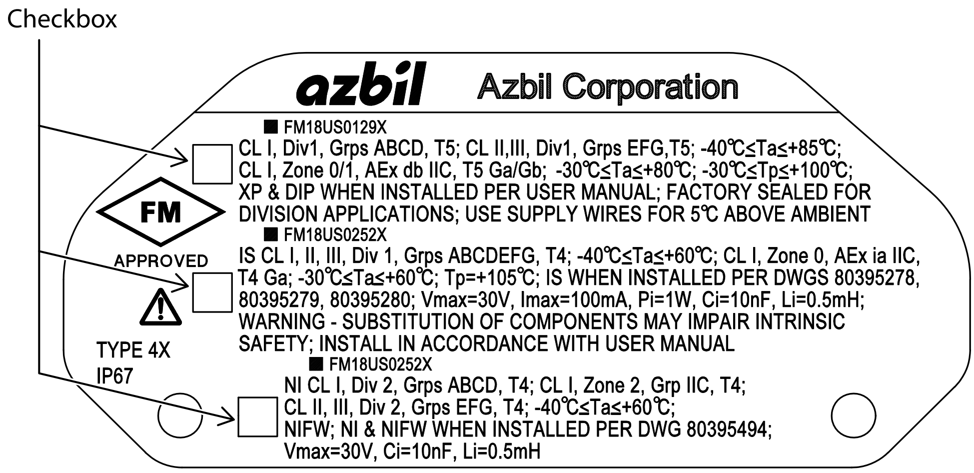
4.1 Model GTX 외함은 알루미늄 소재이므로 EPL(기기보호등급) Ga 기기가 요구되는 Zone 0 에 외함을 설치할 때는 발생 가능성이 낮더라도 충격이나 마찰 스파크로 인한 점화원이 방지되도록 해야 합니다 .
4.2 EPL Db 기기가 요구되는 영역에서 사용하는 경우 , 정전기 방전은 피해야 합니다 .
4.3 배리어 다이어프램 재료 정보는 5.1.2 항의 표 4-1 을 참조해 주십시오 .
배리어 다이어프램은 격벽에 부식 등의 악영향을 미칠 수 있는 환경 조건에 노출되어서는 안 됩니다 .
4.4 내압방폭 이음쇠 수리는 제조사만 허용됩니다 .
4.5 장비는 고장시 제조사로 보내야 합니다 .
4.6 프로세스 유체가 닿는 접액부는 EPL Ga 에 적합하고 , 나머지 부분은 EPL Gb 에 적합합니다 .
4.7 이 제품의 진동 사양은 다음과 같습니다 .
- 다이렉트 마운트 타입 이외의 모든 모델
주파수 5~60Hz / 진폭 0.21mm
주파수 60~200Hz / 2g
- 외함이 스테인레스 스틸인 다이렉트 마운트 타입 모델
주파수 10~60Hz / 진폭 0.15mm
주파수 60~500Hz / 2g
- 외함이 스테인레스 스틸이 아닌 다이렉트 마운트 타입 모델
주파수 10~60Hz / 진폭 0.21mm
주파수 60~2000Hz / 3g

Marking of Nameplates for Devices with Multiple Types of Protection

According to the selected explosionproof code, the device may have multiple types of protection in hazardous areas.
Example: Code F6 = Combination of flameproof+dust ignitionproof, intrinsically safe, and nonincendive.

When this code is selected, the nameplate on the device will have a checkbox next to the description of each type of protection.

Example of checkboxes on the nameplate



Before installing the device, the checkbox of the selected protection type MUST be marked in an indelible manner. Once the checkbox is marked, the device must be used within the conditions stated next to the specific checkbox. If two or more checkboxes are marked, the device may not be used in any hazardous area.

Table of Contents

Chapter 1. Overview-First Time Users Only

1-1. Introduction

This section is intended for users who have never worked with our Advanced Transmitter. It provides some general information to acquaint you with the Advanced Transmitter.

1-2. Advanced Transmitters

Azbil Corporation's Advanced Transmitter includes model variations of these basic pressure measurement types.

- Differential Pressure
- Gauge Pressure
- Absolute Pressure

Transmitter adjustments

Except for optional zero and span adjustments available with Advanced Transmitters only, the Advanced Transmitter has no physical adjustments.
You need a Field Communication Software(Model CFS100) or HART communicator to make adjustments to a transmitter.

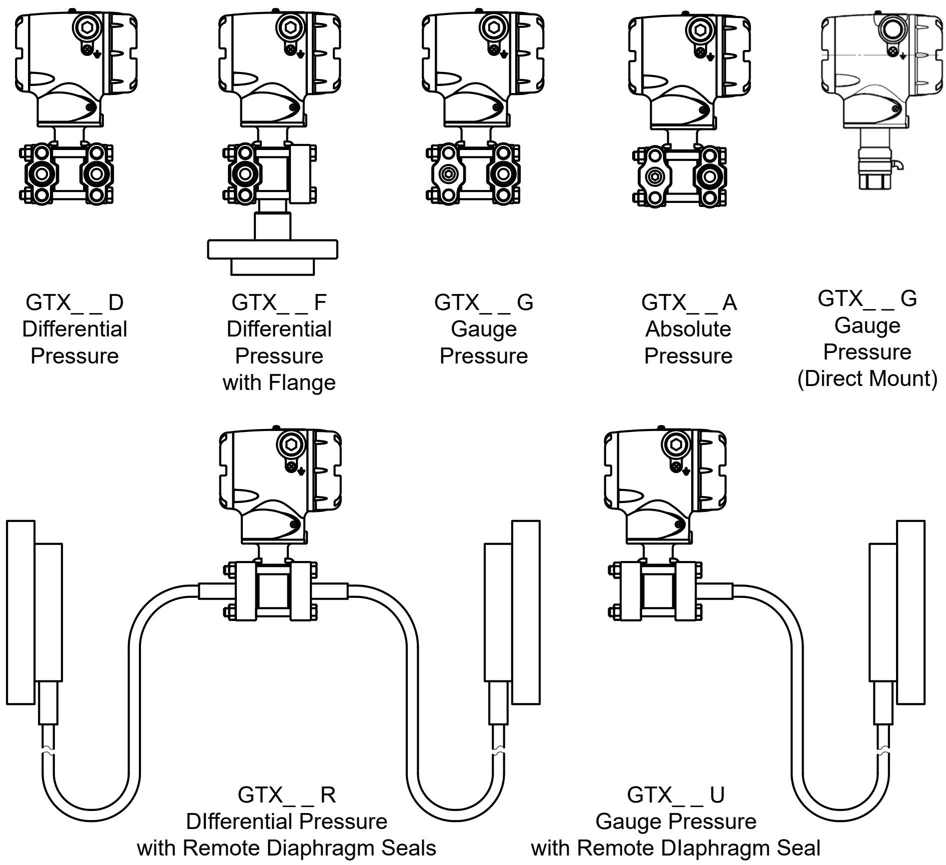


Fig. 1-1. Advanced Transmitter Family

1-3. Parts names of the transmitter

Introduction

This transmitter consists mainly of a terminal block, an electronics module, a transmitter unit case, an indicator, and a center body.

Structure and parts names

The following illustration shows the structure and parts names of this transmitter:

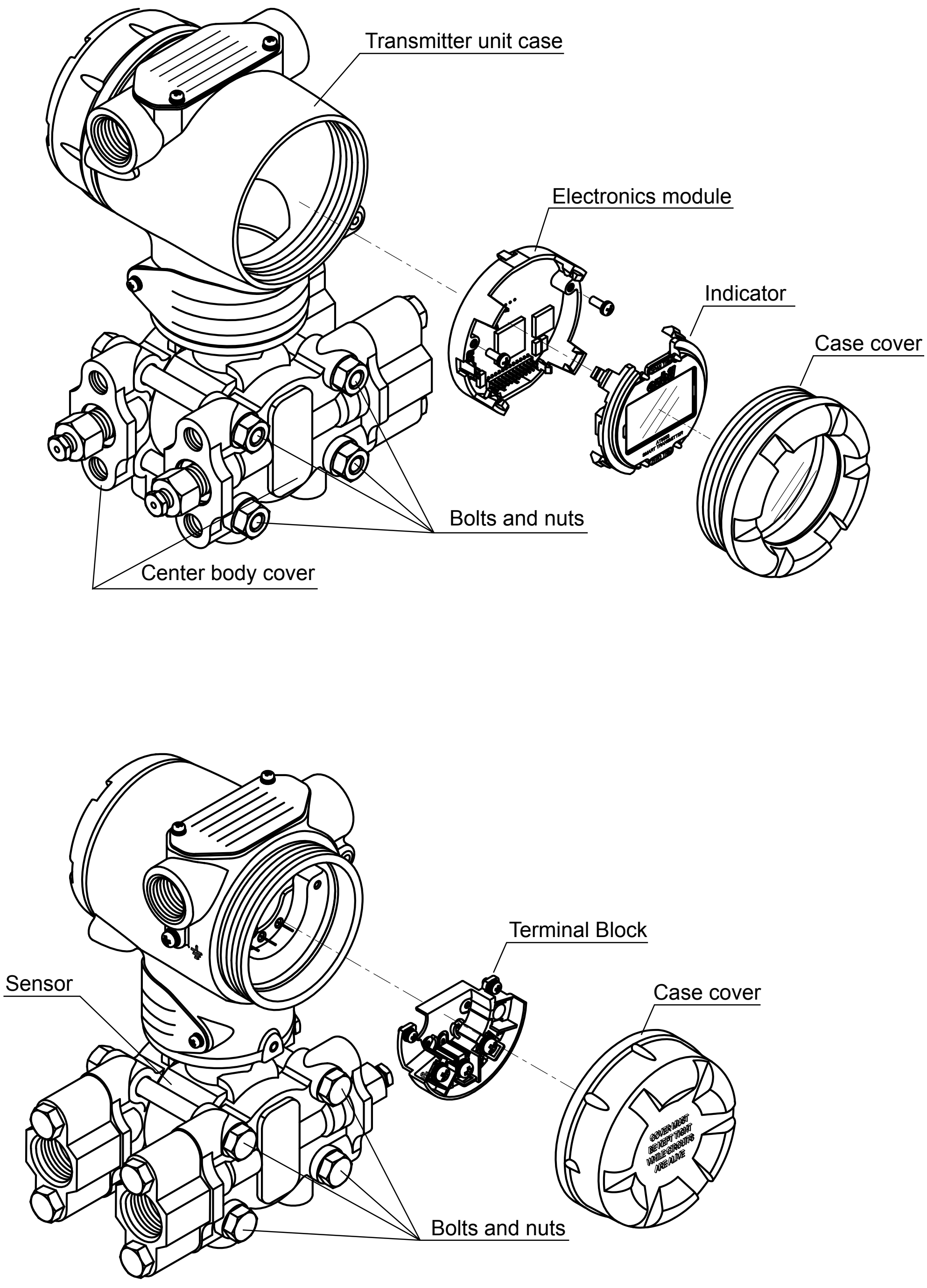


Fig. 1-2. Structure of the transmitter (model GTX _ _D)

Parts name	Description
Center body	Consists of a composite semiconductor sensor, a pressure diaphragm, an excessive pressure protection mechanism, etc.
Center body cover	Two center body covers sandwich the center body. Process connection is made to this part.
Bolts and nuts	Fixing the center body between covers, are a series of bolts and nuts.
Sensor	Consists of a composite semiconductor sensor, a pressure receiving diaphragm, a flange, a capillary tube, etc.
Electronics module	Consists of electronic circuits having functions for processing differential pressure and other signals, and transmitting them.
Transmitter unit case	Housing the electronics module and the terminal board.
Case cover	Encloses the transmitter unit case.
Indicator	It display output value, unit, error message, etc.

1-4. Transmitter Order

Order components

Fig. 1-3 shows the components that are shipped and should be received for a typical Advanced Transmitter order.

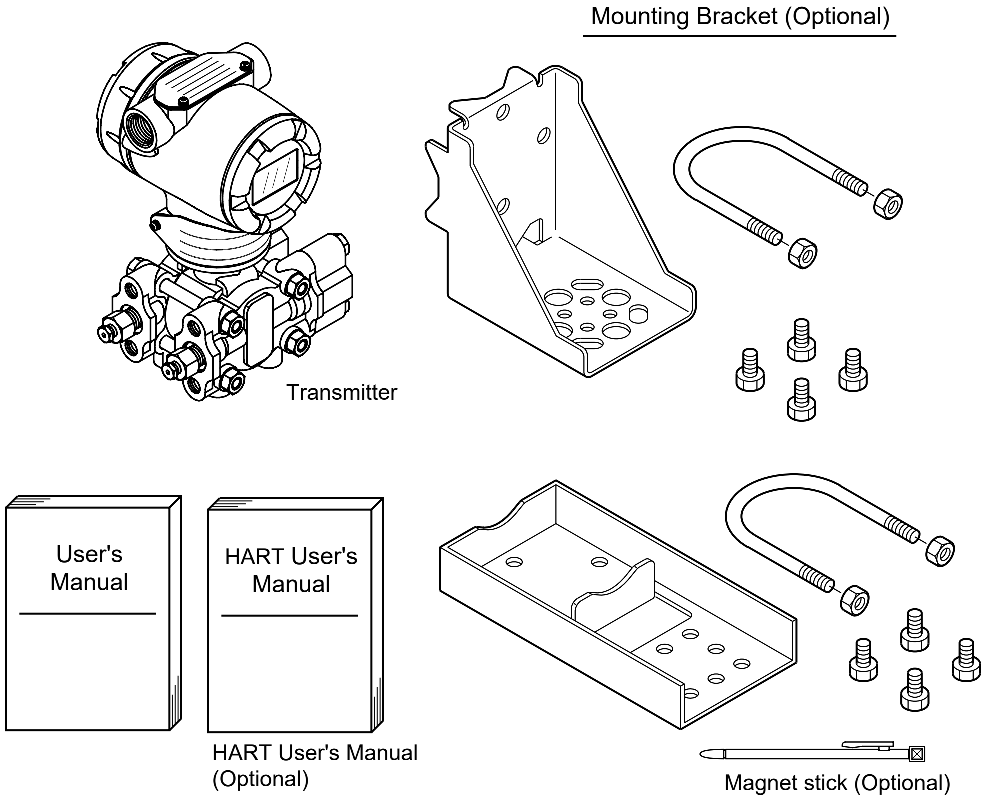


Fig. 1-3. Typical Advanced Transmitter Order Components

Chapter 2. Installation

2-1. Introduction

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

2-2. Mounting Advanced Transmitter

2-2-1. Summary

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

Fig. 2-1 shows typical bracket mounted and flange mounted transmitter installations for comparison.

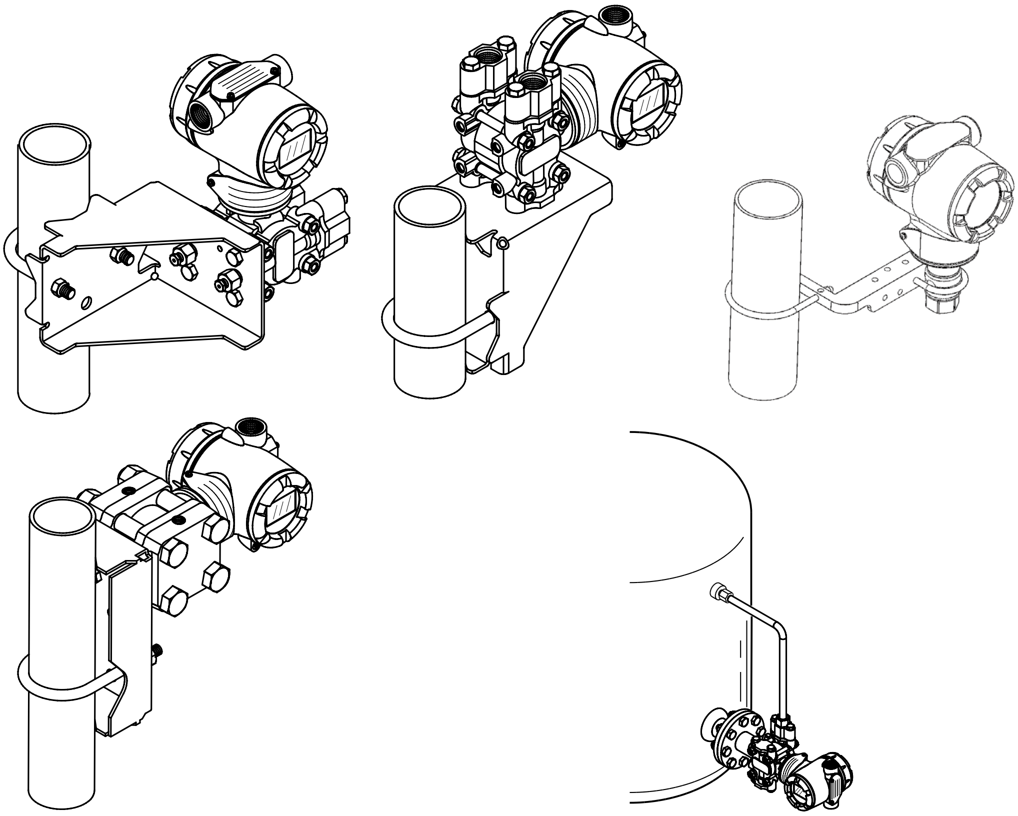


Fig. 2-1. Typical Bracket Mounted and Flange Mounted Installations.

⚠CAUTION
When using the U-bolt to fix the optional bracket to a 2″ pipe, note that the U bolt may be damaged if tightened with excessive force.

2-2-2. Changing Direcion of Indicator

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

a) Rotate electronics housing 90° horizontally.

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

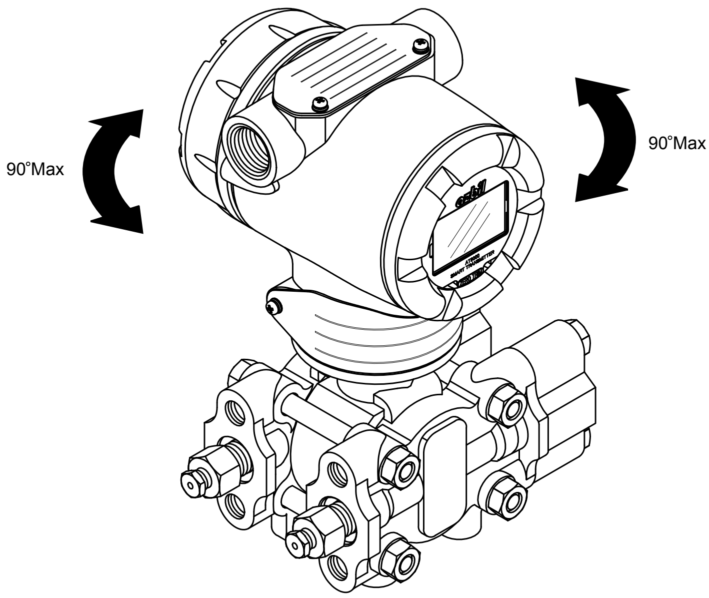


Fig. 2-2.

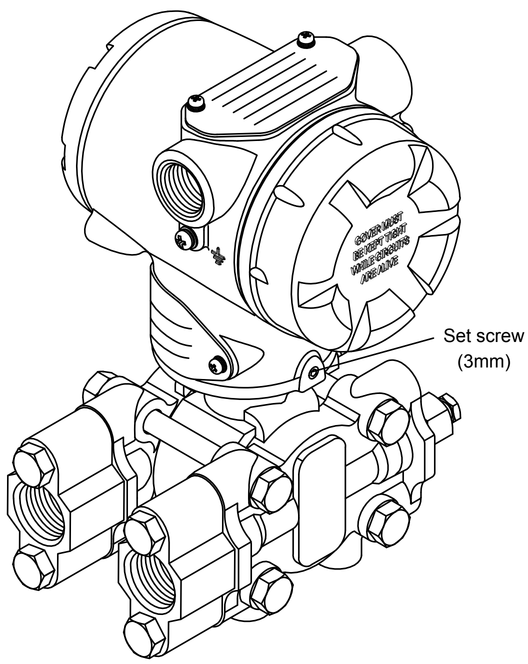


Fig. 2-3.

b) Rotate digital display module

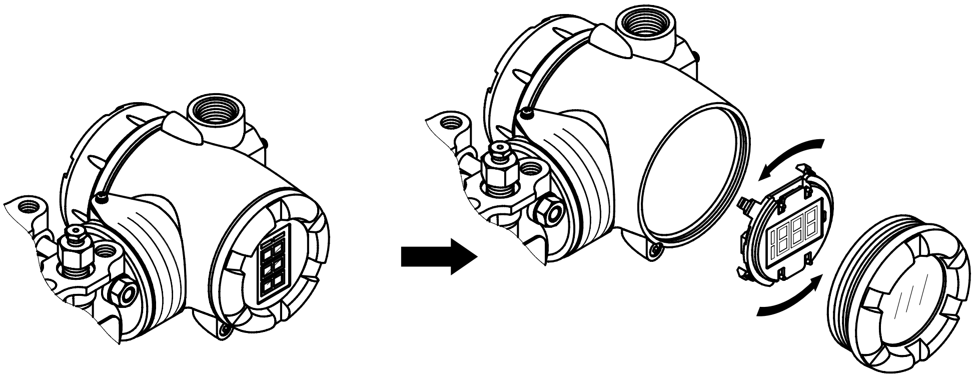


Fig. 2-4.

2-2-3. Precaution for Hanging Nameplate

When the combination approval of ATEX+FM+FMC is selected, there will be a nameplate hanging from the neck of the transmitter as shown in fig. 2-5.
Be sure to comply with the warning stated below.

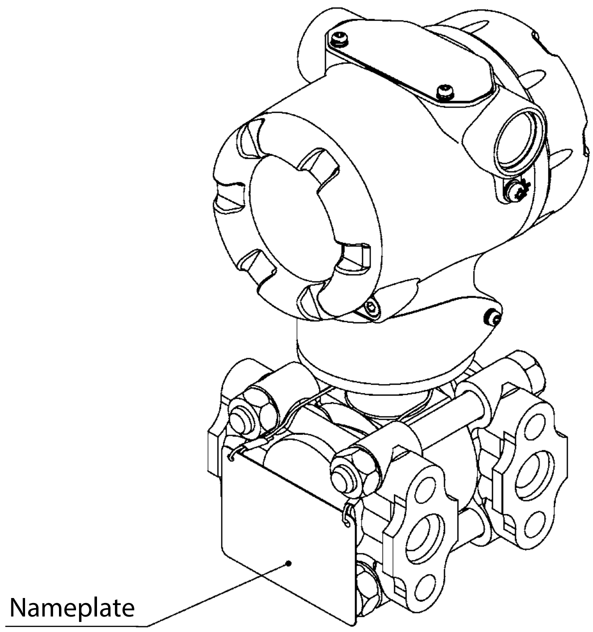


Fig. 2-5.

⚠WARING
To avoid static electricity, be sure the contact between the hanging nameplate and the earthed metal parts of the equipment is maintained during the lifetime of the equipment.

2-2-4. Flange mounting

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

SNB7 : 20 ± 1 N·m

304SST : 10 ± 1 N·m

ATTENTION

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

Fig. 2-6 shows a typical installation for a transmitter with the flange on the high pressure (HP) side so the HP diaphragm is in direct contact with the process fluid. The low pressure (LP) side of the transmitter is vented to atmosphere (no connection).

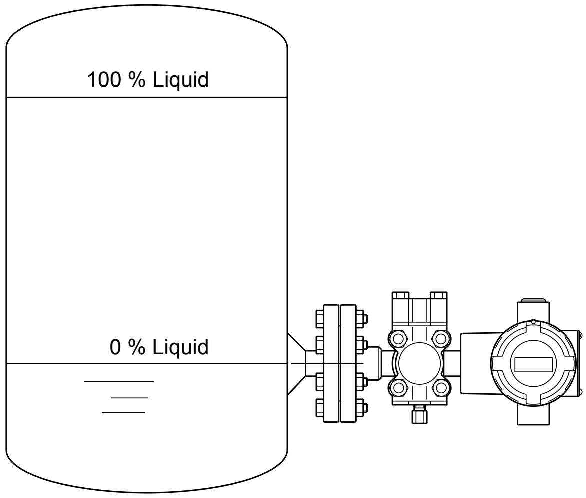


Fig. 2-6. Typical Flange Mounted Transmitter Installation.

2-2-5. Remote seal mounting

Use the procedure in "Table 2-1. Mounting Remote Diaphragm Seal Transmitter" to mount a remote diaphragm seal transmitter model. Fig. 2-7 shows a typical installation for a remote diaphragm seal transmitter for reference.

ATTENTION

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

Table 2-1. Mounting Remote Diaphragm Seal Transmitter

Step	Action
1	Mount transmitter at a remote distance determined by length of capillary tubing.
2	H mark side of transmitter to upper flange mounting on tank wall. ATTENTION On insulated tanks, remove enough insulation to accommodate the flange extension.
3	Tighten bolts to torque of Carbon steel (SNB7): 20 ± 1 N·m , 304SST: 10 ± 1 N·m .

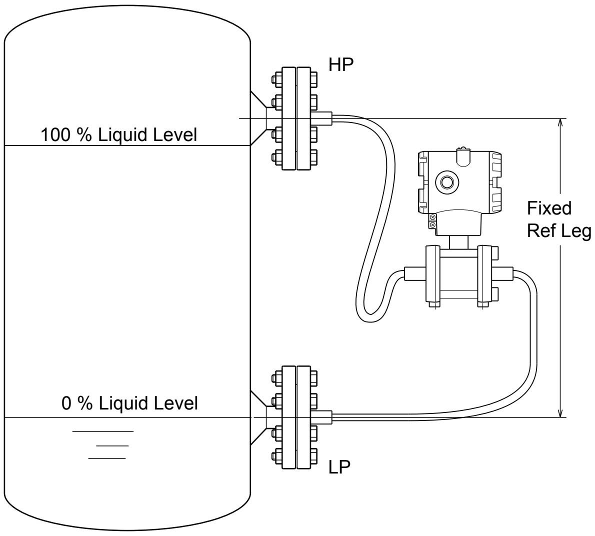


Fig. 2-7. Typical Remote Diaphragm Seal Transmitter Installation

ATTENTION

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

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

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

If a transmitter is installed in the position shown in Fig. 2-8, the inner pressure of the tank (P_0) and the head pressure of the liquid sealed in the capillary can be applied to its main unit (low limit flange side).

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

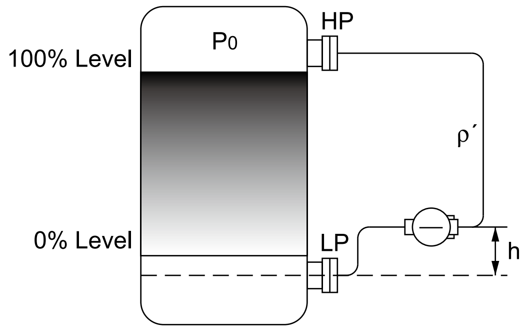


Fig. 2-8.

This condition can be expressed with the following formula;

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

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

Table 2-2.

	Specific gravity of sealed liquid ρ'	**Low limit of allowable pressure P (kPa abs.)**	**Liquid contacting temperature range (°C)**
General application (*1)	0.935	2	-40 to 40
High temperature application (*2)	1.07	2	-5 to 90
High temperature & vacuum application (*3)	1.07	0.1333	-5 to 100
High temperature & high vacuum application (*4)	1.09	0.1333	10 to 250
Oxygen application, chlorine application (*5)	1.87	53	-10 to 40

Remarks

1. An application where the pressure in the tank P_0 becomes a vacuum requires special caution.

2. If the above condition is not met, the pulling force applied to the diaphragm surface will exceed the specified range.
   Foaming occurs because the pressure of sealed liquid exceeds the saturated vapor pressure and can cause zero point shifting. Negative pressure applied to the diaphragm can cause buckling and destroy the diaphragm.

3. When the liquid contacting temperature exceeds the levels shown in the table, the low limit of the allowable pressure also changes. Check the specifications.

4. *1. GTX_ _R-_A
   *2. GTX_ _R-_B
   *3. GTX_ _R-_C
   *4. GTX_ _R-_D
   *5. GTX_ _R-_H&J

<Example of calculation>

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

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

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

$$h \leq (P_0 - P) \times 102 / (\rho')$$
$$h \leq (3 - 2) \times 102 / 0.935 = 109 \text{ mm}$$

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

⚠CAUTION

If the above conditions are not met, the diaphragm surface will be pulled by negative pressure that exceeds its operating limit. When the pressure reaches the saturated vapor pressure, the sealed liquid will form bubbles. If the negative pressure continues to increase, the diaphragm may buckle and be damaged.

Azbil Corporation recommends installing the transmitter at least 10 cm below the lower flange

2-2-6. Using the Flange Size Conversion Adapter (Model HF)

Summary

When the flange size is smaller than the diaphragm size of the remote sealed transmitter, a flange size conversion adapter (model HF adapter) is necessary to connect the remote sealed transmitter (Model GTX_ _R and GTX_ _U) to the piping flange. If you are a first-time user of the HF adapter, read this section to understand the basics.

The HF adapter is necessary for connecting the remote sealed transmitter to customer flange sizes of 1 inch or smaller. There are two types of HF adapters, the short pipe type, and the integrated flange type. For the integrated flange type, the flange size may be converted to sizes as large as 2 inch or 3 inch. Also, for both types, the HF adapters have a built-in drain/vent valve, so that there is no need for a flushing ring.

⚠ 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.
!	Before removing the product, make sure that the internal pressure is low and that no fluid remains inside.
!	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	
!	Do not use this product as a foothold. It may cause injuries or may damage the piping.
!	Use both hands when carrying this instrument. If dropped, it may cause injuries or may damage the instrument.
!	The protection sheet for the sealing surface is not a gasket. Failing to remove it before installing may result in leakage of the process fluid.
!	In locations where there is excessive vibration, take measures so the nuts do not loosen. (using spring washers, double nuts, etc.).
!	If the connecting pipe is too thin to support the weight of the product, provide appropriate reinforcement.
!	After removing the internal pressure, be sure to re-tighten the vent/drain plug. Forgetting to do so will result in process fluid leakage.
!	The protection sheet for the sealing surface is not a gasket. Failing to remove it before installing may result in leakage of the process fluid.
!	When the vent/drain plug is loosened, the process fluid will eject from the small hole in the vent/drain plug. Open slowly so as not to scatter the fluid in the vicinity.
!	When the vent/drain plug is loosened, be aware of the direction in which the process fluid will be released. Do not look in and put your head close.
!	Regularly check the vent/drain plug and vent/drain bushing for leaks.

Short Pipe Type HF Adapter

(1)Parts name and composition

Fig.2-9 shows the structure of the short pipe type HF adapter, and the names of each part.

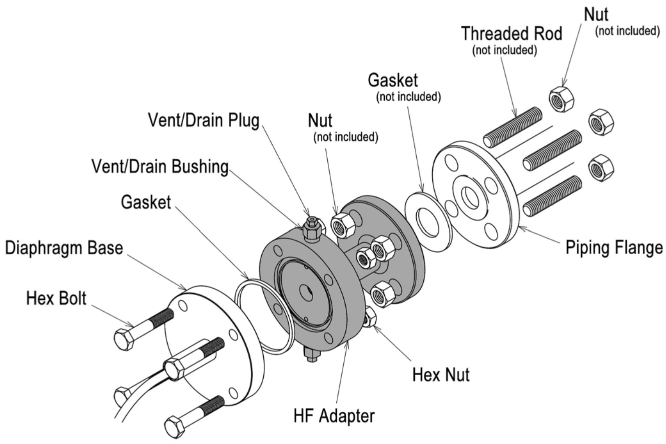


Fig. 2-9. Short Pipe Type HF Adapter

(2) Installation dimensions

Refer to the dimensional drawing in the specification sheet or approval drawing for the dimensions of the short pipe type HF adapter.

(3) Materials required for installation

Prepare the following materials to install the short pipe type HF adapter. (see Fig.2-9)

- Threaded rods
- Hex nuts
- Gasket

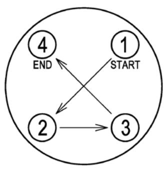
(4) Installation procedure

1) Fix the HF adapter to the transmitter.

Make sure that the HF adapter is fixed firmly to the diaphragm base of the transmitter with four sets of bolts/nuts. Also make sure that the gasket is set within the gasket groove. When screwing in the hex bolts apply anti seizing grease to the threads.

Recommended tightening torque for hex bolts : 20±2 N·m

Refer to figure on right for tightening order.



2) Attach to customer's piping flange.

Fig. 2-9shows an example of mounting the HF adapter to the piping flange.

For details on installation of the remote sealed transmitter, refer to Section 2-2-5.

Integrated Flange Type HF Adapter

(1) Parts name and composition

Fig. 2-10shows the structure of the integrated flange type HF adapter, and the names of each part.

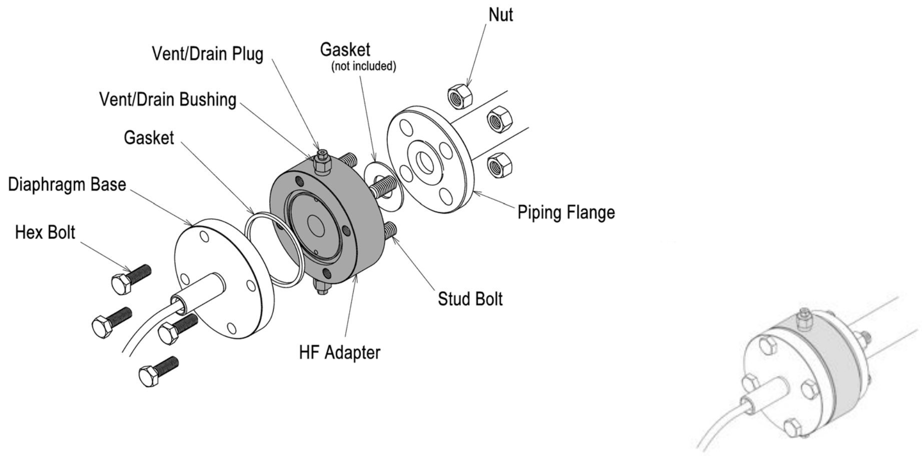


Fig. 2-10. Integrated Flange Type HF Adapter

(2) Installation dimensions

Refer to the dimensional drawing in the specification sheet or approval drawing for the dimensions of the integrated flange type HF adapter.

(3) Materials required for installation

Prepare the following materials to install the integrated flange type HF adapter.

- Gasket
- Stud bolts and nuts (if the attached carbon steel ones do not suit the customer's needs)

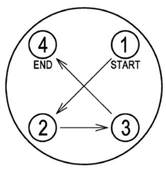
(4) Installation procedure

1) Fix the HF adapter to the transmitter.

Make sure that the HF adapter is fixed firmly to the diaphragm base of the transmitter with four sets of bolts/nuts. Make sure that the gasket is set within the gasket groove. When screwing in the hex bolts apply anti seizing grease to the threads.

Recommended tightening torque for hex bolts: 20±2 N·m

Refer to figure on right for tightening order.



2) Screw in the stud bolts.

Beware of the direction of the stud bolt. The side with the shorter screw is the side that is screwed into the HF adapter. Tighten by hand until the shoulder of the unthreaded part of the stud bolt touches the HF adapter.

Note: The material of the attached stud bolt is carbon steel. If a different material is required, please prepare separately

3) Attach to customer's piping flange.

Insert the protruding stud bolts into the holes of the piping flange. Do not forget to put the gasket in between.

- Centering the gasket is important as to prevent leaks.
- It is recommended to hold the HF adapter with two people as they may get heavy.
- The length of the attached stud bolts is determined according to usage of a gasket of standard thickness. If the length is not enough, prepare stud bolts with an appropriate length.

- For details on installation of the remote sealed transmitter, refer to Section 2-2-5.

4) Tighten the nuts.
Follow applicable standards when tightening the nuts.
Example) ASME PCC-1 - Guidelines for Pressure Boundary Bolted Flange Joint Assembly
or JIS B 2251 Bolt Tightening Procedure for Pressure Boundary Flanged Joint Assembly
Note: The material of the attached nut is carbon steel. If a different material is required, please prepare separately.

To remove the HF adapter, reverse the assembly procedure.

Precautions

- Take extra care when assembling the nuts. If it is not tightened correctly, it may lead to leakage of the process fluid. After lightly tightening for the first pass, firmly tighten to the appropriate torque. If time allows, re-tighten after 4 hours or more to prevent preload loss.
- Apply anti seizing grease to the threads. If nuts get stuck, replace both the stud bolt and nut.
- The width across flats of the vent plug hexagon head is 8mm. Use proper tools and be careful not to wear out the hexagon head.

⚠CAUTION

Do not insert the stud bolt upside down. It may result in insufficient thread length when fixing the nuts.

Removal and Re-Assembly of the Diaphragm Base from the HF Adapter

Here is an example of removing the diaphragm base from a ¾ inch HF adapter and attaching it to a 2inch HF adapter.

1) Remove the 4 hex bolts, the diaphragm base, and gasket. Be careful not to touch the diaphragm surface while doing so.

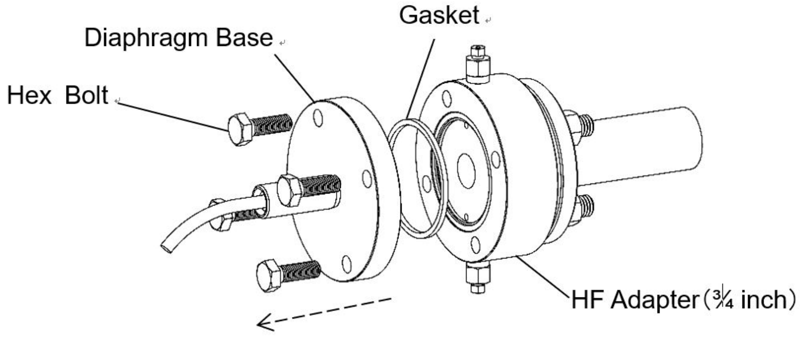


Fig. 2-11. Removing the diaphragm base from the HF Adapter

2)To re-assemble, attach the diaphragm base in the reverse order of removal.

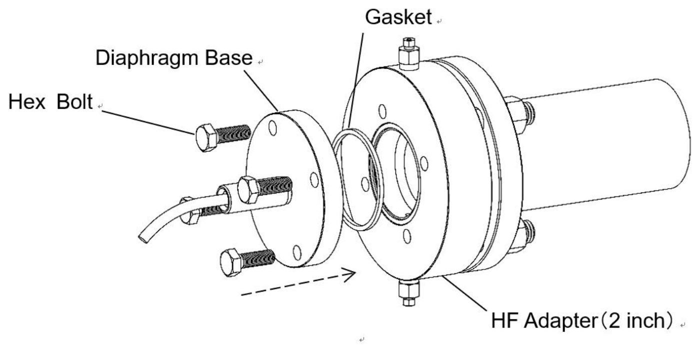
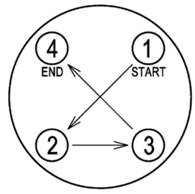


Fig. 2-12. Re-assembling the diaphragm base to the HF Adapter

- Do not forget to insert the gasket. Also, be sure to use a new gasket.
- Tighten the hex bolts in the order shown on the figure on right.
- Recommended tightening torque of hexagon bolt: 20±2 N·m
- If necessary, apply anti-seizing grease to the thread of the hex bolt.
- Make sure that the vent/drain plug is closed before re-starting operatio



Precautions When Using the Vent/Drain Plug

Both types of HF adapters have a built-in vent/drain valve. The vent/drain valve consists of the vent/drain plug and vent/drain bushing. Here are some precautions when using this valve.

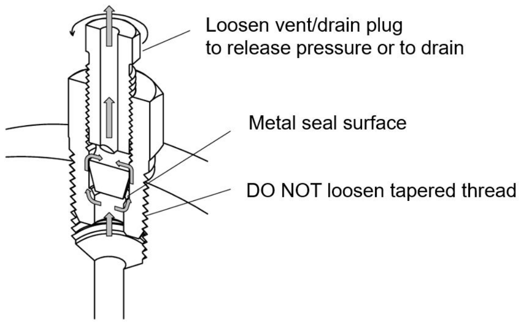


Fig. 2-13. Detailed view of vent/drain plug and vent/drain bushing

⚠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.

2-2-7. Using the Flushing Ring (Model DV)

Function and structure

This chapter describes the function and configuration of the optional flushing ring for the remote seal type transmitters (Models GTX_ _R, GTX_ _U, GTX_ _S) and flange type transmitters (Model GTX_ _F). If you are a first-time user of the flushing ring, read this section to understand the basics.

1)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.

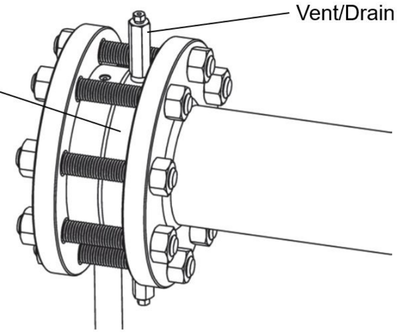


Fig. 2-14. Example of Typical Flushing Ring

2)Name and composition of each part

The flushing ring consists of a ring, a vent/drain plug, and a vent/drain bushing. Fig.2-15 shows the structure and name of each part.

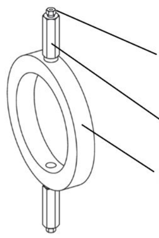


Fig. 2-15. Flushing Ring Components

- 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 Fig. 2-13 for details)

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.

1) 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.

2) Installation dimensions

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

3) Materials required for installation

Prepare the following materials to install the short pipe type HF adapter.

- Threaded rods
- Hex nuts
- Gasket

4) 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 2-2-8.

- 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.

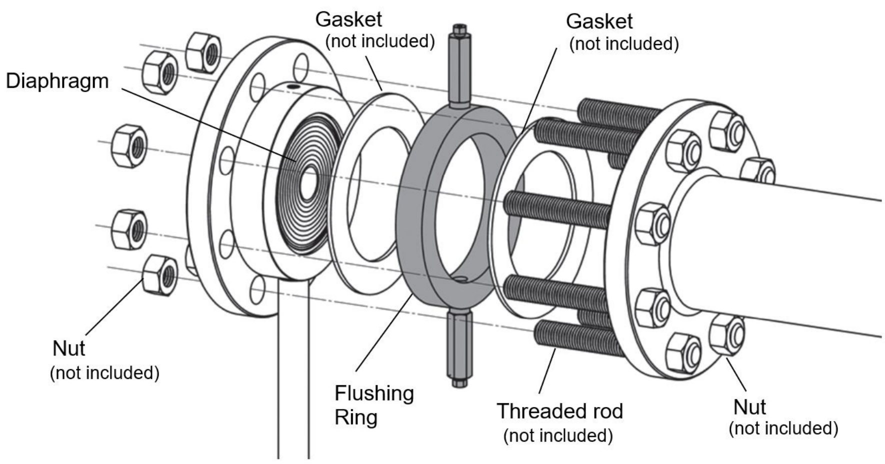


Fig. 2-16. Example of flushing ring installation

2-2-8. Direct Mounting

The direct mount GTX can be installed directly on the pipe (direct mounting), on a 2 inch pipe using the optional mounting brackets, or on a wall, also using the brackets.

⚠CAUTION

Do not use the direct mount GTX transmitter as a foothold, or for any other improper purpose.
Doing so may result in damage to equipment and/or physical damage.
For taper threaded connection, use sealing tape to prevent leakage.
For straight threaded connection be sure to use the gasket included with the transmitter.
When screwing the transmitter to the connecting pipe, do not tighten it holding the housing of the transmitter.
Always use wrenches and hold the hex-head part of the transmitter. (See Fig. 2-17)
Avoid installing the transmitter upside down. Doing so may cause debris to fill inside the transmitter and be the cause of inaccurate measurements.
Make sure the process pressure does not exceed the maximum allowed temperature. If necessary, use siphons or other measures to lower the temperature at the wetted parts of the transmitter.
When measuring liquids, take measures to keep the process fluid from freezing. Install the transmitter in a location where there is no excessive impact, vibration, or pressure.
Screwing on the transmitter to a connecting pipe filled with liquid may damage the transmitter.
(See Fig. 2-17)

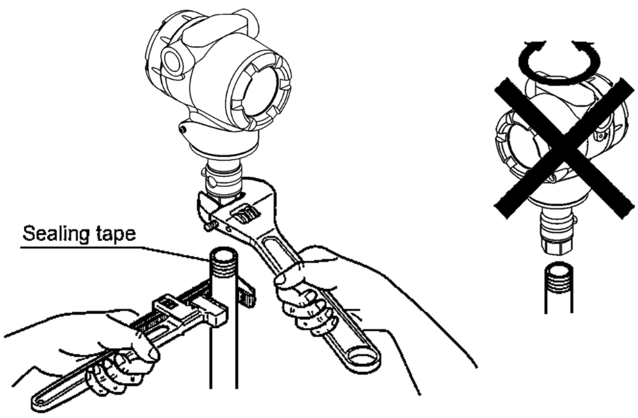


Fig. 2-17. Installation precaution 1

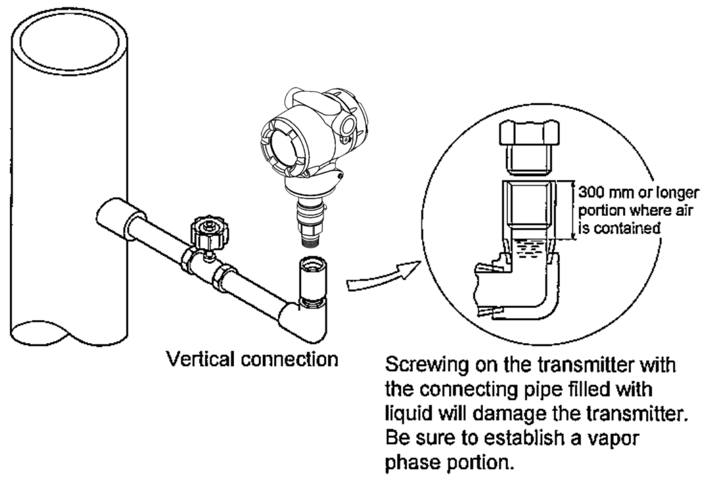


Fig. 2-18. Installation precaution 2

2-2-9. Precautions when attaching the FEP protective film (Models GTX _ _R, GTX _ _U, GTX _ _F)

- This film is used for protection against slurry or other sticky fluids, or for applications that are not compatible to metallic diaphragms touching the process fluid, such as in the semiconductor market.
- Be careful not to overtighten the FEP protective film as it may be damaged.
- If the zero output shifts significantly when attached to the process flange, it may be due to excessive grease or misalignment of the gasket. Check the installation conditions.

Temperature range: 0 to 110°C

Pressure range: Atmospheric pressure to pressure limits of flange rating

Flange rating: Up to JIS10K, ANSI150#, or JPI150#

(Not to be used in negative pressure)

Before installing the instrument to the process flange, carry out the following procedures.

1. Hold transmitter so diaphragm of pressure receiving flange faces upwards.
2. Apply approximately 10grams of grease (1/4 of the whole tube) to the metal diaphragm and sealing face.
3. Spread the grease evenly so that it is flattened to approximately 0.5mm in thickness.

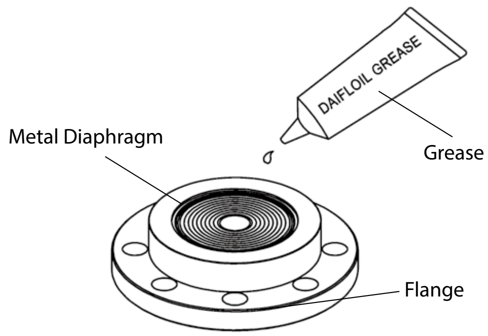


Fig. 2-19. Applying grease

CAUTIONS

Do not inflict excessive force while spreading. May deform diaphragm.

Do not let any bubbles remain.

3. Fit the protective film over the diaphragm. To prevent any remaining air. Hold one side up while quietly fitting in from other side.

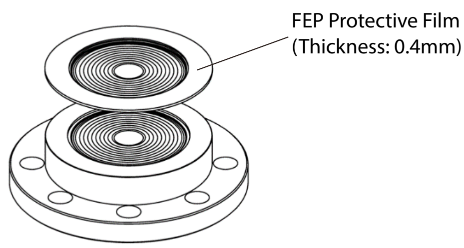


Fig. 2-20. Attaching protective film

CAUTIONS

Make sure to completely fit the protective film to metal diaphragm

Do not let the convoluted surface of protective film to bulge.

4. Make sure no air remains between diaphragm and protective film. Squeeze out any remaining air by pushing with fingers from the center towards the rim. (Fig. 2-21)

* Remaining air can be the cause of output errors.

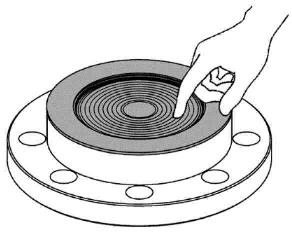


Fig. 2-21. Removing excessive grease

5. Hold gasket to pressure receiving flange and fix the transmitter to the process flange. Adequate clamping torque of bolt and nut is shown on Table 2-3.

Table 2-3. Clamping Torque (for reference)

Flange Rating	Clamping Torque (N•m)
JIS 10K 80A	45
JIS 10K 50A	30
JIS 10K 40A	20
ANSI/JPI 150# 3”	45
ANSI/JPI 150# 2”	28
ANSI/JPI 150# 1-1/2”	20

CAUTION

Torque values are for reference. Tighten with appropriate torque according to type of gasket.

ALL bolts should be clamped with equal torque.

6. If the operation is hindered by a fluctuation of the zero output, collect the zero-point data before and after tightening the flange using the communicator, etc. Confirm the difference is within 0.1 kPa. If the fluctuation range of the error is large, remove the transmitter from the flange and check that the protective film is attached correctly.

CAUTION

Applying grease to the film so that the fluctuation of the zero point is small requires considerable skill. If you have trouble in applying the grease, please confront our service staff.

2-2-10. Direct Mounting Kit (Model GTX _ _ R)

The direct mounting kit is a mounting kit (adapters, tube clamps) for remote seal type transmitters. It enables tank level instrumentation to be carried out easily. Using the direct mounting kit 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.

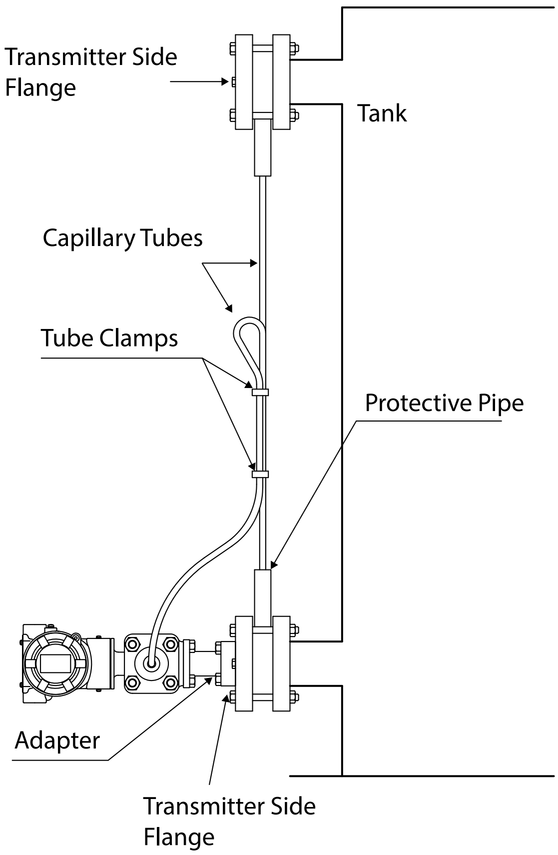


Fig. 2-22. Direct Mounting Kit Installation Example

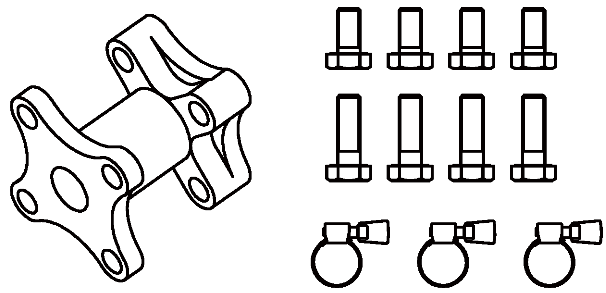


Fig. 2-23. Direct Mount Attachment Kit

(1) Compatible Models

GTX_ _ R 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

Fig. 2-24 shows the adapter assembly attached to the process side, and Fig. 2-25 shows the appearance and length of the adapter in the attachment kit.

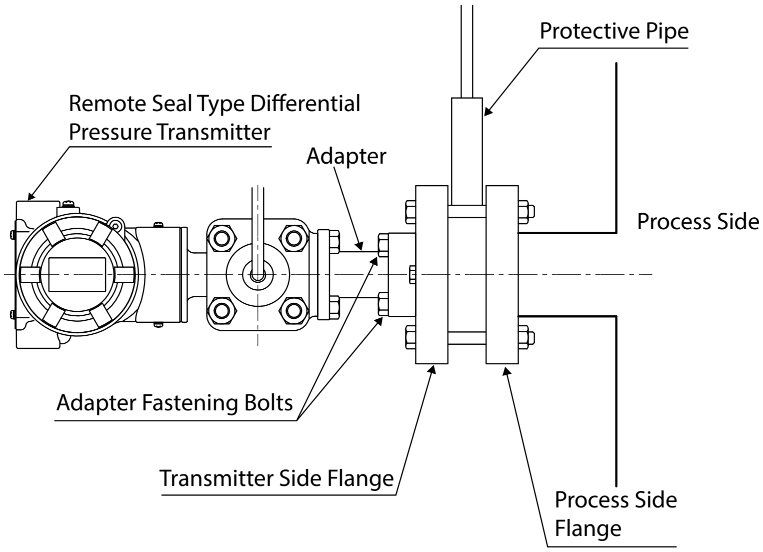


Fig. 2-24. Adapter Assembly

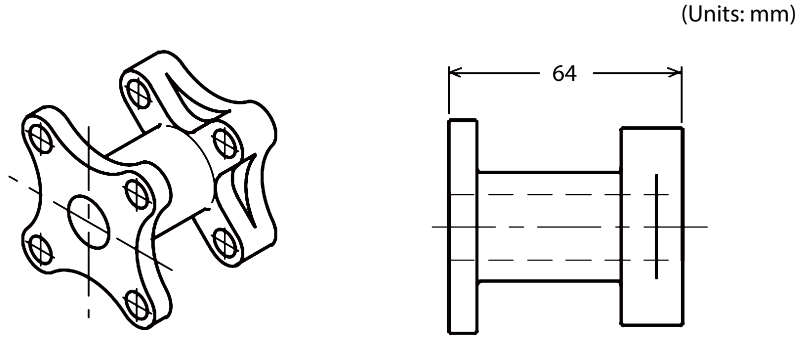


Fig. 2-25. Adapter Appearance

(ii) Attachment location

Refer to the important notes regarding general-purpose installation conditions in section 2-2-5.

(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.

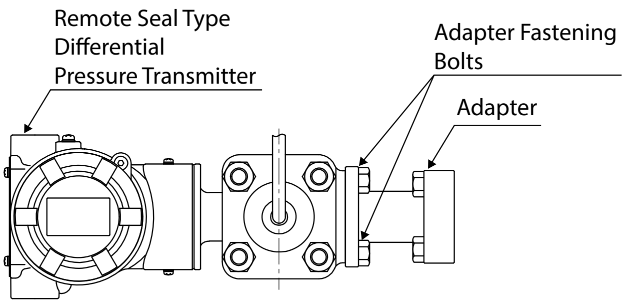


Fig. 2-26. Adapter Attachment

(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 2-2-5. The transmitter can be attached to either the high pressure or low pressure flange.

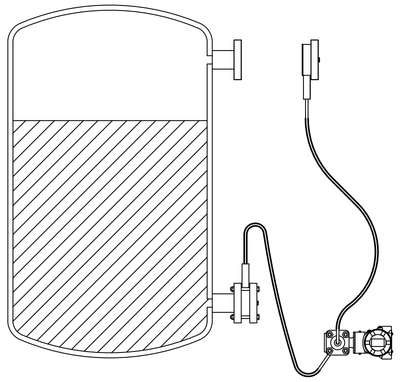


Fig. 2-27. Process Side Flange Attachment 1

(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).

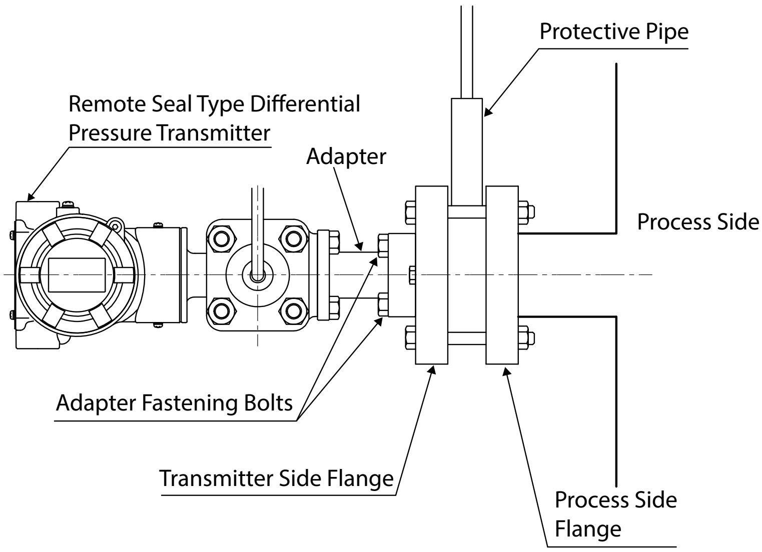


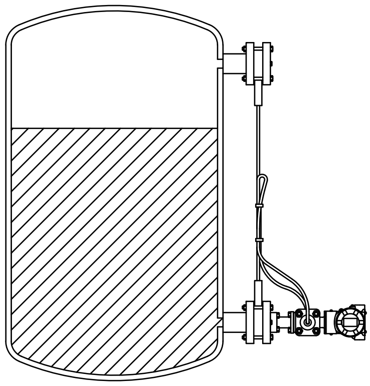
Fig. 2-28. Attachment to the Transmitter Side Flange

⚠CAUTION

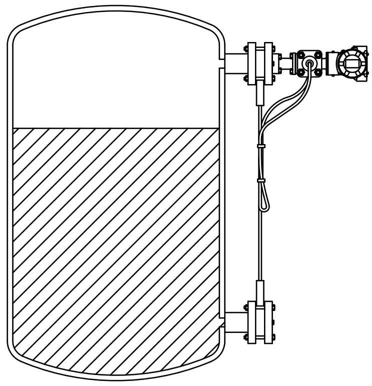
If a capillary tube, bent back as shown in Fig. 2-30, is placed higher than the lower flange of the process, the tank internal pressure must be at least as high as the atmospheric pressure. Accordingly, if the tank internal pressure becomes lower than the atmospheric pressure, the bent-back capillary 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.

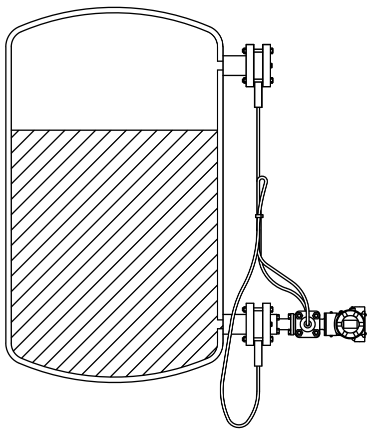
(3) Attachment Examples for Different Process Conditions



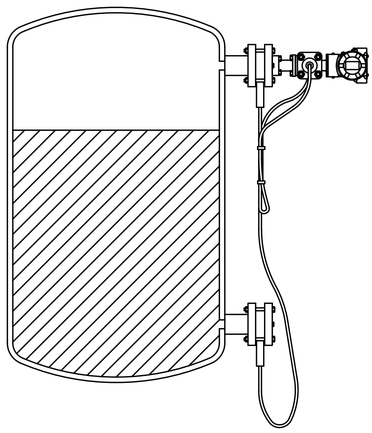
Tank Internal Pressure: Atmospheric Pressure,
Tank Lower Portion Attachment
With Capillary Tube Olefin Coating



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

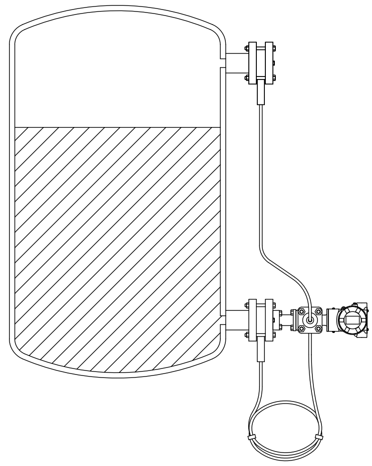


Tank Internal Pressure: Atmospheric Pressure,
Tank Lower Portion Attachment
Capillary Tube Without Olefin Coating



Tank Internal Pressure: Atmospheric Pressure,
Tank Upper Portion Attachment
Capillary Tube Without Olefin Coating

Fig. 2-29. Attachment Example (1)



Tank Internal Pressure: Vacuum
(lower than atmospheric pressure)

Fig. 2-30. Attachment Example (2)

* For attachment to a sealed tank, see section 2-2-5 "Remote seal mounting"

2-3. Piping Advanced Transmitter

Summary

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

The most common type of pipe used is 1/2 inch schedule 80 steel pipe.
Many piping arrangements use a three-valve manifold to connect the process piping to the transmitter. A manifold makes it easy to install and remove a transmitter without interrupting the process. It also accommodates the installation of blow-down valves to clear debris from pressure lines to the transmitter.

Fig. 2-31 shows a diagram of a typical piping arrangement using a three-valve manifold and blow-down lines for a differential pressure transmitter being used to measure flow.

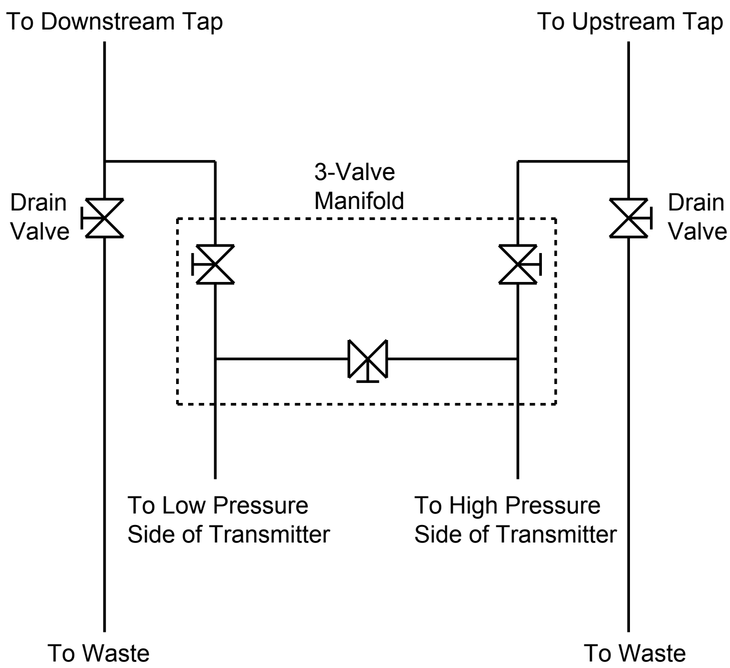


Fig. 2-31. Typical 3-Valve Manifold and Blow-Down Piping Arrangement.

Process connections

Table 2-4 describes typical process connections for a given type of transmitter.

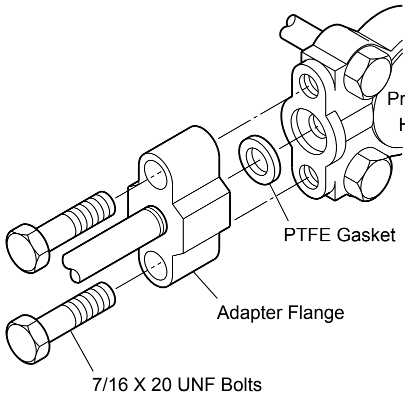
Table 2-4. Process Connections

Transmitter type	Process Connection
Differential Pressure	Process heads with 1/4 inch NPT internal thread connection. Flange adapters and manifolds with 1/2 inch internal thread connections are optional.
Gauge Pressure	Process head with 1/2 inch NPT internal thread connection. Process heads with 1/4 inch NPT internal thread connection. (GTX_ _G) Flange adapters and manifolds with 1/2 inch internal thread connections are optional (GTX_ _G)
Absolute Pressure	Process heads with 1/2 inch NPT internal thread connection (GTX_ _A)
Flange Mounted Liquid Level	1.5. 2 or 3 inches flange with flush or 2, 3 or 4 inches extended diaphragm on high pressure side. Reference side has standard differential pressure process head.
Remote Diaphragm Seals	See Model Selection Guide for description of available Flanged, Button-diaphragm (G1·1/2), and Wafer type process connections.
Gauge Pressure (Direct Mount)	1/2 inch NPT internal thread 1/2 inch NPT external thread Rc1/2 internal thread R1/2 external thread M20 × 1.5 external thread G1/2 external thread

Installing flange Adapter

Table 2-4 gives the steps for installing an optional flange adapter on the process head.
Slightly deforming the gasket supplied with the adapter before you insert it into the adapter may aid in retaining the gasket in the groove while you align the adapter to the process head. To deform the gasket, submerse it in hot water for a few minutes then firmly press it into its recessed mounting groove in the adapter.

Table 2-5. Installing Adapter Flange

Step	Action
1	Carefully seat PTFE (white) gasket into adapter groove.
2	Thread adapter onto 1/2 inch process pipe and align mounting holes in adapter with holes in end of process head as required.
3	Secure adapter to process head by hand tightening 7/16-20 UNF hexhead bolts. Example-Installing adapter on process head **ATTENTION** Apply an anti-seize compound on the stainless steel bolts prior to threading them into the process head. 
4	Evenly tighten adapter bolts to the following torque;

Adapter material	CS/SS	CS/SS	PVC
Bolt material	Carbon steel (SNB7)/ SS630	304SST	Carbon steel (SNB7)/ 304SST
Torque N•m	20 ±1	10 ±0.5	7 ±0.5

2-3-1. Piping for Liquid, Gas or Steam Flow Rate Measurement

Recommended Piping - Example 1

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

The following apply:
Grade the pipe at the differential pressure output part.
Inclination symbol ⊿ in illustration: Low level ⊿ High level
After piping work, ensure that the connecting pipe, the 3-way manifold valve, and the transmitter have no pressure leak.

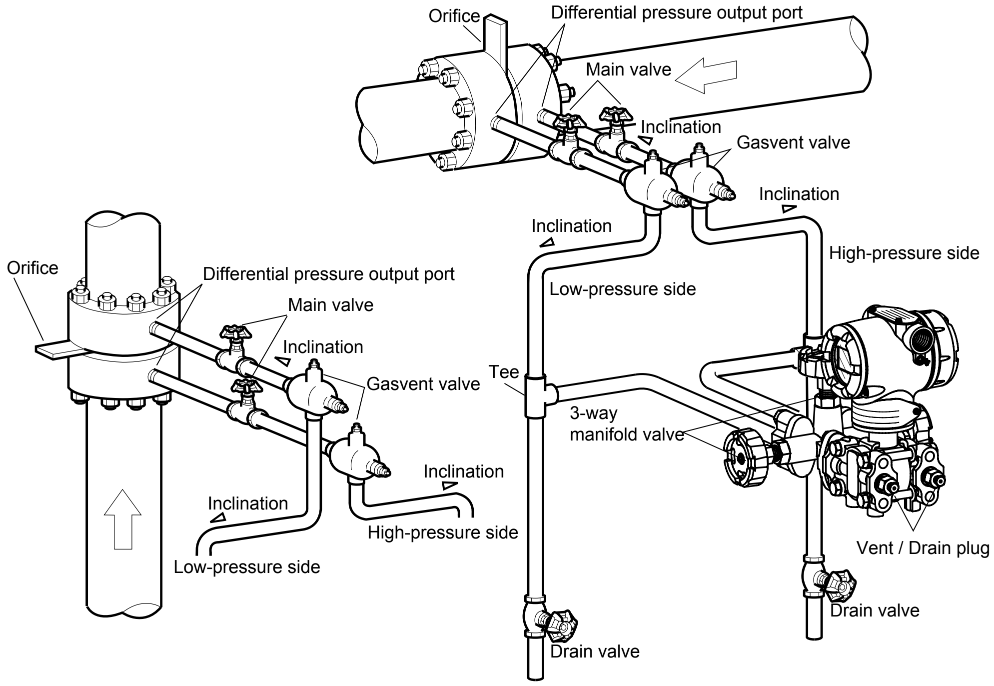


Fig. 2-32. Piping for Liquid Flow Rate Measurement - Example

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

Recommended Piping - Example 2

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

The following apply:
Grade the pipe at the differential pressure output part.
Inclination symbol in illustration: Low level High level

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

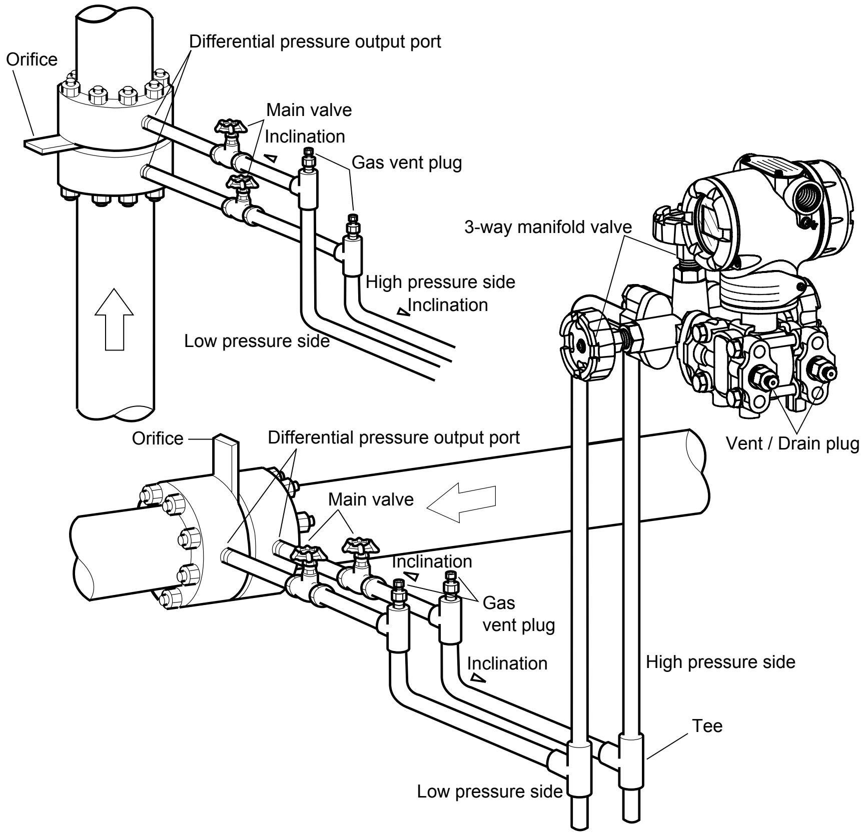


Fig. 2-33. Piping for Gas Flow Rate Measurement - Example

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

Recommended Piping - Example 3

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

The following apply:
Grade the pipe at the differential pressure output part.
Inclination symbol ⊿ in illustration: Low level ⊿ High level

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

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

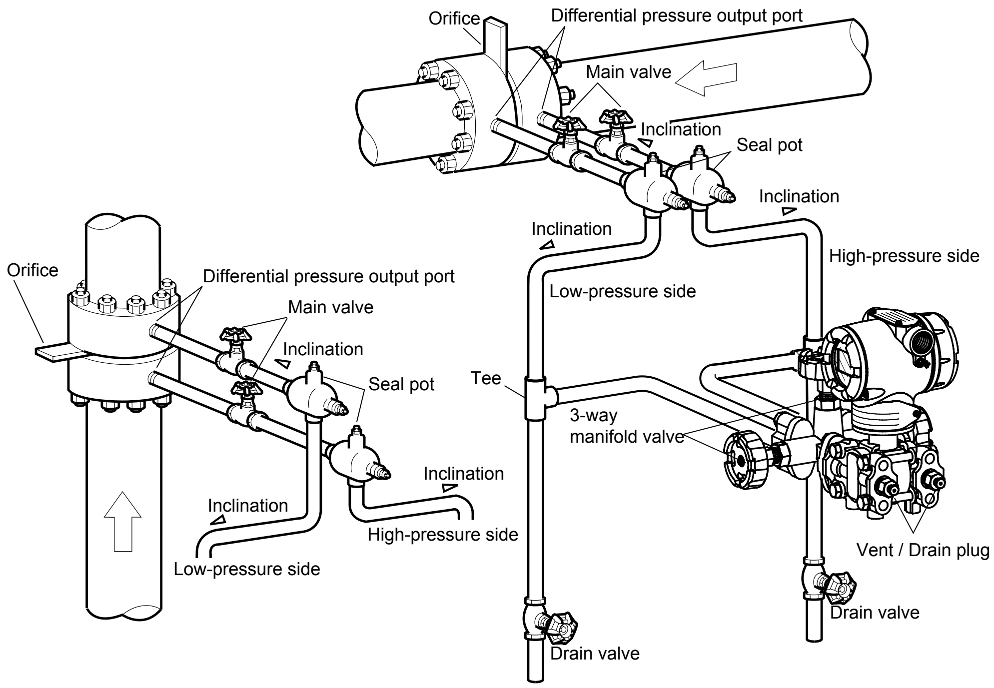


Fig. 2-34. Piping for Steam Flow Rate Measurement - Example

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

2-3-2. Pressure Measurement - Piping

Recommended piping - Example

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

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

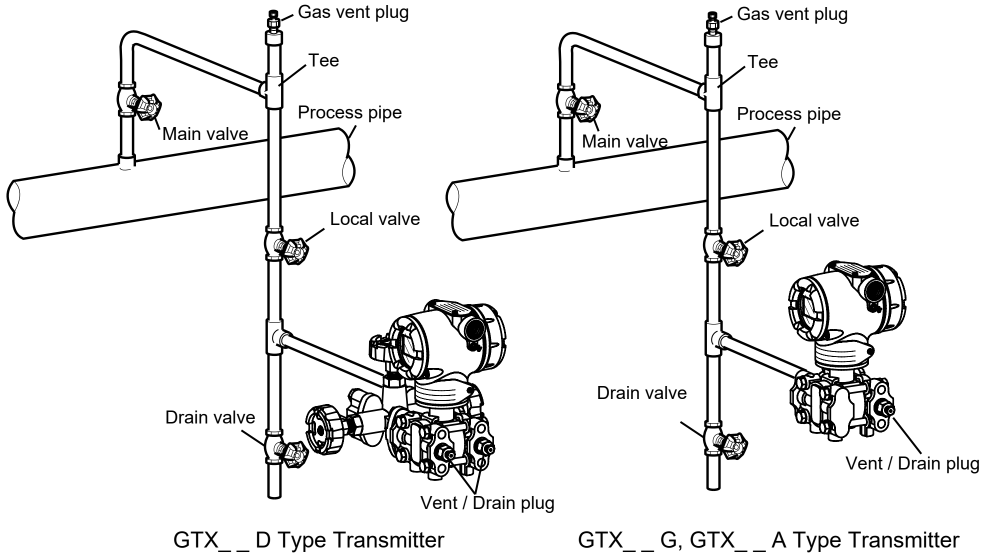


Fig. 2-35. Gas Pressure Measurement - Piping

Piping method

The piping method for the fluid to be measured depends on the meter installation position and the pipe line state. Typical examples of piping are shown in Fig. 2-36.

Connect pipes by the following procedure:

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

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

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

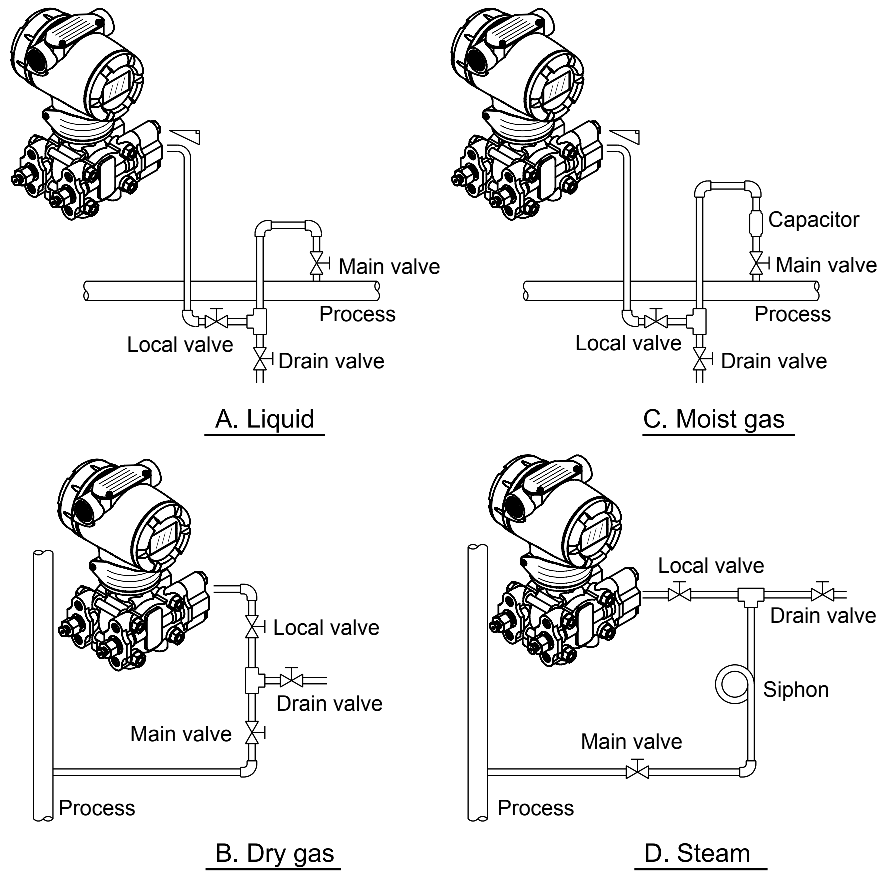


Fig. 2-36. Example of Piping

Auxiliary equipment

(1) Oil sealing and air purging

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

(2) Preventing pulsations

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

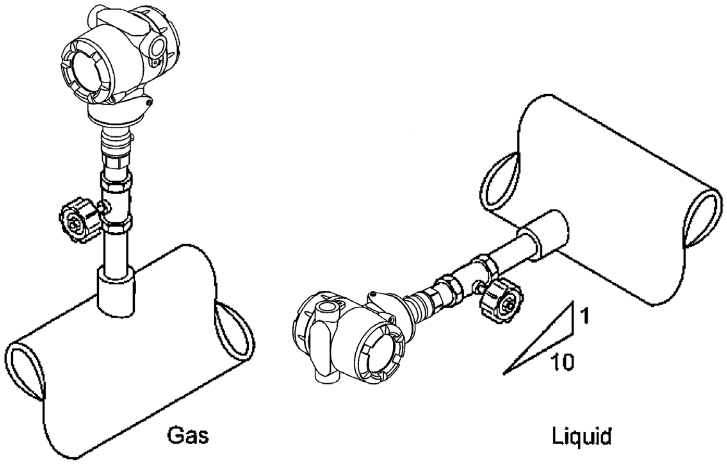


Fig. 2-37. Example of direct mounting

When mounting the transmitter directly onto the process line, takeinto consideration the weight, temperature at wetted part, and vibration. If necessary, use the optional bracket for reinforcement.

2-3-3. Liquid Level Measurement - Piping (GTX_ _D/GTX_ _G)

Piping

Introduction

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

H mark

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

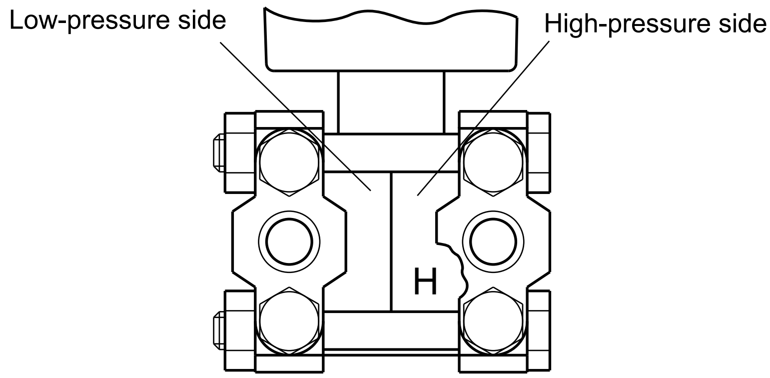


Fig. 2-38. H mark on center body

⚠CAUTION

If the nameplate indicates that the suppression is larger then 1/2 of the span, "H" is etched on the bottom left of the transmitter as viewed from the front. In this case, connect the high-pressure side of the process piping to the port on the right of the transmitter (without "H") as viewed from the front.

Example:
Range: -50 to 20 kPa
Suppression = 50 kPa, Span = 70 kPa

Since the suppression is larger than 1/2 of the span (50 > 70/2 = 35), "H" is etched on the bottom left of the transmitter as viewed from the front. The connection port for the high-pressure side of the process piping is on the right side.

Before your start

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

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

Open Tank - Piping

Recommended piping - Example

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

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

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

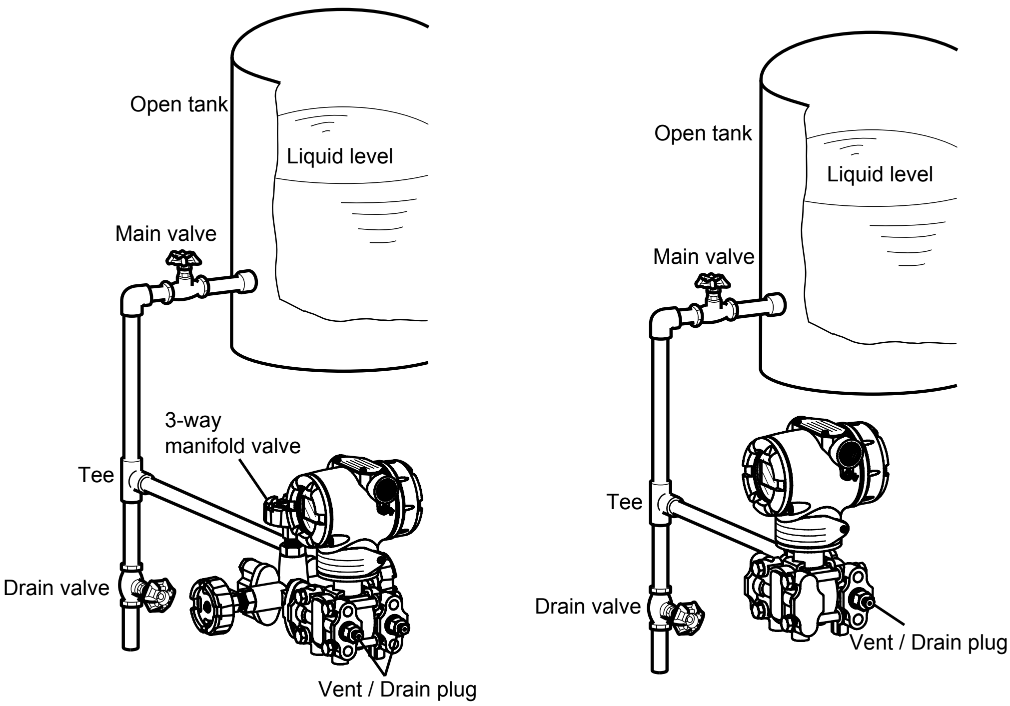


Fig. 2-39. Open Tank - Piping Example

Closed Tank - Piping

Recommended piping for dry leg - Example

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

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

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

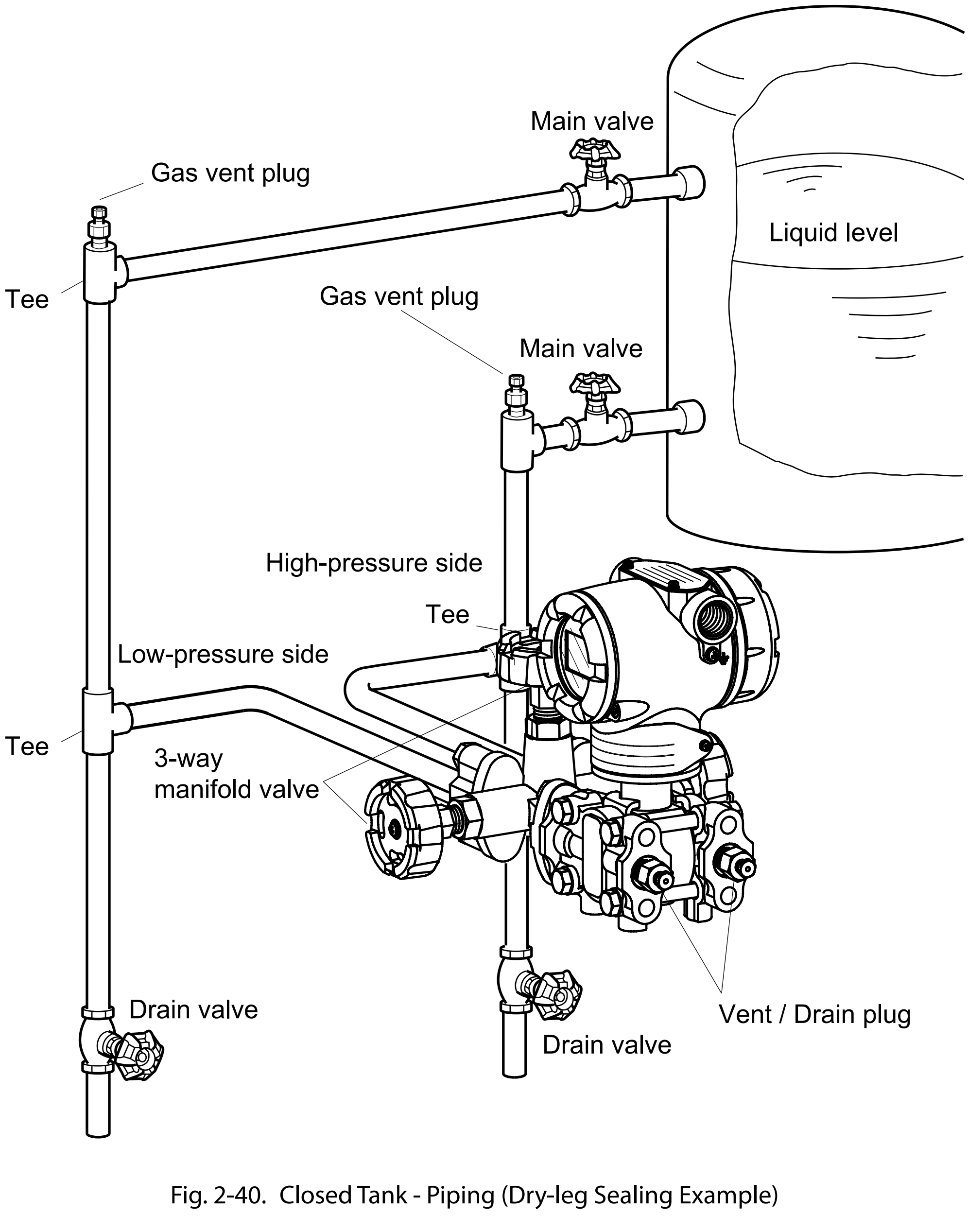


Fig. 2-40. Closed Tank - Piping (Dry-leg Sealing Example)

Recommended piping for wet leg - Example

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

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

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

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

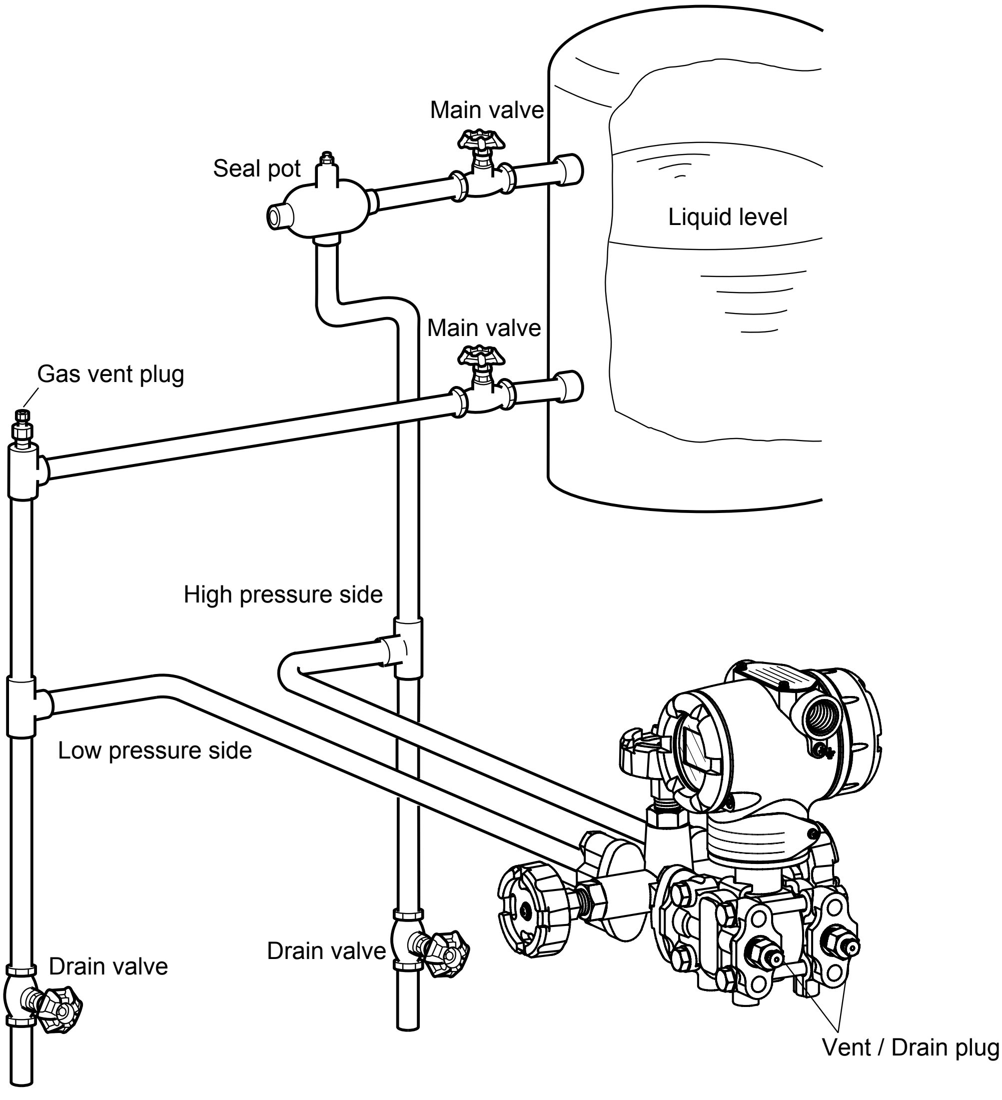


Fig. 2-41. Closed Tank - Piping (Wet-leg Sealing Example)

ATTENTION

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

2-4. Wiring Advanced Transmitter

2-4-1. Wiring for Transmitter -- Regular Model

Introduction

Following wiring instructions when no explosion-proof standards apply. Wire and cable this transmitter as shown in the illustrations.

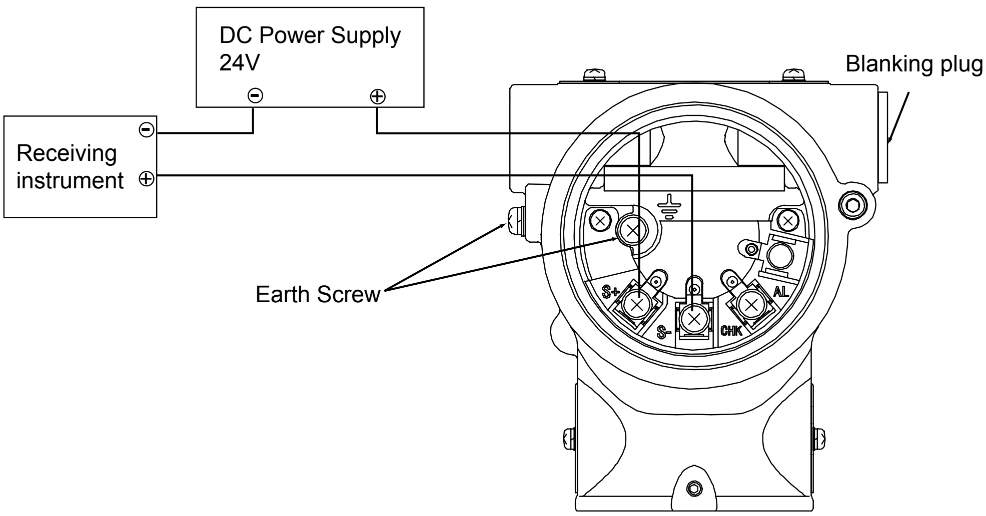


Fig. 2-42. Wiring for transmitter without Alarm output

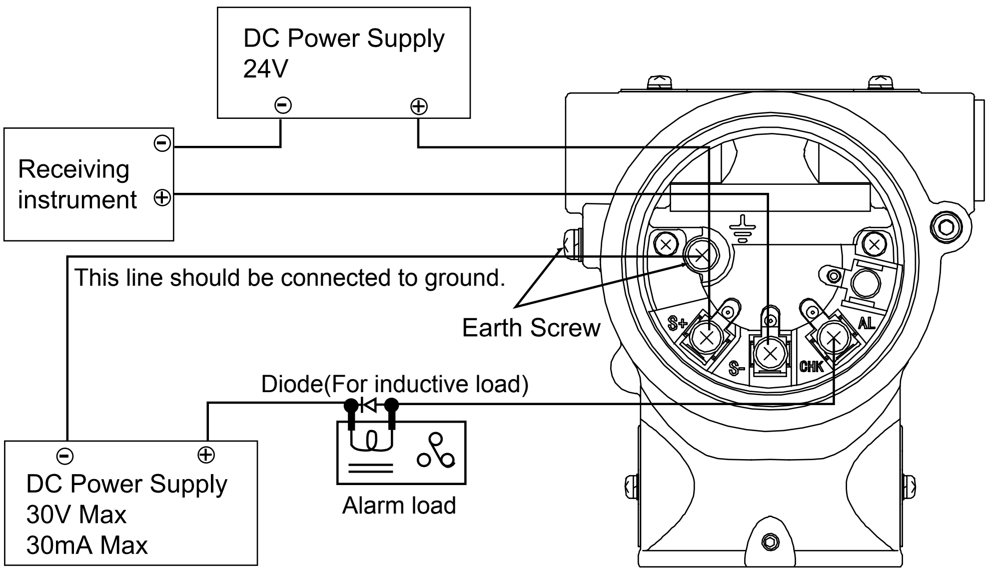


Fig. 2-43. Wiring for transmitter with Alarm output

Note : 1. External load resistance of at least 250Ω required for communications with an HART communicator. If total load resistance of the receiving instrument is less than 250Ω, insert the necessary resistance to the loop.
2. In using Azbil Corporation's field type indicator (Model NWS300, Model NWA300), please consult us.
3. A blanking plug may not be used on the adapter or elbow.
4. Current cannot checked for a transmitter with alarm contact output.
5. Use a power supply with overcurrent protection for the product.

Cable Specification

Use standard lead wires or cables that are the same as, or better than 600V grade PVC insulated wires.

Standard Models or Explosionproof Models
Use wiring rated for at least 5 deg.C higher than ambient temperature.

Intrinsically Safe Models
Use wiring rated for at least 10 deg.C higher than ambient temperature.

Conduit pipe for cables

Lead cables into the transmitter case, as follows:
Mount a conduit pipe in the conduit hole (1/2NPT female thread) provided on the side of a transmitter, and lead cables through the pipe.
Seal the part that contacts with the conduit pipe. Use a sealing agent or a seal plug to prevent entry of water.
Install transmitter so that the cables lead into it, from the bottom.

Grounding

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

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

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

External Earthing or Bonding Connection

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

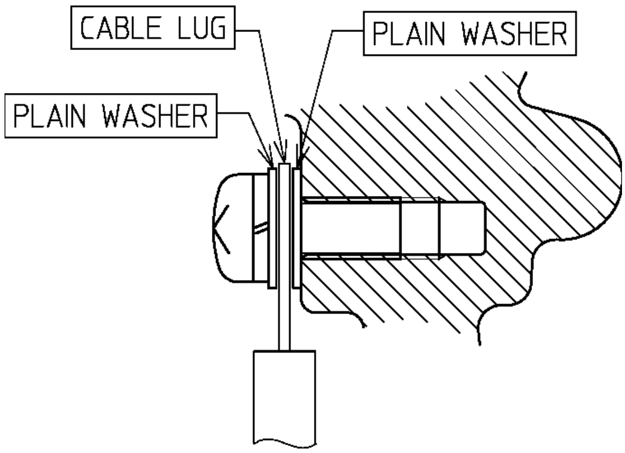


Fig. 2-44. External Grounding or Bonding Connection

Supply power and external load resistance

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

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

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

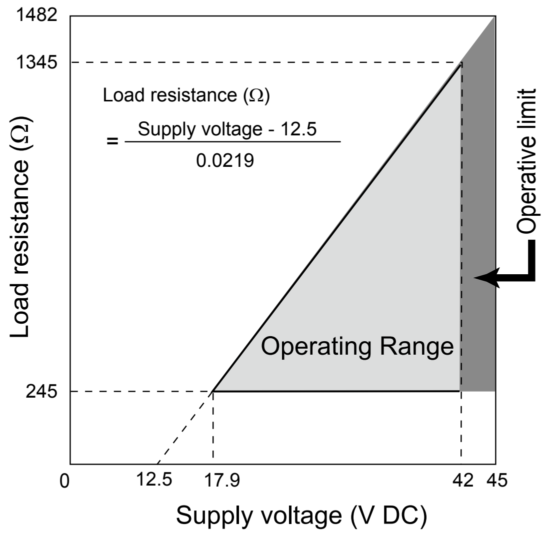


Fig. 2-45. Supply Voltage and External Load Resistance - Relationship

Note : 1. 45 volt operation is permitted.

2. For communication with HART communicator, a load resistance of 250 Ω or more is needed.

Summary

For wiring the transmitter, you simply connect the positive (+) and negative (-) loop wires to the positive (+) and negative (-) signal terminals on the terminal block in the transmitter's electronics housing as shown in Fig. 2-46.

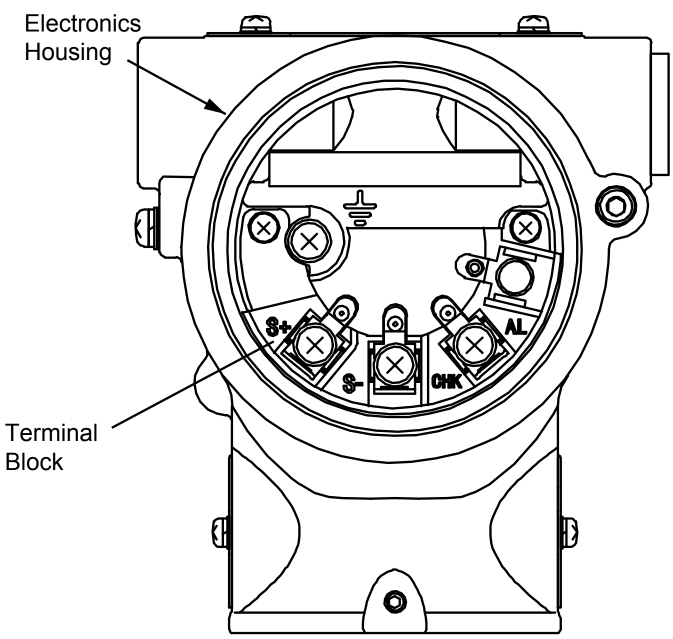


Fig. 2-46. Advanced Transmitter Terminal Block.

Chapter 3. Operation of the Transmitter

⚠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 (Field Communication Software(Model CFS100), 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.

Document title	No.
Field Communication Software(Model CFS100) User's Manual	CM2-CFS100-2001
Field Communication Software(Model CFS100) Instruction Manual(HART 5)	CM2-CFS100-2003
Field Communication Software(Model CFS100) Instruction Manual(HART 7)	CM2-CFS100-2013
Advanced Transmitter HART Communicator Operation Manual(HART 5)	CM2-GTX000-2002
Advanced Transmitter HART Communicator Operation Manual(HART 7)	CM2-GTX000-2003

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

3-1. Preparation

3-1-1. Connecting communicator

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

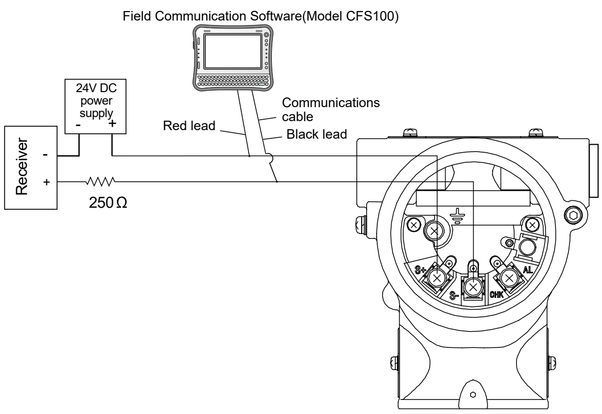


Fig. 3-1.

3-2. 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. Switch by S2 on Fig. 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. Switch by S3 on Fig. 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]
Switching the write protect ON and OFF can be executed with the slide switch (S1) on the electronics module.
Protect ON: Slide the slide switch (S1) to the ON side.
Protect OFF: Slide the slide switch (S1) to the OFF side.

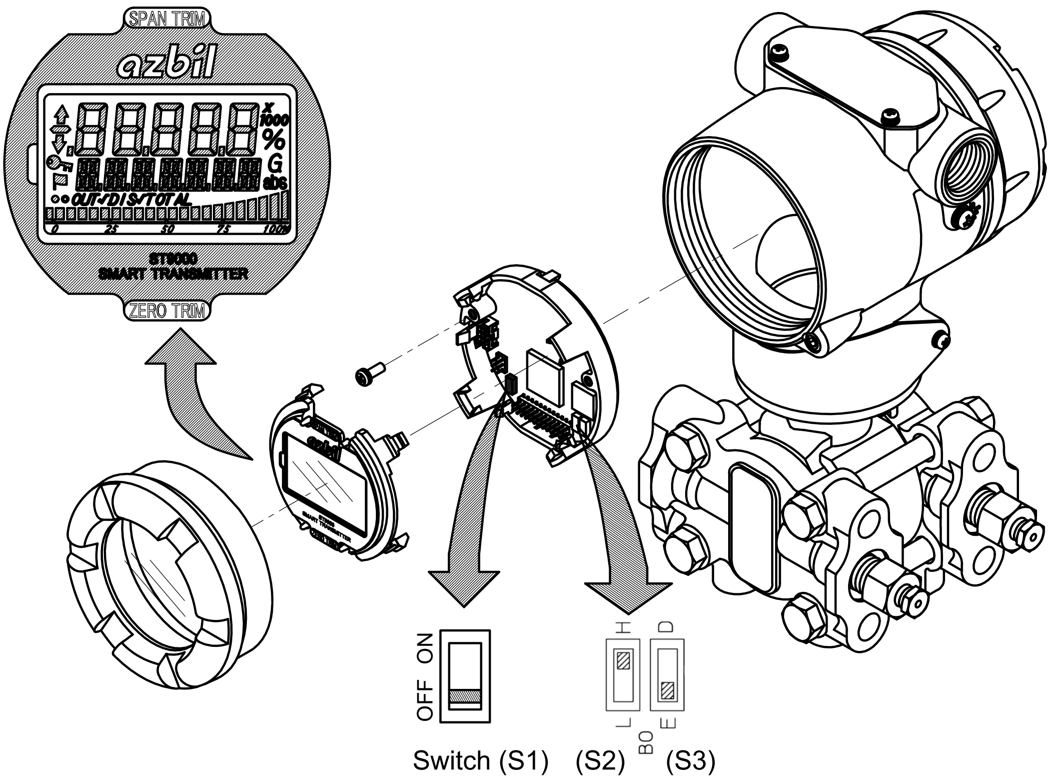


Fig. 3-2.

[Software Write Protection]
For information regarding software write protection, see the operation manual for the communicator.
Field Communication Software(Model CFS100) Instruction Manual (HART5) CM2-CFS100-2003
Field Communication Software(Model CFS100) Instruction Manual (HART7) CM2-CFS100-2013
HART Communicator Operation Manual (HART5) CM2-GTX000-2002
HART Communicator Operation Manual (HART7) CM2-GTX000-2003

(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 - 128.00 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.

3-3. Measurement with model GTX_ _D

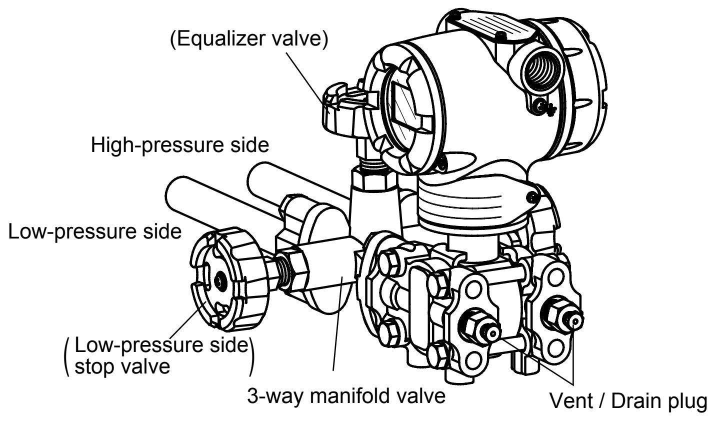
3-3-1. Flow Rate Measurement

Preparation for Measurement

⚠WARNING
• Make sure that the process is in the manual control mode. If in automatic control mode, switch to manual control before starting the following procedures. • Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm. • Always close the differential pressure output valve (main valve), the drain valve, the gas vent plug (Refer to Fig. 2-32, Fig. 2-33 and Fig. 2-34) and the high pressure side and low pressure side stop valves of the 3-way manifold valve. Also, open the equalizer valve of the 3-way manifold valve.

Procedure 1

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

Step	Description
1	Gradually open the main valves of both the high-pressure side and the low-pressure side (Refer to Fig. 2-32 Fig. 2-33 and Fig. 2-34). Lead process fluid into the connecting pipe.1
2	Fill with process fluid, the pressure-receiving part of the transmitter. 1. Gradually open the high pressure side stop valve. Close, after the pressure receiving part has completely filled with process fluid. 2. Gradually open the low pressure side stop valve. Close, after the pressure receiving part has completely filled with process fluid. 

Step	Description
3	Decrease to zero, the differential pressure applied to the transmitter. • Gradually open the high-pressure side stop valve to lead process pressure into the pressure receiving part of the transmitter. • In this state, equal pressure is applied to the high-pressure side and the low-pressure side of the transmitter (equal pressure state).
4	Check for pressure leaks in the connecting pipe, the 3-way manifold valve, and the transmitter.

Procedure 2

Perform zero-point calibration, using this procedure:
Zero point calibration by HART communicator operation
Check that the transmitters input is 0 kPa and its output is 0% at Online display. (Refer to HART Communicator Operation Manual (HART5) CM2-GTX000-2002
HART Communicator Operation Manual (HART7) CM2-GTX000-2003
If the screen display is not 0 kPa perform zero-point calibration using this procedure.

⚠CAUTION

If damping time constant is set to 0 sec. please adjust another value to keep the output stable before calibration. (Refer to HART Communicator Operation Manual (HART5) CM2-GTX000-2002
HART Communicator Operation Manual (HART7) CM2-GTX000-2003)

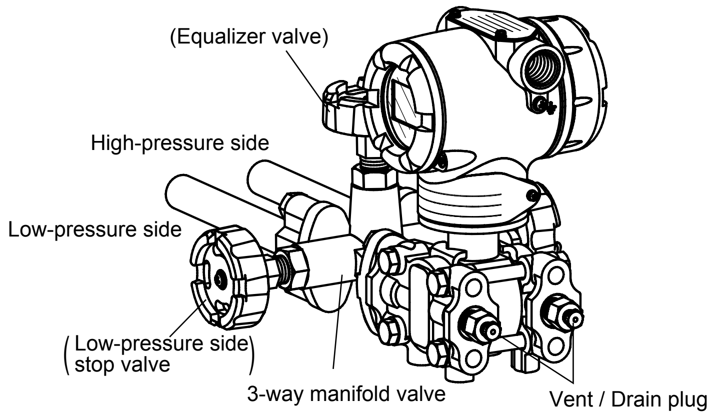
(Device) - (Calibration) - (Correct Input)

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

Starting Measurement

Procedure 3

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

Step	Description
1	Ensure that the 3-way manifold valve is in the following state: 1. High-pressure side stop valve: Fully open 2. Low-pressure side stop valve: Fully closed 3. Equalizer valve: Fully open
2	1. Close the equalizer valve. 2. Open the low-pressure side stop valve gradually. 

⚠ CAUTION

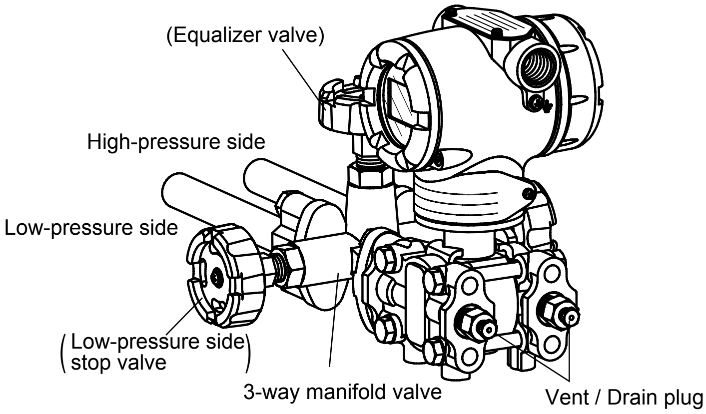
Securely close the cover of the transmitter case. Imperfect closure allows entry of water, and may damage internal terminals as well as the electronics module. Such damage may require parts replacement, possibly of the entire module.

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

Stopping Measurement

Procedure

Stop the transmitter, using this procedure:

Step	Description
1	Turn off the transmitter
2	Operate the 3-way manifold valve by the following procedure: 1. Close the low-pressure side stop valve. 2. Open the equalizer valve. 3. Close the high-pressure side stop valve 
3	Close the main valves on the high and low pressure sides. Refer to Fig. 2-32,Fig. 2-33, and Fig. 2-34.

⚠CAUTION

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

3-3-2. Gas Pressure Measurement

Preparation for Measurement

⚠WARNING

- Ensure that the process is in the manual control mode.
  If the process is in automatic control mode, switch to manual before starting the procedure.
- Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.
- Close the differential pressure output valve (main valve), the local valve, the drain valve, and the gas vent plug. Refer to "Fig. 2-35. Gas Pressure Measurement - Piping".

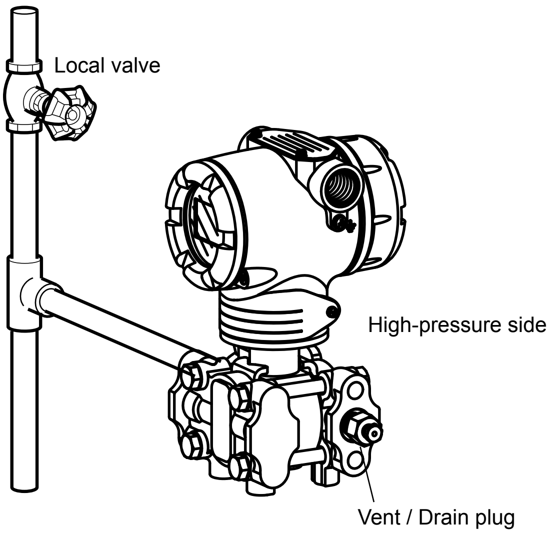
How to measure gas pressure

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

- Zero-point adjustment

Step	Description
1	Open both the high-pressure side and low-pressure side vent plugs and open the pressure receiving part to the air.
2	Refer to procedure 2 on page 3-6. Perform zero-point calibration.
3	After completing zero-point calibration, close the high-pressure side vent plug.

Introducing process pressure and venting air

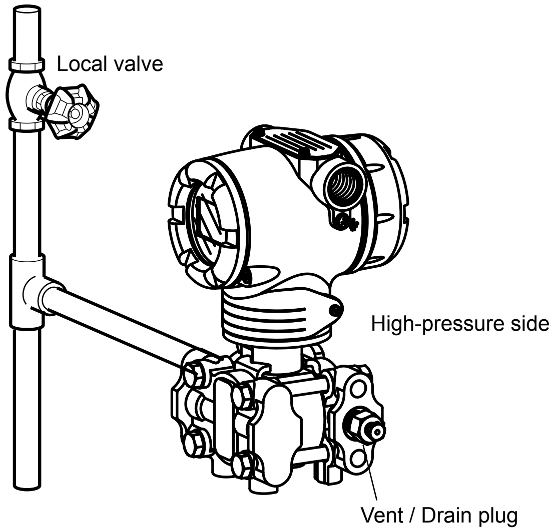
Step	Description
1	1. Open the main valve (refer to “Fig. 2-35. Gas Pressure Measurement - Piping”.) to introduce process pressure into the connecting pipe. 2. Open the local valve gradually, to introduce process pressure into the pressure-receiving part of the transmitter.
2	1. Open the high-pressure side vent plug gradually, to vent air from the center body. 2. After venting air, close the vent plug and the local valve. 
3	Check for pressure leaks in the connecting pipe and the transmitter.

Starting Measurement

Procedure

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

- How to apply process pressure

Step	Description
1	Open the local valve gradually. 

⚠CAUTION

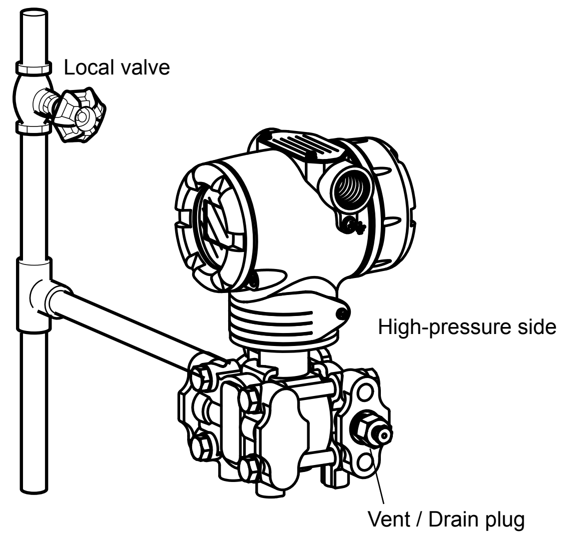
Securely close the cover of the transmitter case. Failure to do so will result in entry of water, and cause damage to internal terminals and the electronics module.

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

Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Close the local valve. 
3	Close the main valve. (Refer to "Fig. 2-35. Gas Pressure Measurement - Piping".)

⚠CAUTION

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

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

Preparation for Measurement

⚠WARNING

- Place the process in the manual control mode.
  If the process is in the automatic control mode, switch to manual before performing work.
- Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.
- Check that the differential pressure output valve (main valve), the drain valve, the gas vent plug (refer to Fig. 2-39 and Fig. 2-40.) are closed, as well as the high pressure side and low pressure side stop valves of the 3-way manifold valve. Also, make sure that the equalizer valve of the 3-way manifold valve is open.

Calculating setting range

Calculate the setting range. Refer to "3-8. Set Range Calculation for Liquid Level Measurement".

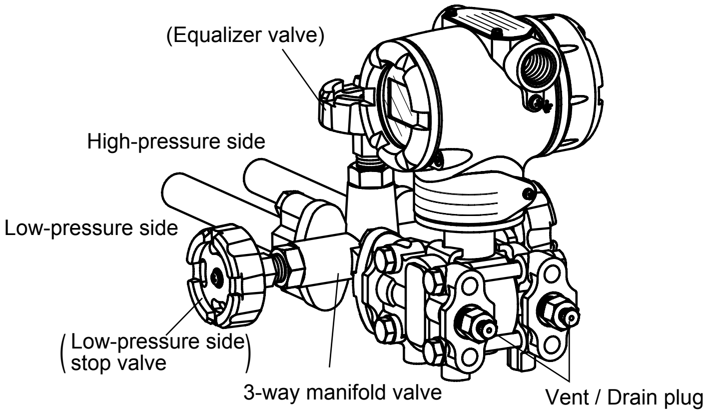
Procedure

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

Zero-point calibration

Step	Description
1	Open the drain plugs and the stop valves of both the high-pressure side and the low-pressure side. Open the pressure receiving part to the air. If fluid remains in the pressure receiving part, blow it to drain.
2	Refer to procedure 2 in page 3-6 and perform zero-point calibration.
3	After completing zero-point calibration, close the high-pressure side drain plug and the high-pressure side stop valve.

Introducing process pressure

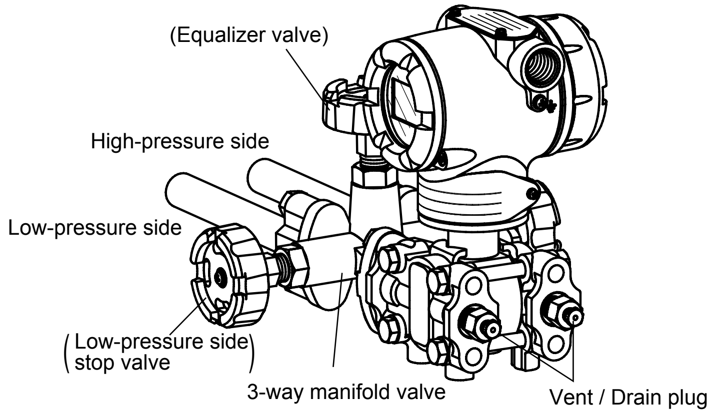
Step	Description
1	1. Open the main valve (refer to Fig. 2-39 and Fig. 2-40) to introduce process pressure into the connecting pipe. 2. Open the high-pressure side stop valve gradually to introduce process pressure. After introducing process pressure into the pressure receiving part of the transmitter, close the high-pressure side stop valve. 
2	Check for pressure leaks in the connecting pipe, the 3-way manifold valve, and the transmitter.

Starting Measurement

Procedure

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

How to apply process pressure

Step	Description
1	Check that the 3-way manifold valve is 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	1. Open the high-pressure side stop valve gradually.

⚠CAUTION

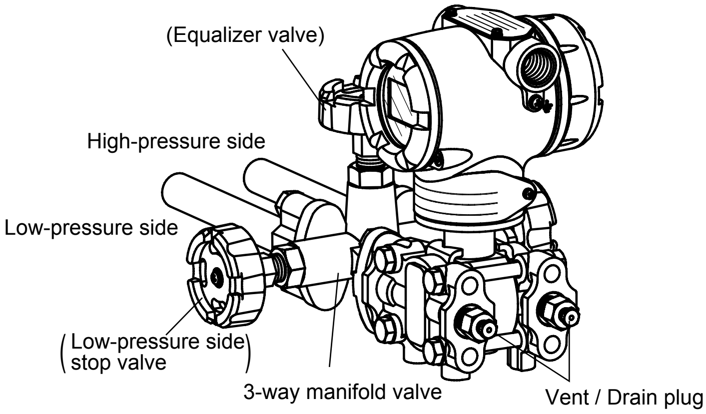
Securely close the cover of the transmitter case. Failure to do so will result in entry of water, and cause damage to internal terminals and the electronics module.

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

Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Operate the 3-way manifold valve using this procedure: 1. Close the low-pressure side stop valve. 2. Open the equalizer valve. 3. Close the high-pressure side stop valve. 
3	Close the main valve. Refer to Fig. 2-39 and Fig. 2-40.

⚠CAUTION

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

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

Preparation for Measurement

⚠WARNING

- Place the process in manual control mode.
  If the process is in automatic control mode, change it to the manual control mode before performing this work.
- Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing gog- gles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.
- Make sure that the differential pressure output valve (main valve), the drain valve, the gas vent plug (refer to Fig. 2-41. Closed Tank - Piping (Wet-leg Sealing Example)".) and the high pressure side and low pressure side stop valves of the 3-way manifold valve are closed. Also, make sure that the equalizer valve of the 3-way manifold valve is open.

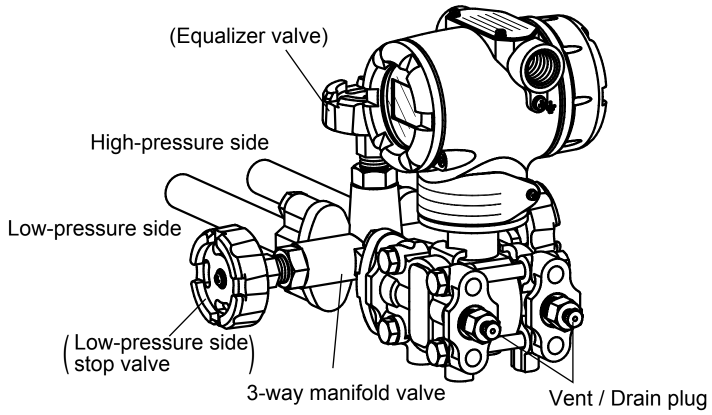
Calculating setting range

For the procedure for obtaining the setting range by calculation, refer to "3-8. Set Range Calculation for Liquid Level Measurement".

Procedure

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

Step	Description
1	Feed sealing liquid from the seal pot to fill the connecting pipe with sealing liquid.
2	Gradually open the stop valves of both the high-pressure side and the low-pressure side, and the drain plugs, to fill the pressure receiving part of the transmitter with sealing liquid.
3	When sealing liquid flows out from the drain plugs, close the stop valves of both the high pressure side and the low pressure side and the drain plugs. In this state, the same pressure is applied to the high pressure side and the low pressure side of the transmitter (equal pressure state).
4	Referring to procedure 2 in page 3-6, perform zero point calibration.
5	After completing zero-point calibration, close the equalizer valve. Open the stop valve and the drain plug of the low-pressure side to drain sealing liquid. Close the stop valve and the drain plug of the low-pressure side.



Introducing process pressure

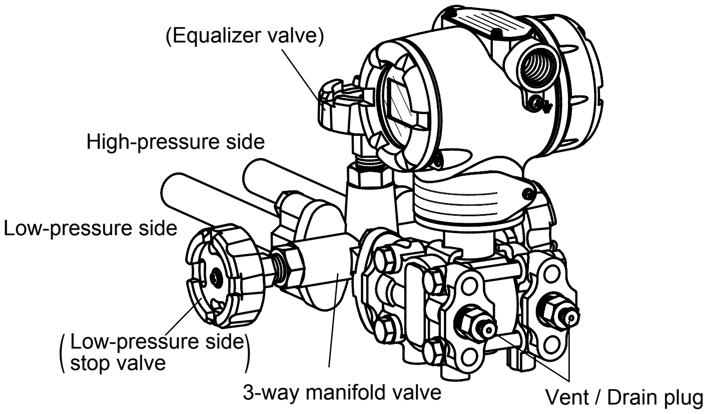
Step	Description
1	Open the main valve (Refer to “Fig. 2-41. Closed Tank - Piping (Wet-leg Sealing Example)”.) to introduce process fluid into the connecting pipe.
2	Gradually open the low pressure side stop valve to introduce process fluid. After introducing process fluid into the pressure receiving part of the transmitter, close the low pressure side stop valve.
3	Make sure that the connecting pipe, the 3-way manifold valve, and the transmitter have no pressure leaks.

Starting Measurement

Procedure

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

How to apply process pressure

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

⚠CAUTION

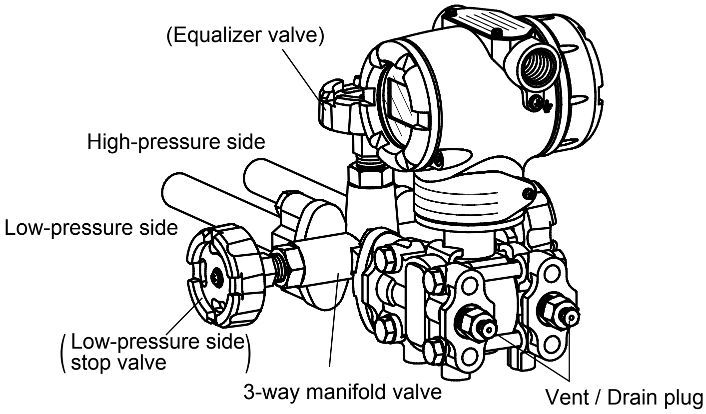
Close the cover of the transmitter case securely. Imperfect closure allows entry of water, damaging internal terminals and the electronics module.

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

Stopping Measurement

Procedure

How to stop the transmitter

Step	Description
1	Turn off the transmitter.
2	Operate the 3-way manifold valve by the following procedure: 1. Close the low pressure side stop valve. 2. Open the equalizer valve. 3. Close the high pressure side stop valve. 
3	Close the main valve. (Refer to Fig. 2-41.)

⚠CAUTION

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

3-4. Measurement with Model GTX_ _G/GTX_ _A

3-4-1. Pressure Measurement

Preparation for Measurement

⚠WARNING
• Make sure that the process is in the manual control mode. If the process is in the automatic control mode, switch it to manual mode. • Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm. • Before starting a measurement procedure, ensure closure of the pressure valve (main valve), the local valve, the drain valve, and the gas vent plug (Refer to Fig. 2-35).

Gas pressure measurement

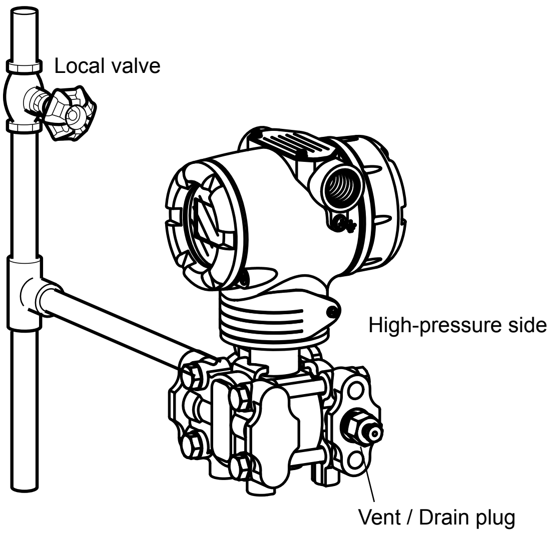
Perform zero-point calibration and introduce process pressure, with this procedure:

⚠CAUTION
If damping time constant is set to 0 sec., please adjust another value to keep output stable before calibration.

Zero-point calibration

Step	Description
1	Open the vent plug to release the pressure receiving part to the open air.
2	Referring to procedure 2 in page 3-6, perform zero-point calibration.
3	When calibration is complete, close the vent plug.

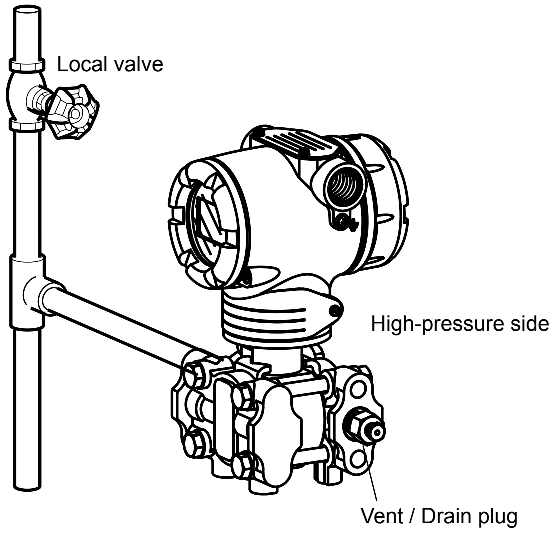
Introducing process pressure and venting air

Step	Description
1	1. Introduce the process pressure into the connecting pipe by opening the main valve (Refer to “Fig. 2-36. Example of Piping”). If the process temperature is high, allow cooling time so that the connecting pipe is stable at a safe temperature, before starting work. 2. Open the local valve gradually to introduce the process pressure into the pressure receiving part of transmitter.
2	1. Vent air from the center body by gradually opening the vent plug. 2. After venting air completely, close the plug and the local valve. 
3	Ensure zero leakage exists at the connecting pipe and transmitter.

Starting Measurement

Procedure

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

Step	Description
1	Open gradually the local valve. 

⚠CAUTION

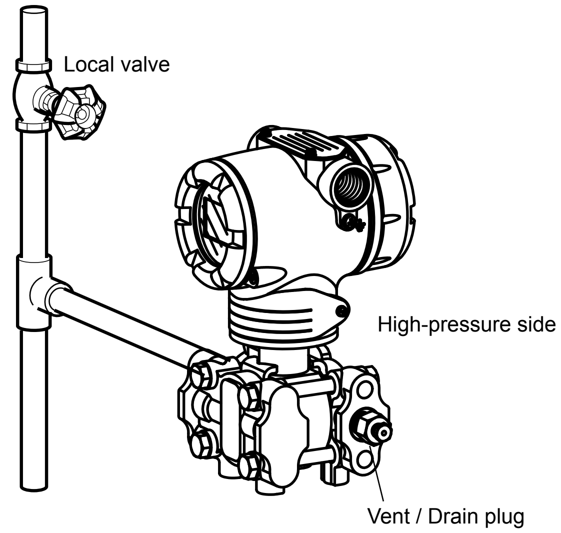
Securely close the case cover of the transmitter. Take precautions against moisture ingress into the transmitter body. Water entering the transmitter will damage the inter- nal terminals and the electronics module.

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

Stopping Measurement

Procedure

Stop the operation of the transmitter by this procedure:

Step	Description
1	Turn OFF the transmitter.
2	Close the local valve. 
3	Close the main valve.

⚠CAUTION

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

3-5. Measurement with Model GTX_ _F

3-5-1. Pressure Measurement

⚠CAUTION

- Make sure that the process is in the manual control mode.
  If in automatic control mode, switch to manual control before starting the following procedures.
- Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.

Preparation for Measurement

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

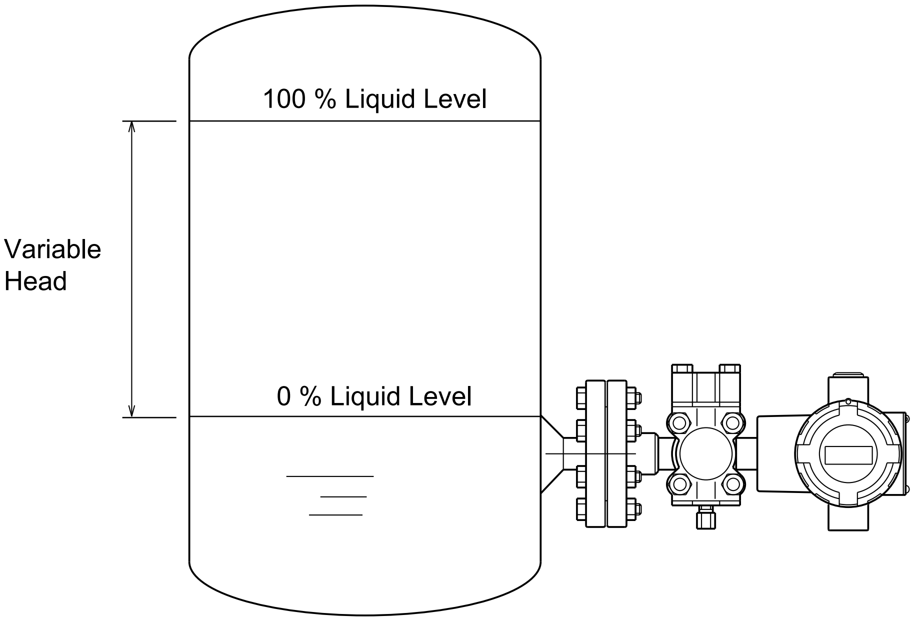


Fig. 3-3.

Starting Measurement

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

(1) Check the correspondence between input and output values.

- If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.

(2) Check the displayed data.

- If unstable value is displayed, adjust the damping time constant.

(3) Perform the following items carefully:

- Disconnect the HART communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
- Close the case cover. Screw in the cover firmly until it can no longer be turned.
- This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

Stopping Measurement

Procedure

Turn off the transmitter.

⚠CAUTION

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

3-6. Measurement with Model GTX_ _R

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

3-6-1. Pressure Measurement

> **⚠CAUTION**
>
> - Make sure that the process is in the manual control mode.
>   If in automatic control mode, switch to manual control before starting the following procedures.
> - Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.

Preparation for Measurement

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

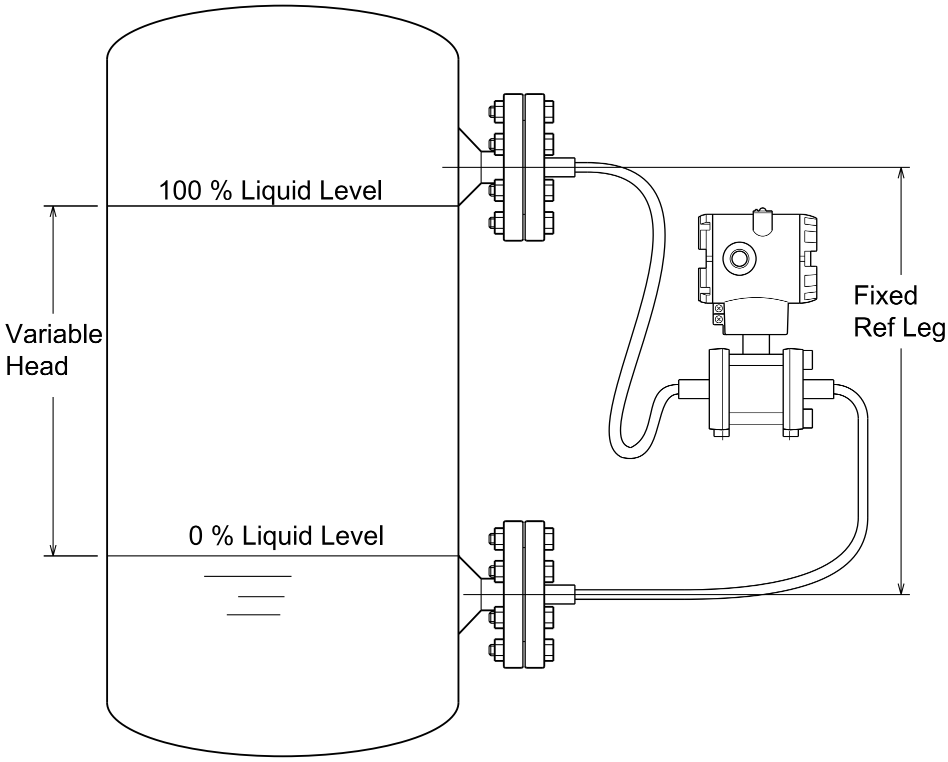
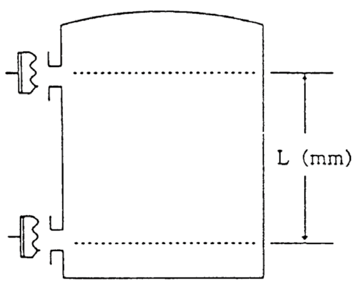


Fig. 3-4.

Sealed liquid temperature correction function

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

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



Example of zero shift

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

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

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

T (Ambient temperature change): 55°C

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

From (1)

Zero shift of a model without temperature correction:

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

(Conventional transmitter)

Zero shift of a model with temperature correction function: 1%

Starting Measurement

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

(1) Check the correspondence between input and output values.

- If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.

(2) Check the displayed data.

- If unstable value is displayed, adjust the damping time constant.

(3) Perform the following items carefully:

- Disconnect the HART communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
- Close the case cover. Screw in the cover firmly until it can no longer be turned.
- This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

Stopping Measurement

Procedure

Turn off the transmitter.

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

3-6-2. Cautions Related to Flow Rate Measurement

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

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

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

3-7. Measurement with Model GTX_ _U/GTX_ _S

When starting operation, adjust the transmitter in its actual process state. The specific gravity of the sealed-in liquid is stated in the specifications of Chapter 3. Specific gravity changes with temperature at the rate of 0.0008/°C. Use the temperature of the capillary tube for items related to specific gravity, in this section.

3-7-1. Pressure Measurement

⚠ **CAUTION**

- Make sure that the process is in the manual control mode.
  If in automatic control mode, switch to manual control before starting the following procedures.
- Before discharging a process fluid that contains toxic substances, check the direc- tion of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm.

Preparation for Measurement

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

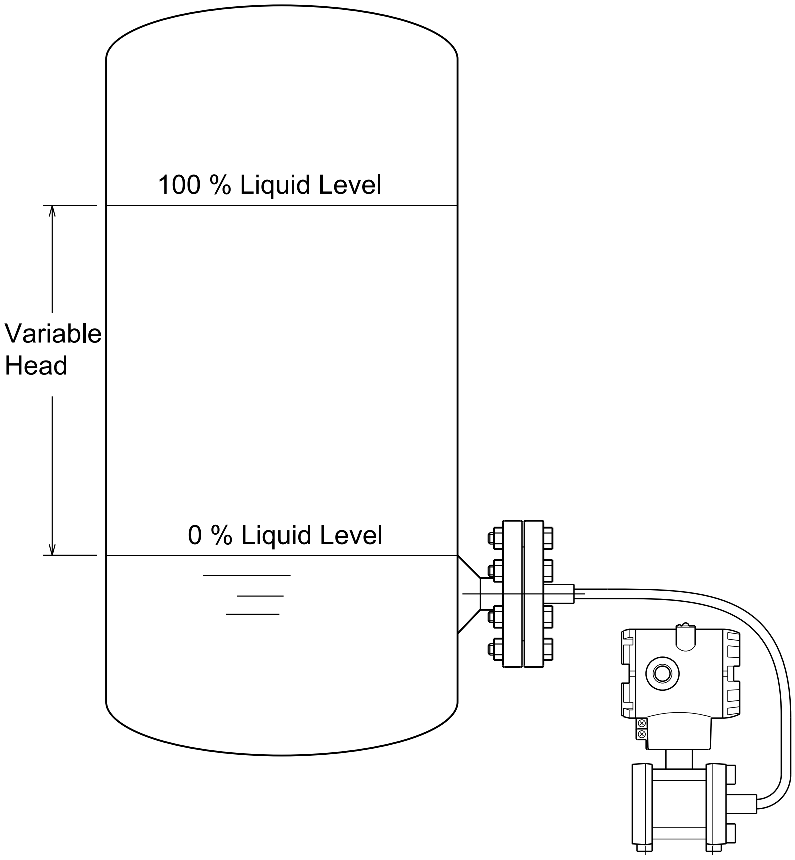


Fig. 3-5.

Starting Measurement

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

(1) Check the correspondence between input and output values.

- If the output does not correctly reflect the input, check the range, check the flange position on the process, and calibrate the transmitter again.

(2) Check the displayed data.

- If unstable value is displayed, adjust the damping time constant.

(3) Perform the following items carefully:

- Disconnect the HART communicator from the transmitter terminal. Ensure that the terminal is sufficiently tight, and not loose.
- Close the case cover. Screw in the cover firmly until it can no longer be turned.
- This transmitter has a locking structure. After closing the cover, tighten the lock using a hexagon wrench.

Stopping Measurement

Procedure

Turn OFF the transmitter.

⚠CAUTION

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

3-8. Set Range Calculation for Liquid Level Measurement

3-8-1. Open Tank or Closed Tank (Dry Leg) or Remote Seal Set Range Calculation

Set range calculation Ex. Model GTX_ _D

Calculate the set range using these procedures:
The following symbols are used to express density and distance.
It is assumed that the density is fixed, during liquid level measurement.

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

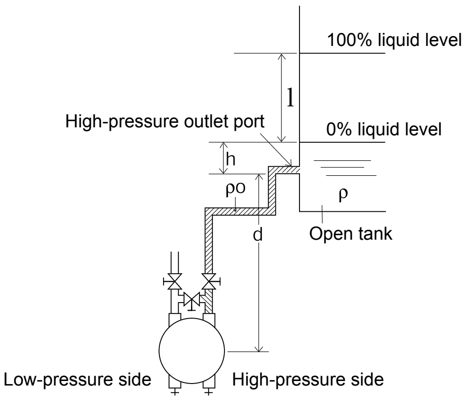


Fig. 3-6. Open Tank

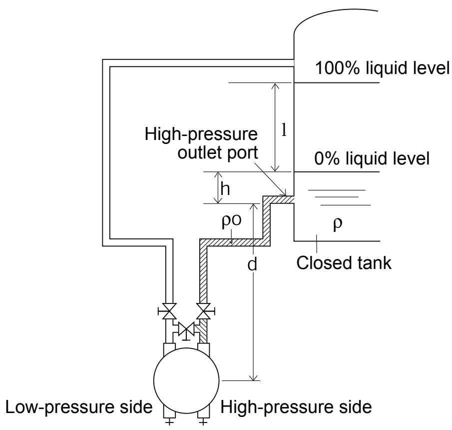


Fig. 3-7. Closed Tank

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $h\,\rho + d\,\rho_0$ = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) =
$l\,\rho + h\,\rho + d\,\rho_0 = (l+h)\,\rho + d\,\rho_0$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\,\rho + d\,\rho_0$; High limit (URV): $(l+h)\,\rho + d\,\rho_0$

Example of calculation: l = 1500 mm, h = 250 mm, d = 500 mm ρ = 0.9, ρ_0 = 1.0
If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (250 × 0.9) + (500 × 1.0) = 725 mmH_2O = 7.110 kPa
Differential pressure at 100% liquid level = {(1500 + 250) × 0.9) + (500 × 1.0) = 2075 mmH_2O = 20.35 kPa

Therefore, set the range as follows:
Low limit (LRV): 7.110 kPa{725 mmH_2O} , High limit (URV): 20.35 kPa{2075 mmH_2O}

Set range calculation Ex. Model GTX_ _G

Calculate the set range using these procedures:
The following symbols are used to express density and distance.
It is assumed that the density is fixed, during liquid level measurement.

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

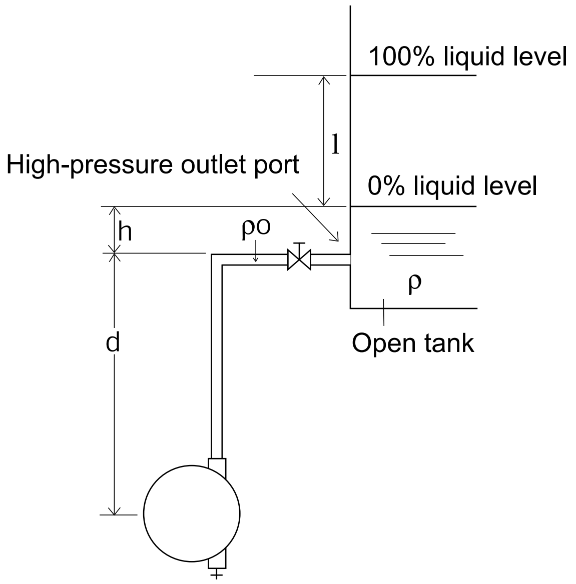


Fig. 3-8.

Pressure at 0% liquid level = $h\,\rho + d\,\rho_0$ = LRV
Pressure at 100% liquid level = $l\,\rho + h\,\rho + d\,\rho_0 = (l+h)\,r + d\,\rho_0$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\,\rho + d\,\rho_0$; High limit (URV): $(l+h)\,\rho + d\,\rho_0$

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

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (250 × 0.9) + (500 × 1.0) = 725 mmH_2O = 7.110 kPa
Differential pressure at 100% liquid level = {(1500 + 250) × 0.9) + (500 × 1.0) = 2075 mmH_2O = 20.35 kPa

Therefore, set the range as follows:
Low limit (LRV): 7.110 kPa{725 mmH_2O} , High limit (URV): 20.35 kPa{2075 mmH_2O}

Set range calculation Ex. Model GTX_ _F

Calculate the set range using these procedures:
The following symbols are used to express density and distance.
It is assumed that the density is fixed, during liquid level measurement.

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

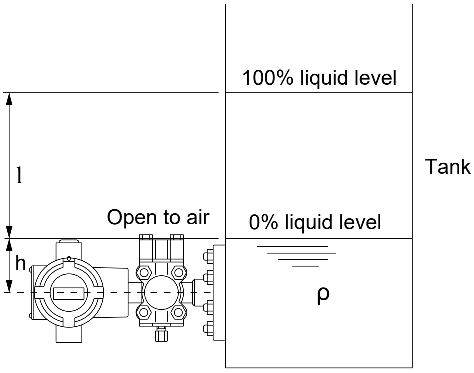


Fig. 3-9. Open Tank

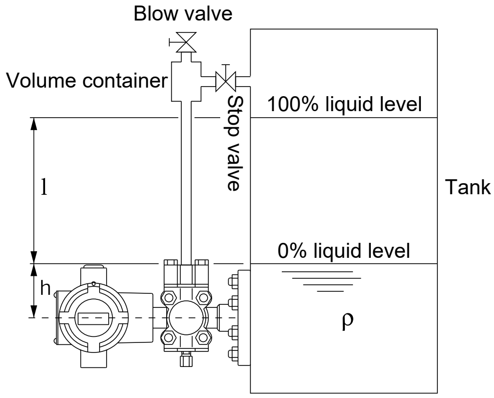


Fig. 3-10. Closed Tank

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $h\,\rho$ = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $l\,\rho + h\,\rho = (l+h)\,\rho$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\,\rho$; High limit (URV): $(l+h)\,\rho$

Example of calculation:
l = 1500 mm, h = 250 mm
ρ = *0.9*

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (250 × 0.9) = 225 mmH_2O = 2.206 kPa
Differential pressure at 100% liquid level = {(1500 + 250) × 0.9) = 1575 mmH_2O = 15.45 kPa

Therefore, set the range as follows:
Low limit (LRV): 2.206 kPa{225 mmH_2O} , High limit (URV): 15.45 kPa{1575 mmH_2O}

Set range calculation Ex. Model GTX_ _R

Calculate the set range using these procedures:
The following symbols are used to express density and distance.
It is assumed that the density is fixed, during liquid level measurement.

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

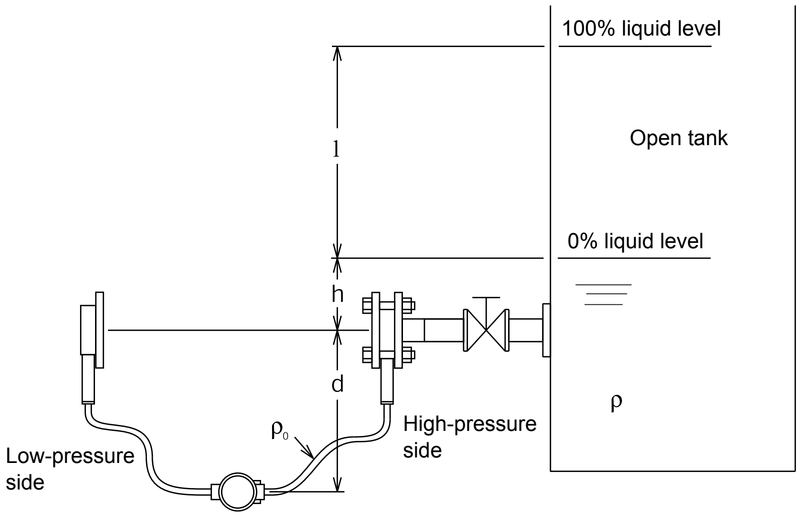


Fig. 3-11. Open Tank

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = hr = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $l\rho + h\rho = (l+h)\rho$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\rho$; High limit (URV): $(l+h)\ r$

Example of calculation:
$l = 1500\ mm,\ h = 250\ mm,\ d = 500\ mm,\ \rho = 0.9,\ \rho_0 = 0.935$

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = 250 × 0.9= 225 mmH_2O = 2.206 kPa
Differential pressure at 100% liquid level = (1500 + 250) × 0.9 = 1575 mmH_2O = 15.45 kPa

Therefore, set the range as follows:
Low limit (LRV): 2.206 kPa, High limit (URV): 15.45 kPa

Set range calculation Ex. Model GTX_ _U

Calculate the set range using these procedures:
The following symbols are used to express density and distance.
It is assumed that the density is fixed, during liquid level measurement.

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

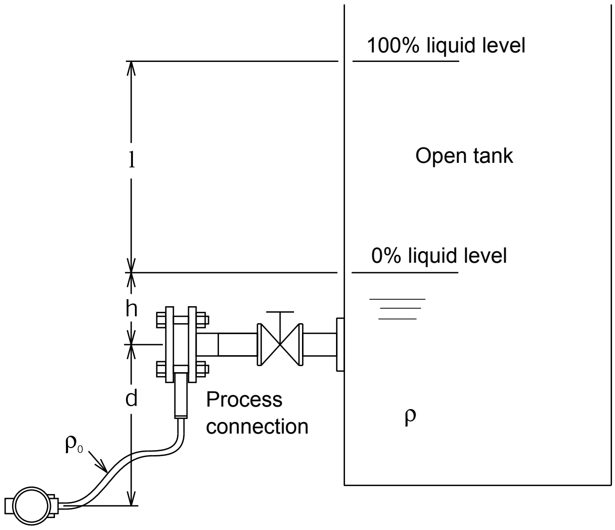


Fig. 3-12. Open Tank

Differential pressure at 0% liquid level = $h\ \rho + d\ \rho0$ = LRV
Differential pressure at 100% liquid level = $l\ \rho + h\ \rho + d\ \rho_0 = (l+h)\ \rho + d\ \rho_0$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\ \rho + d\ \rho0$; High limit (URV): $(l+h)\ \rho + d\ \rho0$

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

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (250 × 0.9) + (500 × 1.0) = 725 mmH_2O = 7.110 kPa
Differential pressure at 100% liquid level = {(1500 + 250) × 0.9) + (500 × 1.0) = 2075 mmH_2O = 20.35 kPa

Therefore, set the range as follows:
Low limit (LRV): 7.110 kPa, High limit (URV): 20.35 kPa

3-8-2. Closed Tank (Wet Leg or Remote Seal) -- Set Range

Set range calculation Ex. Model GTX_ _D

Calculate the set range using these procedure:
The following symbols are used to express density and distance.
It is assumed that the density is fixed during liquid level measurement.

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

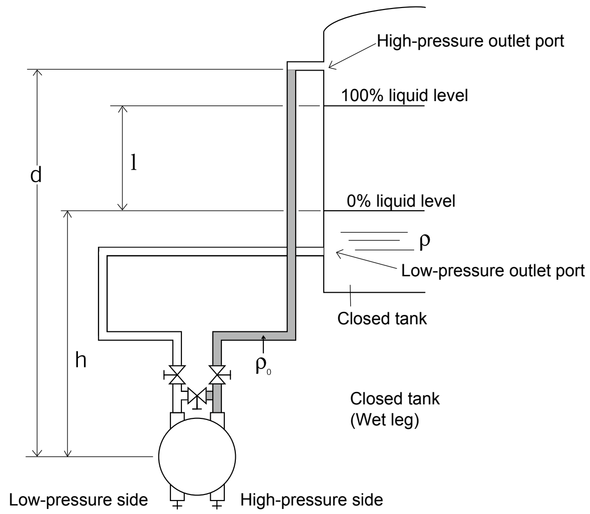


Fig. 3-13. Closed Tank (Wet Leg)

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $d\ \rho_0$ - $h\ r$ = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $d\ \rho_0$ - $(l+h)\ \rho$ = URV

Therefore, set the range as follows:
Low limit (LRV): $d\ \rho_0$ - $h\ \rho\ r$, High limit (URV): $d\ \rho_0$ - $(l+h)\ \rho$

Example of calculation:
l = 1500 mm, h = 250 mm, d = 2000 mm, ρ = 0.9, ρ_0 = 1.0

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (2000 × 1.0) – (250 × 0.9) = 1775 mmH_2O = 17.41 kPa
Differential pressure at 100% liquid level = (2000 × 1.0) – (1500 × 250) x 0.9 = 425 mmH_2O = 4.168 kPa

Therefore, set the range as follows:
Low limit (LRV): 17.41 kPa{1775 mmH_2O}, High limit (URV): 4.168 kPa {425 mmH_2O}

Set range calculation Ex. Model GTX_ _F

Calculate the set range using these procedure:
The following symbols are used to express density and distance.
It is assumed that the density is fixed during liquid level measurement.

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

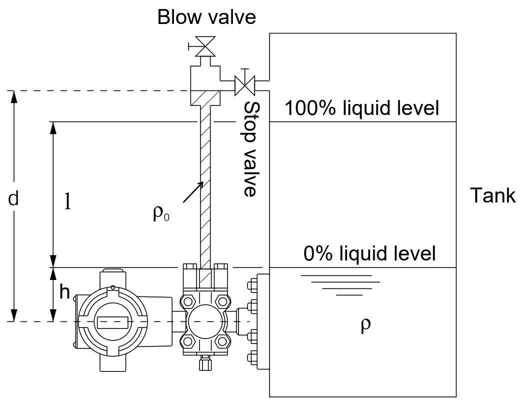


Fig. 3-14. Closed Tank (Wet Leg)

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $h\,\rho$ - $d\,\rho_0$ = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $(l+h)\,\rho$ - $d\,\rho_0$ = URV

Therefore, set the range as follows:
Low limit (LRV): $h\,\rho - d\,\rho0$, High limit (URV): $(l+h)\,\rho - d\,\rho0$

Example of calculation:
l = 1500 mm, h = 250 mm, d = 2000 mm, ρ = 0.9, ρ_0 = 1.0

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (250×0.9)-(2000 × 1.0) = -1775 mmH_2O = -17.41 kPa
Differential pressure at 100% liquid level = (1500 + 250)×0.9-(2000 × 1.0) = -425 mmH_2O = -4.168 kPa

Therefore, set the range as follows:
Low limit (LRV): -17.41 kPa{-1775 mmH_2O}, High limit (URV): -4.168 kPa {-425 mmH_2O}

Set range calculation Ex. Model GTX_ _R

Calculate the set range using these procedure:
The following symbols are used to express density and distance.
It is assumed that the density is fixed during liquid level measurement.

ρ : Specific gravity of liquid in tank
ρ_0 : Specific gravity of sealed liquid
l : Distance between 100% liquid level and 0% liquid level (measurement range)
h : Distance between 0% liquid level and lower flange of tank
d : Distance between upper flange of tank and lower flange of tank

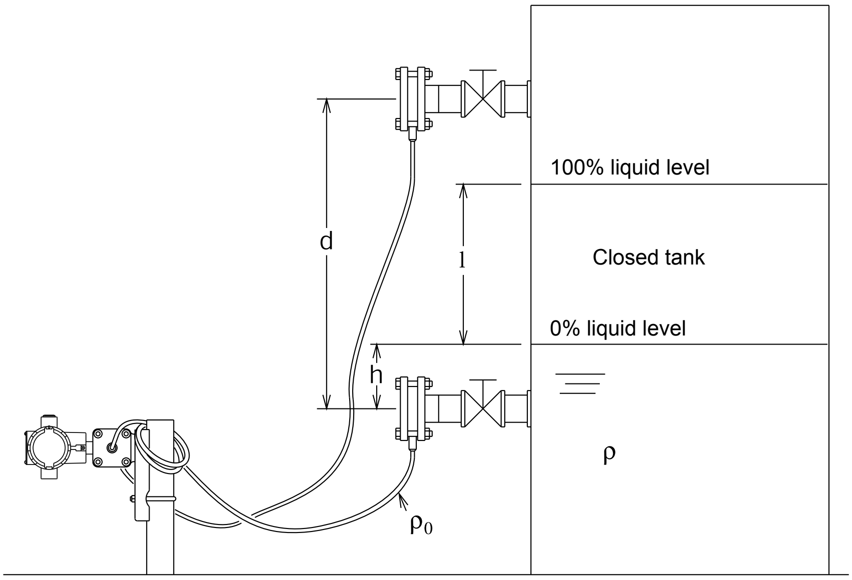


Fig. 3-15. Closed Tank (Wet Leg)

Differential pressure at 0% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $d\ \rho_0$ - $h\ \rho$ = LRV
Differential pressure at 100% liquid level
(Pressure on high-pressure side - Pressure on low-pressure side) = $d\ \rho_0$ - $(l+h)\ \rho$ = URV

Therefore, set the range as follows:
Low limit (LRV): $d\ \rho_0$ - $h\ \rho$, High limit (URV): $d\ \rho_0$ - $(l+h)\ \rho$

Example of calculation:
l = 1500 mm, h = 250 mm, d = 2000 mm, ρ = 0.9, ρ_0 = 0.935

If the above conditions are assumed, the following results are obtained:
Differential pressure at 0% liquid level = (2000 × 0.935) - (250 × 0.9) = 1645 mmH_2O = 16.13 kPa
Differential pressure at 100% liquid level = (2000 × 0.935) - (1500 + 250) × 0.9 = 295 mmH_2O = 2.893 kPa
Therefore, set the range as follows:
Low limit (LRV): 16.13 kPa{1645 mmH_2O}, High limit (URV): 2.893 kPa {295 mmH_2O}

3-9. Indicator (Optional)

3-9-1. Display unit of indicator

The display unit of an indicator consists of the following:

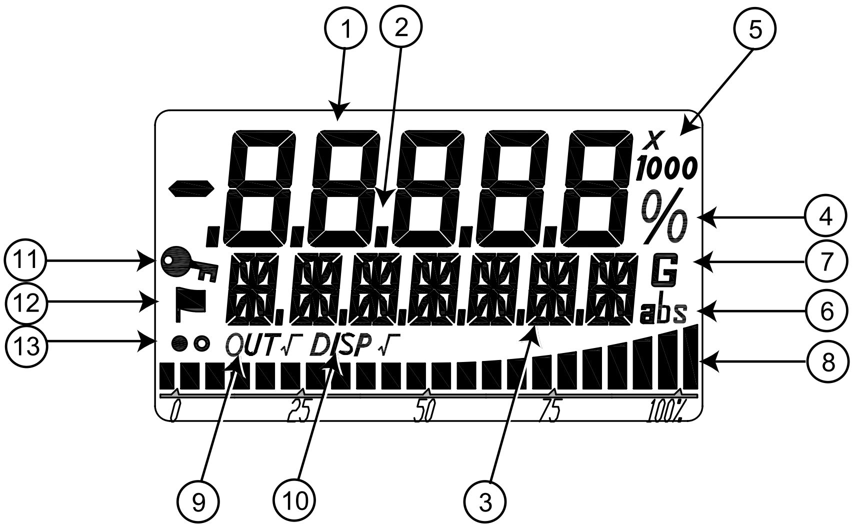


Fig. 3-16. Display unit of indicator

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

Disp. Unit

This is enabled when Display Mode is set to Scale.
Disp. Unit is displayed on the indicator.
Values shown in the table below may be selected.

user_define_unit	mmH_2O	mmAq	mH_2O	inH_2O
ftH_2O	kPa	MPa	Pa	hPa
kPaG	MPaG	kPa_abs	MPa_abs	Pa_abs
hPa_abs	bar	mbar	barG	mbarG
mmHg	inHg	mmHg_abs	inHg_abs	gf/cm^2
kgf/cm^2	g/cm^2	kg/cm^2	kgf/cm^2G	kgf/cm^2_abs
atm	Torr	psi	g/cm^3	kg/m^3
m^3	l	kl	ml/h	l/h
kl/h	Skl/h	Sm^3/h	t/h	m^3/h
km^3/h	Nm^3/h	kNm^3/h	l/min	kl/min
m^3/min	Nml/min	Nl/min	Nm^3/min	kl/d
m^3/d	t/d	Nm^3/d	kg/h	gal/min
gal/h	mm	m	%	t
kg	none			

User define Unit

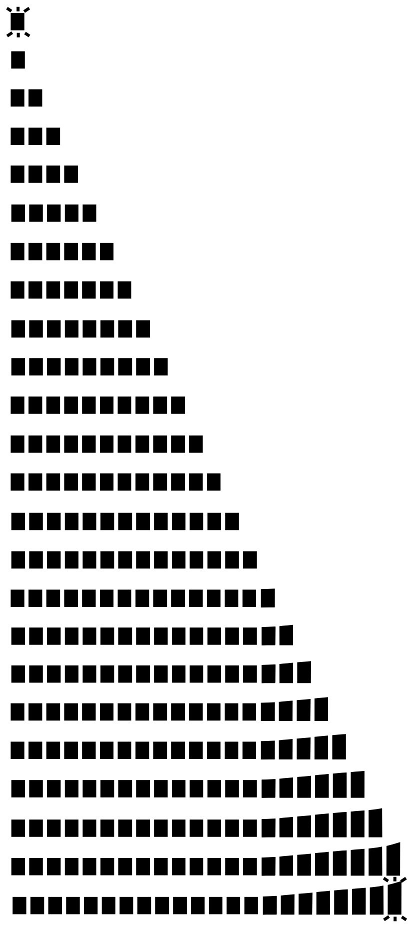
This is enabled when Display Mode is set to Scale.
Available when Disp. Unit is set to User define unit.
Any desired display unit can be set.

3-9-2. Bar Graph Display

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

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

	DISP ≤ -5%	S0 Blinking
-5% <	DISP ≤ 0%	S0 Lit
0% <	DISP ≤ 5%	S0 to S1 Lit
5% <	DISP ≤ 10%	S0 to S2 Lit
10% <	DISP ≤ 15%	S0 to S3 Lit
15% <	DISP ≤ 20%	S0 to S4 Lit
20% <	DISP ≤ 25%	S0 to S5 Lit
25% <	DISP ≤ 30%	S0 to S6 Lit
30% <	DISP ≤ 35%	S0 to S7 Lit
35% <	DISP ≤ 40%	S0 to S8 Lit
40% <	DISP ≤ 45%	S0 to S9 Lit
45% <	DISP ≤ 50%	S0 to S10 Lit
50% <	DISP ≤ 55%	S0 to S11 Lit
55% <	DISP ≤ 60%	S0 to S12 Lit
60% <	DISP ≤ 65%	S0 to S13 Lit
65% <	DISP ≤ 70%	S0 to S14 Lit
70% <	DISP ≤ 75%	S0 to S15 Lit
75% <	DISP ≤ 80%	S0 to S16 Lit
80% <	DISP ≤ 85%	S0 to S17 Lit
85% <	DISP ≤ 90%	S0 to S18 Lit
90% <	DISP ≤ 95%	S0 to S19 Lit
95% <	DISP ≤ 100%	S0 to S20 Lit
100% <	DISP ≤ 105%	S0 to S21 Lit
105% <	DISP	S0 to S20 Lit, S21Blinking



3-9-3. External Zero/Span Adjustment Display

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

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

3-9-4. Square Root Extraction Display

The segments for the square root extraction display are OUT $\sqrt{\ }$ and DISP $\sqrt{\ }$.
Each display lights up or goes out according to the output format and square root extraction display settings of the transmitter.

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

3-9-5. Write Protect Display

The indicator for the write protect display is a key mark.
The key mark lights up or goes out according to the write protect state of the transmitter.
When write protect is ON: The key mark lights up.
When write protect is OFF: The key mark goes out.

3-9-6. Status Record Display

The indicator for the status history display is a flag mark.
The flag mark lights up or goes out according to the presence or absence of status history of the transmitter.
When the status history exists: The flag mark lights up.
When the status history does not exist: The flag mark goes out.

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

3-9-7. Display Update Mark

This mark indicates that the transmitter is working.
The ● and ○ marks alternately blink every 0.5 seconds.

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

3-10. External Zero/Span Adjustment function (Optional)

A transmitter with External Zero/Span adjustment function enables zero/span point adjustment work without using communicator.
Set output to any value corresponding to the pressure input.

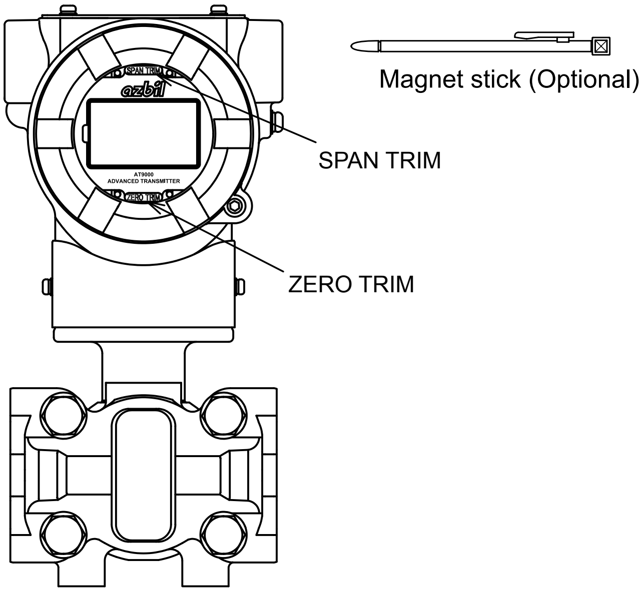


Fig. 3-17.

Procedure differs depending on the S/W version.
The software version is indicated on the nameplate on the main part of the transmitter.

■Procedure for before software version 6.0

How to adjust zero point:

STEP	Procedure
1	Apply the differential pressure that will serve as a reference for 0 % of the range to the transmitter
2	Touch the magnet on the glass at the ZERO TRIM point for 3 seconds or more. And remove it when ammeter reading equals 4 mA.

How to adjust span point:

STEP	Procedure
1	Apply the differential pressure that will serve as a reference 100% of the range to the transmitter.
2	Touch the magnet on the glass at the SPAN TRIM point for 3 seconds or more. And remove it when ammeter reading equals 20 mA.

■Procedure for software version 6.0 or later

How to adjust ZERO point:

STEP	Procedure
1	Apply the differential pressure that will serve as a reference for 0 % of the range to the transmitter.
2	To enable the external zero point adjustment function, touch “ZERO TRIM” 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 point adjustment function will be disabled.
4	With “UNLOCK” displayed, touch “ZERO TRIM” on the glass window with the magnetic stick for 3 seconds or more. The transmitter will be adjusted to output 4 mA. When “ZERO.SET” is displayed, remove the stick from the window to complete zero point adjustment.
5	The external zero point adjustment function is now disabled.

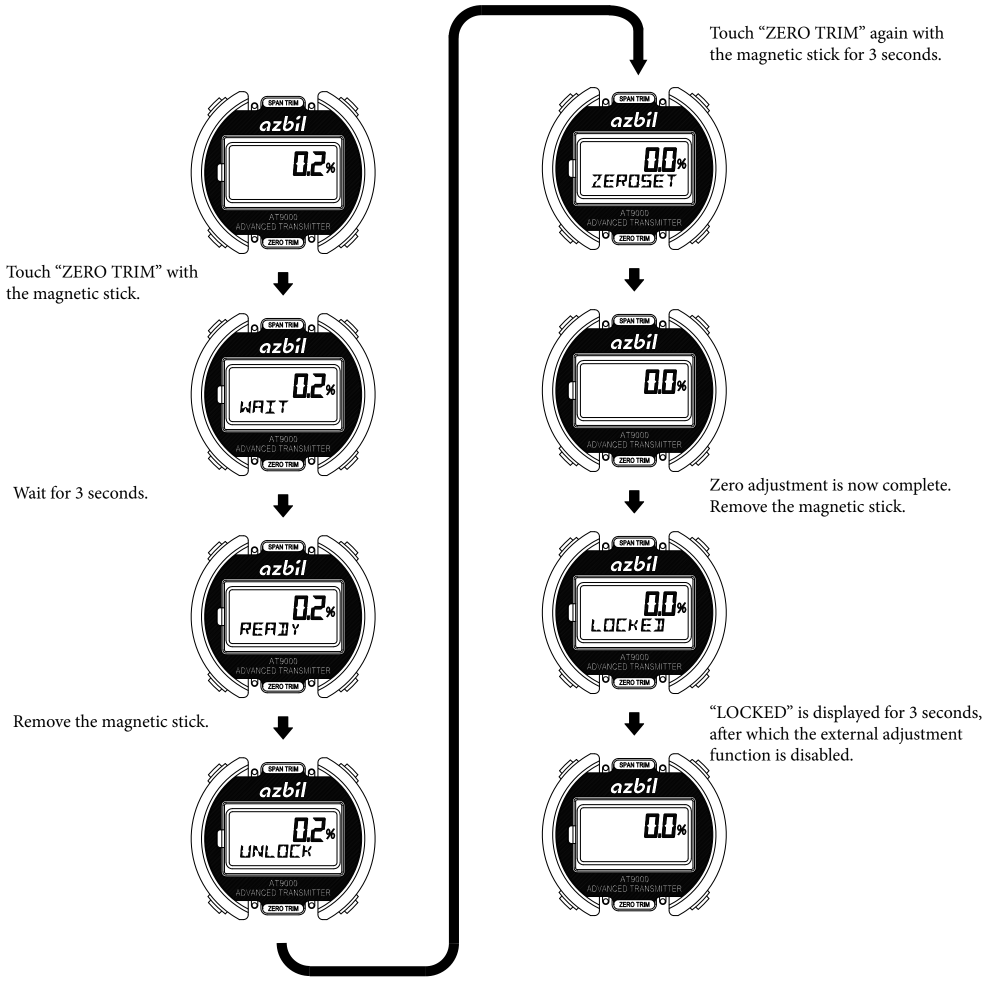


Fig. 3-18.

How to adjust span point:

STEP	Procedure
1	Apply the differential pressure that will serve as a reference 100% of the range to the transmitter.
2	To enable the external span adjustment function, touch “SPAN TRIM” 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 span adjustment function is enabled. With “UNLOCK” displayed, if there is no operation with the magnetic stick for 45 seconds or more, the external span adjustment function will be disabled.
4	With “UNLOCK” displayed, touch “SPAN TRIM” on the glass window with the magnetic stick for 3 seconds or more. The transmitter is adjusted to output 20 mA. When “SPAN.SET” is displayed, remove the stick from the window to complete span adjustment.
5	The external span adjustment function is now disabled.

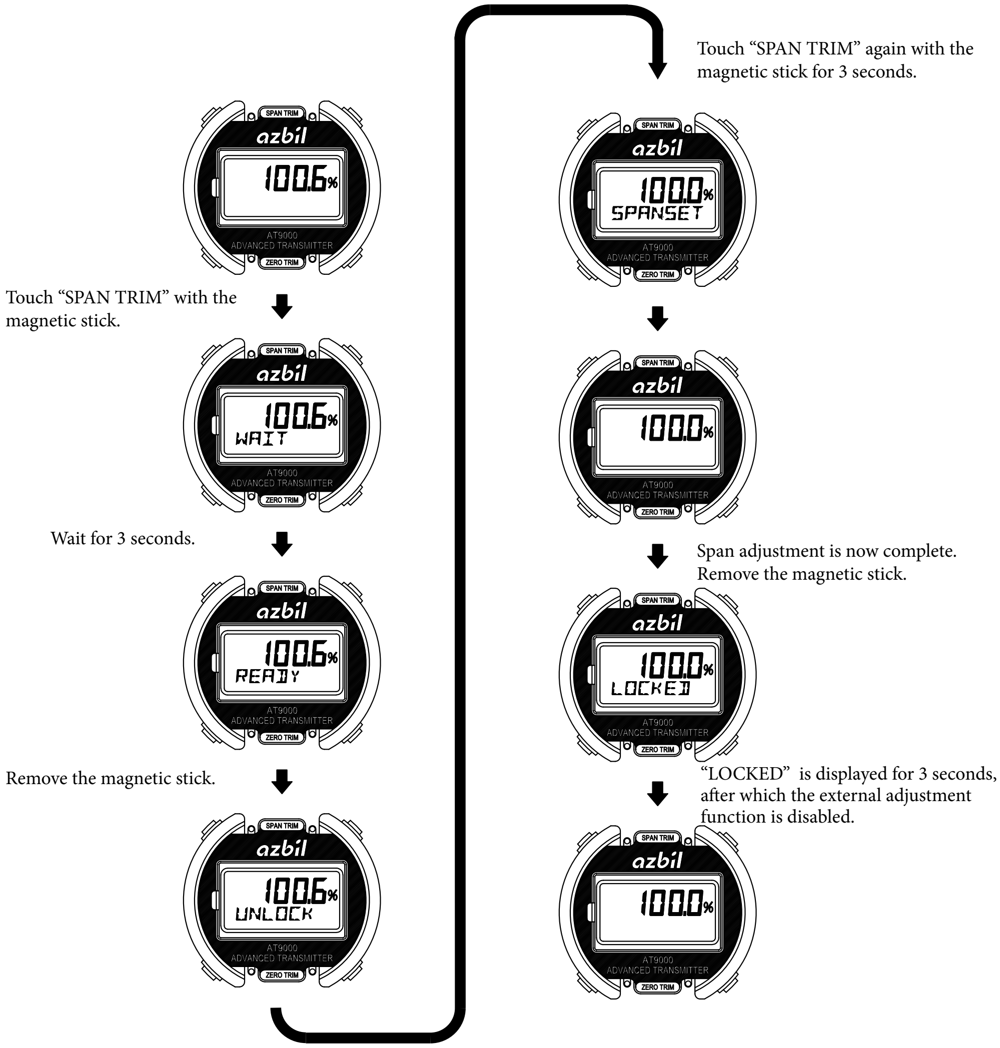


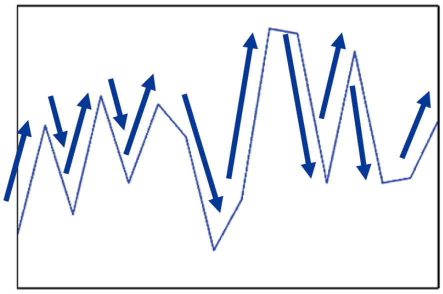
Fig. 3-19.

3-11. Advanced Diagnostics (optional)

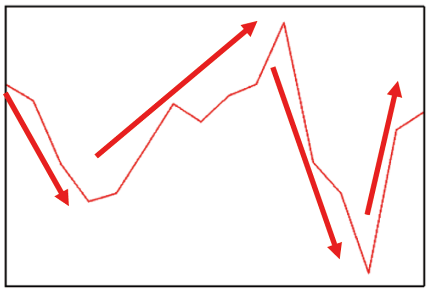
The advanced diagnostics include the pressure frequency index, the standard deviation, and calculation of the out-of-range pressure event count.
The diagnosis also determines whether the pressure frequency index, standard deviation, and the out-of-range pressure event count exceed the threshold values. Users can check alarms on the selfdiagnostics 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-C.
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, “(4) 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 Field Communication Software(Model CFS100) Instruction 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 "Chapter 5. 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 (lowfrequency 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).

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

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, "(4) 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 Field Communication Software(Model CFS100) Instruction 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 “Chapter 5. 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 Field Communication Software(Model CFS100) Instruction 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 selfdiagnostic status. See "Chapter 5. 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

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

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

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

4-1. Disassembly and Assembly

4-1-1. Before You Start

⚠WARNING
• Before removing this product from the process equipment for purposes of maintenance, vent the residual pressure and discharge the residual fluid. When discharging the residual pressure and fluid, check the direction of the vent or drain to prevent injury by the process fluid. Failure to do so may result in burns or other injuries. • If the process fluid contains toxic substances, take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. • Before discharging a process fluid that contains toxic substances, check the direction of discharge and take safety measures such as wearing goggles and a mask to prevent contact with the skin and eyes and to prevent inhalation. Failure to do so is dangerous and may result in physical harm. • To stop transmitter operation for maintenance, see Chapter 3 of this manual and follow the necessary procedures. • If the O-ring attached to the case cover or the terminal cover is damaged or deteriorated, replace it with a new one. If the device is operated with a broken O-ring, since the degree of sealing will be insufficient, internal corrosion may occur, possibly resulting in electric shock from a short circuit or poor device performance. • Never open the case cover while the transmitter is ON or in a hazardous location. • Handle the explosion-proof transmitter with care. It may lose its explosion-proof performance due to corrosion, deformation, damage to the case cover, or damage to a screw or a joined part. • The explosion-proof performance of the special explosion-proof pressure transmitter is not guaranteed unless it is LOCKED. Always tighten the case cover completely, and lock the case cover.

Opening and Closing the case cover

This transmitter has a locking structure. Before opening the case cover, unlock the mechanism using a hexagonal wrench.

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

⚠CAUTION

After closing the case cover, make sure that no dust or rain enters the transmitter case.

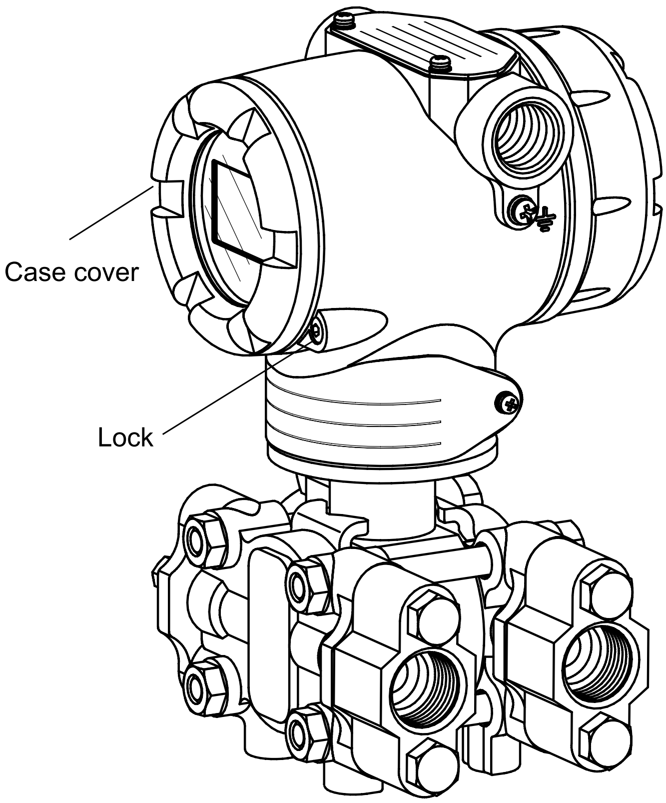


Fig. 4-1. Locking Case Cover

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

Remove covers

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

Remarks:
After removing, handle the center body cover carefully. Avoid damage to the diaphragm.

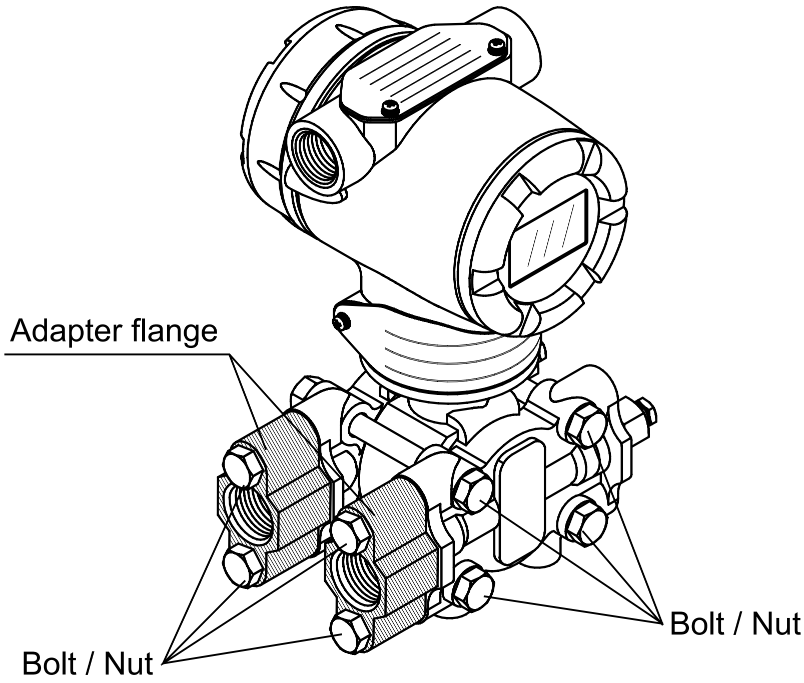


Fig. 4-2. Center Body Cover Fixing Bolts

Mount covers and adapter flanges

When assembling the centers body cover and adapter flanges, tighten the bolts to the following torque.
Replace the seal gasket, if it is damaged.

Table 4-1. Cover Bolts / Nuts and Tightening Torque

If a seal gasket is broken, replace it with a new one. If the device is operated with a broken seal gasket, since the degree of sealing will not be sufficient, the process fluid may spurt out, resulting in burns or other injuries.

Check that the seal gasket is not damaged. If it is, replace it with a new one.

Model No.	Wetted parts material (other than diaphragm)	Bolt / Nut Material	Bolt / Nut tightening torque N·m		
			Cover material Carbon steel / Stainless steel		Cover material PVC
			When new gasket is used	When existing gasket is reused	When new / existing gasket is used
GTX15D	316SST	304SST	15±1	10±1	-
GTX31D GTX41D	316SST ASTM B575	Carbon steel (SNB7)	22±2	17±1	10±1
		630SST			-
		304SST	15±1	10±1	10±1
GTX31D GTX41D GTX71D	Tantalum 316LSST	Carbon steel (SNB7)	22±2	17±1	10±1
		630SST			-
		304SST	15±1	10±1	10±1
GTX32D GTX42D GTX72D	316SST	Carbon steel (SNB7) 630SST	90±20		-
		304SST	55±10		-
GTX60G GTX71G	316SST ASTM B575	Carbon steel (SNB7)	22±2	17±1	10±1
		630SST			-
		304SST	15±1	10±1	10±1
GTX60G GTX71G	Tantalum 316LSST	Carbon steel (SNB7)	22±2	17±1	10±1
		630SST			-
		304SST	15±1	20±1	10±1
GTX82G	316SST ASTM B575	Carbon steel (SNB7) 630SST	90±20		-
		304SST	55±10		-
GTX30A GTX60A	316SST ASTM B575 Tantalum 316LSST	Carbon steel (SNB7) 630SST	22±2	17±1	-
		304SST	15±1	10±1	10±1
GTX35F GTX60F	316SST	Carbon steel (SNB7) 630SST	22±2	17±1	-
		304SST	15±1	10±1	-

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

Bolt / Nut Material	Bolt / Nut tightening torque N·m	
	Adapter flange material Carbon steel / Stainless steel	Adapter flange material PVC
Carbon steel (SNB7)	20±1	7±0.5
630SST		-
304SST	10±0.5	7±0.5

4-1-3. Washing the Center Body

Introduction

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

Rinsing the center body (GTX_ _D/GTX_ _A/GTX_ _G/GTX_ _F)

Rinse the center body using the following procedure:

(1) Remove the hexagon head bolts of the center body and removed the cover.

(2) Wash the diaphragm and the inner surface of the cover with a solvent and a soft brush. Take care not to deform or damage the diaphragm.

(3) In reassembling the center body, replace the cover gasket with a new one as necessary.

(4) Tighten the cover bolts at the specified tightening torque. (Refer to “Table 4-1. Cover Bolts / Nuts and Tightening Torque”)

Remarks related to cold area

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

Maintenance of sensor

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

4-2. Calibrating Set Range and Output Signals

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

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

Preparation

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

Equipment

Prepare the following equipment before calibration:

- Standard pressure generator: Pressure generated must be close to the measurement range of the transmitter.
  Accuracy requirement: ±0.05% F.S. or ± 0.1% setting
- Power supply: 24V DC
- Precision resistance: 250 Ω ± 0.005%
- Voltmeter: Digital voltmeter with accuracy (10V DC range) of ± 0.02% rdg+1 dgt
- Communicator: Field Communication Software(Model CFS100), HART communicator

Calibration conditions

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

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

⚠CAUTION

If damping time constant is set to 0 sec. please adjust another value to keep the output stable before calibration.
Refer to Field Communication Software(Model CFS100) Instruction Manual(HART 5) CM2-CFS100-2003
Field Communication Software(Model CFS100) Instruction Manual(HART 7) CM2-CFS100-2013
HART Communicator Operation Manual(HART 5) CM2-GTX000-2002
HART Communicator Operation Manual(HART 7) CM2-GTX000-2003

Set up for calibration

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

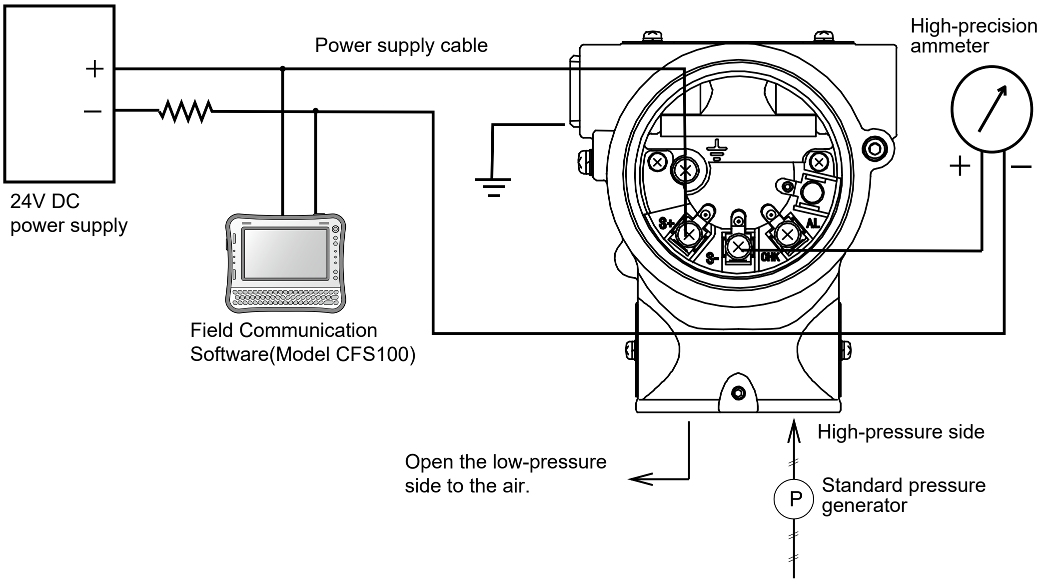


Fig. 4-3. Connection for calibration

Set range

See the operation manuals for the respective communicators.

Field Communication Software(Model CFS100) Instruction Manual

(HART 5)Section 2-6

(HART 7)Section 1-3

Advanced Transmitter HART Communicator Operation Manual

(HART 5)Section 3-2-1

(HART 7)Section 3-2-1

Calibration

See the operation manuals for the respective communicators.

Field Communication Software(Model CFS100) Instruction Manual

(HART 5)Section 4-2

(HART 7)Section 3-2

Advanced Transmitter HART Communicator Operation Manual

(HART 5)Section 3-2-8

(HART 7)Section 3-3-2

4-2-2. Calibrating Output Signals

Preparation

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

Equipment

- High-precision ammeter with accuracy of 0.03% FS or higher
- Resistor with a resistance of 250Ω ±0.005%
- Communicator

Set-up

Refer to Fig. 4-4. Connect the Communicator and an ammeter.

Check to ensure proper wiring. Check that the HART communicator and the transmitter are in the normal communication status.

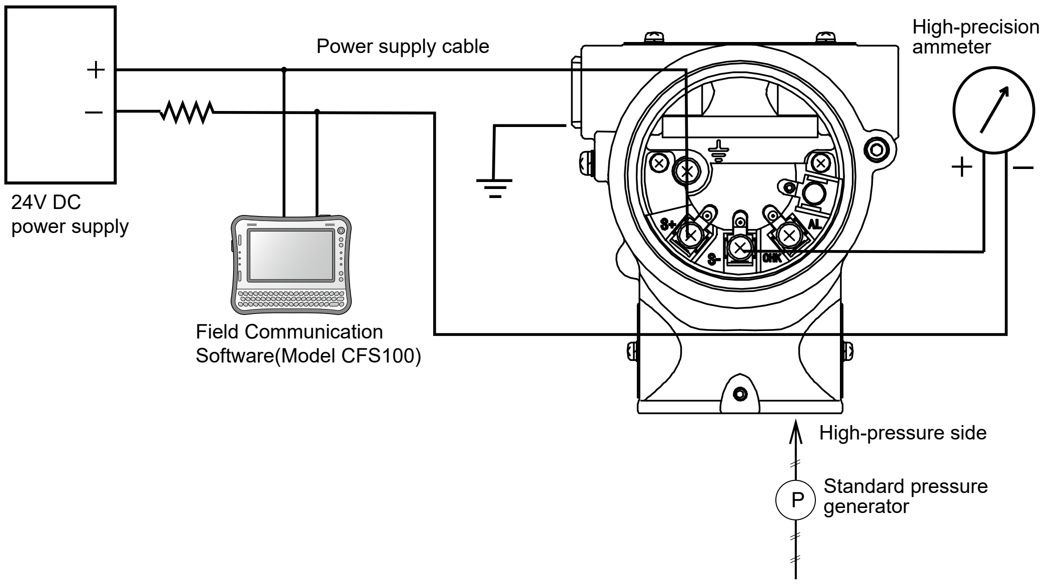


Fig. 4-4. Connection for Calibration.

Calibrating Analog Output Signal

See the operation manuals for the respective communicators.

Field Communication Software(Model CFS100) Instruction Manual

(HART 5)Section 4-2

(HART 7)Section 3-2

Advanced Transmitter HART Communicator Operation Manual

(HART 5)Section 3-2-8

(HART 7)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) Operation 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) Operation 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. Diagnostics Display Message Details

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.
	In Output Mode	The device is operating in Output Mode.
	Meter Body Overload or Fault	"The input pressure is more than two times the upper range limit for the device. Or, Device error"
	Correct Reset	Clears the calibration data.
	External Zero/Span Adjustment Fault	An error occurred during external adjustment of the zero point or span.
	Failure Alarm Simulation Mode	The device is operating in Failure Alarm Simulation Mode.
	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.

HART7

	Diagnostics Display Message	Description
Failure	Analog/Digital Conversion Failure	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
	Invalid Database	Configuration data and/or calibration data is invalid.
Function Check	In Output Mode	The device is operating in Output Mode.
	Failure Alarm Simulation Mode	The device is operating in Failure Alarm Simulation Mode.
Out of Specification	Meter Body Over Temperature	Meter Body Over Temperature
	Meter Body Overload or Failure	Meter Body Overload or Failure
	High Output Alarm	High Output Alarm
	Low Output Alarm	Low Output Alarm
	High Sensor Temp. Alarm	High Sensor Temp. Alarm
	Low Sensor Temp. Alarm	Low Sensor Temp. Alarm
Maintenance Required	External Zero/Span Adjustment Failure	External Zero/Span Adjustment Failure
	Excess Zero Calibration Value	Excess Zero Calibration Value
	Excess Span Calibration Value	Excess Span Calibration Value
	Not Calibrated	Not Calibrated
	Pressure Frequency Index Alarm	Pressure Frequency Index Alarm
	Standard Deviation Alarm	Standard Deviation Alarm
	Out-of-Range Count Alarm	Out-of-Range Count Alarm

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) Operation 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

Chapter 5. Troubleshooting

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

If a fault is judged to be "Internal data inconsistency" or "Critical failure", the output of the transmitter goes to the high or low limit, according to the code selected for Failure Alarm.

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.	
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 Detected	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.

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	
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	

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

Phenomenon	Measures
Nothing appears on the display.	• Make sure the power supply voltage is correctly applied. • Make sure the wire connection of the power supply is provided.
Output remains zero and does not change.	• Make sure the settings are correct. • Make sure the flow rate is within the low flow cut range. • Make sure the pipes are not blocked.
Output is out of alignment.	• Make sure that no fluid is leaking from the pipes. • Make sure the fluid is not flowing backward. • Make sure the connection direction of the HP and LP sides is correct. • Make sure the transmitter is not set at a tilt.

Also check the following points.·

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

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

Appendix-A. Supplement Manual for Field Communication Software (Model CFS100)

A-1. Overview

A-1-1. Introduction

Field Communication Software(Model CFS100) is a tool for communicating with Azbil Corporation's smart field devices (e.g. the Differential Pressure Transmitter) that enables configuration of device settings. It is a software product that operates on Windows PCs. Field Communication Software(Model CFS100) with Azbil Corporation's smart field devices using a USB interface connected to a Windows PC, which is then connected by communications cable to the USB port of a device.

Field Communication Software(Model CFS100) supports Azbil Corporation's proprietary SFN/DE communication protocol as well as the HART communication protocol.

For information on the specifications common to all types of devices and information on how to install Field Communication Software(Model CFS100), please refer to the main Field Communication Software(Model CFS100) Operation Manual. Before reading this manual, make sure that you read the main Field Communication Software(Model CFS100) Operation Manual thoroughly.

A-1-2. Important Notes

* When changing connected devices

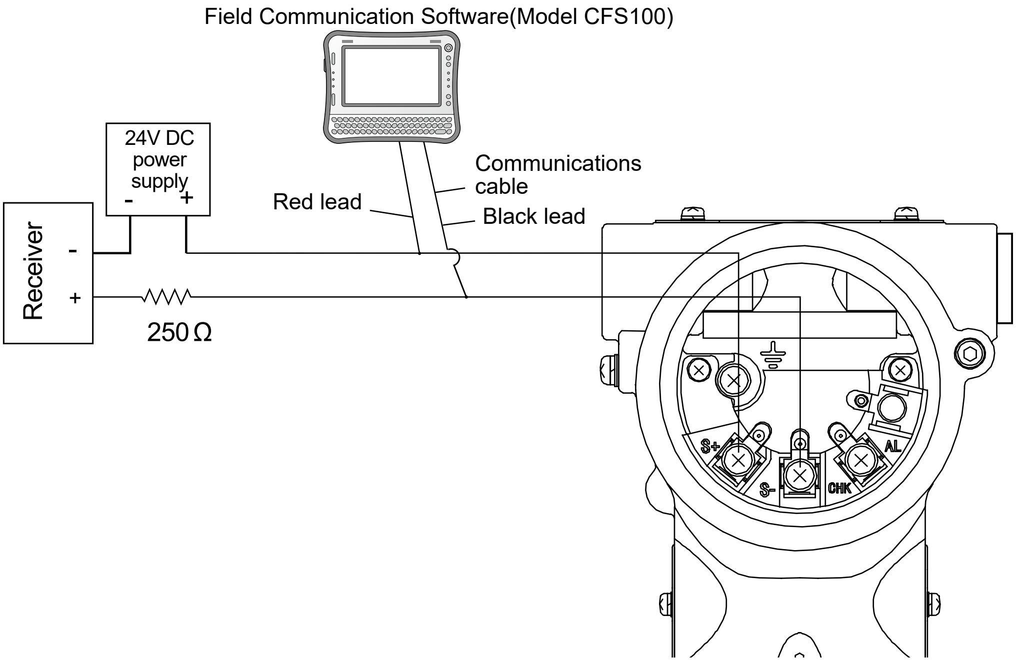
  Field Communication Software(Model CFS100) continues communicating with the device when displaying dynamic values, such as pressure, so that it can continuously update these values. If you remove the communications cable to change the device during this communication, an error will occur.
  Exit Field Communication Software(Model CFS100) before detaching the communications cable from the device, and then start Field Communication Software(Model CFS100) again after connecting the communications cable to the new device.

* The use of SFN communication changes the transmission signal, so be sure to switch the process control loop to manual mode beforehand.
* For known troubleshooting issues, refer to section 7.4 of CM2-CFS100-2001, the common edition manual.

A-2. How to Connect the Field Communication Software(Model CFS100)

Please see “Fig. A-1. Wiring for connection with Model GTX” for instructions on connecting Field Communication Software(Model CFS100).

Note : Do not connect two or more communicators at the same time.



Note : Always connect the communications cable to the loop wiring as follows:

Always connect

Red lead: S+ terminal

Black lead: S- terminal

Fig. A-1. Wiring for connection with Model GTX

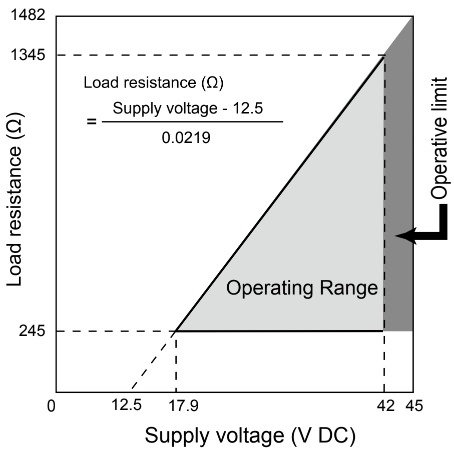


Fig. A-2. Supply voltage vs. load resistance

Appendix-B. Default damping time constant

Unless specified in ordering information, the damping time constant is according to the following table.

Model	Measuring span	Calibration span (x) /Default damping time constant		
		4sec	2sec	1sec
GTX15D	0.1 to 2kPa	-	0.1 ≤ x ≤ 2kPa	-
GTX30D/31D/32D	0.5 to 100kPa	0.5 ≤ x < 2.5kPa	2.5 ≤ x < 5kPa	5kPa ≤ x
GTX40D/41D/42D	35 to 700kPa	35 ≤ x < 45kPa	45 ≤ x < 90kPa	90kPa ≤ x
GTX71D/72D	0.25 to 14MPa	0.25 ≤ x < 0.7MPa	0.7 ≤ x < 1.4MPa	1.4MPa ≤ x
GTX60G	17.5 to 3500kPa	17.5 ≤ x < 80kPa	80 ≤ x < 210kPa	210kPa ≤ x
GTX71G	0.7 to 14MPa	-	0.7 ≤ x < 1.4MPa	1.4kPa ≤ x
GTX82G	0.7 to 42MPa	-	0.7 ≤ x ≤ 1MPa	1MPa ≤ x
GTX30A	4 to 104kPa	-	4 ≤ x < 5kPa	5kPa ≤ x
GTX60A	35 to 3500kPa	35 ≤ x < 80kPa abs	80k ≤ x < 210kPa	210kPa ≤ x
GTX35F	2.5 to 100kPa	-	2.5 ≤ x < 5kPa	5kPa ≤ x
GTX60F	35 to 3500kPa	35 ≤ x < 80kPa	80 ≤ x < 210kPa	210kPa ≤ x
GTX35R	2.5 to 100kPa	-	2.5 ≤ x < 5kPa	5kPa ≤ x
GTX40R	35 to 700kPa	35 ≤ x < 45kPa	45 ≤ x < 90kPa	90kPa ≤ x
GTX35U	2.5 to 100kPa	-	2.5 ≤ x < 5kPa	5kPa ≤ x
GTX60U	35 to 3500kPa	35 ≤ x < 80kPa	80 ≤ x < 210kPa	210kPa ≤ x
GTX71U	0.7 to 10MPa	-	0.7 ≤ x < 1.4MPa	1.4kPa ≤ x
GTX82U	0.7 to 42MPa	-	0.7 ≤ x < 1MPa	1MPa ≤ x
GTX30S	4 to 104kPa	-	4 ≤ x < 5kPa	5kPa ≤ x
GTX60S	35 to 3500kPa	35 ≤ x < 80kPa	80 ≤ x < 210KPa	210kPa ≤ x

Appendix-C. 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 C-1 of Appendix-C describes the principle behind the diagnosis of clogging in the connecting pipe. Read this section first.
Sections C-2-4 describe how to configure the diagnostic functions by transmitter and application type.

- When measuring the pressure using a pressure gauge, see section C-2.
- When measuring the differential pressure and flow rate using the differential pressure gauge, see section C-3.
- When measuring the level, see section C-4.

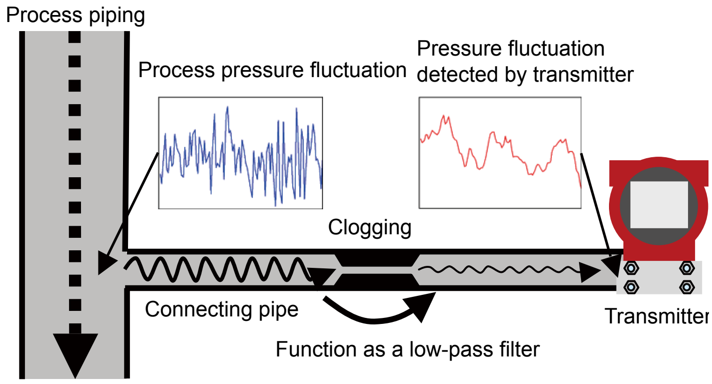
Section C-5 provides a supplemental description of parameters related to the diagnosis of clogging.

C-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.

C-2. Configuration using a pressure gauge

C-2-1. 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.

C-2-2. 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.

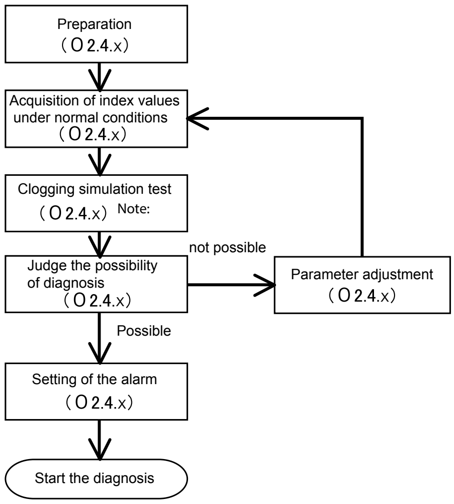
If the frequency of pressure fluctuation is abnormal from the beginning, as is a case where the connecting pipe was clogged from the start, it may not be possible to diagnose the clogging. Do the setup procedures (C-2–4) when the connecting pipe is operating normally.

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.

C-2-3. 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 C-2-4-1): Initialize the parameters in preparation for obtaining the index values.
Acquisition of index values under normal conditions (see section C-2-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.
Clogging simulation test (see section C-2-4-3): 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 C-2-4-3 to C-2-4-6, and then read section C-2-4-7.

Judging the possibility of diagnosis (see section C-2-4-4): 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 C-2-4-5): 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 C-2-4-6): 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.

C-2-4. Configuration procedures

This section describes the configuration procedures in order.

C-2-4-1. 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).

C-2-4-2. 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.

C-2-4-3. 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.

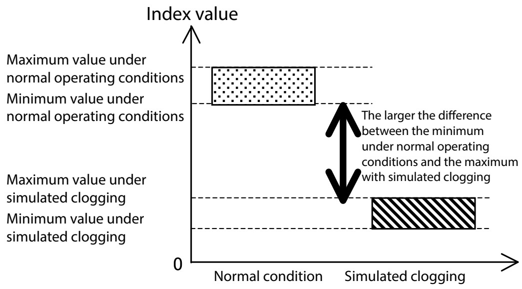
(5) Obtain the values for Standard Deviation, Standard Deviation Min, and Standard Deviation Max as reference values, and record them.

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.

C-2-4-4. 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 C-2-4-2) and under a simulated clogged condition (section C-2-4-3).

<table>
<tr><th colspan="2">Judgment criteria</th></tr>
<tr><td>• 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.

</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 C-2-4-5 and set the diagnostic alarm.

If diagnosis is judged to be not possible, go to section C-2-4-6 and consider parameter adjustment.

⚠CAUTION

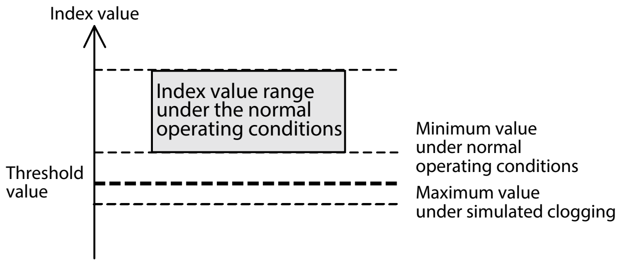
The position of a clog may affect the amount of variation of the pressure frequency index. In particular, if the fluid is a compressible fluid or gas, the effect can be significant. In such a case, if clogging is closer to the process side, the amount of variation will be greater. Therefore, when the 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.

C-2-4-5. 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.

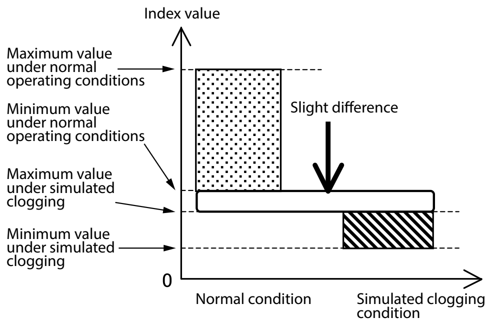
C-2-4-6. Parameter adjustment

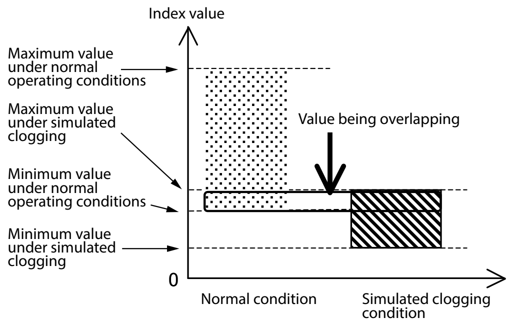
If diagnosis is judged to be not possible, the data collected under normal operating conditions (section C-2-4-2) and when there is simulated clogging (section C-2-4-3) can be analyzed and the parameters adjusted.
The reason why diagnosis cannot be performed is that the index value—even under normal 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.



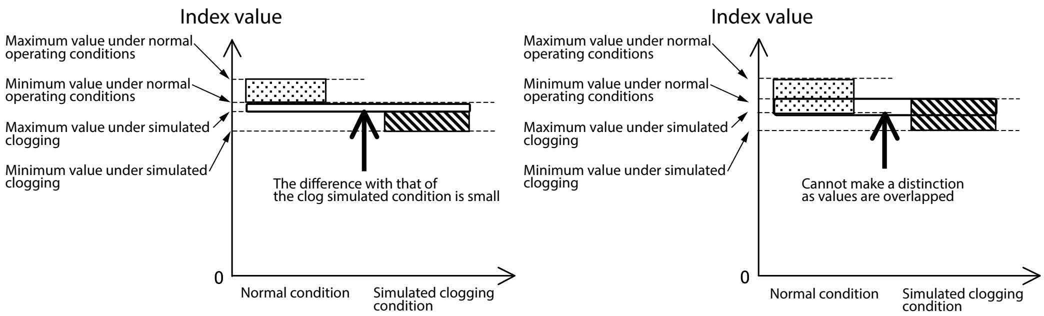


In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

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.

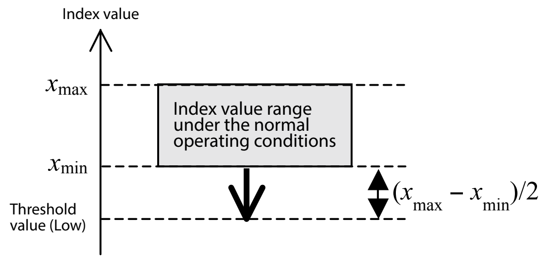
In this case, although variation in the index is relatively small under normal operating conditions, the value of the index is almost the same as with simulated clogging, as shown in the figure below. In this case, the index value under normal operating conditions is similar to that with clogging, or 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.

C-2-4-7. 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 C-2-4-2) 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.

C-3. Setting using a differential pressure gauge

C-3-1. 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.

C-3-2. 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 A-3-4-3.

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.

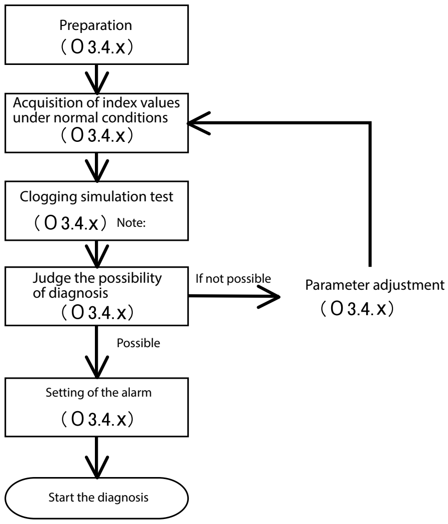
If the frequency of pressure fluctuation is abnormal from the beginning, as is a case where the connecting pipe was clogged from the start, it may not be possible to diagnose the clogging. Do the setup procedures (section C-3-4) when the connecting pipe is operating normally.

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.

C-3-3. 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 C-3-4-1): Initialize the parameters in preparation for obtaining the index values.
Acquisition of index values under normal conditions (see section C-3-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.
Clogging simulation test (see section C-3-4-3): 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 C-3-4-3 to C-3-4-7, and go to section C-3-4-8.

Judging the possibility of diagnosis (see section C-3-4-4): 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 C-3-4-5): 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 C-3-4-6 and C-3-4-7): 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.

C-3-4. Configuration procedures

This section describes the configuration procedures in order.

C-3-4-1. 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).

C-3-4-2. 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.

C-3-4-3. 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.

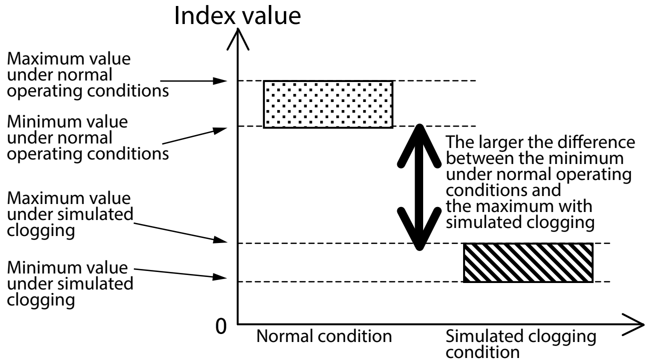
If there are multiple operating conditions and the index value under normal operating conditions varies depending on the operating conditions, it is recommended that the steps described above be repeated under each operating condition.

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.

C-3-4-4. 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 C-3-4-2) and under a simulated clogged condition (section C-3-4-3)

(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.

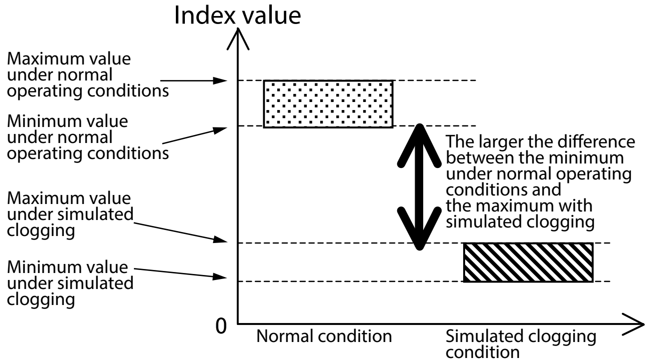
If diagnosis is judged to be possible, go on to the next step and judge the possibility of one-side clogging diagnosis.

If diagnosis is judged to be not possible, go to section C-3-4-6 and consider parameter adjustment.

(B) Judging the possibility of one-side clogging diagnosis

<table>
<tr><th colspan="2">Judgment criteria</th></tr>
<tr><td>

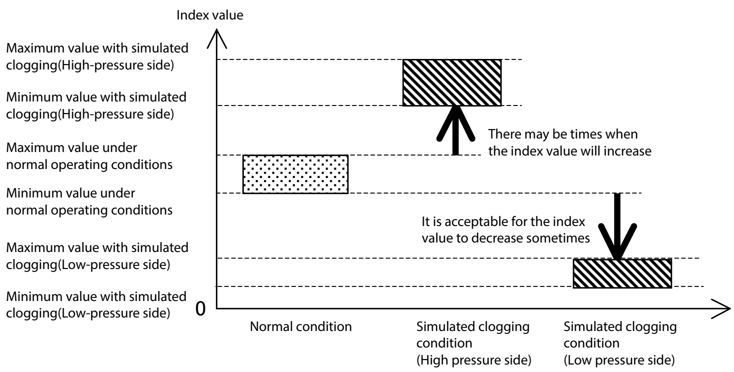
- The maximum value in either the one-side clogging simulation state on the high pressure or low pressure side is smaller than the minimum value under normal operating conditions.
- The difference between the minimum under normal operating conditions and the maximum with simulated clogging is equivalent 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>

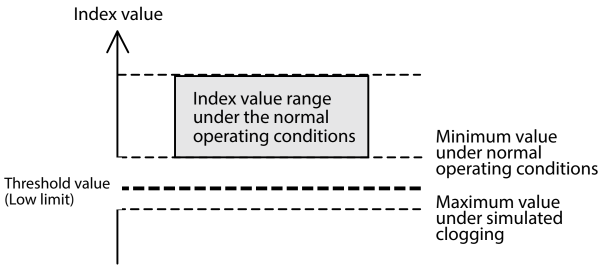
If the diagnosis is judged to be possible, go to section C-3-4-5 and set the diagnostic alarm.
If only the one-side diagnosis is judged to be not possible, go to section C-3-4-7 and change the settings to enable easier detection of one-side clogging, or set only both-side clogging for the diagnosis target, and then set the diagnosis alarm as described in section C-3-4-5.

C-3-4-5. 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 C-3-4-4
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.

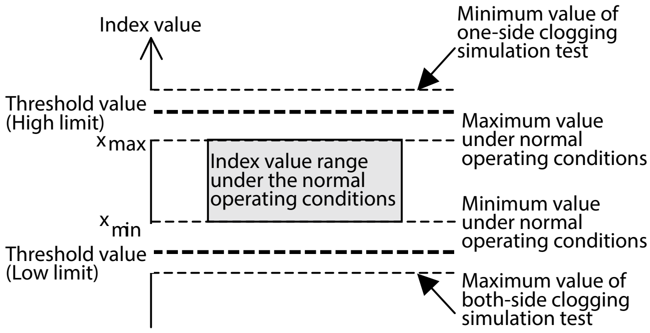


After determining the threshold value, follow the steps below to set the alarm and start the diagnosis.

◆ 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 C-3-4-4
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.

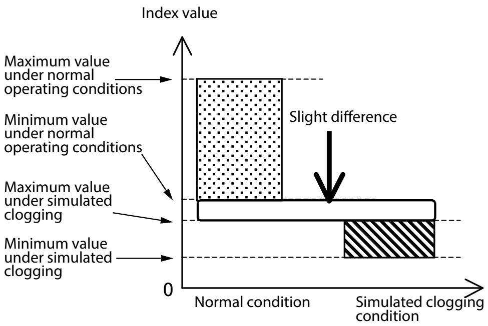
C-3-4-6. Parameter adjustment (for both-side clogging diagnosis)

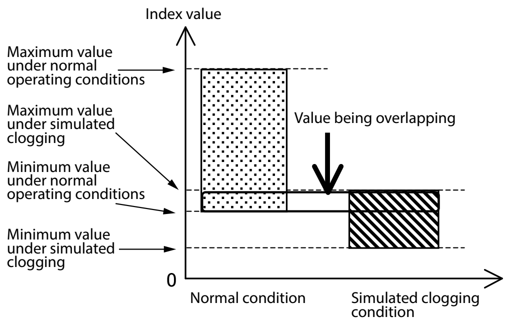
If both-side clogging diagnosis is judged to be not possible, the data that is collected under normal operating conditions (section C-3-4-2) and when there is simulated clogging (C-3-4-3) can be analyzed and the parameters adjusted. The reason why diagnosis cannot be performed is that the index value—even 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.



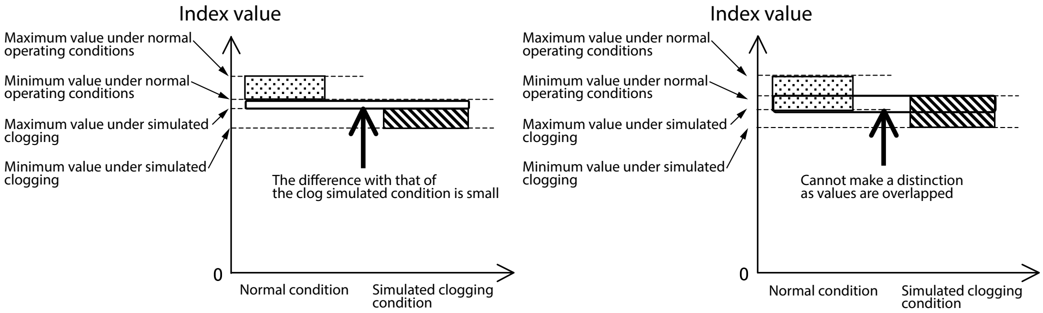


In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

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.

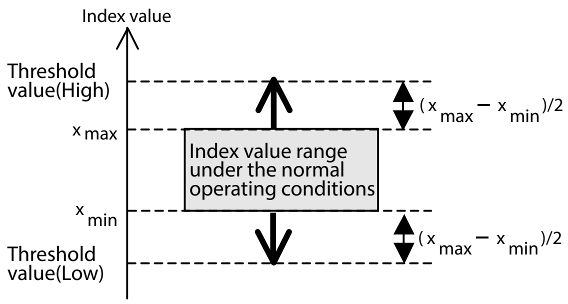
Guidelines for parameter adjustment	
Phenomenon	**Adjustment**
Since the process variable fluctuates and there is always low-frequency pressure fluctuation, the value of the index is small even under normal operating conditions. The standard deviation is relatively large.	Decrease the Press Freq Filter 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.

C-3-4-7. 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 C-3-4-1, and obtain the index value under normal operating conditions again. Since the data collected so far cannot be used, follow sections C-3-4-1 to C-3-4-4 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 C-3-4-5.

C-3-4-8. 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 C-3-4-2) 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.
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.

C-4. Setting using a level meter

C-4-1. 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.

C-4-2. 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.

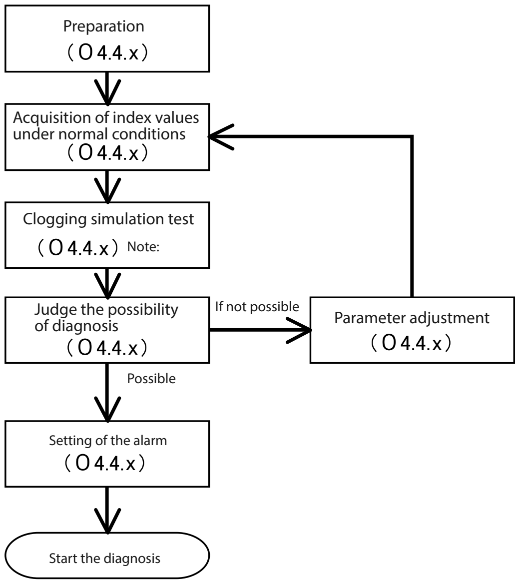
Variation in the pressure frequency index does not always mean that clogging in the connecting pipe has occurred. The index may vary due to other factors, such as the following.

- 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 (C-4–4) 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.

C-4-3. 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 C-4-4-1): Initialize the parameters in preparation for obtaining the index values.

Acquisition of index values under normal conditions (see section C-4-4-2): Obtain index values under normal conditions, and also the maximum and minimum index values.

Clogging simulation test (see section C-4-4-3): 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 C-4-4-3 to C-4-4-6, and then read section C-4-4-7.

Judging the possibility of diagnosis (see section C-4-4-4): 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 C-4-4-5): 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 C-4-4-6): 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.

C-4-4. Configuration procedures

This section describes the configuration procedures in order.

C-4-4-1. 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).

C-4-4-2. 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.

C-4-4-3. 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.

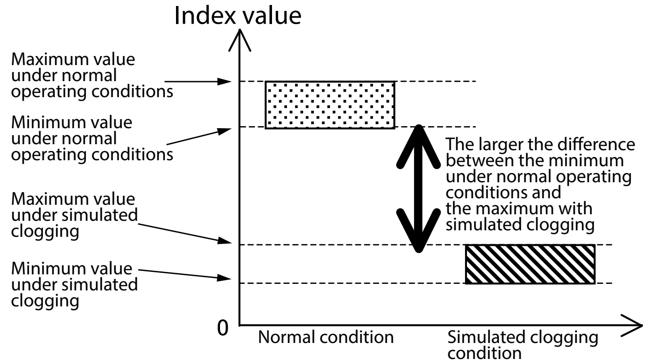
◆ **Procedure** ◆

(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.

C-4-4-4. 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 C-4-4-2) and under a simulated clogged condition (section C-4-4-3).

<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 C-4-4-5 and set the diagnostic alarm. If diagnosis is judged to be not possible, go to section C-4-4-6 and consider parameter adjustment.

⚠CAUTION

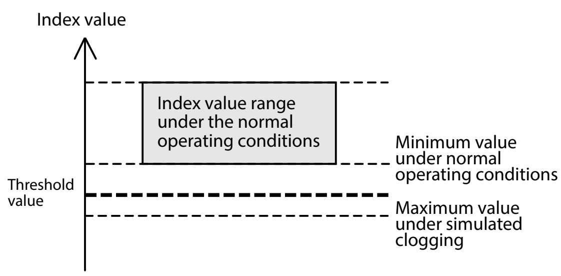
The position of a clog may affect the amount of variation of the pressure frequency index. In particular, if the fluid is a compressible fluid, the effect can be significant. In such a case, if clogging is closer to the process side, the amount of variation will be greater. Therefore, when the position 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.

C-4-4-5. 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.

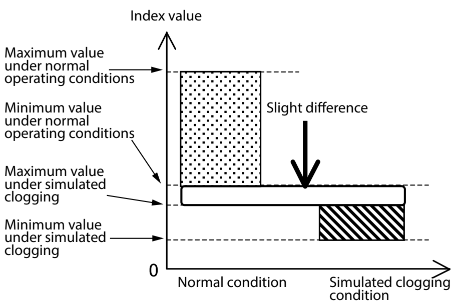
C-4-4-6. Parameter adjustment

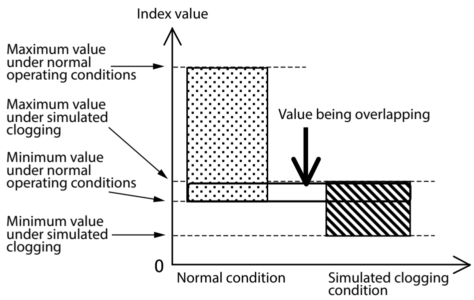
If diagnosis is judged to be not possible, the data collected under normal operating conditions (section C-4-4-2) and when there is simulated clogging (section C-4-4-3) can be analyzed and the parameters adjusted. The reason why diagnosis cannot be performed is that the index value—even under normal 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.

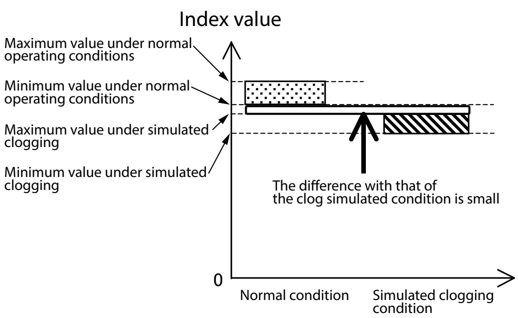


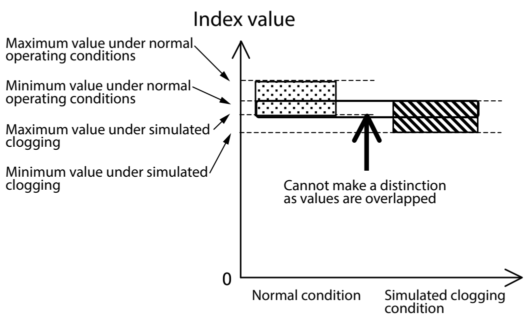


In this case, it is necessary to examine the cause of the large variation that occurs under normal conditions, and to reduce this effect. Use the following the guidelines for adjustment.

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.



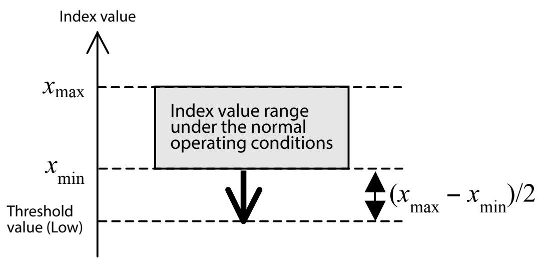


In this case, the index value under normal operating conditions is similar to that with clogging, or the index value is almost the same even when clogging occurs. In either case, it is necessary to examine the cause and to minimize this effect. Use the following guidelines for adjustment.

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.

C-4-4-7. 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 C-4-4-2) 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.

C-5. 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 C-2 to C-4.

C-5-1. 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).

$$F_{cut} = \frac{1}{2\pi Ts} \cos^{-1}\left(1 - \frac{c^2}{2\,(c+1)}\right)$$

$$T_{cut} = \frac{2\pi Ts}{\cos^{-1}\left(1 - \frac{c^2}{2\,(c+1)}\right)}$$

C-5-2. 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

C-5-2-1. 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 “C-1. 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.

C-5-2-2. 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-D.
General Specifications

D-1. Measuring Span / Setting Range / Working Pressure Range

Table D-1. GTR _ _ D

Model	Measuring Span	Measuring Range	Working Pressure Range
GTX15D	0.1 to 2 kPa	-1 to 1 kPa	-70 to 210 kPa
GTX30D	0.5 to 100 kPa	-100 to 100 kPa	2kPa abs to 3.5MPa (Note 1)
GTX31D	0.5 to 100 kPa	-100 to 100 kPa	2kPa abs to 21 MPa (Note 1, 2, 3)
GTX32D	0.5 to 100 kPa	-100 to 100 kPa	2kPa abs to 42 MPa (Note 3, 4)
GTX40D	35 to 700 kPa	-100 to 700 kPa	-70 to 210 kPa (Note 1)
GTX41D	35 to 700 kPa	-100 to 700 kPa	-70 to 210 kPa (Note 1, 2, 3)
GTX42D	35 to 700 kPa	-100 to 700 kPa	-70 to 210 kPa (Note 3, 4)
GTX71D	0.25 to 14 MPa	-0.1 to 14 MPa	-70 to 210 kPa (Note 1, 2, 3)
GTX72D	0.25 to 14 MPa	-0.1 to 14 MPa	-70 to 210 kPa (Note 3, 4)

Notes:
1. With PVC wetted parts, the maximum working pressure is 1.5 MPa.
2. With 304 SST bolts and nuts, the maximum working pressure is 10MPa.
3. For vacuum pressure, see Fig. D-2.
4. With 304 SST bolts and nuts, the maximum working pressure is 23 MPa.

Table D-2. GTR _ _ G

Model	Measuring Span	Measuring Range	Overload Resistance Pressure
GTX60G	17.5 to 3500 kPa	-100 to 3500 kPa (Note 1, 4)	5250 kPa
GTX71G	0.7 to 14 MPa	-0.1 to 14 MPa (Note 2, 4)	21 MPa
GTX82G	0.7 to 42 MPa	-0.1 to 42 MPa (Note 3, 4)	63 MPa

Notes:
1. With PVC wetted parts, the maximum working pressure is 1.5 MPa.
2. With 304 SST bolts and nuts, the maximum working pressure is 10MPa.
3. With 304 SST bolts and nuts, the maximum working pressure is 23 MPa.
4. For vacuum pressure, see Fig. D-2, D-3, and D-4.

Table D-3. GTR _ _ A

Model	Measuring Span	Setting Range	Working Pressure Range	Overload Resistance Pressure
GTX30A	4 to 104 kPa abs.	0 to 104 kPa abs.	0.01 to 104 kPa abs. (Note 1)	294 kPa abs.
GTX60A	35 to 3500 kPa abs.	0 to 3500 kPa abs.	0.01 to 3500 kPa abs. (Note 1, 2)	5250 kPa abs.

Notes:
1. For vacuum pressure, see Fig. D-5.
2. With PVC wetted parts, the maximum working pressure is 1.5 MPa.

Table D-4. GTR _ _ F

Model	Measuring Span	Measuring Range	Working Pressure Limit
GTX35F	2.5 to 100 kPa	-100 to 100 kPa	Lesser of flange rating or 10 MPa (Note 1)
GTX60F	35 to 3500 kPa	-100 to 3500 kPa	

Note: 1. For vacuum pressure, see Fig. D-2.

Table D-5. GTR _ _ R

Model	Measuring Span	Measuring Range	Working Pressure Limit
GTX35R	2.5 to 100 kPa	-100 to 100 kPa	Lesser of flange rating or 10 MPa (Note 1)
GTX40R	35 to 700 kPa	-100 to 700 kPa	

Note: 1. For vacuum pressure, see Fig.D-7, D-8, D-9, and D-10.

Table D-6. GTR _ _ U

Model	Measuring Span	Measuring Range	Working Pressure	Overload Resistance Pressure
GTX35U	2.5 to 100 kPa	-100 to 100 kPa	-100 to 100 kPa	15 MPa
GTX60U	17.5 to 3500 kPa	-100 to 3500 kPa	Lesser of flange rating or 3500 kPa (Note 1)	5250 kPa
GTX71U	0.7 to 10 MPa	-0.1 to 10 MPa	Lesser of flange rating or 10 MPa (Note 1)	15 MPa
GTX82U	0.7 to 42 MPa	-0.1 to 42 MPa	Lesser of flange rating or 42 MPa (Note 1)	63 MPa

Note: 1. For vacuum pressure, see Fig.D-7, D-8, D-9, and D-10.

Table D-7. GTR _ _ S

Model	Measuring Span	Setting Range	Working Pressure	Overload Resistance Pressure
GTX30S	4 to 104 kPa abs.	0 to 104 kPa abs.	0.13 to 104 kPa abs (Note 1)	294 kPa abs.
GTX60S	35 to 3500 kPa abs.	0 to 3500 kPa abs.	0.13 to lesser of flange rating or 3500 kPa (Note 1)	5250 kPa abs.

Note: 1. For vacuum pressure, see Fig.D-9 and D-10.

D-2. Supply Voltage and Load Resistance

Supply Voltage: 17.9 to 42V DC
Load Resistance: 250 Ω or more necessary between loops. See Fig. D-1.

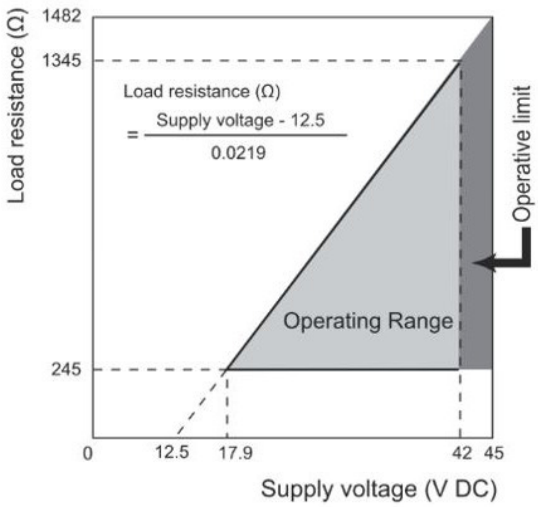


Fig. D-1. Supply voltage vs. load resistance characteristics

Note: For communication with communicator, a load resistance of 250 Ω or more is necessary.

D-3. Output

Analog Output

4 to 20 mA DC with DE protocol, or
4 to 20 mA DC with HART5 protocol, or
4 to 20 mA DC with HART7 protocol

Output Range

3.6 to 21.6 mA, or
3.8 to 20.5 mA (NAMUR NE43 compliant) or

Failure Alarm

Upper: 21.6 mA or more
Lower: 3.6 mA or less

Digital Output

FOUNDATION Fieldbus

Alarm output

Contact output

D-4. Enclosure Type

NEMA 3 and 4X
IEC 60529 IP66/IP67

D-5. Ambient Temperatures

GTX30D/31D/40D/41D/71D/60G/71G/30A/60A (not including Direct Mount)

Normal Operating Range: -40 to 85°C
Operative Limits: -50 to 93°C
Transportation and storage conditions: -50 to 85°C

GTX32D/42D/72D

Normal Operating Range: -15 to 85°C
Operative Limits: -20 to 93°C
Transportation and storage conditions: -15 to 85°C

GTX15D

Normal Operating Range: -15 to 65°C (See Fig.D-2)
Operative Limits: -40 to 70°C (See Fig.D-2)
Transportation and storage conditions: -15 to 65°C

GTX60G (Direct Mount)

Normal Operating Range: -40 to 85°C
Operative Limits: -40 to 85°C
Transportation and storage conditions: -40 to 85°C

GTX71G (Direct Mount)

Normal Operating Range: -25 to 70°C
Operative Limits: -40 to 85°C
Transportation and storage conditions: -40 to 85°C

GTX35F/60F (not including Sanitary Models), **GTX82U** (G1-1/2 Button)

Normal Operating Range: -30 to 75°C
Operative Limits: -50 to 80°C
Transportation and storage conditions: -50 to 85°C

GTX_ _R/_ _U/_ _S

General Purpose Models
(3″ Flush Diaphragm, 4″ Extended Diaphragm)

Normal Operating Range: -30 to 75°C
Operative Limits: -50 to 80°C

Transportation and storage conditions: -50 to 85°C

(1/2″, 3/4″, 1-1/2″, or 2″ Flush Diaphragm, 2″ or 3″ Extended Diaphragm)

Normal Operating Range: -15 to 65°C
Operative Limits: -30 to 80°C
Transportation and storage conditions: -50 to 85°C

High Temperature Models
(3″ Flush Diaphragm, 4″ Extended Diaphragm)

Normal Operating Range: -5 to 55°C
Operative Limits: -10 to 60°C
Transportation and storage conditions: -20 to 85°C

(1/2", 3/4", 1-1/2", or 2" Flush Diaphragm, 2" or 3" Extended Diaphragm)
Normal Operating Range: -5 to 45°C
Operative Limits: -10 to 55°C
Transportation and storage conditions: -15 to 65°C

High Temperature Vacuum Models
(3" Flush Diaphragm, 4" Extended Diaphragm)
Normal Operating Range: -5 to 55°C
Operative Limits: -10 to 60°C
Transportation and storage conditions: -20 to 85°C

(1-1/2", or 2" Flush Diaphragm, 2" or 3" Extended Diaphragm)
Normal Operating Range: -5 to 45°C
Operative Limits: -10 to 55°C
Transportation and storage conditions: -15 to 65°C

High Temperature High Vacuum Models
(3" Flush Diaphragm, 4" Extended Diaphragm)
Normal Operating Range: 10 to 55°C
Operative Limits: -10 to 60°C
Transportation and storage conditions: -20 to 85°C

Wetted Parts: Tantalum
Normal Operating Range: -5 to 45°C
Operative Limits: -10 to 55°C
Transportation and storage conditions: -10 to 55°C

Sanitary Models
Normal Operating Range: -10 to 60°C
Operative Limits: -10 to 60°C
Transportation and storage conditions: -20 to 60°C

Additional Limits

1) Explosionproof Models
(See rating information of each approval)

2) Oxygen or Chlorine Models
Normal Operating Range: -10 to 75°C
Operative Limits: -40 to 80°C
Transportation and storage conditions: -50 to 80°C

3) Models with PVC Cover Flanges
Normal Operating Range: 0 to 55°C
Operative Limits: -10 to 60°C
Transportation and storage conditions: -10 to 60°C

4) Models with Digital Indicators
Normal Operating Range: -25 to 80°C
Operative Limits: -30 to 85°C
Transportation and storage conditions: -25 to 80°C

D-6. Process Temperatures

GTX30D/31D/40D/41D/71D/60G/71G/82G (not including Direct Mount)
Normal Operating Range: -40 to 110°C
Operative Limits: -50 to 115°C
(See Fig.D-2 for temperature limits according to working pressure)

GTX32D/42D/72D
Normal Operating Range: -15 to 110°C
Operative Limits: -20 to 115°C
(See Fig.D-2 for temperature limits according to working pressure)

GTX15D
Normal Operating Range: -15 to 65°C
Operative Limits: -40 to 70°C

GTX60G (Direct Mount)
Normal Operating Range: -40 to 85°C
Operative Limits: -40 to 85°C
(See Fig.D-3 for temperature limits according to working pressure)

GTX71G (Direct Mount)
Normal Operating Range: -25 to 70°C
Operative Limits: -40 to 85°C
(See Fig.D-4 for temperature limits according to working pressure)

GTX30A/60A
Normal Operating Range: -40 to 110°C
Operative Limits: -50 to 115°C
(See Fig.D-5, D-6 for temperature limits according to working pressure)

GTX35F/60F (not including Sanitary Models), **GTX82U** (G1-1/2 Button)
Normal Operating Range: -40 to 110°C
Operative Limits: -50 to 115°C
(See Fig.D-2 for temperature limits according to working pressure)

GTX_ _R/_ _U/_ _S
General Purpose Models (Flush Diaphragm, Extended Diaphragm)
Normal Operating Range: -40 to 180°C
Operative Limits: -50 to 185°C
(See Figs.D-7, D-8 for temperature limits according to working pressure)

High Temperature Models (Flush Diaphragm, Extended Diaphragm)

Normal Operating Range: -5 to 280°C (Tantalum: 180°C)
Operative Limits: -10 to 310°C (Tantalum: 200°C)
(See Fig.D-9 for temperature limits according to working pressure)

High Temperature Vacuum Models (Flush Diaphragm, Extended Diaphragm)

Normal Operating Range: -5 to 280°C (Tantalum: 180°C)
Operative Limits: -10 to 310°C (Tantalum: 200°C)
(See Fig.D-9 for temperature limits according to working pressure)

High Temperature High Vacuum Models

Normal Operating Range: 10 to 300°C (Tantalum: 180°C)
Operative Limits: -10 to 310°C (Tantalum: 200°C)
(See Fig.D-10 for temperature limits according to working pressure)

GTX35F/60F/35R/40R (Sanitary Models)

Normal Operating Range: -10 to 121°C
Operative Limits: -10 to 121°C
May be used at 150°C if within 30 minutes.
(See Fig.D-11 for temperature limits according to working pressure)

Additional Limits

1)Explosionproof Models
(See rating information of each approval)

2)Oxygen or Chlorine Models
See Figs. D-12, D-13, D-14, D-15

3)Models with PVC Cover Flanges
Normal Operating Range: 0 to 55°C
Operative Limits: -10 to 60°C

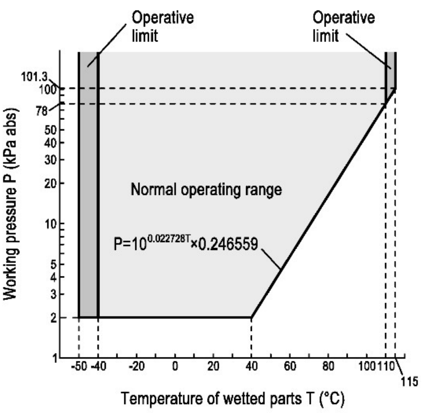


Fig. D-2. Process Temperature of GTX3_D/4_D/7_ D/60G/71G/82G General Purpose Models

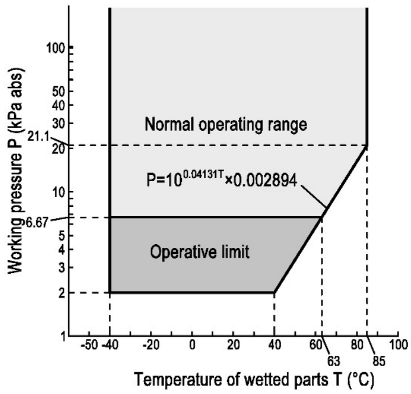


Fig. D-3. Process Temperature of GTX60G Direct Mount General Purpose Models

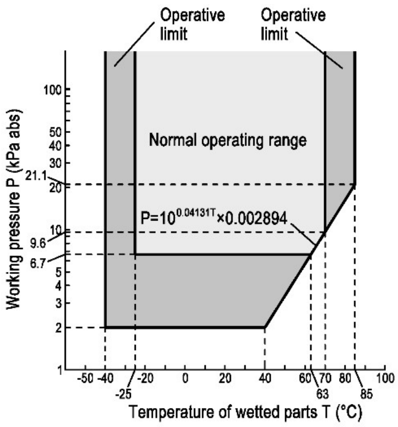


Fig. D-4. Process Temperature of GTX71G Direct Mount General Purpose Models

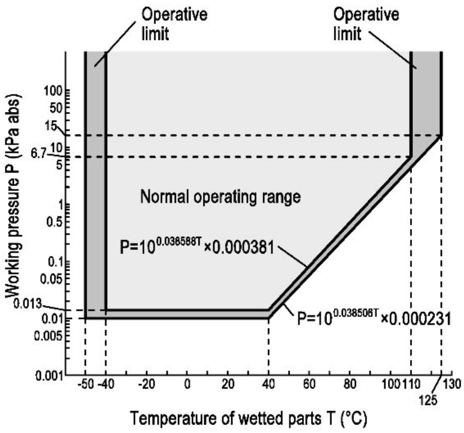


Fig. D-5. Process Temperature of GTX30A/60A Wetted Material SUS316

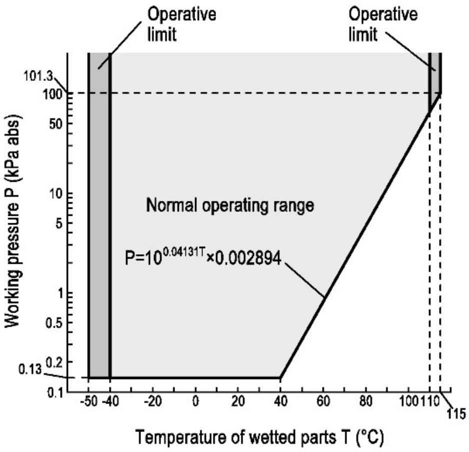


Fig. D-6. Process Temperature of GTX30A/60A Wetted Material SUS316L, Alloy C-276, Tantalum

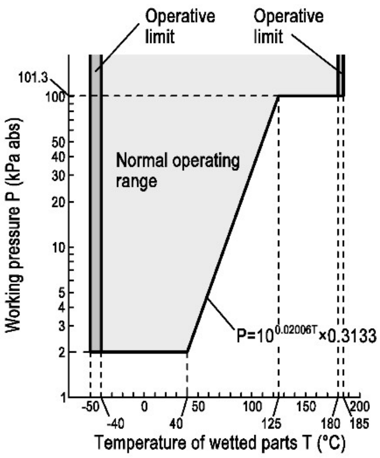


Fig. D-7. Process Temperature of GTX_ _R, GTX_ _U General Purpose Models

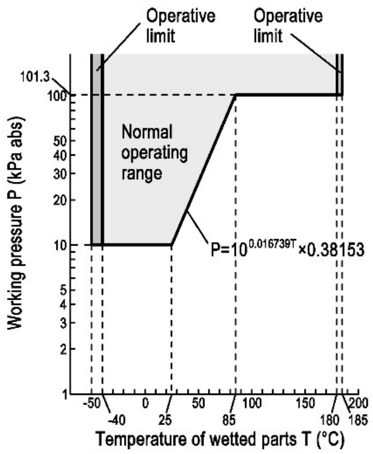


Fig. D-8. Process Temperature of GTX_ _R, GTX_ _U General Purpose Models (Fill Fluid Code=M)

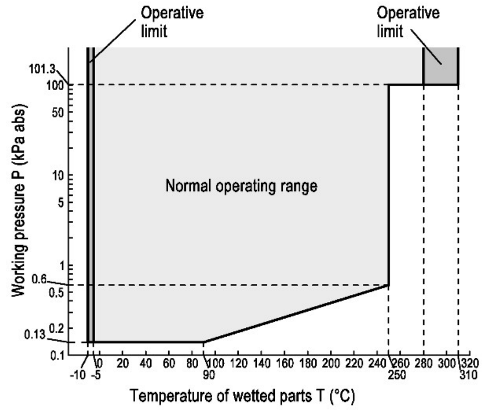


Fig. D-9. Process Temperature of GTX_ _R, GTX_ _U, GTX_ _S High Temperature and Vacuum Models

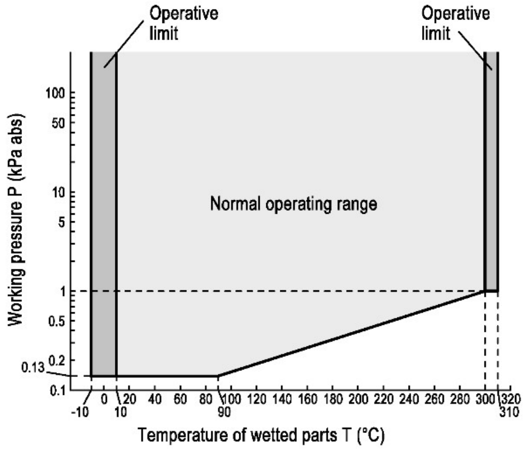


Fig. D-10. Process Temperature of GTX_ _R, GTX_ _U, GTX_ _S High Temperature and High Vacuum Models

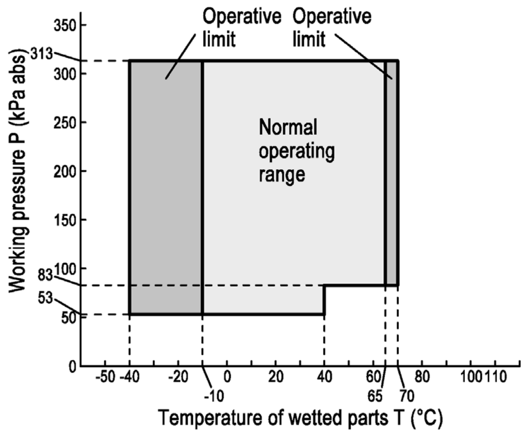


Fig. D-11. Process Temperature of GTX_ _R, GTX_ _F Sanitary Purpose Models

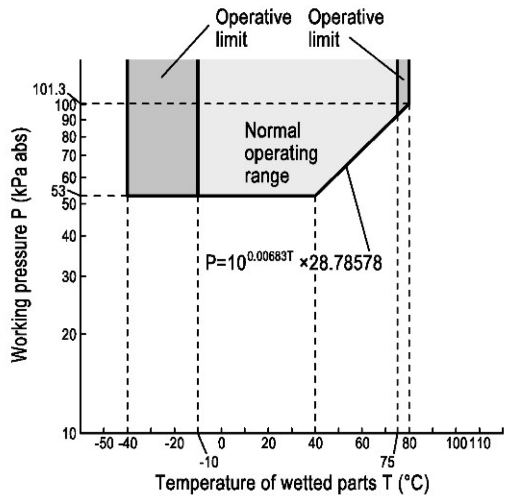


Fig. D-12. Process Temperature of GTX3_D/4_D/7_D/60G/71G/82G Oxygen or Chlorine Purpose Models

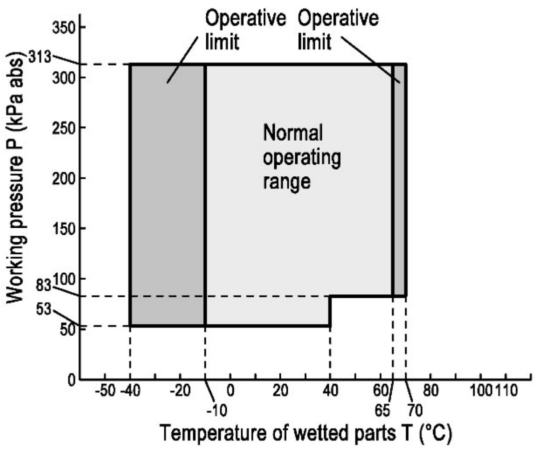


Fig. D-13. Process Temperature of GTX15D Oxygen or Chlorine Purpose Models

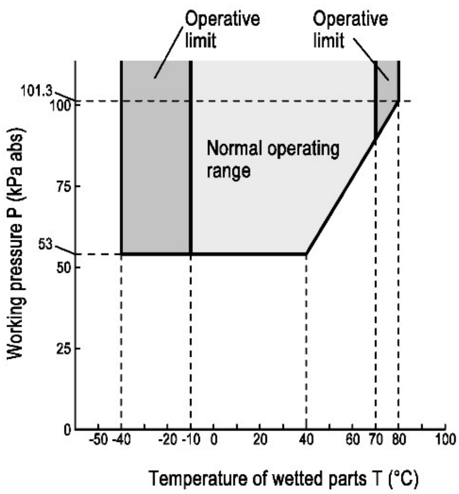


Fig. D-14. Process Temperature of TX60G/71G Direct Mount Oxygen or Chlorine Purpose Models

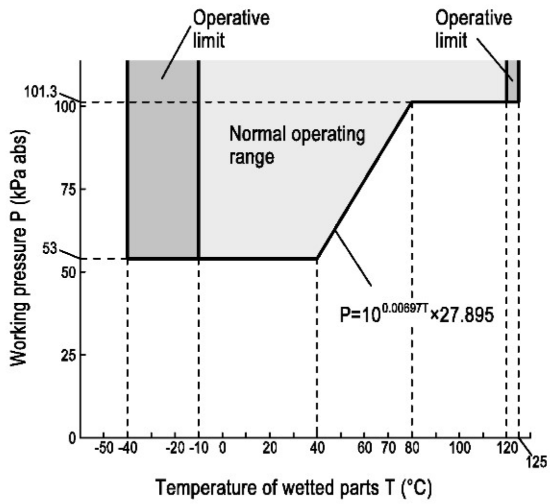


Fig. D-15. Process Temperature of GTX_ _R/_ _U/_ _S Oxygen or Chlorine Purpose Models

D-7. Ambient humidity limits

5 to 100% RH

D-8. Stability against supply voltage change

± 0.005% FS/V

D-9. Damping time

Selectable from 0 to 32 sec. in ten stages

D-10. Lightning protection

Applicable Standards; IEC 61000-4-5

Peak value of current surge (80/20μ sec.): 6000A

D-11. Materials of Construction

Common Parts

Transmitter case

Aluminum alloy or stainless steel

Paint

Standard: Baked acrylic paint

Corrosion-proof: Baked urethane paint

Fill fluid

Silicone oil (general purpose models)

Fluorine oil (oxygen and chlorine models)

GTX_ _ D, _ _G, _ _A (not including direct mount)

Wetted parts

Center body

316 SST, 316L SST, Alloy C-276, Tantalum

Vents and plugs

316 SST, PVC

Meter body cover flange, adapter flange

SCS14A (Equivalent to 316 SST) or 316 SST, PVC

Gaskets

PTFE

Bolts and nuts (for fastening cover flange)

Carbon steel (B7), 304 SST, 630 SST

GTX_ _G (Direct mount)

Wetted Parts

316 SST

GTX_ _ F

Wetted parts

Center body

316 SST, 316L SST, Alloy C-276, Tantalum

Vents and plugs

316 SST

Meter body cover flange, adapter flange

SCS14A (Equivalent to 316 SST) or 316 SST, PVC

Gaskets

PTFE

Bolts and nuts (for fastening cover flange)

Carbon steel (B7), 304 SST, 630 SST

Flange

304 SST, 316 SST, 316L SST

GTX_ _ R, _ _ U

Wetted parts

316SST, 316L SST, Ally C-276, Tantalum

Flange

304 SST, 316 SST, 316L SST

Capillary tube

316 SST

Armored tube

304 SST

Meter body cover flange

SCS13 (Equivalent to 304 SST)

Bolts and nuts (for fastening cover flange)

304 SST

GTX_ _ S

Wetted parts

316 SST, 316L SST

Flange materials

304 SST, 316 SST, 316L SST

Capillary tube

316 SST

Armored tube

304 SST

Meter body cover flange

SCS13 (Equivalent to 304 SST)

Bolts and nuts (for fastening cover flange)

304 SST

D-12. Weight

GTX15D/30D/40D/60G

Approx. 3.4 kg

GTX31D/41D/71D/71G/30A/60A

Approx. 3.7 kg

GTX32D/42D/72D/82G

Approx. 6.3 kg

GTX60G/71G (Direct Mount)

Approx. 1.3 kg

GTX_ _F

Approx. 5.9 kg (ANSI 150# - 1-1/2" flange)

GTX_ _R

Approx. 20.0 kg (ANSI150 # - 3" flange, capillary length 5m)

GTX_ _U, _ _S

Approx. 13.5 kg (ANSI150 # - 3" flange, capillary length 5m)

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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