azbil

CM2-CVM100-2001

Natural Gas Calorimeter

Model: CVM400

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.

HART is a trademark of the FieldComm Group.

Safety

Precautions for Use

For safe use of the product, the following symbols are used in this manual.

⚠WARNING	Warnings are indicated when mishandling the product might result in the death or serious injury of the user.
⚠CAUTION	Cautions are indicated when mishandling the product might result in minor injury to the user or damage to property.

■ In describing the product, this manual uses the icons and conventions listed below.

Use caution when handling the product.

The indicated action is prohibited.

Be sure to follow the indicated instructions.

Handling Precautions:

Handling Precautions indicate items that the user should pay attention to when handling the CVM400.

To use this product correctly and safely, always observe the following precautions.
We are not responsible for damage or injury caused by the use of the product in violation of these precautions.

Handling Precautions for This Product

Installation Precautions

⚠WARNING	
	When installing, use proper fittings and proper tightening torque for connections to the process and to the exhaust. Gas leakage is dangerous because process gas and calibration gas are flammable. Please refer to the leak check instructions in this manual and verify that there is no gas leakage.
	Do not use the product except at the rated pressure, specified connection standards, and rated temperature. Use under other circumstances might cause damage that leads to a serious accident.
	For wiring work in an explosion-proof area, follow the work method stated in the explosion-proof policy.

⚠WARNING

Process gas and calibration gas (pure methane) are dangerous flammable gases that can ignite and explode when mixed with air. To ensure safety, be sure to check the following before starting work:

- With a detector for flammable gas, check that there is no gas leak in the workspace or the surrounding area. Keeping the gas detector turned on throughout the work is recommended.
- Make sure there is no source of ignition near the workspace, since there is a possibility that a gas leak could occur during the work.
- Inhaling gas will seriously harm your health. Do not work in a closed space.
  After the piping work, see "Piping leak check" in section 2-3, "Piping," and confirm that there is no gas leak from the connecting part (fitting) or other sections of the piping before starting trial operation or normal operation.

⚠CAUTION

⊘	After installation, do not step or stand on this unit. Doing so may damage the device or cause injury.
!	Bumping the glass of the display with a tool may cause damage or injury. Be careful.
!	Install the device correctly. Incorrect or incomplete installation will cause output errors and violation of regulations.
!	This product is quite heavy. Protect your feet with safety shoes when working.
⊘	Do not subject the product to shock or impact.
!	The vent of CVM400 must be connected to a pipe with a diameter large enough to not be affected by back pressure. Gas should be vented to the air in a place not affected by wind, rain, or snow. Flammable gas is discharged from the vent, so it must be located where people will not be harmed. When cleaning the piping by blowing gas through it, do not blow gas into the CVM400 in order to protect its sensor and adapter filter. Be sure to blow clean inert gas away from CVM400 into the pipes.

Wiring Precautions

⚠WARNING
Do not do wiring work with wet hands or while electricity is being supplied to the product. There is a danger of electric shock. When working, keep hands dry or wear gloves, and turn off the power.

⚠CAUTION
When wiring, check the specifications carefully and make sure to wire correctly. Incorrect wiring can cause device damage or malfunction.
Supply electric power correctly according to the specifications. Supplying power that differs from the specifications can damage the device.
Use a DC power supply that has overload protection.

Explosion Precautions

⚠WARNING
Do not open the case cover while CVM400 is powered in a hazardous location.
Handle CVM400 with care. If the case cover is corroded, deformed, or damaged, or if screws or connecting parts are damaged, the device might lose its explosion-proof performance.
Explosion-proof performance is not guaranteed unless the case cover is locked. Always tighten the case cover completely and lock it.

Maintenance Precautions

⚠WARNING
When removing this device for maintenance, be careful of residual pressure or residual process gas. Leakage of process gas is dangerous.
When working on the vent, check its direction so that people do not come into contact with vented gas. There is a danger of burns or other physical harm.
When the device is being used in an explosion-proof area, do not open the cover. Opening the cover may cause an explosion.
When replacing the adapter, see the warning in 2-3, "Piping," and 3-1, "Before using CVM400." Remove and mount the adapter securely in a safe place. See "Piping leak check" in 2-3, "Piping," and check for gas leaks at the connection to the piping after replacement.

⚠CAUTION
This product was kept under carefully controlled conditions until it was shipped. Never try to modify this device. Doing so could damage it.

Precautions for Using Communication Devices

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

If output of CVM400 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.

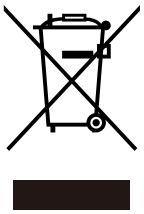
Cautions to Disposal of Electrical and Electronic Equipment

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.



Hazardous Area Certifications

CVM400 complies with the types of protection that are based on the standards listed below.

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ATEX Flameproof and Dust Certifications

1. Marking information

CE 0344 Ex DEKRA 11ATEX0036 X

II 2 G Ex db IIB T6 Gb;

II 2 D Ex tb IIIC T80 °C Db; -20 °C ≤ T_{amb} ≤ +50 °C; IP66

2. Standards compliance

- EN 60079-0: 2018
- EN 60079-1: 2014
- EN 60079-31: 2014

3. Special conditions of use

3-1. To maintain a degree of protection of at least IP 66, in accordance with IEC 60529, suitable Ex d certified cable entries must be used and correctly installed. Unused openings must be closed with suitable Ex d certified stopping plugs.

3-2. For model numbers in the form "CVMxxx–xyxxxx -...":
If y=1, all entries have 1/2 NPT thread.

3-3. For connection of an external grounding or bonding conductor a cable lug should be used. The conductor should be mounted so that it will not loosen or twist.

3-4. The process gas pressure range is 80 kPa to 110 kPa(abs).

3-5. The process temperature range is from -20 to +50 °C.

3-6. The sensor adapter has at least 6 engaged threads.
Tighten the sensor adapter till foot of an adapter touch the manifold and cannot be tighten any more.

3-7. Tighten the terminal cover till foot of a terminal cover touch the housing and cannot be tighten any more.

3-8. The flameproof joints are not intended to be repaired.

3-9. For the use in the area where an EPL Db apparatus is required, electrostatic charging shall be avoided.

4. Precautions

4-1. Charging mechanisms such as, but not limited to: fast moving particles along a surface, charge spraying for an electrostatic coating or fast moving non-conductive parts like conveyor belts or drive belts, can lead to ignitable discharges and shall be avoided.

IECEx Flameproof and Dust Certifications

1. Marking information

IECEx DEK 11.0016X

Ex db IIB T6 Gb;

Ex tb IIIC T80 °C Db; -20 °C ≤ T_{amb} ≤ +50 °C; IP66

2. Standards compliance

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

3. Special conditions of use

3-1. To maintain a degree of protection of at least IP 66, in accordance with IEC 60529, suitable Ex d certified cable entries must be used and correctly installed. Unused openings must be closed with suitable Ex d certified stopping plugs.

3-2. For model numbers in the form "CVMxxx–xyxxxx -...":
If y=1, all entries have 1/2 NPT thread.

3-3. For connection of an external grounding or bonding conductor a cable lug should be used. The conductor should be mounted so that it will not loosen or twist.

3-4. The process gas pressure range is 80 kPa to 110 kPa(abs).

3-5. The process temperature range is from -20 to +50 °C.

3-6. The sensor adapter has at least 6 engaged threads.
Tighten the sensor adapter till foot of an adapter touch the manifold and cannot be tighten any more.

3-7. Tighten the terminal cover till foot of a terminal cover touch the housing and cannot be tighten any more.

3-8. The flameproof joints are not intended to be repaired.

3-9. For the use in the area where an EPL Db apparatus is required, electrostatic charging shall be avoided.

4. Precautions

4-1. Charging mechanisms such as, but not limited to: fast moving particles along a surface, charge spraying for an electrostatic coating or fast moving non-conductive parts like conveyor belts or drive belts, can lead to ignitable discharges and shall be avoided.

TIIS Explosion-Proof Certification (certification for Japan)

1. Marking information

Ex d IIB T6 X

"X" indicates the following:

- Mounting orientation is specified.
- Input process pressure: 110 kPa (abs) max.

2. Standards compliance

"Recommended Practice for Explosion-Protected Electrical Installations in General Industries" (2008 technical recommendations conforming to international standards)

3. Special conditions for safe use

3-1. Be sure to use the pressure-resistant cable gland that is included with the product to ensure a TIIS explosion-proof structure.

3-2. The maximum process pressure at the inlet of the CVM400 is 110 kPa (abs).

3-3. The process temperature range is –10 to +50 °C

3-4. The thread of the CVM400 main unit is 1/2 NPT (F). When the pressure-resistant cable gland that is included with the product is attached, the size of the wiring port is G 1/2 (F).

NEPSI Explosion Protection Certificate of Conformity

1. Marking information

Ex d IIB T6 Gb;

Ex tD A21 IP66 T80 °C

The" X" at the end of the certification number indicates that specific conditions must be met for safe use of the product. For this product, the following is required:

- An adapter with a flame arrestor must have a fitting length of 6 threads or more.

2. Standards compliance

- GB3836.1-2010
- GB3836.2-2010
- GB12476.1-2013
- GB12476.5-2013

3. Special conditions for safe use

3-1. Ground the external ground terminal of the device securely.

3-2. The ambient temperature range: –20 to +50 °C

3-3. The maximum process temperature: +50 °C

3-4. The rating is as follows:

Supply voltage: 24 Vdc +/- 10%, 100 mA

Output: 4-20 mA (HART)

Contact: 24 Vdc +/- 10%, 1 A (For calibration)

24 Vdc +/- 10%, 50 mA (For alarming)

3-5. When installing the device, use cable glands and blanking element that have passed an inspection by a government-designated testing organization. Use 1/2 NPT (male) connection threads that satisfy Ex d IIB explosion-proof standards and the IP66 protection level specified by GB 4208.

3-6. Never open the cover in an atmosphere that contains explosive gas when the device is powered.

3-7. Install the device in an environment where there is no gas that corrodes aluminum alloy.

3-8. Do not replace parts for which replacement is not allowed. Please contact us if necessary.

3-9. Clean this device regularly. However, do not apply compressed air to the surface of the device.

3-10. For installation, operation, and maintenance of this device, instructions in this user's manual and the following standards must be observed:

- GB 3836.13-2013: Explosive atmospheres --Part 13: Equipment repair, overhaul and reclamation
- GB/T 3836.15-2017: Explosive atmospheres --Part 15: Electrical installations design, selection and erection
- GB/T 3836.16-2017: Explosive atmospheres --Part 16: Electrical installations inspection and maintenance
- GB 50257-2014: Code for construction and acceptance of electric equipment on fire and explosion hazard electric equipment installation engineering
- GB 15577-2018: Safety regulations for dust explosion prevention and protection

KCs Flameproof Certifications

1. Marking information

Ex d IIB T6

2. Special conditions for safe use

2-1. To maintain a degree of protection of at least IP 66, in accordance with IEC 60529, suitable Ex d KCs certified cable entries must be used and correctly installed. Unused openings must be closed with suitable Ex d KCs certified stopping plugs.

2-2. For model numbers in the form "CVMxxx–yxxxx -...":
If y=1, all entries have 1/2 NPT thread.

2-3. For connection of an external grounding or bonding conductor a cable lug should be used. The conductor should be mounted so that it does not loosen or twist.

2-4. The maximum process pressure is 110 kPa (abs.).

2-5. The process gas temperature range is from -0 to +50 °C.

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Metrology Approval (OIML R140 Compliant)

Requirements

- Process alarm setting: Upper alarm value 100 %, Lower alarm value 0 %.
  See 4-5-4, Process alarm.

! Handling Precautions:

For the OIML R140-compliant model, do not change the default upper and lower limit alarm values.

- Operating temperature: -10 to +40 °C
- Measured gas component limit: CO_2 < 2 mol %, N_2 < 7 mol %, C_4^+ < 1.2 mol %
- The latest SCV value is saved when the power is down. See 4-9-4: Log.

Table of Contents

Chapter 1: Introduction

Thank you for purchasing the Natural Gas Calorimeter model: CVM400 ("gas calorific value determining device".) CVM400 measures gas properties using Azbil Corporation's own thermal flow sensor and calculates the SCV (superior calorific value), the ICV (inferior calorific value), the WI (Wobbe Index), the MN (Methane Number), or other values determined by model number using a unique correlation method based on support vector regression (SVR) analysis. CVM400 transmits the SCV, ICV and WI as 4-20 mA analog output and communicates with HART Communicator. To ensure both safety and efficiency, please read this manual carefully before you operate the instrument. Keep this user's manual on hand so that you can refer to it whenever needed.

1-1: Precautions

Unpacking

CVM400 is a precision instrument. When unpacking, handle it with care to prevent accident or damage. Don't touch electronic parts. Check that the following items are included:

1. CVM400 main unit
2. Hex wrenches (small and large, 1 each)
3. Hexagon head bolts for mounting (M8, length 10 mm, 2 bolts)
4. Manual

Verifying the specifications

The specifications for this device are written on the nameplate.

Compare these specifications to those in the appendix or the specification sheets, and verify that the CVM400 matches your order. In particular, be sure to check the following items.

1. SCV, ICV and WI calculation parameter
2. Explosion-proof structure
3. Approvals
4. Pipe and cable entry connection

Inquiries

If you have any questions regarding the specifications, contact your local Azbil Corporation representative. When making an inquiry, be sure to provide the Model and the Product No.

Storage precautions

When storing this instrument before use, observe the following instructions:

1. Store indoors at room temperature and humidity, in a place safe from vibration and shock.
2. Store the device packed in the same way that it was shipped.

When storing this instrument after usage, observe the following instructions:

1. Flush the inside of the flow path with dry methane gas to remove any residual fluids and then put the seal plugs on the inlet and outlet of CVM400.
2. Tighten the display cover and terminal box cover in order to prevent ingress of moisture.
3. Return the instrument to its original packing.
4. Store the device indoors at room temperature and humidity in a place safe from

vibration and shock.

Installation environment

Install in a sheltered place. Prevention of direct exposure to sunshine, rain, snow, and wind is required.

Ambient temperature: -10°C ≤ Tamb ≤+ 50°C

This instrumentation is designed for use in an industrial electromagnetic environment. Do not use it in other environments.

Application/measured gas specifications

CVM400 can be used for natural gas only. Gas specifications are as follows:

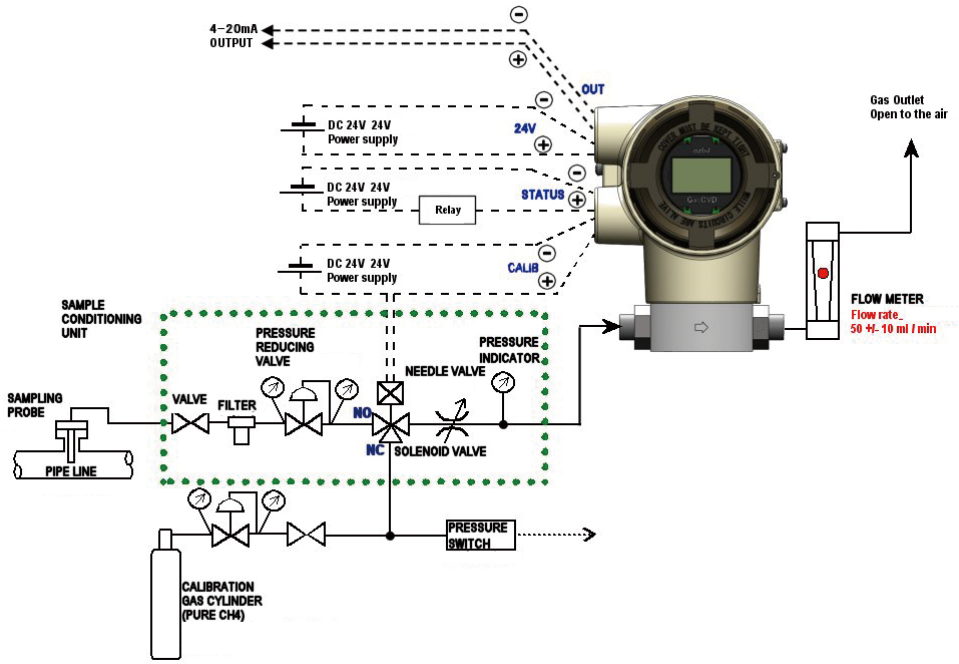
Component limits:	Refer to Appendix A for detail.
Gas temperature:	-10 to +50°C
Max. gas pressure:	At the gas inlet of the CVM400: 110 kPa (abs.)

For OIML metrology approval, please refer to Metrology Approval on page ii of the Safety section.

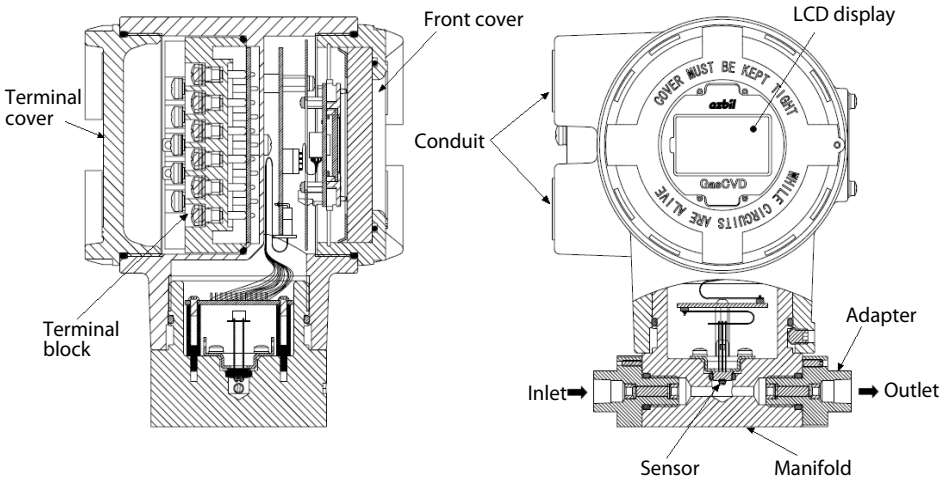
1-2: Definition of terms

CVM400	A natural gas "calorific value determining device"
CVM400	CVM400 model No.
OIML R140	The International Organization of Legal Metrology's measuring systems for gaseous fuel
SCV	Superior calorific value
ICV	Inferior calorific value
WI	Wobbe Index
NG	Natural gas
Pure methane	Methane gas 4.5 (99.995% or more)
SVR	Support vector regression
CF	Abbreviation of Calibration factor
Sensor	Micro Flow sensor, designed and built by Azbil Corporation
Sensor temp	Temperature measured by temperature sensor on the sensor chips
HART	HART communication protocol
HART Communicator	HART 475 communicator, CommStaff (azbil)
SP	Set point: The set value of each variable
PV	Process variable: The present value of each variable
URV	Upper range value
LRV	Lower range value
AO	Analog output
DO	Digital output

1-3: CVM400 measuring system



1-4: CVM400 structure



Chapter 2: Installation

This section provides information about installing CVM400. It includes procedures for mounting, piping and wiring CVM400. CVM400 is normally placed after a sample-conditioning unit or inside of the sample-conditioning box.

⚠WARNING	
❗	When installing, use proper fittings and proper tightening torque for connections to the process and to the exhaust. Gas leakage is dangerous because process gas and calibration gas are flammable. Please refer to the leak check instructions in this manual and verify that there is no gas leakage.
⃠	Do not use the product except at the rated pressure, specified connection standards, and rated temperature. Use under other circumstances might cause damage that leads to a serious accident.
❗	For wiring work in an explosion-proof area, follow the work method stated in the explosion-proof policy.

⚠CAUTION	
⃠	After installation, do not step or stand on this unit. Doing so may damage the device or cause injury.
❗	Bumping the glass of the display with a tool may cause damage or injury. Be careful.
❗	Install the device correctly. Incorrect or incomplete installation will cause output errors and violation of regulations.
❗	This product is quite heavy. Protect your feet with safety shoes when working.
⃠	Do not subject the product to shock or impact.
⃠	This instrumentation is designed for use in an industrial electromagnetic environment. Do not use it in other environments.

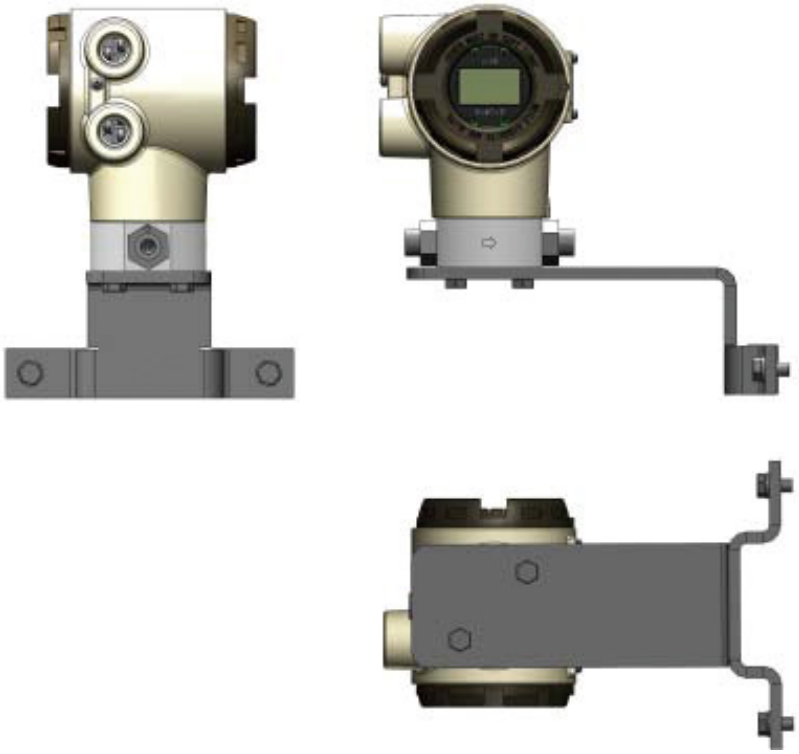
2-1: CVM400 standard accessories

CVM400 comes with the following standard accessories.

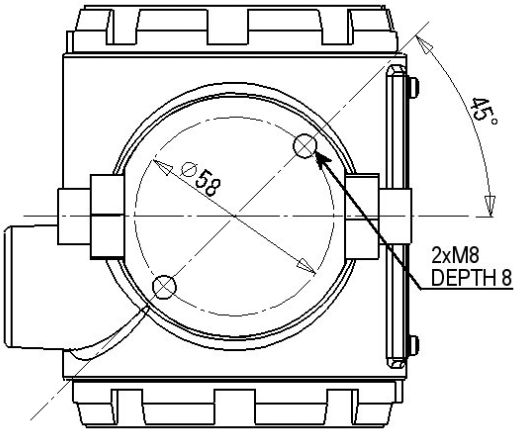
- Hex wrenches (small and large, 1 each)
- Hexagon head bolts (M8, length 10 mm, 2 bolts)

2-2: Mounting

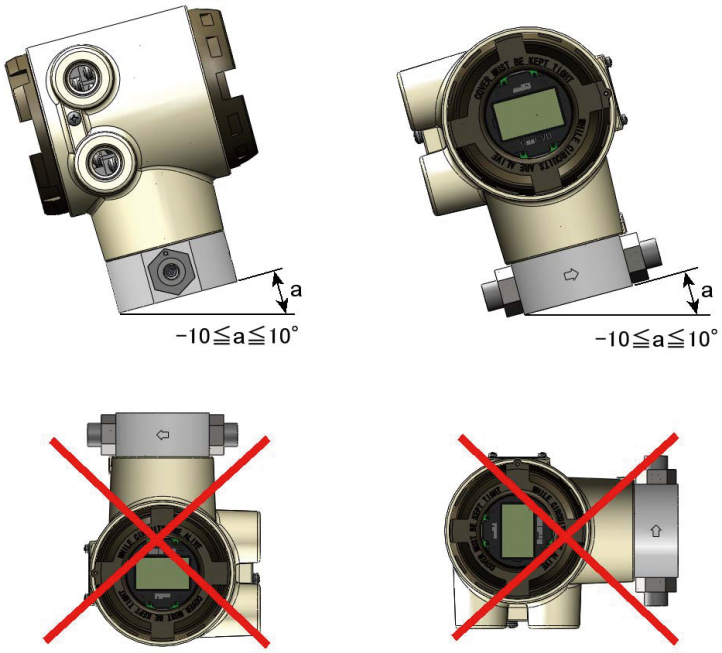
The figure below shows a sample mounting method for CVM400. CVM400 comes with hexagon head bolts. The mounting bracket is user-supplied.



Dimensions for installing CVM400 are shown below. There are mounting screw holes on the bottom.



Install CVM400 at not more than a 10 degree angle from the horizontal.



2-3: Piping

⚠ WARNING

Both the process gas and calibration gas (pure methane) are flammable, and if mixed with air and ignited, they may explode. For safety, do the following before beginning to work.

- Use a gas detector to make sure that no flammable gas can be detected in the work area, instruments, or surrounding air. We recommend the continued use of the gas detector during work.
- Since a leakage of gas might occur during work, remove any flammable objects from the workplace.
- To prevent gas absorption by the human body, keep the workplace ventilated.

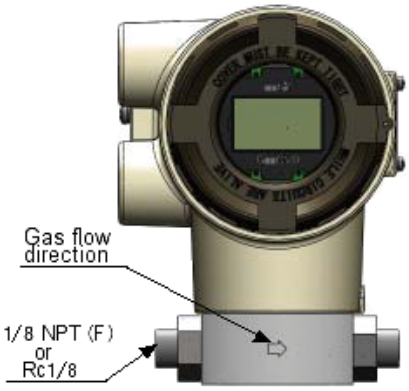
Also, after piping work is complete, refer to "Piping leak check" on page 8 and make sure that there is no leakage from connected parts, etc., before starting a test-run or regular operation.

Inside the adapters in both sides of manifold, there's gas inlet and outlet of CVM400. Make sure the gas flow direction is the same as the arrow on the surface of the manifold. Make sure that the adapters do not loosen when attaching the pipes.

There are two types of screws for piping, 1/8 NPT female or Rc1/8, depending on the CVM400 model.

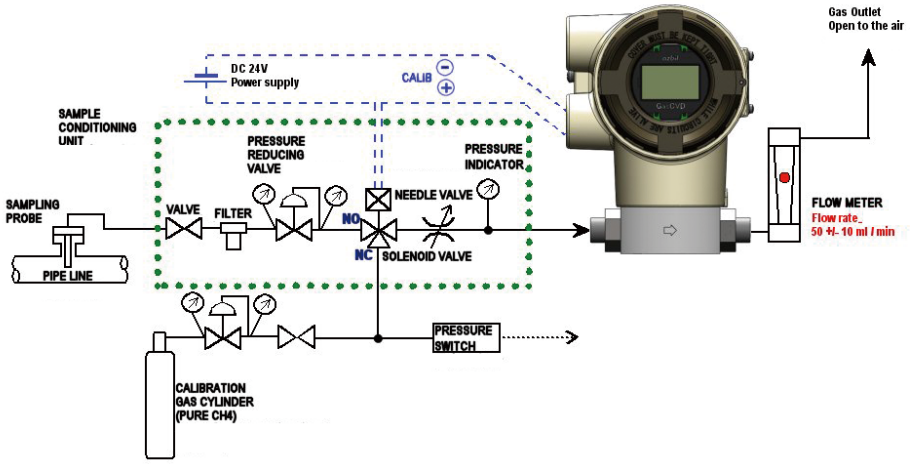
Material

For piping the CVM400 and sample conditioning unit, use a seamless stainless steel 316 tube or equivalent that is specialized for gas analysis use or is finished with an inert internal surface treatment so that it does not degas impurities. Avoid using plastic, elastomer, copper, brass or steel tube. Use stainless steel 316 tube fittings.



Sample conditioning unit

The following illustration shows a minimal system for a sample-conditioning unit. In some cases, additional filters, oil mist separator, drier, and so forth might be required, depending on the properties of the gas. Evaluate which components are needed within the sample-conditioning unit from the gas properties, and avoid increasing the inner volume by adding useless components, since that will interfere with speedy gas replacement.



Note: CALIB contact output for auto calibration is fixed at NO, so connect NG (Process Gas) for NO side of three-way solenoid valve, and Calibration Gas Cylinder for NC side.

Pressure and flow rate

Supply the process gas and pure methane gas for calibration to the inlet of CVM400 under the following conditions.

- Pressure: ≤ 110 kPa (abs.)
- Flow rate: 50 ml/min ± 10 ml/min

Vent line

⚠CAUTION

The outlet of CVM400 should be connected to a ventilation tube with an inner diameter large enough to not be affected by backpressure. It should open to the air in a place not affected by wind, rain or snow. Natural gas and methane are discharged directly from the vent, so the vent should be located where human beings will not be harmed. When cleaning the inside of the tube by blowing back clean inert gas, to protect the device, do not blow gas into CVM400.

Piping leak check

Conduct a leak test using pure methane (99.995 % CH_4). The leak test may be either the soap bubble method or the falling pressure method. If the falling pressure method is used, make sure there are no effects from the wind and no change of temperature. These factors can make it seem that there is some leakage even when none actually exists. If some leakage is observed, tighten the tube fittings and then check again.

The detailed procedure for the leak test is as follows.

Step	Action (Soap Bubble Method)	Action (Falling Pressure Method)
1	Plug the outlet of CVM400	
2	Supply pure methane at 300 kPa	
3	Put liquid soap on the piping connections	Stop supplying pure methane and check the pressure
4	Check if there are soap bubbles	Wait 10 minutes
5	Wipe off the liquid soap with a clean dry cloth	Check the pressure to see whether there is leakage

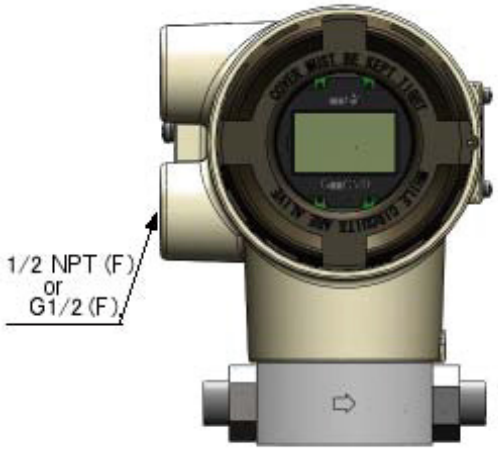
If soap bubble method is used, wipe the soap off completely after the test. Otherwise it might contaminate the gas or cause corrosion.

2-4: Wiring

When wiring CVM400, use conduits that are rated as flameproof to attach to the conduit connecting ports. Put cables through the conduits and then connect to CVM400's internal terminal block. There are 2 possible types of thread on the conduit connecting ports, either 1/2 NPT female or G1/2 female, depending on the model of CVM400. The model with M20 connecting ports requires adapters between the ports and the flameproof conduits.

For the TIIS explosion-proof model, the thread on the CVM400 main unit is 1/2 NPT female . Insert the 1/2 NPT screws of the cable gland that is included with the product into the thread on the CVM400.

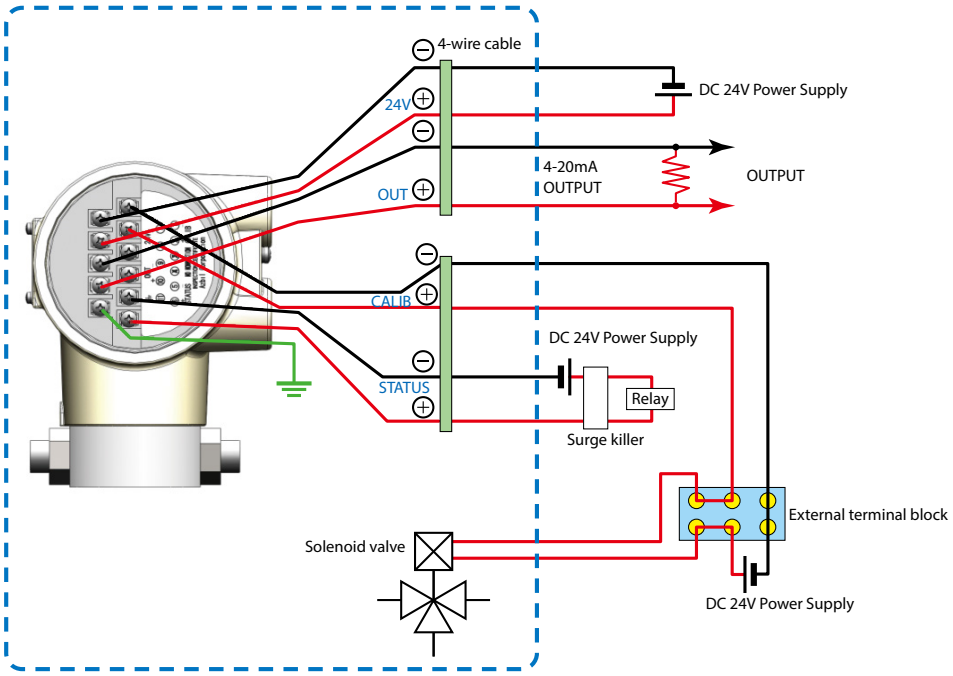
This will leave a G 1/2 female thread for the wiring port. For details, refer to "TIIS Explosion-Proof Certification (certification for Japan)" in the "Safety" section.



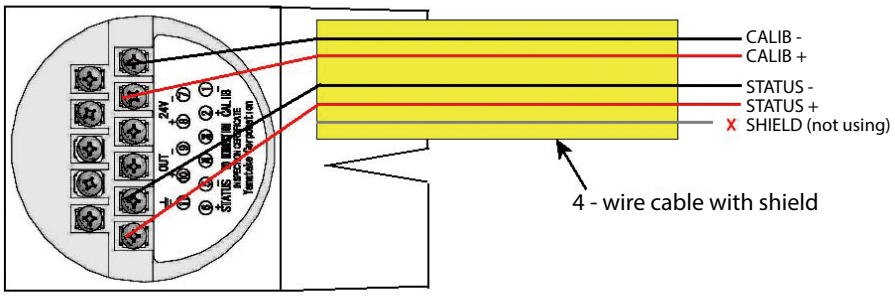
⚠WARNING	
⊘	Do not do wiring work with wet hands or while electricity is being supplied to the product. There is a danger of electric shock. When working, keep hands dry or wear gloves, and turn off the power.

⚠CAUTION	
❗	When wiring, check the specifications carefully and make sure to wire correctly. Incorrect wiring can cause device damage or malfunction.
❗	Supply electric power correctly according to the specifications. Supplying power that differs from the specifications can damage the device.
❗	Use a DC power supply that has overload protection.

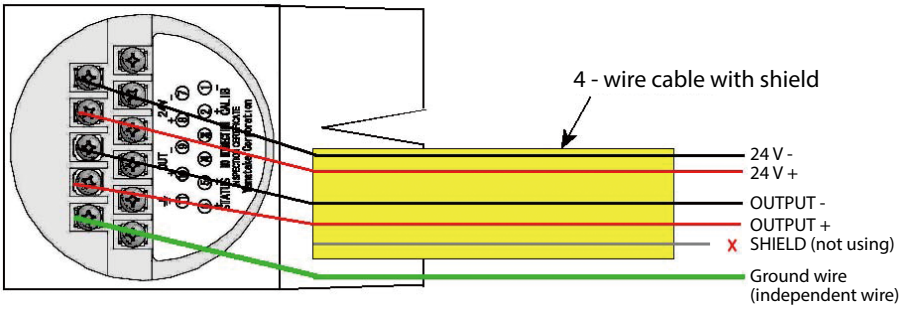
The following figures show the wiring connections from CVM400's terminal block and detailed examples of wiring at the terminal block.



UPPER CONDUIT from LOWER LEVEL of TERMINAL BLOCK



LOWER CONDUIT from UPPER LEVEL of TERMINAL BLOCK



The maximum length of the power cable

The minimum voltage between the terminals of the CVM400 is 21.6 V. When the supply voltage is 24 V DC and the maximum current consumption is 300 mA, the wiring resistance of the power cable must be 4 Ω or under for both the positive and negative ends.

Therefore, the maximum length of the power cable is:

Conductor area 2 mm^2 cable (9.4 Ω/km): 400 m

Conductor area 1.25 mm^2 cable (16.8 Ω/km): 200 m

Check the relationship between the external load resistance and the supply voltage. The supply voltage is 24 V DC ± 10 % between the terminals in the terminal box, and the external load resistance at this supply voltage is 250 to 540 Ω. External resistance is the total resistance connected to the output terminals of CVM400, including the resistance of all cables in the loop plus the internal resistance of the instruments.

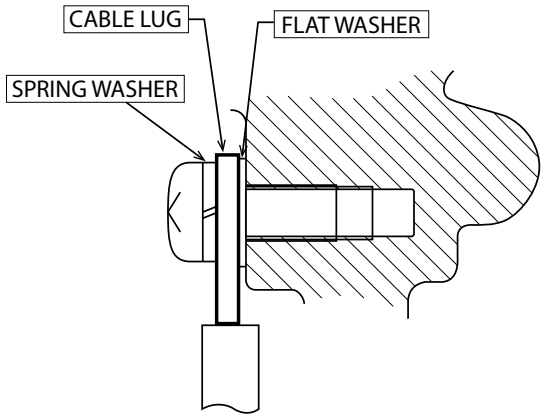
⚠ CAUTION

Use a DC power supply with overload protection. This function protects the DC power supply from problems related to the load, such as a short circuit, which can cause part failure due to overheating, or in the worst case fire.

External power is required when using the process alarm function or calibration function. Use 26.4 Vdc max., 50 mA max. for STATUS contacts, and 26.4 Vdc max. 1 A max. for CALIB contacts. (For the minimum allowable voltage, please refer to the specifications for the relay or solenoid valve used.)

The installation of a surge protector suitable for the relay or solenoid valve is required. If a shielded cable is used, do not connect the shield wire. Instead, ground CVM400 using its ground terminal attached to an independent wire. The ground resistance must be 100 Ω or lower.

The connection of a grounding or equipotential bonding conductor with the external grounding terminal must use the method illustrated below.



Chapter 3: Operation

This section provides procedures about starting and stopping the operation of CVM400. This section also provides information about modes and display indication

3-1: Before using CVM400

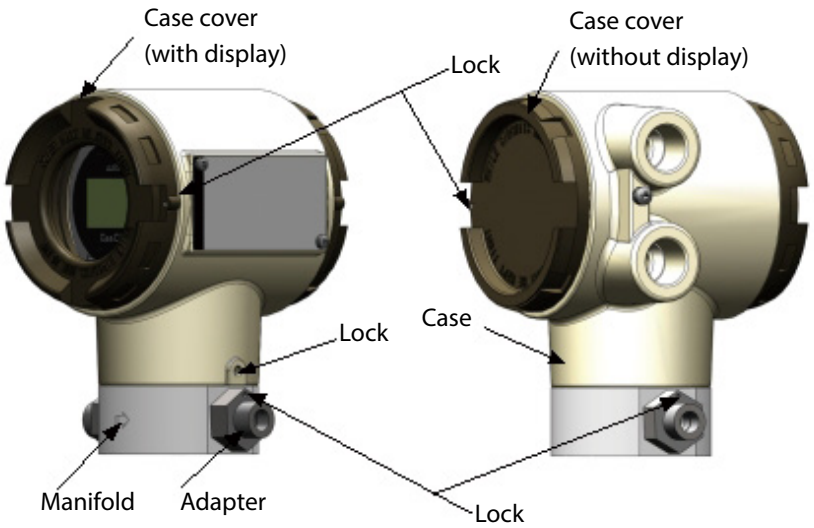
⚠WARNING	
⊘	• Never open the case cover while CVM400 is ON or in a hazardous location.
❗	• Handle CVM400 with care. It may lose its explosion-proof performance due to corrosion, deformation, damage to the case cover, or damage to a screw or a joined part.
❗	• Explosion-proof performance is not guaranteed unless the case is LOCKED. Always tighten the case cover completely and lock it.
❗	To achieve the specified performance of CVM400, calibrate the device with pure methane gas before starting or restarting operation. Otherwise the performance specifications of the device might not be satisfied.

Opening and tightening the case cover

CVM400 has a locking structure. Before opening the case cover, unlock the mechanism using a hex wrench (included).
When closing, insert the case cover fully and lock it, using a hex wrench.

! Handling Precautions:

When a case cover is open, take care dust or moisture does not enter inside it. After mounting case cover, confirm dust or moisture does not enter inside it during use.



Precautions for Using Communication Devices

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.

3-2: Starting CVM400 operation

To start CVM400 operation, follow the steps below.

1	Supply the process gas	
2	Adjust the flow rate with the needle valve so that the flowmeter indicates a flow rate of 50 mL/min ± 10 mL/min.	
3	Supply power to CVM400	
4	Wait until the output is stable.	
5	Open the methane gas cylinder used for calibration and adjust the secondary pressure of the pressure reducing valve for the cylinder to be the same pressure as the process gas.	
	With a three-way solenoid valve	With only a manual three-way valve
6	Carry out manual calibration (methane gas starts flowing).	Switch the position of the three-way valve to discharge methane gas into the device and wait until the gas flow is stable.
7		Carry out manual calibration.
8		Switch the position of the three-way valve so that process gas flows into the device.

For the first 10 seconds after power is turned on, the two software versions of the device are displayed on the indicator. One is the metrology software version and the other is the device software version. During this period the output is determined by the fail safe direction. After 10 seconds CVM400 begins measurement and transmits output automatically. For details on manual calibration, refer to 4-5-5-3, “Manual calibration / auto calibration.” Adjust the secondary pressure of the methane gas cylinder so that the flow rate is 50 ± 10 mL/min.

3-3: Stopping CVM400 operation

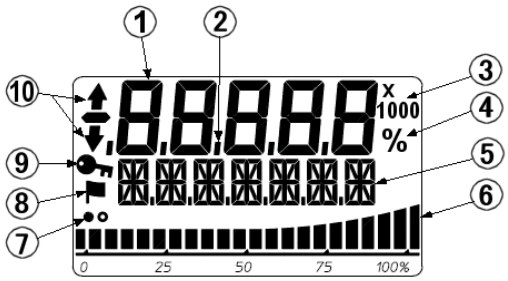
To stop CVM400 operation, follow the steps listed below.

1	Turn off the power to CVM400
2	Shut off the process gas line

Follow the step below when storing CVM400.

1	Make sure no process gas remains in CVM400.
2	Purge CVM400’s gas flow path with pure methane gas.
3	Insert metal plugs into the inlet and outlet in order to keep moisture out.
4	Pack CVM400 as it was packed when it was originally received.
5	Store CVM400 indoors in a safe place at room temperature and humidity.

3-4: Modes and Indicators



No.	Displayed item	Description
1	5-digit display	PV or status number
2	5-position decimal point display	Decimal point
3	(Nothing), X10, X100, X1000	Multiplicand
4	Percentage	%
5	16-segment (7-digit) display	Units, status, mode
6	Bar Graph	Output percentage
7	● and ○	When auto calibration is scheduled, ● and ○ will be lit by turns (blink by turns). When not scheduled, neither will be lit.
8	Flag	Calibration failure
9	Key	Write protected
10	↑ and ↓	This will be lit only when operating PV Trim with external switch. When setting by HART communicator, it will not be lit.

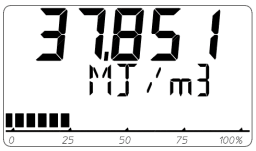
Bar Graph Display

The indicated values are displayed in terms of percentage on a 22-segment graph. For descriptive purposes we will refer to the 22 segments as S0–S21, going from left to right.

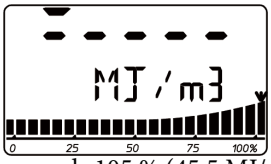
The indicated value in percentage terms (DISP) corresponds to the lighting or blinking of the segments as shown below.

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

Operation mode

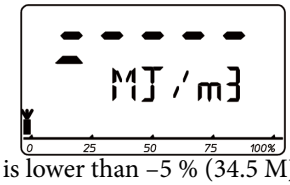


Normal Operation



PV exceeds 105 % (45.5 MJ/m^3)

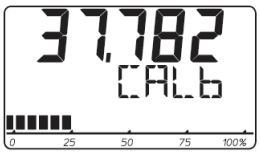
Non-critical status



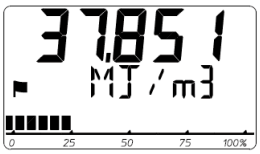
PV is lower than –5 % (34.5 MJ/m^3)

Non-critical status

Calibration mode

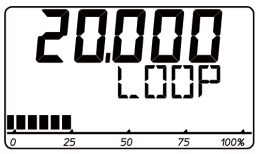


Calibration in process



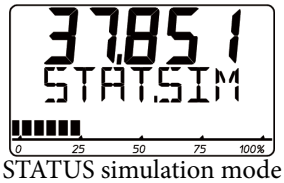
Calibration factor (CF) error

Loop test mode



FAILSAFE / STATUS / CALIB simulation mode

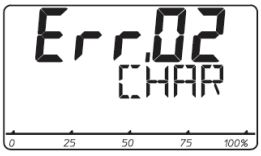
FAIL SAFE simulation mode



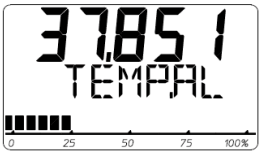
STATUS simulation mode

CALIB simulation mode

Error mode



Example of Critical error



Non-critical status

Chapter 4: Operation Using HART Communicator

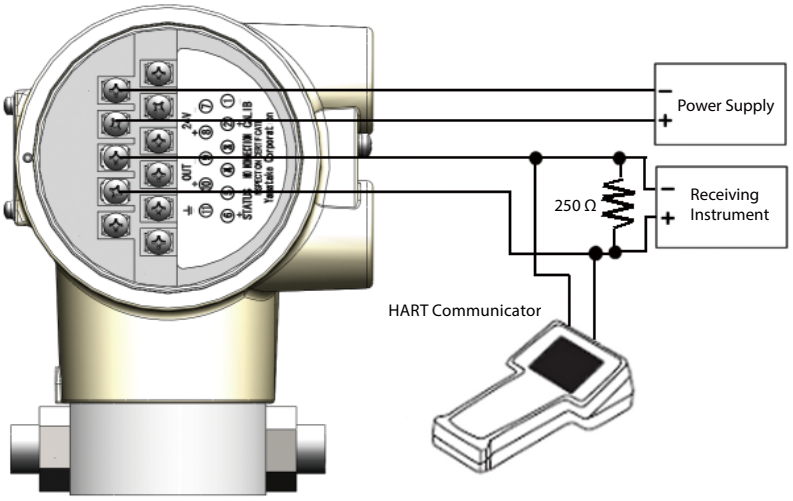
This section explains how to configure CVM400 using HART Communicator. For details on the Communicator, please refer to the user's manual for HART Communicator 375/475.

The menus and operation are almost the same when CommStaff is used. CommStaff is software that runs on a PC, so the procedure of establishing communication, and specifications or operations of keys and icons are different. For details on the basic operation method, refer to Field Communication Software CommStaff: Model CFS100 (Common Edition) User's Manual (CM2-CFS100-2001).

4-1: Starting communications

4-1-1: Connecting Communicator

The Communicator can be connected directly to the signal terminals on CVM400's terminal block, or at any location in the 4–20 mA loop. The polarity of the connection does not matter.
The connection method is the same for CommStaff.



4-1-2: Establishing communication

This procedure starts communication between CVM400 and the Communicator.
If CommStaff is used, refer to the user's manual for it indicated above.

Step	Action and/or Description
1	Turn on the Communicator. The Communicator runs a self-test check and then determines if it is connected to CVM400.
2	If you receive a communication error message (No Device Found), check the following. • Loop resistance: Is the Communicator connected with a minimum of 250 Ω resistance? • Power supply: Is power being applied? Is there greater than 21.6 V at the CVM400 terminal? Correct any problems, and try communication again.
3	When the "Online" display appears, communication is established. The flashing heart icon in the upper middle indicates that the devices are communicating. Note: If CommStaff is used, the "HART beat" icon on the bottom right of the display blinks.

4-1-3: Checking basic data

This procedure starts communication between CVM400 and the Communicator.

Step	Action and/or Description
1	From the “Online” menu, enter “Device” by pressing the right arrow key (→) on the Communicator keypad.
2	Press the down arrow (↓) key to scroll down to menu-item.

1. Device information

   Information about the CVM400 device can be checked with a HART Communicator. For details on device information, refer to 4-6, “Device information.”

- Manufacturer
- Model
- Model No.
- Dev id
- GasCVD serial number
- Tag
- Long Tag
- Date
- Descriptor
- Message
- Serial number
- Final assembly num
- Distributor
- Cfg chng count
- Revision numbers (Universal rev, Fld dev rev, Software rev, Hardware rev)
- Write protect
- Production No.
- Software version (OIML S/W ver., Operation S/W ver.)

2. Configuration parameter

   Parameters of the CVM400 can be configured (setup and change) using the HART Communicator. The configurable parameters are listed below. For details, see the description of each command in 4-5, “Detailed setup.” The parameters marked “(read/write)” in that section are configurable.

- Fail safe direction (default is downscale)
- PV trim (default is '0' with or without unit)
- Hold time (default is 20 minutes)
- First calib. time (default is 24 hours)
- Interval (default is 7 days)
- Config proc. alarm / Proc. alarm lower alarm value (default is 0 % of the range)
- Config proc. alarm / Proc. alarm upper alarm value (default is 100 % of the range)
- Config proc. alarm / Proc. alarm hysteresis (default is 5 %)
- Config temp. alarm / Temp. alarm lower alarm value (default is 50 °C)
- Config temp. alarm / Temp. alarm upper alarm value (default is 70 °C)
- STATUS selection (default is Process alarm)
- STATUS type (default is Normally Open)

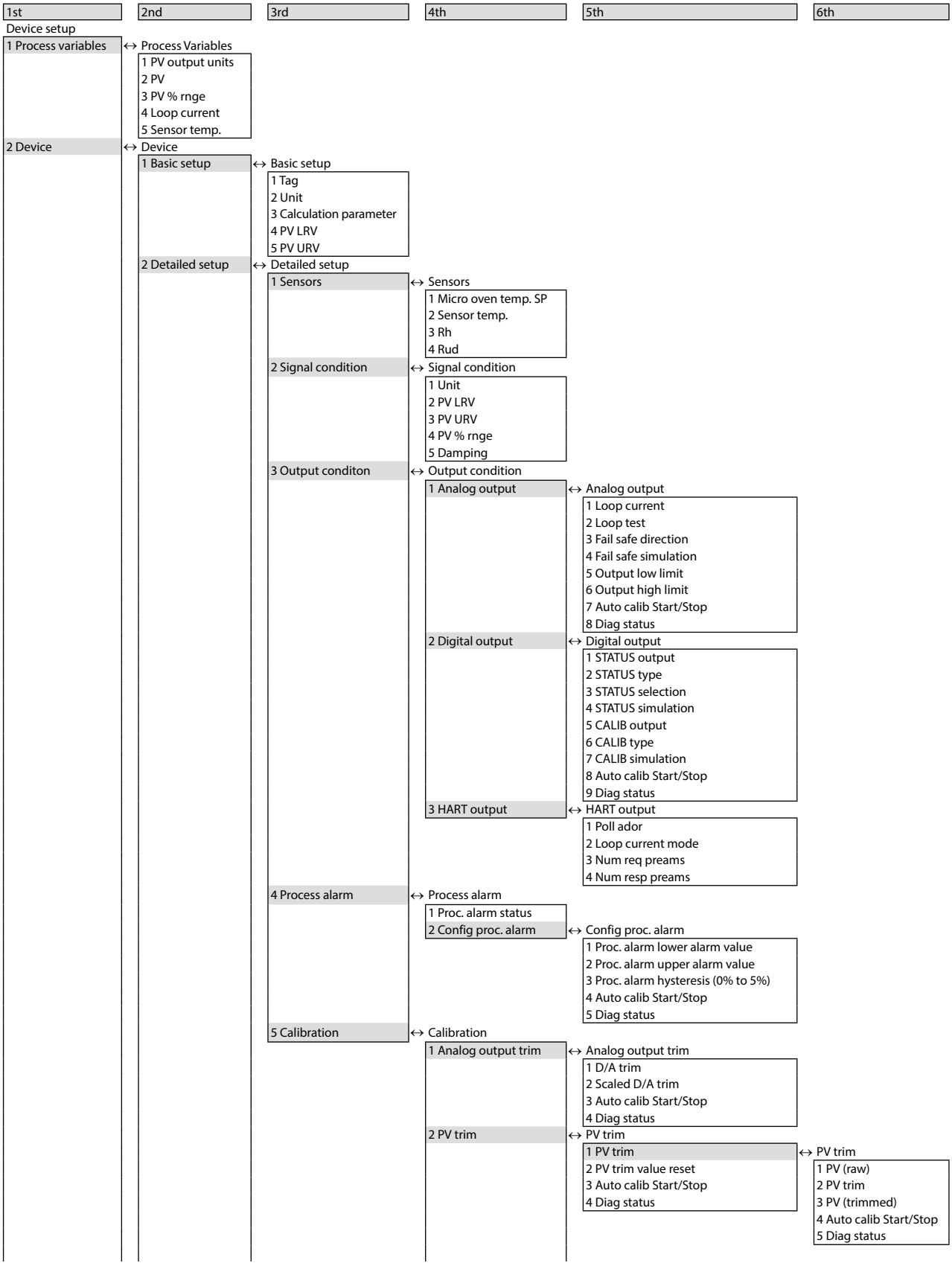
4-2: Top menu (menu tree)

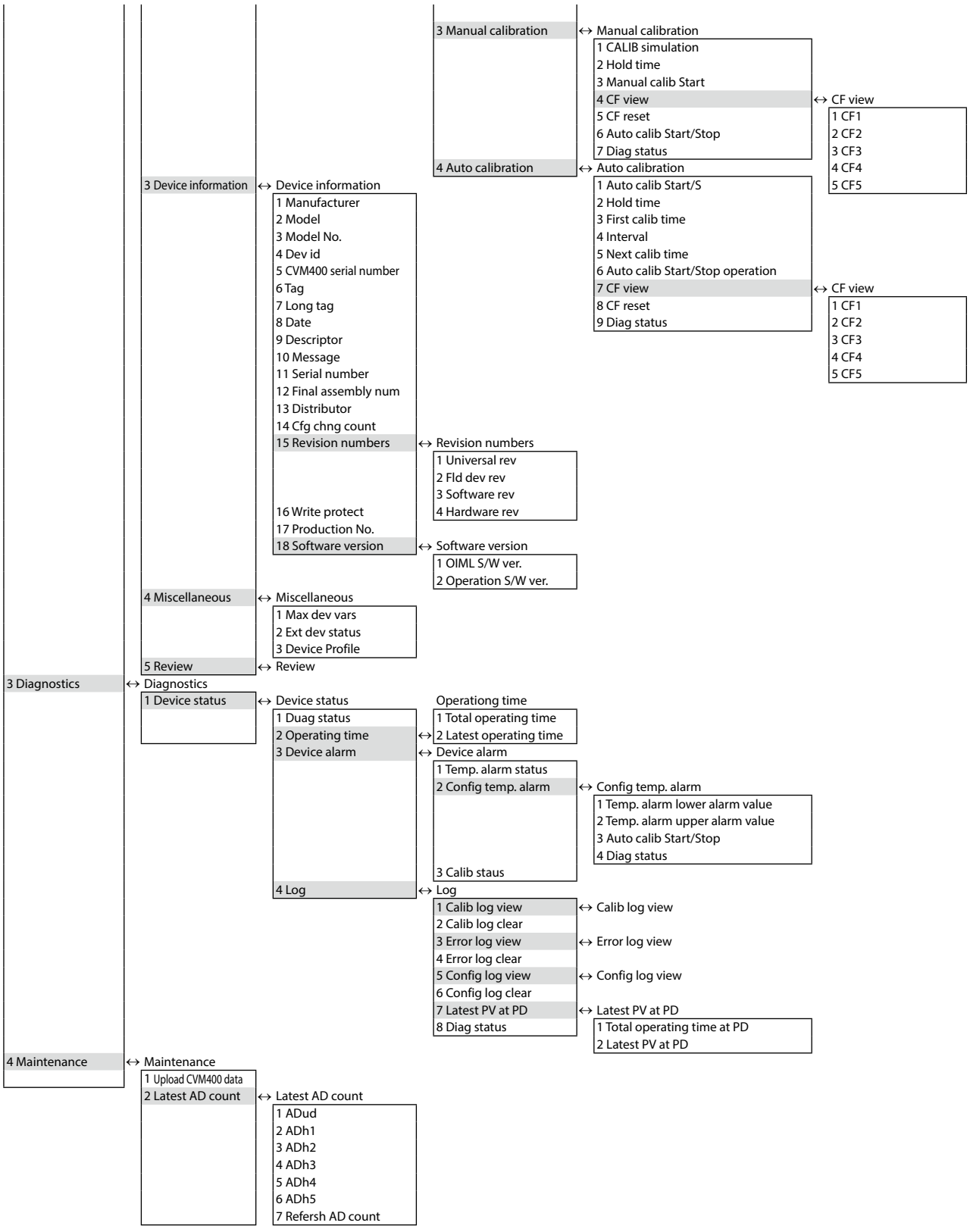
The top menu consists of 4 items:

1. Process variables
2. Device
3. Diagnostics
4. Maintenance

Menu tree

Depending on the version of the HART DD (Device Descriptions), some items will not be displayed or cannot be used.




3 Manual calibration
↔ Manual calibration
1 CALIB simulation
2 Hold time
3 Manual calib Start
4 CF view
↔ CF view
1 CF1
2 CF2
3 CF3
4 CF4
5 CF5
5 CF reset
6 Auto calib Start/Stop
7 Diag status
4 Auto calibration
↔ Auto calibration
1 Auto calib Start/S
2 Hold time
3 First calib time
4 Interval
5 Next calib time
6 Auto calib Start/Stop operation
7 CF view
↔ CF view
1 CF1
2 CF2
3 CF3
4 CF4
5 CF5
8 CF reset
9 Diag status
3 Device information
↔ Device information
1 Manufacturer
2 Model
3 Model No.
4 Dev id
5 CVM400 serial number
6 Tag
7 Long tag
8 Date
9 Descriptor
10 Message
11 Serial number
12 Final assembly num
13 Distributor
14 Cfg chng count
15 Revision numbers
↔ Revision numbers
1 Universal rev
2 Fld dev rev
3 Software rev
4 Hardware rev
16 Write protect
17 Production No.
18 Software version
↔ Software version
1 OIML S/W ver.
2 Operation S/W ver.
4 Miscellaneous
↔ Miscellaneous
1 Max dev vars
2 Ext dev status
3 Device Profile
5 Review
↔ Review
3 Diagnostics
↔ Diagnostics
1 Device status
↔ Device status
Operationg time
1 Duag status
2 Operating time
↔ 1 Total operating time
2 Latest operating time
3 Device alarm
↔ Device alarm
1 Temp. alarm status
2 Config temp. alarm
↔ Config temp. alarm
1 Temp. alarm lower alarm value
2 Temp. alarm upper alarm value
3 Auto calib Start/Stop
4 Diag status
3 Calib staus
4 Log
↔ Log
1 Calib log view
↔ Calib log view
2 Calib log clear
3 Error log view
↔ Error log view
4 Error log clear
5 Config log view
↔ Config log view
6 Config log clear
7 Latest PV at PD
↔ Latest PV at PD
8 Diag status
1 Total operating time at PD
2 Latest PV at PD
4 Maintenance
↔ Maintenance
1 Upload CVM400 data
2 Latest AD count
↔ Latest AD count
1 ADud
2 ADh1
3 ADh2
4 ADh3
5 ADh4
6 ADh5
7 Refersh AD count

Detail of Review and Log view display

Review

1	Manufacturer
2	Model
3	Model No.
4	Dev id
5	CVM400 serial number
6	Tag
7	Long tag
8	Date
9	Descriptor
10	Message
11	Serial number
12	Final assembly num
13	Distributor
14	Cfg chng count
15	Universal rev
16	Fld dev rev
17	Software rev
18	Hardware rev
19	Write protect
20	Production No.
21	OIML S/W ver.
22	Operation S/W ver.
23	Poll addr
24	Loop current mode
25	Num req preams
26	Num resp preams
27	Max dev vars
28	Ext dev status
29	Device Profile
30	Unit
31	Calculation parameter
32	PV LRV
33	PV URV
34	Micro oven temp. SP
35	CVM400 sensor serial number
36	Rh
37	Rud
38	Damping
39	Fail safe direction
40	Output low limit
41	Output high limit
42	STATUS type
43	STATUS selection
44	CALIB type
45	Proc. alarm lower alarm value
46	Proc. alarm upper alarm value
47	Proc alarm hysteresis(0 to 5)
48	Temp. alarm lower alarm value
49	Temp. alarm upper alarm value
50	PV trim
51	Auto calib Start/Stop
52	Hold time
53	First calib time
54	Interval
55	PV output units
56	PV
57	PV % rnge
58	Loop current
59	Sensor temp.
60	STATUS output
61	CALIB output
62	Diag status
63	Total operating time
64	Latest operating time
65	Proc. alarm status
66	Temp. alarm status
67	Calib status

Calib log view

1	Calib log1 Total operating time
2	Calib log1 Calib status
3	Calib log1 CF1
4	Calib log1 CF2
5	Calib log1 CF3
6	Calib log1 CF4
7	Calib log1 CF5
8	Calib log2 Total operating time
9	Calib log2 Calib status
10	Calib log2 CF1
11	Calib log2 CF2
12	Calib log2 CF3
13	Calib log2 CF4
14	Calib log2 CF5
15	Calib log3 Total operating time
16	Calib log3 Calib status
17	Calib log3 CF1
18	Calib log3 CF2
19	Calib log3 CF3
20	Calib log3 CF4
21	Calib log3 CF5
22	Calib log4 Total operating time
23	Calib log4 Calib status
24	Calib log4 CF1
25	Calib log4 CF2
26	Calib log4 CF3
27	Calib log4 CF4
28	Calib log4 CF5
29	Calib log5 Total operating time
30	Calib log5 Calib status
31	Calib log5 CF1
32	Calib log5 CF2
33	Calib log5 CF3
34	Calib log5 CF4
35	Calib log5 CF5

Error log view

1	Error log1 Total operating time
2	Error log1 Error
3	Error log2 Total operating time
4	Error log2 Error
5	Error log3 Total operating time
6	Error log3 Error
7	Error log4 Total operating time
8	Error log4 Error
9	Error log5 Total operating time
10	Error log5 Error

Config log view

1	Config log1 Total operating time
2	Config log1 Operation
3	Config log2 Total operating time
4	Config log2 Operation
5	Config log3 Total operating time
6	Config log3 Operation
7	Config log4 Total operating time
8	Config log4 Operation
9	Config log5 Total operating time
10	Config log5 Operation

4-3: Process variables

This is for checking the operation output.

Process variables

PV output units (read):	Output unit by model number
PV (read):	Value of output
PV (%) rnge (read):	% full scale of output
Loop current (read):	Current output in mA
Sensor temp (read):	Temperature of the sensor chip

4-4: Basic setup

This is for checking the basic setup.

Device → Basic setup

Device Tag (read/write):	Maximum 8 characters (alphabetic and numeric)
Unit (read):	Determined by model number
Calculation parameter (read):	Determined by model number
PV LRV (read):	Lower range value
PV URV (read):	Upper range value

4-5: Detailed setup

4-5-1: Sensors

This section shows how to read the Micro oven temp SP and Sensor temp.

Device → Detailed setup → Sensors

Micro oven temp SP (read):	The sensor tip temperature setting, which is fixed at 60 °C.
Sensor temp (read):	A sensor temperature when the device is operating. It is controlled to be 60 °C ± 1 °C. The operating sensor temperature. CVM400 maintains accuracy in an ambient temperature range of –10 to +50 °C by temperature compensation.
R_h (read):	Sensor resistance R_h at 60 °C (for manufacturer use).
R_{ud} (read):	Sensor resistance R_{ud} at 60 °C (for manufacturer use).

4-5-2: Signal condition

This section shows how to read the signal condition.

Device → Detailed setup → Signal condition

Units (read):	Determined by model number
PV LRV (read):	Lower range value
PV URV (read):	Upper range value
PV (%) rnge (read):	% full scale of output
Damping (read/write):	Fixed at 0.0 s

4-5-3: Output condition

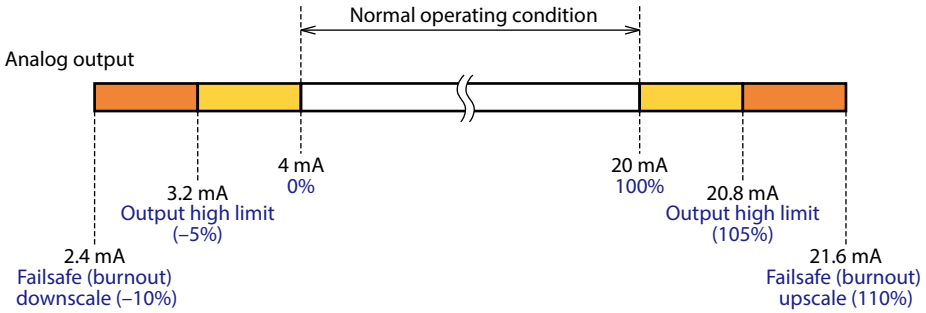
Analog output

This section shows how to configure the analog output.

Device → Detailed setup → Output condition → Analog output

Analog output level is shown in the diagram below.

Analog Output Level



Loop current (read):	Analog output current value (mA)
Loop test (read/write):	CVM400 can be set to a constant-current source mode, and automatically returns to the calorie measuring condition. → Regular operating condition as CVM • 4mA: Sets the output signal level to 4 mA (0%) • 20mA: Sets the output signal level to 20 mA (100%) • 4→8→12→16→20 mA manual switching: output signal level is switched sequentially. After 20 mA the test ends. • Other Enter any value between 3.2 and 20.8 mA. Whether communicator is connected or not, constant current mode will be released in ten minutes, and it will return to ordinary measuring condition.
Fail safe direction (read/write):	When a critical failure occurs, CVM400 sets the analog output to the fail safe (burnout) direction, either down (2.4 mA (-10%)) or up (21.6 mA (110%)). The default setting is down (2.4 mA).
Fail safe simulation (read/write):	Simulates the fail safe condition. After the fail safe simulation starts, it will continue for ten minutes and then automatically stop.
Output low limit (read):	For checking the lowest current output within the normal output range (fixed at 3.2 mA (-5% F.S.)).
Output high limit (read):	For checking the highest current output within the normal output range (fixed at 20.8 mA (105% F.S.)).
Auto calib Start/Stop setting (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, “Manual calibration / auto calibration.”
Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, “0x00000000” is shown. If any error or alarm occurs, the description can be displayed by pressing the arrow key on the HART Communicator keypad . For details on errors and alarms, refer to chapter 6, “Troubleshooting.” Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

Digital output

This section shows how to configure the digital output. There are two digital outputs, namely STATUS output and CALIB output.

Device → Detailed setup → Output condition → Digital output

STATUS output (read):	Tells if STATUS contact output is No alarm or Alarm.
STATUS type (read/write):	Configures STATUS contact output to open or close the circuit upon detection of an alarm condition. The default setting is NO. • Normally Open (NO): When no alarm is detected, contact output is OPEN. When an alarm is detected, contact output is CLOSE. • Normally Close (NC): When no alarm is detected, contact output is CLOSE. When an alarm is detected, contact output is OPEN.
STATUS selection (read/write):	Select STATUS output item from below. • None • Process alarm (default) • Sensor temp. alarm • Calibration in process or Calibration failure • Process + Sensor temp. • Sensor temp. + Calibration • Calibration + Process • All
STATUS simulation (read/write):	Simulates the condition of the STATUS contact output, OPEN or CLOSE. After status contact output simulation starts, it continues for ten minutes and then automatically stops. If "Continue" is clicked before that time, the simulation continues for two hours more. Note: If CommStaff is used, when a simulation is executed, a simulation mode can be selected from the following options: Continue simulation mode 10 minutes Continue simulation mode 2 hours End simulation mode When the simulation is complete, simulation mode ends automatically.
CALIB output (read):	Tells if CALIB contact output is OPEN or CLOSE.
CALIB type (read):	The CALIB contact output is fixed at NO. • Normally Open (NO): In non-calibration, gas will flow from flow pass (NO) of NG (process gas) to CVM400, and in the beginning of calibration it will flow from flow pass (NC) of calibration gas to CVM400.
CALIB simulation (read/write):	Simulates the condition of the CALIB contact output, OPEN or CLOSE. If CALIB simulation is set, simulation time for contact output will be ten minutes. If continued before end, it will be two hours. If not continued, it will be stopped automatically in 10 minutes. Note: If CommStaff is used, when a simulation is executed, a simulation mode can be selected from the following options: Continue simulation mode 10 minutes Continue simulation mode 2 hours End simulation mode When the simulation is complete, simulation mode ends automatically.
Auto calib Start/Stop (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, "Manual calibration / auto calibration."

Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. Refer to Chapter 6, "Troubleshooting" for detail. Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

HART output

This section shows how to configure the HART output.

Device → Detailed setup → Output condition → HART output

Poll addr (read):	0 (fixed)
Loop current mode (read):	Enabled (fixed)
Num req preams (read):	5 (fixed)
Num res preams (read/write):	5 (default)

Note: CVM400 is not suitable for multidrop use.

4-5-4: Process alarm

This shows how to configure the process alarm.

Device → Detailed setup → Process alarm

When an alarm condition is detected, the alarm code is displayed on the LCD, the STATUS contacts are activated if digital output has been configured, and the alarm is logged in the status history of the device.

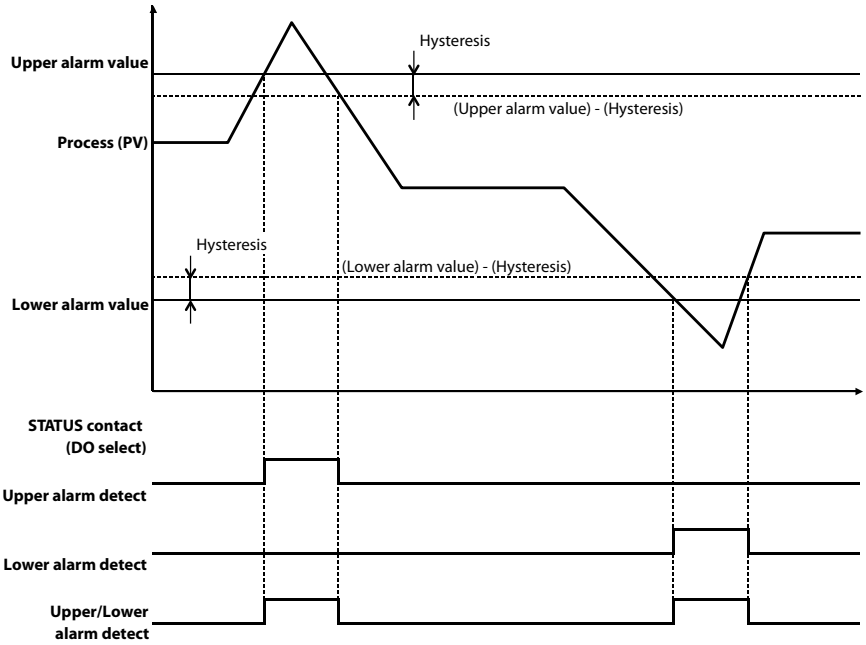
Proc. alarm status (read):	Shows the condition of the process alarm, No alarm or Alarm.
Config proc. alarm (read/write):	There are 3 possible settings. (Proc. alarm lower alarm value, Proc. alarm upper alarm value, and Proc. alarm hysteresis). The upper limit cannot be equal to or less than the lower limit.

Process alarm setting

Proc. alarm lower alarm value (read/write):	Lower limit alarm value: The threshold for the lower limit alarm (setting range: -5 to +100 % of LRV, default: 0 %)
Proc. alarm upper alarm value (read/write):	Upper limit alarm value: The threshold for the upper limit alarm (setting range: 0 to 105 % of URV, default: 100 %)
Proc. alarm hysteresis (read/write):	Hysteresis: The hysteresis alarm threshold is selectable from 0 to 5 % in 1 % increments. The hysteresis can be set in a range just below the upper limit alarm value and just above the lower limit alarm value.
Auto calib start/stop (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, "Manual calibration / auto calibration."
Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. Refer to Chapter 6, "Troubleshooting" for detail. Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

For the OIML R140-compliant model, do not change the default upper and lower alarm values because specific settings are required by the OIML recommendation. For details, refer to "Metrology Approval" in the "Safety" section.

• Sample operation of process alarm



4-5-5: Calibration

This section provides information about analog output trim, PV trim and calibration.

Device → Detailed setup → Calibration

4-5-5-1: Analog output trim

Before you start

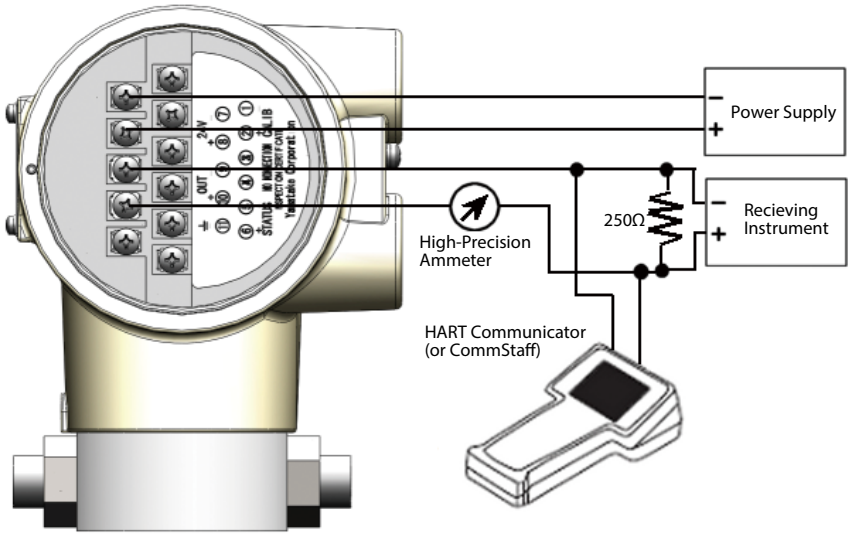
Output signal calibration (adjustment of the D/A conversion unit) is unnecessary under ordinary operating conditions. Normally, a Azbil Corporation authorized service provider performs this work. End-users who must do this work need the equipment listed below.

Equipment

- High-precision ammeter or voltmeter with accuracy of 0.03 % FS or higher
- Resistor, 250 Ω ± 0.005 %
- HART Communicator or CommStaff

Set-up

Devices will be connected as shown in the following figure.



Calibrating the Analog Output Signal

To calibrate CVM400's analog output circuit, use its constant-current source mode.

Device → Detailed setup → Calibration → Analog output trim → D/A trim

Device → Detailed setup → Calibration → Analog output trim → Scaled D/A trim

D/A trim procedure:

1	When a prompt appears, connect the precision ammeter or voltage meter in loop to check reading. Press OK.
2	The following display prompts will appear: "Setting field device output to 4 mA." —Press OK. "Enter meter value." —Key in meter value, then press OK. "Is field device 4.000 m A output equal to the reference meter reading? 1 Yes 2 No" • If the two are not equal, select No, press ENTER, and then enter the new meter value. (As many as 4 digits after the decimal point can be input. Return to the "Enter meter value" prompt until the field device output equals the reference meter.) • If the two are equal, select Yes and press ENTER.
3	The following display prompts will appear: "Setting field device output to 20mA." —Press OK. "Enter meter value." —Key in meter value, then press OK. "Is field device 20.000 mA output equal to the reference meter reading? 1 Yes 2 No" • If the two are not equal, select No, press ENTER, and then enter the new meter value. (As many as 4 digits after the decimal point can be input. Return to the "Enter meter value" prompt until the field device output equals the reference meter.) • If the two are equal, select Yes and press ENTER.

Note: In the case of scaled D/A trim, voltage will be displayed instead of current.
Example: 4,000 mA → 1.000 V, 20.000 mA → 5.000 V
As many as 4 digits after the decimal point can be input. For example: 1.0001, 4.9999.

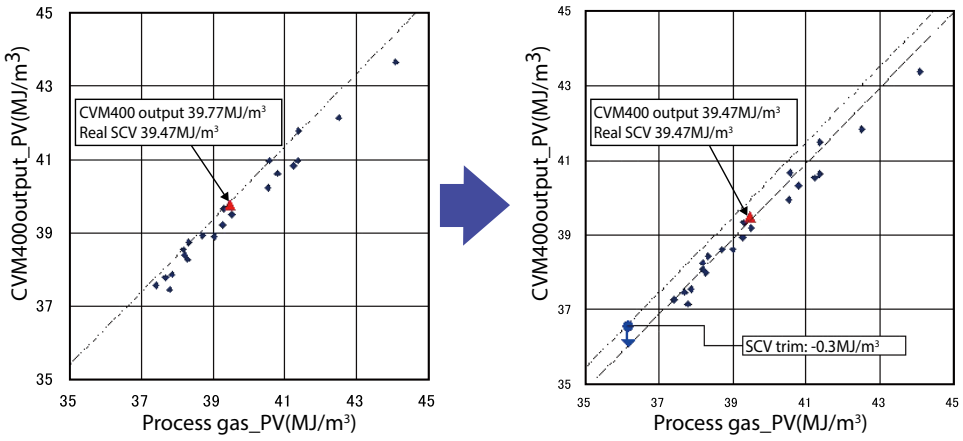
4-5-5-2: PV trim

PV trim adjusts the PV output by shifting it. If the PV of the process gas is known and is slightly different from CVM400's output, you can fix the output using this shift adjustment. (See figure below.)
This function adjusts the formula used for calculation in order to shift the output, but it does not improve the accuracy of the output.

Device → Detailed setup → Calibration → PV trim

PV trim (read/write):	Increases or decreases the PV output from -2 to + 2 with unit or from -5 to + 5 for Methane number. Set the amount to increase or decrease and press ENTER.
PV trim value reset (read/write):	Clears the PV trim setting and restores the factory default (±0 with or without unit)
Auto calib Start/Stop (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, "Manual calibration / auto calibration."

Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. If an error or alarm occurs, a description of it can be displayed by pressing the arrow key on the HART Communicator keypad. For details on errors and alarms, refer to chapter 6, "Troubleshooting." Note: If CommStaff is used, right-click [Diag status] and click the displayed value to show a description of the error or alarm.



Before SCV trim　　After SCV trim (-0.3 MJ/m³)

4-5-5-3: Manual calibration / auto calibration

Calibration compensates for sensor sensitivity drift caused by long-term use or long-term storage. CVM400 has already been calibrated at the factory but you should recalibrate it with your own calibration gas (pure methane gas) to ensure the accuracy of analysis in the following cases:

- When first installing CVM400.
- When an unused CVM400 is returned to active service.
- At a calibration interval decided by the user. The recommended calibration cycle is once per week.

The calibration gas must be pure methane 4.5 (≥99.995 %). The consumption of calibration gas depends on the sampling system. If Hold time is set to 20 minutes and the flow rate is 50 ml/min, the consumption will be about 500 ml for one calibration.

There are two methods of calibrating CVM400, Manual Calibration and Auto Calibration. The difference between the two methods lies in whether calibration is repeated at a user-defined interval or not. The calibration procedure during hold time is the same. The calibration procedure is described below.

Note: During manual calibration and after auto calibration has started, settings cannot be changed and simulations cannot be run.

Step	Calibration procedure
1	Turn CALIB contact output on. Change the inlet gas from process gas to calibration gas. The LCD displays "Calib" and the output is held at the latest PV value.
2	Wait for the first half of hold time.

Step	Calibration procedure
3	Execute calibration and calculate the new calibration factors (CFs). If all the new CFs are within the 0.95 –1.05 range, the calibration was successful and the CFs are changed to the new ones. If one or more CFs are outside the 0.95 –1.05 range, the calibration has failed and the CFs have not been changed. Note: For the CVM400 with operation software version 1.4 or earlier, CFs are the 0.99 –1.01 range.
4	Turn the CALIB contact output off. Change the inlet gas from calibration gas to process gas.
5	Wait for the second half of hold time to allow replacement of the gas.
6	At the end of the hold time, the calibration process and "Calib" mode end. The LCD shows the normal operation display and the output hold is cleared.

If calibration fails, an alarm flag appears on the LCD display. The flag means that there was a calibration failure, and it is not cleared until calibration succeeds. The calibration log is updated regardless of success or failure.

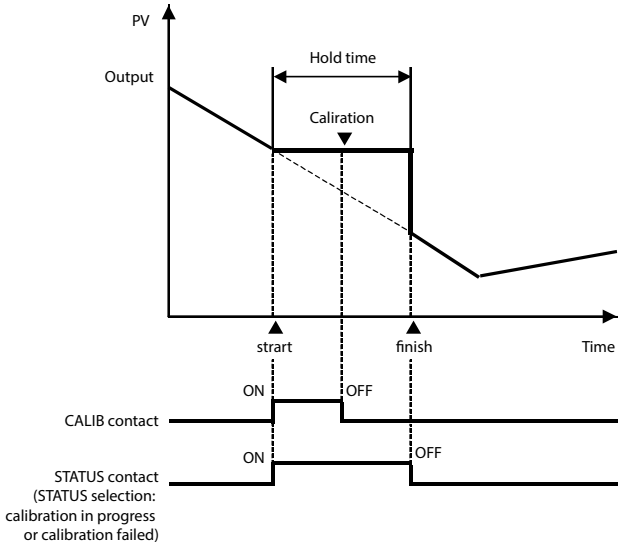
Manual calibration

This shows how to execute Manual calibration.

Device → Detailed setup → Calibration → Manual calibration

CALIB simulation (read/write):	OPEN/CLOSE When CVM400 is newly installed with the sampling system, use this CALIB contact control command to switch the solenoid valve and check the calibration gas replacement time in order to decide the hold time for calibration. For extension of the time of a CALIB simulation, or cancellation, refer to "CALIB simulation" in the table under "Digital output" in 4-5-3, "Output condition."
Hold time (read/write):	The hold time setting range is from 2 to 120 minutes. (default: 20min) Calibration takes place halfway through the hold time. Allow enough hold time for replacement of the process gas with calibration gas. Hold time > gas replacement time × 2 + α (α:Preparation time)
Manual calib start (read/write):	Selecting "Manual calib start" starts the hold time of the manual calibration process. Once "Manual calib start", it cannot stop till end.
CF view (read):	You can check the four CFs generated by the latest successful calibration. The factory default CF settings are all 1.00000. CFs serve as a correction factor for PV calculation and also allow the user to track sensor sensitivity drift.
CF reset (read/write):	"CF reset" clears the latest CFs, restores the default values of 1.00000, and clears the calibration failure flag and alarm.
Auto calib Start/Stop (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, "Manual calibration / auto calibration."
Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. If an error or alarm occurs, a description of it can be displayed by pressing the arrow key on the HART Communicator keypad. For details on errors and alarms, refer to chapter 6, "Troubleshooting." Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

• Sample operation of manual calibration



Auto calibration

This shows how to execute automatic calibration.

Device → Detailed setup → Calibration → Auto calibration

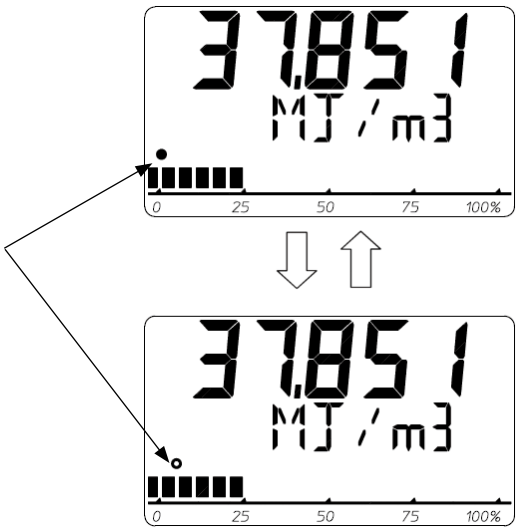
Auto calibration will repeatedly execute manual calibration at a user-defined interval.

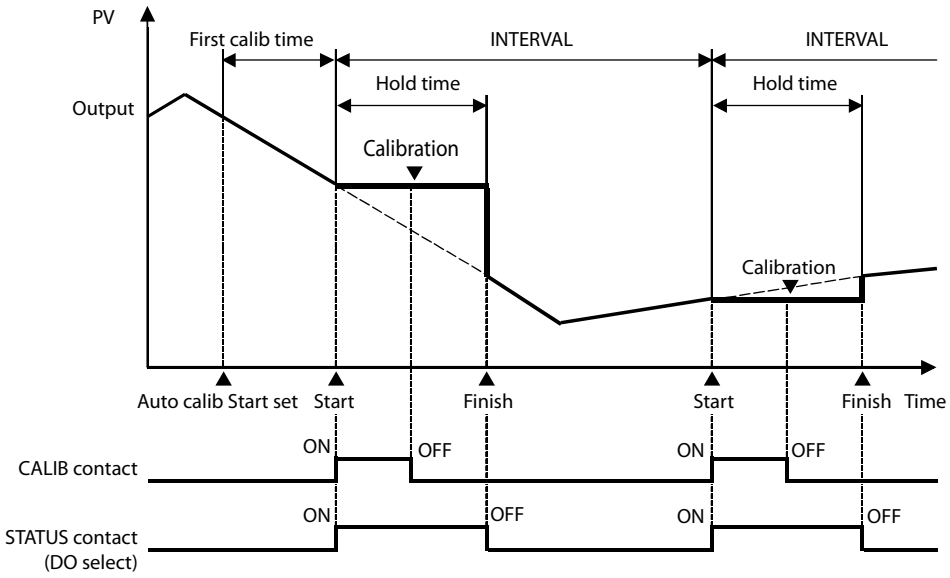
Auto cailb Start/Stop (read):	Shows if auto calibration has been set.
Hold time (read/write):	The same parameter as hold time in manual calibration. The default setting is twenty minutes.
First calib time (read/write):	Setting range is 0 – 200 hours. The setting is activated once "Auto calib Start/Stop" is set, The default setting is twenty-hour hours. Note: For the CVM400 with operation software version 1.3 or earlier, the maximum time is 24 hours.
Interval (read/write):	Setting range is 1 – 180 days. The recommended calibration cycle and default setting is once per week (7 days).
Next calibration time (read):	The remaining time to the next calibration.
Auto calib Start/Stop operation (read/write):	When "Start" is set, auto calibration starts. When "Stop" is set, auto calibration stops. "●↔○" appears and blinks on the LCD display if Auto calib is scheduled.
CF view (read):	You can check the four CFs generated by the latest successful calibration. The factory default CF settings are all 1.00000. CFs serve as a correction factor for SCV calculation and also allow the user to track sensor sensitivity drift.
CF reset (read/write):	"CF reset" clears the latest CFs, restores the default values of 1.00000, and clears the calibration failure flag and alarm.
Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. If an error or alarm occurs, a description of it can be displayed by pressing the arrow key on the HART Communicator keypad. For details on errors and alarms, refer to chapter 6, "Troubleshooting." Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

• Sample operation of auto calibration

Hold time: 20 min
First calib time: 13 h
Interval: 1 day

"●" and "○" are shown here alternately.





! Handling Precautions:

If the power is turned off when auto calibration is running, the elapsed time will be ignored when the power is turned back on. The first calib time and interval settings become valid when auto calibration is set up.
When the power is turned on again, auto calibration will start to count the first calib time. Reset the first calib time or intervals as needed.

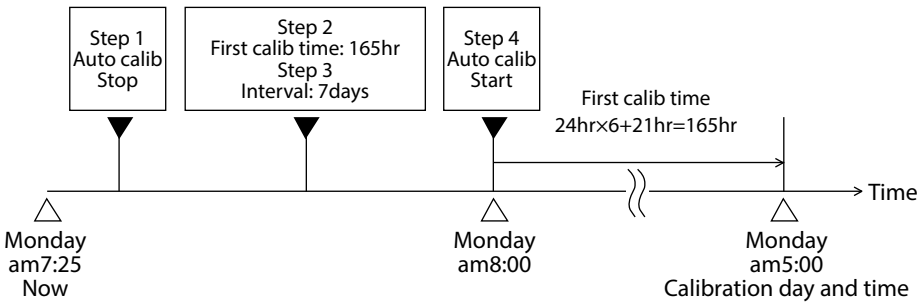
During an auto calibration (Auto calib: Start), the settings of the CVM400 cannot be changed and some operations are prohibited. If these are needed, stop the auto calibration. The operations that cannot be executed are as follows:

Analog output
Digital output
Config proc. alarm
Analog output trim
PV trim
Manual calibration
Auto calibration
Config. temp alarm

If auto-calibration does not start at the scheduled time, perform the following reset with a HART communicator, referring to 4.2, “Top menu (menu tree).”

Step	Procedure to correct the auto-calibration start time
1	Stop the auto-calibration.
2	Reset the time until the first auto-calibration.
3	Reset the interval between the auto-calibration operations, if needed.
4	Start the auto-calibration.

Example of auto-calibration start time correction
(when executing auto-calibration every Monday at 5:00 a.m.)



4-6: Device information

This shows how to read and write device information. (Follow the maximum character number)

Device → Device information

Manufacturer (read):	Azbil Corporation
Model (read):	GasCVD
Model No. (read):	CVM400-xxxxxx-xxxx-x
Dev id (read):	XXXXXX
GasCVD serial number (read):	32XXXXXX
Tag (read/write):	Maximum 8 characters (alphabetic and numeric)
Long Tag (read/write)	Maximum 32 characters (alphabetic and numeric)
Date (read/write):	mm/dd/yyyy • mm: month, 2-digit number • dd: day 2-digit number • yyyy: year 4-digit number
Descriptor (read/write):	Maximum 16 characters (alphabetic and numeric)
Message (read/write):	Maximum 32 characters (alphabetic and numeric)
Serial number (read):	"0" (fixed)
Final assembly num (read/write):	Instruments update No.
Distributor (read):	Seller
Cfg chng count (read):	Setting change counter
Revision number:	For details, See the table below.
Write protect:	For details, See the table below.
Production No. (read):	Production No.
Software version:	For details, See the table below.

Revision number

Here various revisions regarding HART communication can be confirmed.

Device → Device information → Revision number

Revision number (read):	There are 4 types of revision. • Universal rev • Fld dev rev • Software rev • Hardware rev

Write Protect

Software write protection can be checked. .

Device → Device information → Write protect

Write protect (read):	None

Software version

Here S/W version unique to CVM400 can be confirmed.

Device → Device information → Software version

Software version (read):	There are 2 types of version. • OIML S/W version • Operation S/W version

Note: The software version is shown as follows:

Ex: ver. 1.0 → 10, ver. 1.1 → 11

4-7: Miscellaneous

This section shows how to read the Miscellaneous.

Device → Miscellaneous

Max dev vars (read):	"1" fixed
Ext dev status Status (read):	“0x00” No problem “0x02” Device variable alert
Device profile (read):	"Process Automation Device" fixed

4-8: Review (read only)

This section shows how to read the Review.

Device → Review

All setting data of CVM400 will be shown.

Review

1	Manufacturer	35	GasCVD sensor serial number
2	Model	36	Rh
3	Model No.	37	Rud
4	Dev id	38	Damping
5	GasCVD serial number	39	Fail safe direction
6	Tag	40	Output low limit
7	Long tag	41	Output high limit
8	Date	42	STATUS type
9	Descriptor	43	STATUS selection
10	Message	44	CALIB type
11	Serial number	45	Proc. alarm lower alarm value
12	Final assembly num	46	Proc. alarm upper alarm value
13	Distributor	47	Proc alarm hysteresis(0 to 5)
14	Cfg chng count	48	Temp. alarm lower alarm value
15	Universal rev	49	Temp. alarm upper alarm value
16	Fld dev rev	50	PV trim
17	Software rev	51	Auto calib Start/Stop
18	Hardware rev	52	Hold time
19	Write protect	53	First calib time
20	Production No.	54	Interval
21	OIML S/W ver.	55	PV output units
22	Operation S/W ver.	56	PV
23	Poll addr	57	PV % rnge
24	Loop current mode	58	Loop current
25	Num req preams	59	Sensor temp.
26	Num resp preams	60	STATUS output
27	Max dev vars	61	CALIB output
28	Ext dev status	62	Diag status
29	Device Profile	63	Total operating time
30	Unit	64	Latest operating time
31	Calculation parameter	65	Proc. alarm status
32	PV LRV	66	Temp. alarm status
33	PV URV	67	Calib status
34	Micro oven temp. SP		

4-9: Diagnostics

This section provides information about the Device status.

Device → Device status

If a process alarm is detected, it is reflected on the indicator display and in the status contact output. If a critical failure is detected, it is reflected on the indicator display, and output changes according to the burnout (fail safe) setting.

4-9-1: Diag status (read only)

The results of self-diagnostics can be checked.

Device → Device status → Diag status

If a critical failure error or non-critical status alarm is detected, a status message is shown using the error code or alarm. Refer to chapter 6, "Troubleshooting."

4-9-2: Operating time (read only)

Device → Device status → Operating time

CVM400 has 2 counters, used for the calibration setting and the time stamp for the log.

- Total operating time (read): Total operating time (in hours) since shipment from the factory.
  Example: Total operating time: xxxxx h
- Latest operating time (read): Latest operating time (in hours) since the latest power on.
  Example: Latest operating time: xxxxx h

4-9-3: Device alarms

Device → Device status → Device alarm

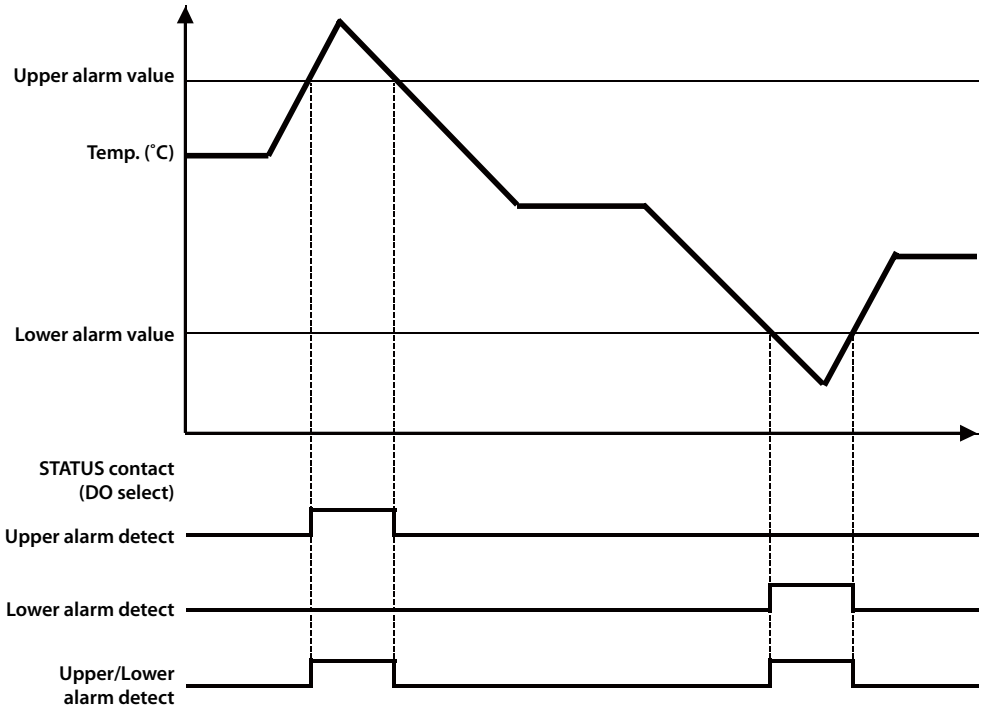
Temp. alarm status (read):	Shows if Temp alarm is occurring or not
Config temp alarm (read/write):	There are 3 possible settings. The upper limit cannot be equal to or less than the lower limit. • Lower alarm value: Threshold of lower limit alarm (setting range: 50–70 °C. Default is 50 °C.) • Upper alarm value: Threshold of upper limit alarm (setting range: 50–70 °C. Default is 70 °C.)
Calib. status (read):	For checking the latest calibration result.

Temp. alarm setting

Temp. alarm lower alarm value (read/write):	Lower alarm value: Threshold of lower limit alarm (setting range: 50–70 °C, Default is 50 °C.)
Temp. alarm upper alarm value (read/write):	Upper alarm value: Threshold of upper limit alarm (setting range: 50–70 °C, Default is 70 °C.)
Auto calib. Start/ Stop (read):	Whether an auto calibration is started or stopped is indicated. If it is started, settings cannot be changed and some operations are prohibited. For details, refer to 4-5-5-3, "Manual calibration / auto calibration."

Diag status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, "0x00000000" is shown. If an error or alarm occurs, a description of it can be displayed by pressing the arrow key on the HART Communicator keypad. For details on errors and alarms, refer to chapter 6, "Troubleshooting." Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

• Sample operation of status alarm



4-9-4: Log

Three types of log (Calib. log, Error log, and Config log) are stored in CVM400. Each log keeps the latest 5 records. Latest PV at PD, which is the PV just before both power failure and suspension of power supply, is also stored in CVM400. HART Communicator can read all three log files and latest PV at PD.

Device → Device status → Log

Calib log view(read):	The latest 5 calibration result records, including S/F (success or failure), CF_1–CF_5 (the 5 calibration factors), and total operating times.
Calib log clear (read/ write):	Clears calibration logs.
Error log view (read):	The latest 5 error code records (operations involving a parameter change) and total operating times.
Error log clear (read/ write):	Clears error logs.
Config log view(read):	The latest 5 configuration records (operations involving a parameter change) and total operating times.

Config log clear (read/ write):	Clears configuration logs.
Latest PV at PD (read):	The PV just before power-down and total operating times.
Diag. status (read):	Whether an error or failure has occurred is shown by a hexadecimal digit. If neither an error nor a failure has occurred, “0x00000000” is shown. If an error or alarm occurs, a description of it can be displayed by pressing the arrow key on the HART Communicator keypad. For details on errors and alarms, refer to chapter 6, “Troubleshooting.” Note: If CommStaff is used, right-click [Diag status] and click the displayed value to display a description of the error or alarm.

Calib log view

1 Calib log1 Total operating time
2 Calib log1 Calib status
3 Calib log1 CF1
4 Calib log1 CF2
5 Calib log1 CF3
6 Calib log1 CF4
7 Calib log1 CF5
8 Calib log2 Total operating time
9 Calib log2 Calib status
10 Calib log2 CF1
11 Calib log2 CF2
12 Calib log2 CF3
13 Calib log2 CF4
14 Calib log2 CF5
15 Calib log3 Total operating time
16 Calib log3 Calib status
17 Calib log3 CF1
18 Calib log3 CF2
19 Calib log3 CF3
20 Calib log3 CF4
21 Calib log3 CF5
22 Calib log4 Total operating time
23 Calib log4 Calib status
24 Calib log4 CF1
25 Calib log4 CF2
26 Calib log4 CF3
27 Calib log4 CF4
28 Calib log4 CF5
29 Calib log5 Total operating time
30 Calib log5 Calib status
31 Calib log5 CF1
32 Calib log5 CF2
33 Calib log5 CF3
34 Calib log5 CF4
35 Calib log5 CF5

Error log view

1 Error log1 Total operating time
2 Error log1 Error
3 Error log2 Total operating time
4 Error log2 Error
5 Error log3 Total operating time
6 Error log3 Error
7 Error log4 Total operating time
8 Error log4 Error
9 Error log5 Total operating time
Error log5 Error

Config log view

1 Config log1 Total operating time
2 Config log1 Operation
3 Config log2 Total operating time
4 Config log2 Operation
5 Config log3 Total operating time
6 Config log3 Operation
7 Config log4 Total operating time
8 Config log4 Operation
9 Config log5 Total operating time
Config log5 Operation

4-10: Service menu

The service menu is used by Azbil's service staff.

Chapter 5: Maintenance

5-1: Calibration

When end users calibrate CVM400, pure methane gas must be used. For OIML R140 compliant models, calibration is required at least every 90 days. Refer to 4-5-5-3: for calibration gas requirements, as well as calibration setup and execution.

Maintenance Precautions

⚠WARNING	
❗	When removing this device for maintenance, be careful of residual pressure or residual process gas. Leakage of process gas is dangerous.
❗	When working on the vent, check its direction so that people do not come into contact with vented gas. There is a danger of burns or other physical harm.
🚫	When the device is being used in an explosion-proof area, do not open the cover. Opening the cover may cause an explosion.

⚠CAUTION	
🚫	This product was kept under carefully controlled conditions until it was shipped. Never try to modify this device. Doing so could damage it.

Calibration gas consumption and cylinder exchange cycle

Calibrate using pure methane gas (purity of 99.995 % or better, = methane 4.5). Methane gas consumption (in ml) during calibration can be calculated by multiplying 50 ml/min by half of the hold time (min). For example, if the hold time is 20 minutes, methane gas consumption will be approximately 500 ml.

A corroded gas cylinder is dangerous because it contains high-pressure methane. Install the gas cylinder in a safe area where it will not corrode. Change the gas cylinder if you find corrosion. Even if no corrosion is found, changing the gas cylinder every two years is recommended.

5-2: Replacement parts

Changing and cleaning the sensor and wet parts cannot be done by the customer. Replacement filters for the inlet and outlet of the adapters are the only parts required for normal periodical maintenance. Refer to the WARNING and CAUTION notices in chapter 3-1 Before using CVM400. The spare parts list is shown below.

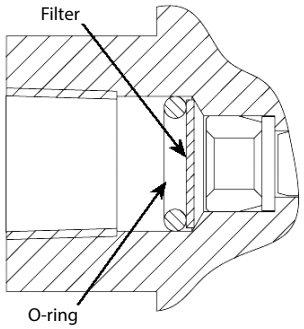
Refer to the WARNING and CAUTION notices in 3-1 Before using CVM400.

Replacement parts

Part name		Part No.	Quantity
O-rings (for covers)		80347035-00100	5
Cover (without window)		80347036-00100	1
Cover (with window)		80347052-00100	1
Hex wrenches (large, small)		80347037-00100	1 each
Adapters	1/8NPT	80347038-00100	2
	Rc 1/8	80347038-00200	
Filters and O-rings		80347039-00100	10

Changing the filter

The filter in the adapter is held by an O-ring. Remove the O-ring and then remove and change the filter. Install a new O-ring after changing the filter and confirm that the filter is securely installed.



Changing the adapters

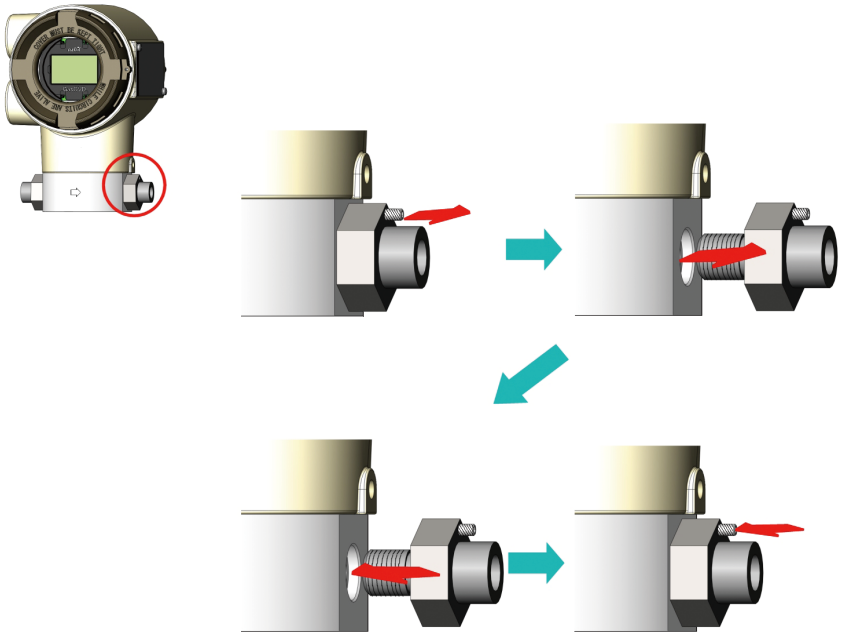
If the adapters seem to be plugged up, they must be changed using the following procedure. The inside of the adapters cannot be cleaned. When ordering, make sure that the thread specification for the adapter is correct. The adapter is important for maintaining the flameproof structure. Replace adapters in a safe place, and assemble carefully. After the replacement, conduct a leak check according to "Piping leak check" in section 2-3.

⚠WARNING

When replacing adapters, make sure to refer again to the warnings in section 2-3, "Piping," and section 3-1, "Before using CVM400."

Also, do adapter replacement work in a safe place, assembling the parts carefully. After the replacement, conduct a leak check according to "Piping leak check" in section 2-3.

Step	Action
1	Turn off the power, stop the process gas, and wait until the secondary pressure is zero. Then disconnect the terminal wiring and piping, and put them in a safe place.
2	Loosen the setscrew of the hexagonal part of adapters in both sides of manifold
3	Loosen the adapters and remove them
4	Check the new adapters to make sure that the threads and O-ring are not damaged
5	Tighten the new adapter till foot of an adapter touch the manifold and cannot be tighten any more.
6	Tighten the setscrew of the hexagonal part of adapters in both sides of manifold



Handling Precautions:

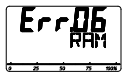
Do not damage the O-ring, as damage will cause leakage of the process gas.

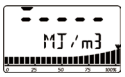
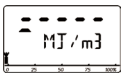
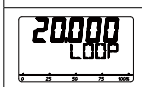
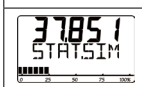
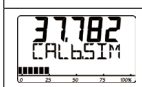
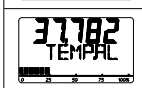
Chapter 6: Troubleshooting

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

If CVM400 does not work normally or not at all, check the following points.

- Check the result of self-diagnostics with the Communicator.
- Check for any leakage at the pipe connections.
- Check if flow rate of process gas is within specification.
- Check for loose or broken wires.
- Check for wrong wiring.
- Check that the supply voltage and load resistance are in accordance with the specifications.
- Check that the pressure and temperature are within specifications.
- Check for nearby sources of strong magnetism or electrical noise.

Status message	Indicator Display	Status message on Communicator	Meaning	Output	Required Action
Critical Failure		Sensor characteristic data fault	Sensor characteristic data failure	Burnout	Contact appropriate personnel
		Suspect input	Input data error	Burnout	Check the inlet gas specification. Contact appropriate personnel
		NVM fault	Nonvolatile memory failure	Burnout	Bad electronics board. Contact appropriate personnel
		RAM fault	RAM failure	Burnout	Bad electronics board. Contact appropriate personnel

Status message	Indicator Display	Status message on Communicator	Meaning	Output	Required Action
Non-critical Status		PV > 105%	PV exceeds 105 % (> 45.5 MJ/m^3)	20.8mA (105% saturated)	Check the process gas pressure and flow
		PV < -5%	PV is less than –5 % (< 34.5 MJ/m^3)	3.2mA (-5% saturated)	Check the process gas pressure and flow
		Calibration failure	CF < 0.99 or 1.01 < CF	Current PV output	Check the calibration gas pressure and flow. Retry calibration
		Calibration in process	Device is operating in calibration mode (counting down hold time)	Latest PV is held	Wait until hold time ends
		Loop test in operation	Device is operating in output mode	Output mode current	Go to the output mode menu and end output mode
		Fail safe simulation in operation	Device is operating in Fail safe simulation mode	Burnout high/low	Go to simulation menu and end the simulation mode
		STATUS output simulation in operation	Device is operating in STATUS output simulation mode	Current PV output	Go to the simulation menu and end the simulation mode
		CALIB output simulation in operation	Device is operating in CALIB output simulation mode	Current PV output	Go to the simulation menu and end the simulation mode
		Process Alarm Detected	PV is beyond output alarm upper/lower limit	Current PV output	Check the output and the alarm setting
		Sensor Temp. Alarm Detected	Sensor temp. is beyond sensor hi/lo limit	Current PV output	Check the ambient temp. and alarm setting

Appendix A: Specifications

STANDARD SPECIFICATIONS

Instrument

Process gas connection port: NPT 1/8 (F), Rc 1/8
Electrical conduit: NPT 1/2 (F)
Case structure: IEC IP66
Display: LCD
Calorie display: 5 digits
% display: setting range is shown by a % and by a bar graph
Automatic calibration setting display:
● and ○ light up alternately when set.
Calibration factor display: a flag is shown if calibration fails
Communications: HART protocol ver. 7.0 (with CommStaff and HART 475 Communicator)
Power: 24 Vdc ±10 %, 0.3 A max. (inrush current at startup)
Output: Analog output: 4–20 mAdc
Contact output: 24 Vdc ±10 %, 50 mA max. (transistor contact for status); 24 Vdc ±10 %, 1 A max. (transistor contact for calibration)
Paint: Baked acrylic resin finish
Color:

Housing:	Light beige
Front cover:	Dark beige
Terminal cover:	dark beige

Material

Case material:

Housing:	aluminum alloy (ADC 12)
Front cover:	aluminum alloy (ADC 12)
Terminal cover:	aluminum alloy (ADC 12)
Window:	reinforced glass
Cover O-ring:	NBR rubber

Wet parts materials:

Manifold:	304 stainless steel
Adapter:	304 stainless steel
µTCD sensor:	platinum, glass, gold, Kovar, silicon
O-ring:	Fluoro rubber

Process gas specifications

Temperature:	–10 to +50 °C
Pressure:	110 kPa (abs) max. (at CVM400 process connection port inlet)
Flow rate:	50 ±10 ml/min
Dust:	Less than 1 µm in diameter, 1 mg/m^3 max.
Mist:	none at –20 °C
Moisture:	dew-point temperature –20 °C max.

Calibration conditions

Calibration:	Automatic/Manual
Calibration gas:	Pure methane (99.995% purity min.)

Installation conditions

Ambient temperature	–10 to +50 °C
Ambient humidity:	95 % RH max.
Mass:	2.5 kg

Table-1. Acceptable limits of components/Unit: mol%

Components \ Gas type		Natural gas						LNG					
		Code A Natural Gas	Code F OIML R140	Code Q Natural Gas (Methane Number)	Code L Natural gas (G-gas)	Code M Natural gas (B-gas)	Code N Bio gas	Code G LNG	Code H LNG 13A C3 Base gas	Code J LNG 13A	Code K LNG 13A C4 Base gas	Code R LNG (Methane Number)	Code S LNG for ship
CH_4(C1)	Methane	80 to 100	82 to 100	80 to 100	65 to 85	77 to 100	40 to 100	85 to 100	86 to 93	86 to 100	86 to 93	82 to 100	80 to 100
C_2H_6(C2)	Ethane	0 to 11	0 to 11	0 to 11	0 to 11	0 to 4	0	0 to 9 *9 to 14	0 to 7	0 to 7	2 to 6	0 to 15	0 to 16
C_3H_8(C3)	Propane	0 to 5	0 to 5	0 to 5	0 to 3.5	0 to 1	0	0 to 4	0 to 8	0 to 9	0 to 4	0 to 3	0 to 9
C_4+(C4)	Butane +higher alkanes	0 to 2	0 to 1.2	0 to 2	0 to 1.2	0 to 0.5	0	0 to 2	0 to 2	0 to 2	2 to 5	0 to 2 *0 to 1.5	0 to 3
N_2	Nitrogen	0 to 7	0 to 7	0 to 5	10 to 20	0 to 15	0 to 60	0 to 1	0 to 0.2	0 to 1	0 to 0.2	0 to 10	0 to 16
CO_2	Carbon Dioxide	0 to 2	0 to 1.8	0 to 1.2	0 to 1.8	1 to 2.5	0 to 60	0	0	0	0	0	0
Condition		C1>C2≥C3≥C4 (C3≤0.4×C2, C4≤0.6×C3) • CO_2≥1.0→ C4≥0.3 • C4-CO2 ≤ 0.6% (Except in case C4>1 and C4≤2×CO_2)	 • CO_2≥1.0→ C4≥0.4 • CO_2≤0.3→ C4≤0.35	 • C4+= C4+(2.3×C5)+ (5.3×C6+) • C5+<0.3 *In case code M of output units, C2≠0, C3≠0	· C2≥C3 · C2≥C4 *Special model	· C1>C2≥C3≥C4 *Special model	*Special model	• C1>C2≥C3≥C4 • 0.7×C2≥C3≥ 0.2×C2 and 0.7×C3≥C4 • C1<95→N2 : 0 to0.2	C1>C2≥C4	C1>C2≥C4		•C1>C2≥C3≥C4 •C5+<0.03 *In case code M of output units, C2≠0, C3≠0 *In case code N of output units C4+ : 0 to1.5	

Table-2. Performance/Unit : % reading. Code Q,R: Absolute error

Performance \ Gas type			Natural gas						LNG					
			Code A Natural Gas	Code F OIML R140	Code Q Natural Gas (Methane Number)	Code L Natural gas (G-gas)	Code M Natural gas (B-gas)	Code N Bio gas	Code G LNG	Code H LNG 13A C3 Base gas	Code J LNG 13A	Code K LNG 13A C4 Base gas	Code R LNG (Methane Number)	Code S LNG for ship
Accuracy (Reading)		*1	±1.5%	±1%	±3	±2.0%	±1.5%	±2.0%	±1%	±1%	±1.2%	±1%	±2	±1%
Repeatability		*2	±0.2%	±0.2%	±0.3	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.3	±0.2%
Variations*2	Ambient temp.	*3	±0.2%	±0.3%	±0.5	±0.3%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.5	±0.2%
	Atmospheric press.	*4	±0.2%	±0.2%	±0.5	±0.3%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.5	±0.3%
	Sample gas flow	*5	±0.2%	±0.2%	±0.5	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.2%	±0.5	±0.2%

*1: Accuracy=(Trueness)+(Repeatability)

• Trueness is the proximity of measurement results to the true value.

• True value is the value calculated by following method.

Calorific value (SCV,ICV,WI):Calculated by the components according to ISO6976:1998.

Methane Number (MN): Calculated by the components using the software made by Azbil, according to the standard CEN EN 16726, or accoring to CARB/GRI method.

CARB/GRI method

Methane Number = $1.624 \times (- 406.14 + 508.04 \times RHCR - 173.55^* \times RHCR^2 + 20.17 \times RHCR^3) - 119.1$

$$RHCR = \frac{(CH4 \times 4 + C2H6 \times 6 + C3H8 \times 8 + (i - C4H10 + n - C4H10) \times 10 + (i - C5H12 + n - C5H12) \times 12 + (C6H14 \text{ or higher}) \times 14)}{(CH4 \times 1 + C2H6 \times 2 + C3H8 \times 3 + (i - C4H10 + n - C4H10) \times 4 + (i - C5H12 + n - C5H12) \times 5 + (C6H14 \text{ or higher}) \times 6)}$$

*2: Repeatability=σ*2$\sqrt{2}$. σ: Standard deviations of the measurement value.

*3:Ambient temperature effect per 30 °C change. Range from -10 to +50 °C.

*4: Static pressure effect per 30 hPa change. Range from 983 to 1043 hPa.

*5: Sampling gas flow rate effect per 10 ml/min change. Range from 40 to 60 mL/min.

*6:These performance do not include the effect of PV trim.

Table-3. Output range (LRV-URV) *Code Q, R: No unit

Gas calorific value calculation parameters		Output unit		Gas type: Natural gas					
				Code A Natural Gas	Code F OIML R140	Code Q Natural Gas (Methane Number)	Code L Natural gas (G-gas)	Code M Natural gas (B-gas)	Code N Bio gas
1	15 °C/15 °C	1	SCV(MJ/m³)	35-45	35-45		25-41	30-42	14-40
		4	WI_Hs(MJ/m³)	44-54			36-52	38-52	
4	20 °C/20 °C	7	ICV(MJ/m³)	31-41					
		A	WI_Hi(MJ/m³)	40-50					
6	25 °C/20 °C	D	SCV(MJ/kg)						
		F	ICV(MJ/kg)						
2	0 °C/ 0 °C	1	SCV(MJ/m³)	37-47					14-40
		4	WI_Hs(MJ/m³)	48-58					
3	25 °C/ 0 °C	7	ICV(MJ/m³)	33-43					
		A	WI_Hi(MJ/m³)	43-53					
5	15 °C/ 0 °C	D	SCV(MJ/kg)						
		F	ICV(MJ/kg)						
X	Unspecified	M	MN(CEN) --			60-110			
		N	MN(CARB/ GRI) --			60-110			

Gas calorific value calculation parameters		Output unit		Gas type: LNG					
				Code G LNG	Code H LNG 13A C3 Base gas	Code J LNG 13A	Code K LNG 13A C4 Base gas	Code R LNG (Methane Number)	Code S LNG for ship
1	15 °C/15 °C	1	SCV(MJ/m³)	37-47	37-47	37-47	37-47		
		4	WI_Hs(MJ/m³)	48-58	48-58	48-58	48-58		
4	20 °C/20 °C	7	ICV(MJ/m³)	33-43	33-43	33-43	33-43		
		A	WI_Hi(MJ/m³)	43-53	43-53	43-53	43-53		
6	25 °C/20 °C	D	SCV(MJ/kg)						41-56
		F	ICV(MJ/kg)						37-51
2	0 °C/ 0 °C	1	SCV(MJ/m³)	39-49	39-49	39-49	39-49		
		4	WI_Hs(MJ/m³)	50-60	50-60	50-60	50-60		
3	25 °C/ 0 °C	7	ICV(MJ/m³)	35-45	35-45	35-45	35-45		
		A	WI_Hi(MJ/m³)	45-55	45-55	45-55	45-55		
5	15 °C/ 0 °C	D	SCV(MJ/kg)						41-56
		F	ICV(MJ/kg)						37-51
X	Unspecified	M	MN(CEN) --					60-110	
		N	MN(CARB/ GRI) --					60-110	

SCV: Superior Calorific Value: MJ/m^3, MJ/kg

WI_Hs: Wobbe Index ($SCV/\sqrt{\text{Relative density}}$) MJ/m^3

ICV: Inferior Calorific Value: MJ/m^3, MJ/kg

WI_Hi: Wobbe Index ($ICV/\sqrt{\text{Relative Density}}$): MJ/m^3

MN(CEN): Methane Number, according to European Committee for standard "EN 16726".

MN(CARB/GRI): Methane Number, according to CARB/GRI method.

Model number table

CVM400	-							-					-	
Process connection	1/8 NPT (F)	1												
	Rc 1/8	3												
Electrical conduit connection	1/8 NPT (F)		1											
	G 1/2		3											
Accuracy	Always "A"			A										
Explosion-proof structure	ATEX Flameproof *9				E									
	IEC flameproof *9				G									
	KCs flameproof *9				K									
	TIIS flameproof				J									
	Water proof				W									
Communications	HART					H								
Gas type	Natural gas						A							
	OIML R140 CVDD compliant *1*2						F							
	LNG						G							
	LNG13A C3 base gas						H							
	LNG13A						J							
	LNG 13A C4 base gas						K							
	Natural gas(G-gas) *10 *12						L							
	Natural gas(B-gas) *10 *12						M							
	Bio gas *11 *12						N							
	Natural gas(Methane Number) *4						Q							
	LNG(Methane Number) *4						R							
	LNG for ship *5						S							
Indicator	Without Display							X						
	With Display							A						
Paint	Standard finish								X					
	Corrosion-proof finish								B					
Gas calorific value calculation parameters	15 °C/15 °C									1				
	0 °C/0 °C									2				
	25 °C/0 °C									3				
	20 °C/20 °C									4				
	15 °C/0 °C									5				
	25 °C/20 °C									6				
	Unspecified									X				
Output units	SCV MJ/m^3										1			
	WI_Hs MJ/m^3										4			
	ICV MJ/m^3										7			
	WI_Hi MJ/m^3										A			
	SCV MJ/kg *6										D			
	ICV MJ/kg*6										F			
	Methane Number(CEN) *7 *8										M			
	Methane Number(CARB/GRI) *7 *8										N			

X	No
1	Test report
2	Traceability
3	OIML/MID
4	Material

Note) *1: The code 1 "15 °C/15 °C" of the gas calorific value calculation parameter should be selected.

*2: The code 1 " SCV MJ/m^3" of the output units should be selected.

*3: The certification sheet for gas cylinder is not included.

*4: Code M or N of Output units should be selected.

*5: Code D or F of Ouput units should be selected.

*6: Code S of Gas type should be selected.

*7: Code Q or R of Gas type should be selected.

*8: Code X of Gas calorific value calculation parameters should be selected.

*9: Cannot be combined with code 3 of Electrical conduit connection.

*10: Code 1 or 4 of Output units should be selected.

*11: Code 1 of Output units should be selected.

*12: Special model.

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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