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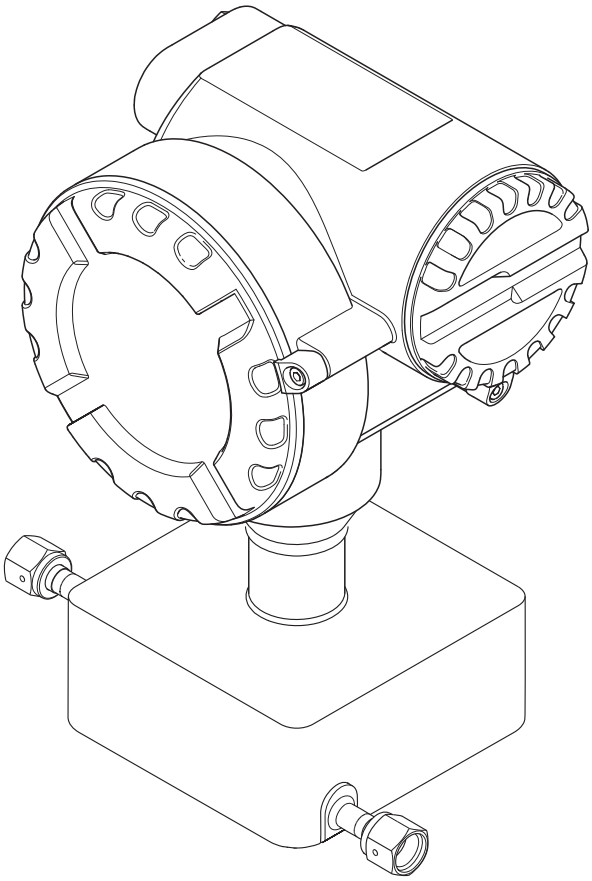
valid as of version
V 1.01.00 (Device software)

Operating Instructions
Cubemass

Modbus RS485
Coriolis flowmeter



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1 Safety instructions

1.1 Designated use

The measuring device described in these operating instructions may only be used for measuring the mass flow of liquids and gases. At the same time, the system also measures fluid density and fluid temperature. These parameters are then used to calculate other variables such as volume flow. Fluids with widely differing properties can be measured. Resulting from incorrect use or from use other than that designated the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damages being produced from this.

1.2 Installation, commissioning and operation

Note the following points:
- Installation, connection to the electricity supply, commissioning and maintenance of the measuring device must be carried out by trained, qualified specialists authorized to perform such work by the facility's owner-operator. The specialist must have read and understood these Operating Instructions and must follow the instructions they contain.
- The device must be operated by persons authorized and trained by the facility's owner-operator. Strict compliance with the instructions in the Operating Instructions is mandatory.
- Endress+Hauser will be happy to assist in clarifying the corrosion resistance properties of materials wetted by special fluids, including fluids used for cleaning. However, small changes of temperature, concentration or degree of contamination in the process can result in differences in corrosion resistance. Therefore, Endress+Hauser provides no warranty and assumes no liability with regard to corrosion resistance of fluid wetted materials in an application. The user is responsible for choosing suitable fluid wetted materials in the process.
- If welding work is performed on the piping system, do not ground the welding appliance via the measuring device.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be grounded, except in cases where special protective measures have been taken, e.g. galvanically isolated power supply SELV or PELV. (SELV = Safety Extra Low Voltage; PELV = Protective Extra Low Voltage).
- Invariably, local regulations governing the maintenance and repair of electrical devices apply.

1.3 Operational safety

Note the following points:
- Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of these Operating Instructions. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory. The symbol on the front of this supplementary Ex documentation indicates the approval and the inspection body (Ⓔx Europe, NEC/CEC[1)], NEPSI).
- The measuring device complies with the general safety requirements in accordance with EN 61010, the EMC requirements of IEC/EN 61326, and NAMUR recommendations NE 21, 43 and 53.
- Depending on the version, the housing of the sensor can be equipped with a rupture disk to prevent the pressure in the sensor housing from increasing in the event of an error. As long as the adhesive label (→ 7) is intact, the rupture disk is also intact.

1) NEC (National Electrical Code) / CEC (Canadian Electrical Code)

- For measuring systems used in SIL 2 applications, the separate manual on functional safety (SD077D/06) must be observed.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser representative will supply you with current information and any updates to these Operating Instructions.
- Danger - hot surfaces. Hot fluids passing through the measuring tube increase the surface temperature of the sensor housing. Temperatures close to the fluid temperature must be expected. If fluid temperatures are high, take suitable measures to protect against scalding from the hot surfaces.

1.4 Return

- Do not return a measuring device if you are not absolutely certain that all traces of hazardous substances have been removed, e.g. substances which have penetrated crevices or diffused through plastic.
- Costs incurred for waste disposal and injury (burns, etc.) due to inadequate cleaning will be charged to the owner-operator.
- Please note the measures on → 46

1.5 Notes on safety conventions and icons

The devices are designed to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010 "Safety requirements for electrical equipment for measurement, control and laboratory use". They can, however, be a source of danger if used incorrectly or for other than the designated use. Consequently, always pay particular attention to the safety instructions indicated in these Operating Instructions by the following icons:

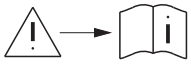
Warning!
"Warning" indicates an action or procedure which, if not performed correctly, can result in injury or a safety hazard. Comply strictly with the instructions and proceed with care.

Caution!
"Caution" indicates an action or procedure which, if not performed correctly, can result in incorrect operation or destruction of the measuring device. Comply strictly with the instructions.

Note!
"Note" indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.

1.6 Symbols on nameplates

The following symbol appears on nameplates (refer to the corresponding documentation):



In the case of devices for potentially explosive atmospheres, a documentation code appears, representing supplementary Ex documentation that it is mandatory to read.

2 Identification

The following options are available for identification of the measuring device:
- Nameplate specifications.
- Order code with breakdown of the device features on the delivery note.
- Enter serial numbers from nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer): All information about the measuring device is displayed.

For an overview of the scope of the Technical Documentation provided, refer to the following:
- The chapters "Documentation" → 56.
- The *W@M Device Viewer*: Enter the serial number from the nameplate (www.endress.com/deviceviewer).

Reorder
The measuring device is reordered using the order code.

Extended order code:
- The device type (product root) and basic specifications (mandatory features) are always listed.
- Of the optional specifications (optional features), only the safety and approval-related specifications are listed (e.g. LA). If other optional specifications are also ordered, these are indicated collectively using the # placeholder symbol (e.g. #LA#).
- If the ordered optional specifications do not include any safety and approval-related specifications, they are indicated by the + placeholder symbol (e.g. 8CN**-AACCCAAD2S1+).

2.1 Device designation

The "Cubemass" flow measuring system is a compact measuring device.

2.1.1 Nameplate of the transmitter

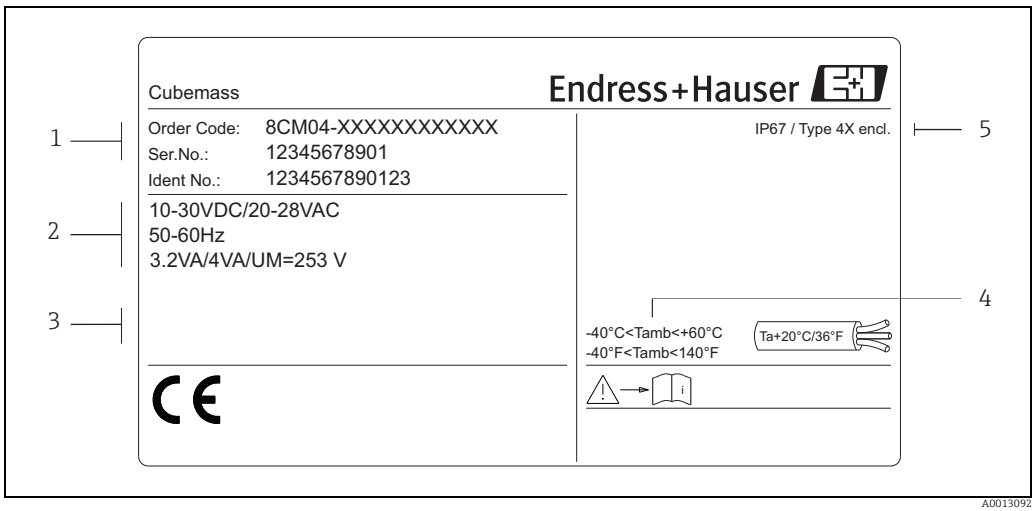


Fig. 1: Nameplate specifications for the transmitter (example)

1 *Order code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits*
2 *Power supply / frequency / Power consumption*
3 *Reserved for information on special products*
4 *Ambient temperature range*
5 *Degree of protection*

2.1.2 Nameplate of the sensor

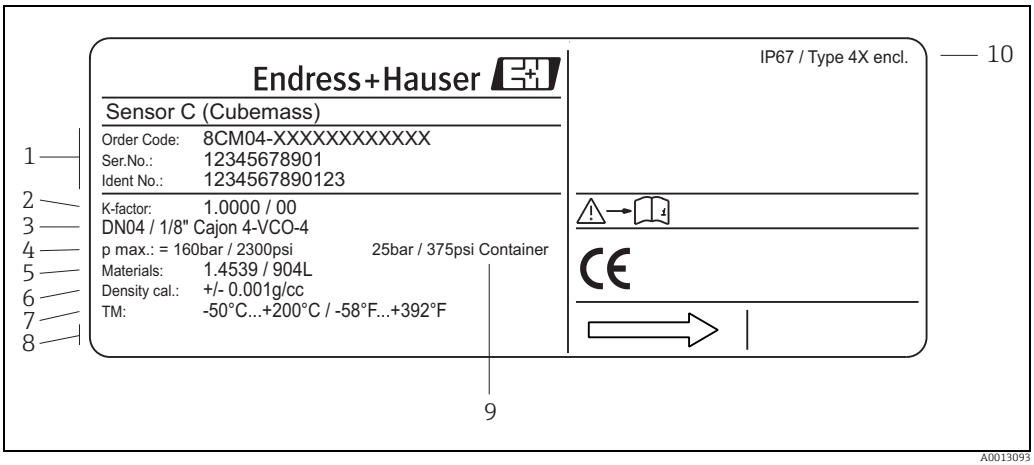


Fig. 2: Nameplate specifications for the sensor (example)

1 Order code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits
2 Calibration factor
3 Flange nominal diameter
4 Max. pressure
5 Material
6 Density
7 Fluid temperature range
8 Reserved for information on special products
9 Secondary containment pressure range
10 Degree of protection

2.1.3 Nameplate for connections

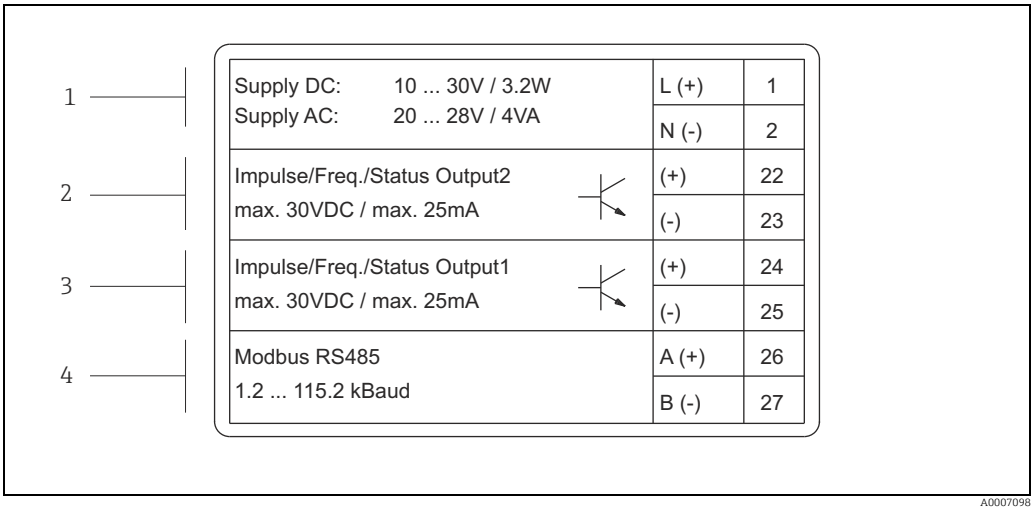


Fig. 3: Nameplate specifications for transmitter connections (example)

1 Terminal assignment for power supply
2 Terminal assignment pulse/frequency/status output
3 Terminal assignment pulse/frequency/status output
4 Terminal assignment Modbus RS485

2.2 Certificates and approvals

The devices are designed in accordance with good engineering practice to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate.
The measuring devices comply with the applicable standards and regulations in accordance with EN 61010 -1, "Safety requirements for electrical equipment for measurement, control and laboratory use" and with the EMC requirements of IEC/EN 61326.
The measuring system described in these Operating Instructions thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.
The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

The measuring device meets all the requirements of the Modbus/TCP conformity and integration test and holds the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.

2.3 Registered trademarks

KALREZ® and VITON®
Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA

Modbus®
Registered trademark of the SCHNEIDER AUTOMATION, INC.

Applicator®, FieldCare®, Fieldcheck®, HistoROM™, S-DAT®
Registered or registration-pending trademarks of the Endress+Hauser Group

3 Incoming acceptance, transport and storage

3.1 Incoming acceptance

On receipt of the goods, check the following points:
- Is the packaging or content damaged?
- Is anything missing from the shipment and does the scope of supply match your order?

3.2 Transport

Comply with the following instructions when unpacking the device and transporting it to its final location:
- Transport the devices in the containers in which they are delivered.
- The covers or caps fitted to the process connections prevent mechanical damage to the sealing faces and the ingress of foreign matter to the measuring tube during transportation and storage. Consequently, do not remove these covers or caps until immediately before installation.

3.3 Storage

Note the following points:
- Pack the measuring device in such a way as to protect it reliably against impact for storage (and transportation). The original packaging provides optimum protection.
- The permitted storage temperature is −40 to +80 °C (−40 to 176 °F), preferably +20 °C (+68 °F).
- Do not remove the protective caps on the process connections until you are ready to install the device.
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.

4 Installation

4.1 Installation conditions

Note the following points:
- The measuring device is designed for mounting on tabletops, walls or pipes.
- The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations.
- No special precautions need to be taken for fittings which create turbulence (valves, elbows, T-pieces etc.) as long as no cavitation occurs.
- For mechanical reasons, and in order to protect the piping, it is advisable to support heavy sensors.

4.1.1 Dimensions

All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation entitled "Technical Information" → 56.

4.1.2 Mounting location

The accumulation of air and the formation of gas bubbles in the measuring tube could result in an increase in measuring errors. For this reason, **avoid** the following mounting locations in the pipe:
- The highest point of a pipeline. Risk of air accumulating.
- Directly upstream of a free pipe outlet in a down pipe.

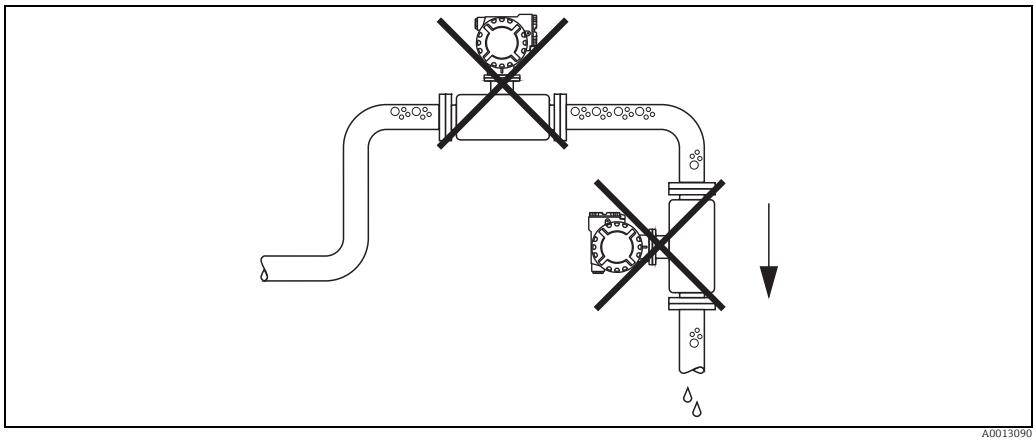


Fig. 4: Mounting location

The proposed configuration in the following diagram, however, permits installation in an open down pipe. Pipe restrictors or the use of an orifice plate with a smaller cross-section than the nominal diameter prevent the sensor from running empty during measurement.

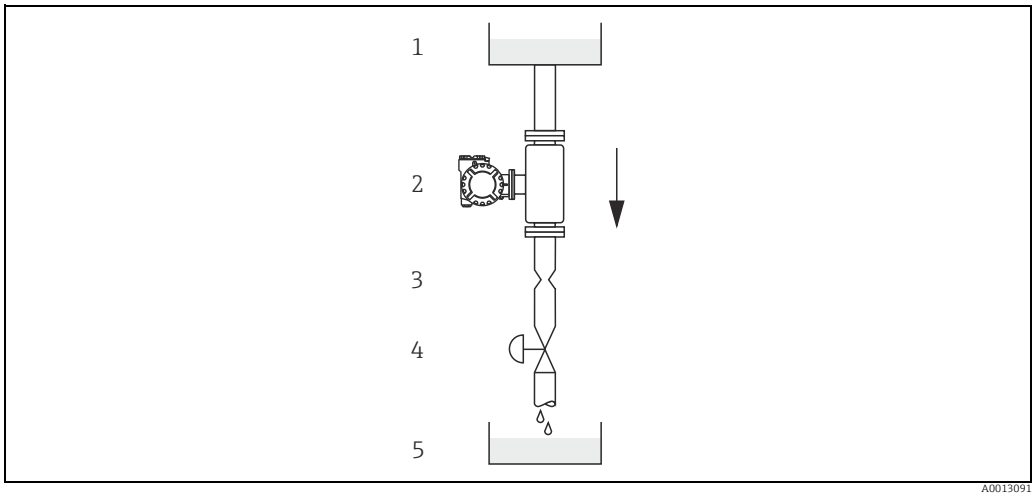


Fig. 5: Installation in a down pipe (e.g. for batching applications)

1 Supply tank
2 Sensor
3 Orifice plate, pipe restriction (see Table)
4 Valve
5 Batching tank

DN		ø Orifice plate, pipe restriction	
mm	in	mm	in
1	1/24"	0.8	0.03
2	1/12"	1.5	0.06
4	1/8"	3.0	0.12
6	1/4"	5.0	0.20

System pressure

It is important to ensure that cavitation does not occur as it could influence the oscillation of the measuring tube. No special measures need to be taken for fluids which have properties similar to water under normal conditions.
In the case of liquids with a low boiling point (hydrocarbons, solvents, liquefied gases) or in suction lines, it is important to ensure that pressure does not drop below the vapor pressure and that the liquid does not start to boil. It is also important to ensure that the gases that occur naturally in many liquids do not outgas. Such effects can be prevented when system pressure is sufficiently high.

Consequently, it is generally best to install the sensor:
- On the pump pressure side (no risk of vacuum)
- At the lowest point in a riser

4.1.3 Orientation

Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction in which the fluid flows through the pipe).

Vertical/horizontal:

When installed correctly, the transmitter housing is above or below the pipe. This arrangement means that no gas bubbles or solid deposits can accumulate in the curved measuring tube (single-tube system).
Do not install the sensor in such a way that it is suspended in the pipe without support or measures to secure it. This prevents excessive material strain at the process connection. The base plate of the sensor housing is designed for mounting on a tabletop, wall or post.

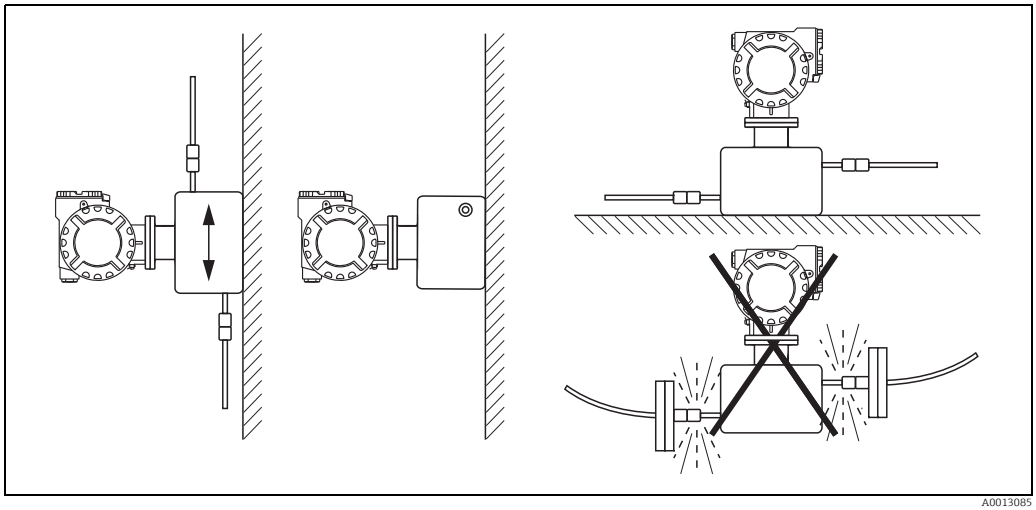


Fig. 6: Vertical and horizontal orientation

4.1.4 Heating

Some fluids require suitable measures to avoid loss of heat at the sensor. Heating can be electric, e.g. with heated elements, or by means of heating jackets or copper pipes conveying hot water or steam.

Caution!

- Danger of electronics overheating. Make sure that the maximum permissible ambient temperature for the transmitter is not exceeded.
  The adapter between the sensor and transmitter and the connection housing of the remote version must always remain free of insulating material.
- If using an electric trace heating system whose heating is regulated via phase control or pulse packages, there is the possibility that measured values could be influenced by magnetic fields which may occur (i.e. for values greater than those permitted by the EC standard (sine 30 A/m)). In such instances, it is necessary to magnetically shield the sensor.
  The secondary containment can be shielded with tin plate or electric sheets without privileged direction (e.g. V330-35A) with the following properties:
  – Relative magnetic permeability $\mu_r \geq 300$
  – Plate thickness d ≥ 0.35 mm (≥0.0011")
- For information on the permitted temperature ranges → 52. In the case of measuring devices that are used in hazardous areas, the trace heating system may not generate temperatures above the permitted fluid temperature per temperature class.

4.1.5 Inlet and outlet runs

There are no installation requirements regarding inlet and outlet runs. If possible, mount the sensor upstream of fittings such as valves, T-pieces, elbows etc.

4.1.6 Vibrations

The high oscillation frequency of the measuring tubes ensures that the correct operation of the measuring system is not influenced by pipe vibrations. Consequently, the sensors require no special measures for attachment.

4.1.7 Limiting flow

Limiting flow information can be found in the separate "Technical Information" document, → 56.

4.1.8 Special installation instructions

Rupture disk

Make sure that the function and operation of the rupture disk is not impeded through the installation of the device. The position of the rupture disk is indicated on a sticker beside it. For additional information that is relevant to the process (→ 53).

The existing connecting nozzles are not intended for the purpose of rinsing or pressure monitoring, but instead serve as the mounting location for the rupture disk.

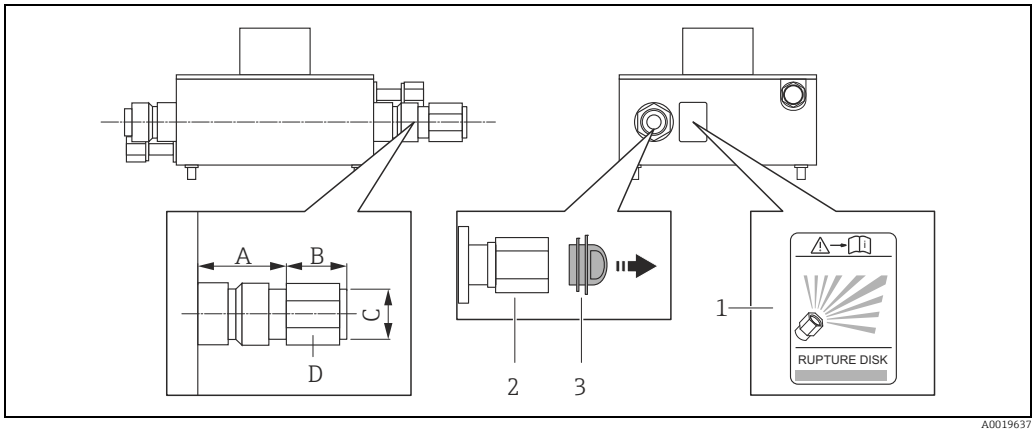


Abb. 7: Sensor housing with rupture disk for defined medium exit

1 Rupture disk label
2 Rupture disk with ½" NPT internal thread with 1" width across flat
3 Transport protection

Dimensions in SI units

DN	A	B	C	D
1 to 6	33	Approx. 42	½" NPT	AF 1"

All dimensions in [mm]

Dimensions in US units

DN	A	B	C	D
1/24 to ¼"	1.3	Approx. 1.65	½" NPT	AF 1"

All dimensions in [in]

Warning!
Limited functional reliability of the rupture disk.
Danger to persons from escaping fluids.
- Do not remove the rupture disk.
- When using a rupture disk, do not use a heating jacket.
- Make sure that the function and operation of the rupture disk is not impeded through the installation of the device.
- Take precautions to prevent damage and danger to persons if the rupture disk is actuated.
- Observe information on the rupture disk sticker.

4.2 Installation instructions

4.2.1 Turning the transmitter housing

The transmitter housing can be rotated counterclockwise continuously up to 360°.

1. Loosen the Allen setscrew (1) partially, but do not unscrew it all the way.
2. Rotate the transmitter housing into the desired position.
3. Tighten the Allen setscrew (1).

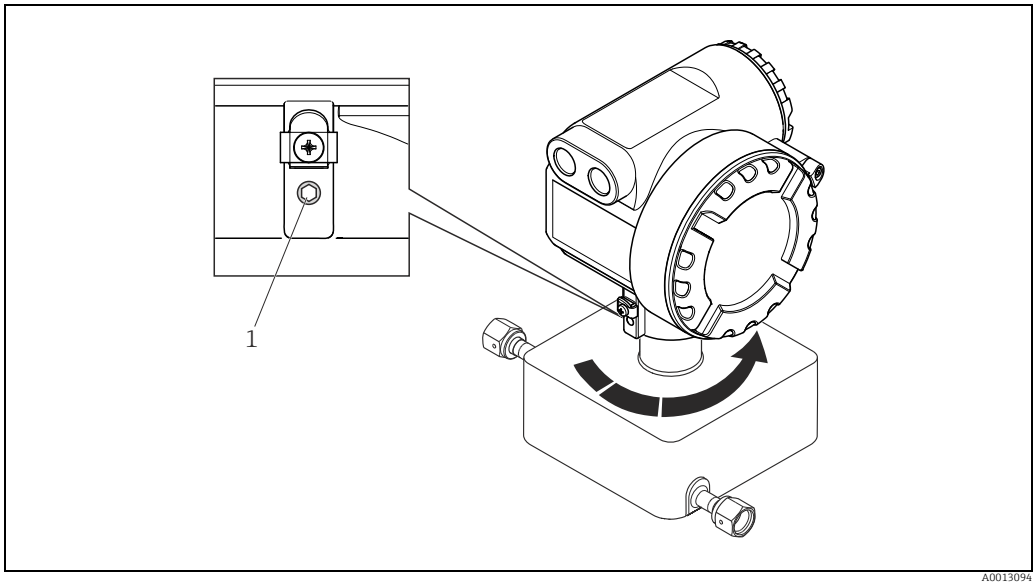


Fig. 8: Rotating the transmitter housing

4.3 Post-installation check

Perform the following checks after installing the measuring device in the pipe:

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, measuring range etc.?	→ 🖹 7
Installation	Notes
Does the arrow on the sensor nameplate match the direction of flow through the pipe?	–
Are the measuring point number and labeling correct (visual inspection)?	–
Is the orientation chosen for the sensor correct, in other words suitable for sensor type, fluid properties (outgassing, with entrained solids) and fluid temperature?	→ 🖹 10
Process environment / process conditions	Notes
Is the measuring device protected against moisture and direct sunlight?	–

5 Wiring

Warning!
When connecting Ex-certified devices, see the notes and diagrams in the Ex-specific supplement to these Operating Instructions. Please do not hesitate to contact your Endress+Hauser sales office if you have any questions.

Note!
The measuring device does not have an internal disconnecting device. Therefore, assign a switch or circuit breaker to the measuring device with which the voltage supply line can be disconnected from the power system.

5.1 Modbus RS485 cable specifications

In the EIA/TIA-485 standard, two versions (cable type A and B) are specified for the bus line and can be used for all transmission rates. However, we recommend you use cable type A. The cable specification for cable type A is provided in the following table:

Cable type A	
Characteristic impedance	135 to 165 Ω at a measuring frequency of 3 to 20 MHz
Cable capacitance	< 30 pF/m (< 9.2 pF/ft)
Core cross-section	> 0.34 mm² (AWG 22)
Cable type	Twisted pairs
Loop-resistance	≤110 Ω/km (≤0.034 Ω/ft)
Signal damping	Max. 9 dB over the entire length of the cable cross-section
Shielding	Copper braided shielding or braided shielding and foil shielding

Note the following points for the bus structure:
- All the measuring devices are connected in a bus structure (line).
- Using cable type A and with a transmission rate of 115200 Baud, the maximum line length (segment length) of the Modbus RS485 system is 1200 m (3936 ft). The total length of the spurs may not exceed a maximum of 6.6 m (21.7 ft) here.
- A maximum of 32 users are permitted per segment.
- Each segment is terminated at either end with a terminating resistor.
- The bus length or the number of users can be increased by introducing a repeater.

5.1.1 Shielding and grounding

When planning the shielding and grounding for a fieldbus system, there are three important points to consider:
- Electromagnetic compatibility (EMC)
- Explosion protection
- Employee safety

To ensure the optimum electromagnetic compatibility of systems, it is important that the system components and above all the cables, which connect the components, are shielded and that no portion of the system is unshielded. Ideally, the cable shields are connected to the normally metal housings of the connected field devices. Since these are generally connected to the protective ground, the shield of the bus cable is grounded many times. Make sure that the stripped and twisted lengths of cable shield to the terminals are as short as possible. This approach, which provides the best electromagnetic compatibility and employee safety, can be used without restriction in systems with optimum potential equalization.
In the case of systems without potential equalization, a mains frequency (50 Hz) equalizing current can flow between two grounding points which can destroy the cable in unfavorable cases, e.g. when it exceeds the permissible shield current.
To suppress the low frequency equalizing currents on systems without potential equalization, it is therefore recommended to connect the cable shield directly to the building ground (or protective ground) at one end only and to use capacitive coupling to connect all other grounding points.

Caution!
The legal EMC requirements are fulfilled **only** when the cable shield is grounded on both sides.

5.2 Connecting the measuring unit

5.2.1 Transmitter connection

Warning!
- Risk of electric shock. Switch off the power supply before opening the device. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock. Connect the protective ground to the ground terminal on the housing before the power supply is applied unless special protection measures have been taken (e. g. galvanically isolated power supply SELV or PELV).
- Compare the specifications on the nameplate with the local supply voltage and frequency. The national regulations governing the installation of electrical equipment also apply.

1. Detach the safety claw (a) and remove the cover of the connection compartment (b) from the transmitter housing.
2. Feed the signal cable (c) and power supply cable (d) through the appropriate cable entries.
3. Perform wiring in accordance with the terminal assignment (→ 🖹 18).
4. Screw the cover of the connection compartment (b) firmly onto the transmitter housing and retighten the safety claw (a).

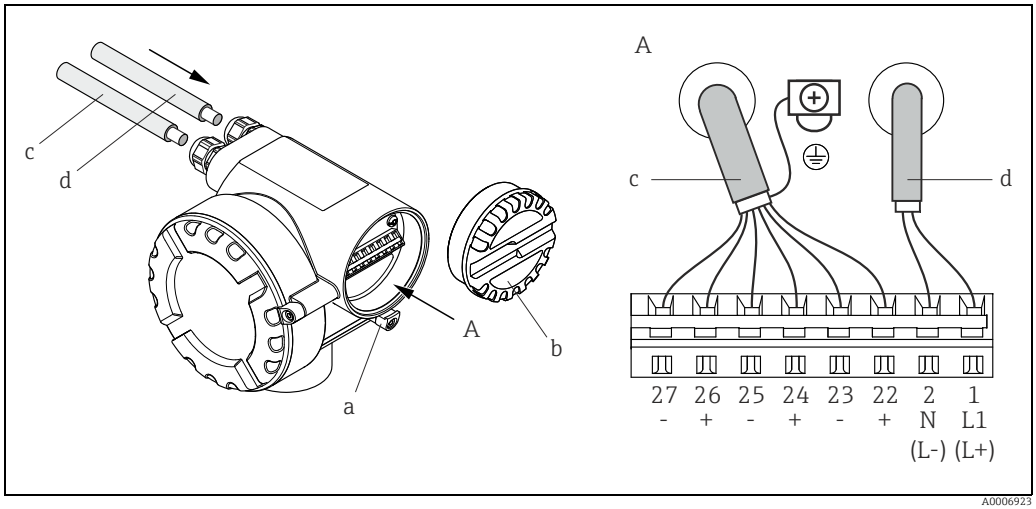


Fig. 9: Connecting the transmitter, cable cross-section: max. 2.5 mm² (14 AWG)

A View A

a Safety claw
b Connection compartment cover
c Signal cable: terminal Nos. 22 to 27
(shield for Modbus RS485 is mandatory; shield for pulse, frequency and status outputs is not required, but recommended)
d Cable for power supply: 20 to 28 V AC, 10 to 30 V DC
– Terminal No. 1: L1 for AC, L+ for DC
– Terminal No. 2: N for AC, L- for DC

5.2.2 Terminal assignment

Electrical values for outputs → 🖹 47.

Order characteristic for "inputs/outputs"	Terminal No. (outputs)		
	22 (+) / 23 (-)	24 (+) / 25 (-)	26 (+) / 27 (–)
Fixed communication board (permanent assignment)			
B	Pulse / frequency /status output 2	Pulse / frequency /status output 1	Modbus RS485

5.3 Degree of protection

The measuring device fulfills all the requirements for IP 67.

Compliance with the following points is mandatory following installation in the field or servicing, in order to ensure that IP 67 protection is maintained:
- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- The screws and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter (8 to 12 mm / 0.32 to 0.47").
- The cable entries must be firmly tightened (point **a** → 10).
- The cable must loop down in front of the cable entry ("water trap") (point **b** → 10). This arrangement prevents moisture penetrating the entry.

Note!
The cable entries may not point up.

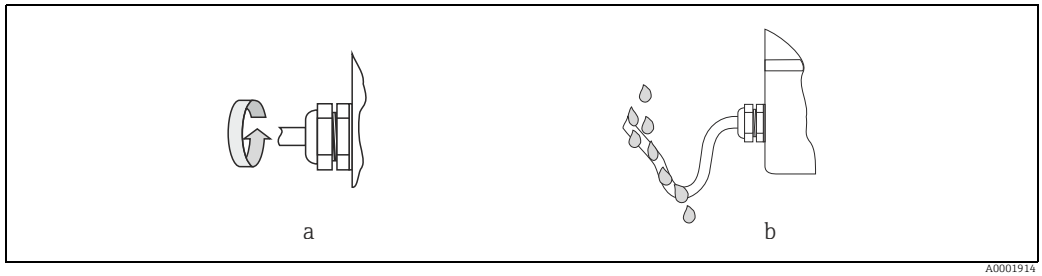


Fig. 10: Installation instructions, cable entries

- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

Caution!
Do not loosen the screws of the sensor housing, as otherwise the degree of protection guaranteed by Endress+Hauser no longer applies.

5.4 Post-connection check

Perform the following checks after completing electrical installation of the measuring device:

Device condition and specifications	Notes
Are cables or the device damaged (visual inspection)?	–
Electrical connection	**Notes**
Does the supply voltage match the specifications on the nameplate?	20 to 28 V AC (45 to 65 Hz) 10 to 30 V DC
Do the cables comply with the specifications?	→ 🖹 16
Do the cables have adequate strain relief?	–
Is the cable type route completely isolated? Without loops and crossovers?	–
Are the power supply and signal cables correctly connected?	→ Wiring diagram inside the cover of the terminal compartment
Are all screw terminals firmly tightened?	–
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 🖹 19, "Degree of protection" section
Are all housing covers installed and firmly tightened?	–
Fieldbus electrical connection	**Notes**
Has each fieldbus segment been terminated at both ends with a bus terminator?	→ 🖹 16
Has the max. length of the fieldbus cable been observed in accordance with the specifications?	→ 🖹 16
Has the max. length of the spurs been observed in accordance with the specifications?	→ 🖹 16
Is the fieldbus cable fully shielded and correctly grounded?	→ 🖹 17

6 Operation

6.1 Quick operation guide

You have the following option for configuring and commissioning the device:

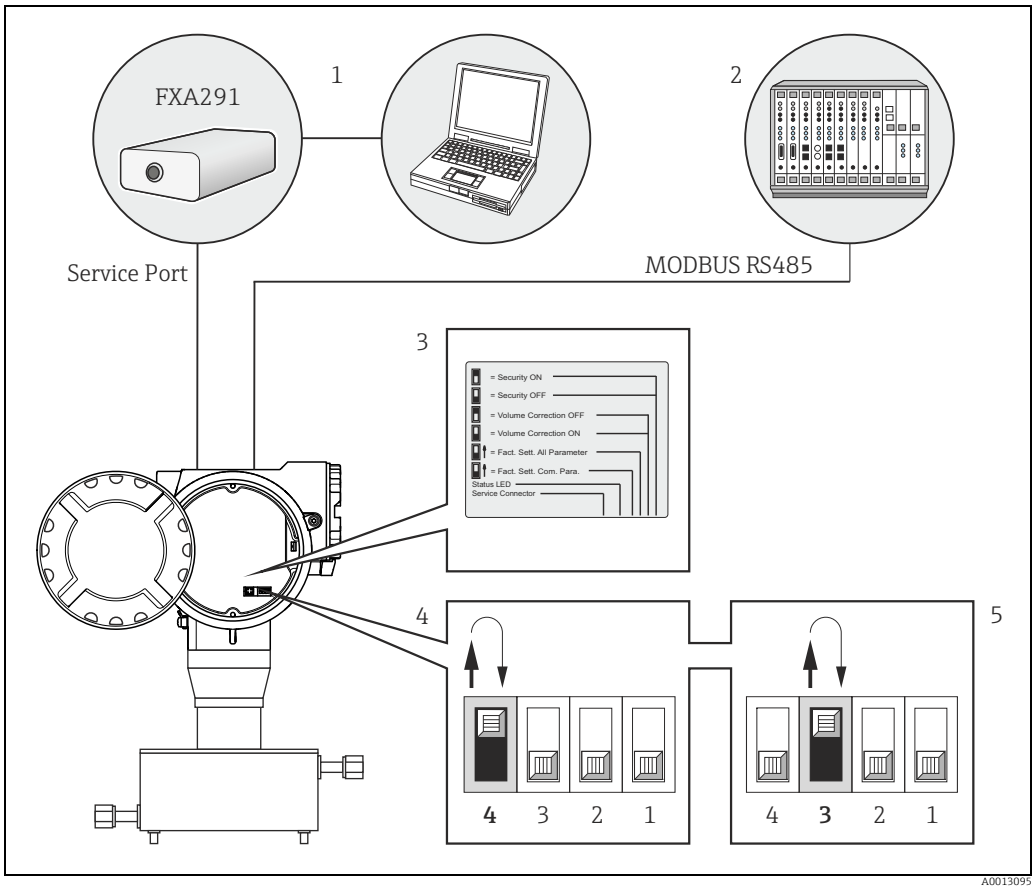


Fig. 11: Method of operating Modbus RS485 devices

1 Configuration/operating program for operating via the service interface FXA291 (e.g. FieldCare)
2 Operation via Modbus RS485 process control system
3 Situation sticker of the various DIP switch positions and their function
4 Operation via device-internal DIP switch (4):
If the DIP switch (4) is switched upwards, the device restores the factory settings of the communication parameters of the Modbus RS485 (return it afterwards to its original lower position).
5 Operation via device-internal DIP switch (3):
If the DIP switch (3) is switched upwards, the device restores the factory settings of all communication parameters of the Modbus RS485 (return it afterwards to its original lower position).

Note!
Setting back parameters can require several minutes, followed by a start-up of the device. The power supply must not be switched off while the factory settings are being restored.

6.2 Modbus RS485 communication

6.2.1 Modbus RS485 technology

The Modbus is an open, standardized fieldbus system which is deployed in the areas of manufacturing automation, process automation and building automation.

System architecture

The Modbus RS485 is used to specify the functional characteristics of a serial fieldbus system with which distributed, digital automation systems are networked together.
The Modbus RS485 distinguishes between master and slave devices.

- **Master devices**
  Master devices determine the data traffic on the fieldbus system. They can send data without an external request.
- **Slave devices**
  Slave devices, like this measuring device, are peripheral devices. They do not have their own access rights to the data traffic of the fieldbus system and only send their data due to an external request from a master.

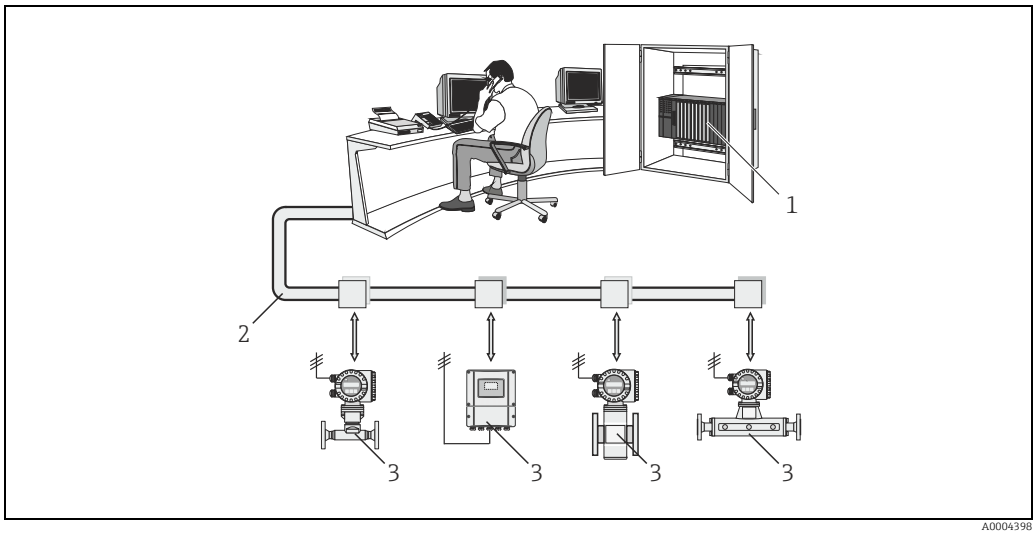


Fig. 12: Modbus RS485 system architecture

1 Modbus master (PLC etc.)
2 Modbus RS485
3 Modbus slave (measuring devices etc.)

Master/slave communication

A distinction is made between two methods of communication with regard to master/slave communication via Modbus RS485:

- **Polling (request-response-transaction)**
  The master sends a request telegram to **one** slave and waits for the slave's response telegram. Here, the slave is contacted directly due to its unique bus address (1 to 247).

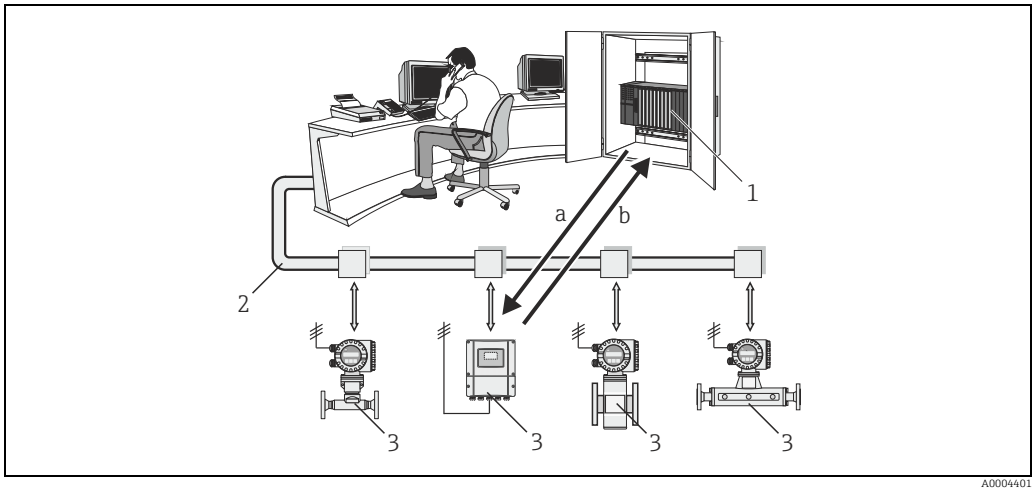


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Fig. 13: Modbus RS485 polling data traffic

1 Modbus master (PLC etc.)
2 Modbus RS485
3 Modbus slave (measuring devices etc.)
a Request telegram to this one specific Modbus slave
b Response telegram to the Modbus master

- **Broadcast message**
  By means of the global address 0 (broadcast address), the master sends a command to all the slaves in the fieldbus system. The slaves execute the command without reporting back to the master. Broadcast messages are only permitted in conjunction with write function codes.

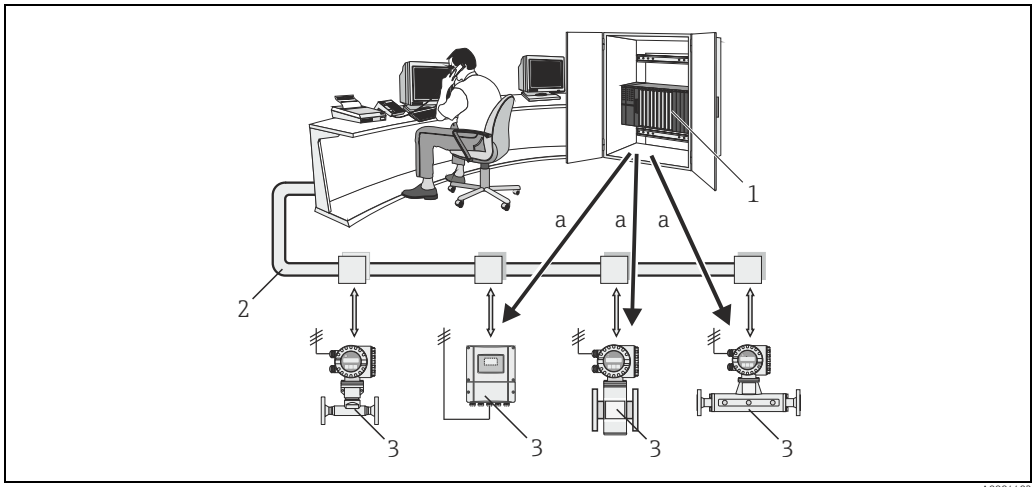

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Fig. 14: Modbus RS485 polling data traffic

1 Modbus master (PLC etc.)
2 Modbus RS485
3 Modbus slave (measuring devices etc.)
a Broadcast message - command to all Modbus slaves (request is executed without a response telegram to the master)

6.2.2 Modbus telegram

General

The master-slave process is used for data exchange. Only the master can initiate data transmission. Following the prompt, the slave sends the master the necessary data as a response telegram or executes the command requested by the master.

Telegram structure

The data is transferred between the master and slave by means of a telegram.
A request telegram from the master contains the following telegram fields:

Telegram structure:

Slave address	Function code	Data	Check sum

- **Slave address**
  The slave address can be in an address range from 1 to 247.
  The master talks to all the slaves simultaneously by means of the slave address 0 (broadcast message).
- **Function code**
  The function code determines which read, write and test operations should be executed by means of the Modbus protocol.
  Function codes supported by the measuring device → 📄 24
- **Data**
  Depending on the function code, the following values are transmitted in this data field:
  – Register start address (from which the data are transmitted)
  – Number of registers
  – Write/read data
  – Data length
  – etc.
- **Check sum (CRC or LRC check)**
  The telegram check sum forms the end of the telegram.

The master can send another telegram to the slave as soon as it has received an answer to the previous telegram or once the time-out period set at the master has expired. This time-out period can be specified or modified by the user and depends on the slave response time.

If an error occurs during data transfer or if the slave cannot execute the command from the master, the slave returns an error telegram (exception response) to the master.

The slave response telegram consists of telegram fields which contain the requested data or which confirm that the action requested by the master has been executed. It also contains a check sum.

6.2.3 Modbus function codes

The function code determines which read, write and test operations should be executed by means of the Modbus protocol. The measuring device supports the following function codes:

Function code	Name in accordance with Modbus specification	Description
03	READ HOLDING REGISTER	Reads one or more registers of the Modbus slave. 1 to a maximum of 125 consecutive registers (1 register = 2 byte) can be read with a telegram. **Application:** For reading measuring device parameters with read and write access, such as reading the batch quantity.

Function code	Name in accordance with Modbus specification	Description
04	READ INPUT REGISTER	Reads one or more registers of the Modbus slave. 1 to a maximum of 125 consecutive registers (1 register = 2 byte) can be read with a telegram. **Application:** For reading measuring device parameters with read access, such as reading the measured values (mass flow, temperature etc.).
06	WRITE SINGLE REGISTERS	Writes **a single** slave register with a new value. **Application:** For writing just one measuring device parameter, such as writing the batch quantity or resetting the totalizer. Note! Function code 16 is used for writing several registers by means of just one telegram.
08	DIAGNOSTICS	Checks the communication connection between the master and slave. The following diagnostics codes are supported: ▪ Sub-function 00 = Return query data (loopback test) ▪ Sub-function 02 = Return diagnostics register
16	WRITE MULTIPLE REGISTERS	Writes several slave registers with a new value. A maximum of 120 consecutive registers can be written with a telegram. **Application:** For writing several measuring device parameters, such as writing the batch quantity and resetting the totalizer.
23	READ/WRITE MULTIPLE REGISTERS	Simultaneous reading and writing of 1 to max. 118 registers in a telegram. Write access is executed before read access. **Application:** For writing and reading several measuring device parameters, such as writing the batch quantity and the correction quantity and reading the totalizer value.

Note!
- Broadcast messages are only permitted with function codes 06, 16 and 23.
- The measuring device does not differentiate between function codes 03 and 04. These codes have the same result.

6.2.4 Maximum number of writes

If a nonvolatile device parameter is modified via the Modbus function codes 06, 16 or 23, this change is saved in the EEPROM of the measuring device. The number of writes to the EEPROM is technically restricted to a maximum of 1 million. Attention must be paid to this limit since, if exceeded, it results in data loss and measuring device failure. For this reason, avoid constantly writing nonvolatile device parameters via the Modbus.

6.2.5 Modbus register addresses

Each device parameter has its own register address. The Modbus master uses this register address to talk to the individual device parameters and access the device data.
The register addresses of the individual device parameters can be found in the "Description of Device Parameters" manual under the parameter description in question.

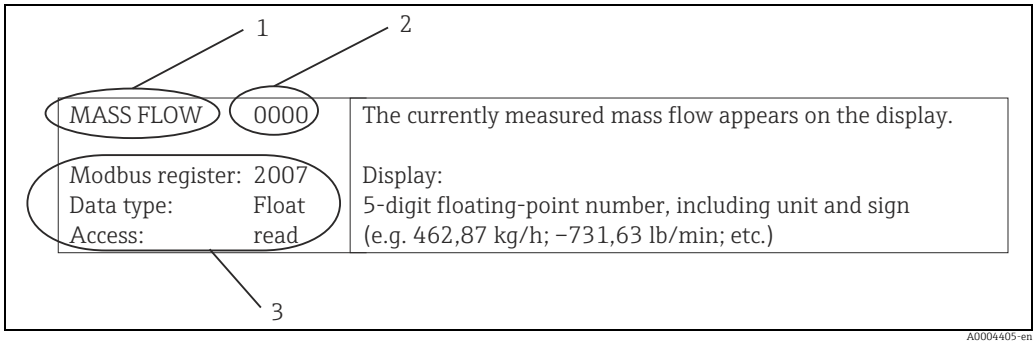

Fig. 15: Example of how a function description is illustrated in the "Description of Device Parameters" manual

1 Name of the function
*2 Number of the function (appears on the local display; is **not** identical to the Modbus register address)*
3 Information on communication via Modbus RS485
– Modbus register (information in decimal numerical format)
– Data type: Float, Integer or String
– Possible ways of accessing the function:
read = read access via function codes 03, 04 or 23
write = write access via function codes 06, 16 or 23

Modbus register address model

The Modbus RS485 register addresses of the measuring device are implemented in accordance with "Modbus Applications Protocol Specification V1.1".

Note!
In addition to the specification mentioned above, systems are also deployed which work with a register address model in accordance with the "Modicon Modbus Protocol Reference Guide (PI-MBUS-300 Rev. J)" specification. With this specification, the register address is extended, depending on the function code used. A "3" is put in front of the register address in the "read" access mode and a "4" in the "write" access mode.

Function code	Access type	Register in accordance with: "Modbus Applications Protocol Specification"		Register in accordance with: "Modicon Modbus Protocol Reference Guide"
03 04 23	Read	XXXX Example: mass flow = 2007	→	3XXXX Example: mass flow = 32007
06 16 23	Write	XXXX Example: reset totalizer = 6401	→	4XXXX Example: reset totalizer = 46401

Response times

The time it takes a measuring device to respond to a request telegram from the Modbus master is typically 25 to 50 ms. If faster response times are needed for time-critical applications (e.g. batching applications), the "auto-scan buffer" is to be used.

Note!
It may take longer for a command to be executed in the device. The data is not updated until the command has been executed. Especially write commands are affected by this.

Data types

The following data types are supported by the measuring device:

- **FLOAT** (floating-point numbers IEEE 754)
  Data length = 4 bytes (2 registers)

Byte 3	Byte 2	Byte 1	Byte 0
SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM

S = sign
E = exponent
M = mantissa

- **INTEGER**
  Data length = 2 bytes (1 register)

Byte 1	Byte 0
Most significant byte (MSB)	Least significant byte (LSB)

- **STRING**
  Data length = depends on device parameter,
  e.g. illustration of a device parameter with a data length = 18 bytes (9 registers):

Byte 17	Byte 16	to	Byte 1	Byte 0
Most significant byte (MSB)		to		Least significant byte (LSB)

Byte transmission sequence

Byte addressing, i.e. the transmission sequence of the bytes, is not specified in the Modbus specification. For this reason, it is important to coordinate the addressing method between the master and slave during commissioning. This can be configured in the measuring device by means of the "BYTE ORDER" parameter (→ "Description of Device Parameters" manual).

The bytes are transmitted depending on the option selected in the "BYTE ORDER" parameter:

FLOAT:

	Sequence			
Selection	1st	2nd	3rd	4th
1 – 0 – 3 – 2 *	Byte 1 (MMMMMMMM)	Byte 0 (MMMMMMMM)	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM)
0 – 1 – 2 – 3	Byte 0 (MMMMMMMM)	Byte 1 (MMMMMMMM)	Byte 2 (EMMMMMMM)	Byte 3 (SEEEEEEE)
2 – 3 – 0 – 1	Byte 2 (EMMMMMMM)	Byte 3 (SEEEEEEE)	Byte 0 (MMMMMMM)	Byte 1 (MMMMMMM)
3 – 2 – 1 – 0	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM)	Byte 1 (MMMMMMMM)	Byte 0 (MMMMMMMM)

* = Factory setting
S = sign
E = exponent
M = mantissa

INTEGER:

Selection	Sequence	
	1st	2nd
1 – 0 – 3 – 2 * 3 – 2 – **1 – 0**	Byte 1 (MSB)	Byte 0 (LSB)
0 – 1 – 2 – 3 2 – 3 – **0 – 1**	Byte 0 (LSB)	Byte 1 (MSB)

* = Factory setting
MSB = most significant byte
LSB = least significant byte

STRING:
Illustration using the example of a device parameter with a data length of 18 bytes.

Selection	Sequence				
	1st	2nd	to	17th	18th
1 – 0 – 3 – 2 * 3 – 2 – **1 – 0**	Byte 1	Byte 0 (LSB)	to	Byte 17 (MSB)	Byte 16
0 – 1 – 2 – 3 2 – 3 – **0 – 1**	Byte 0 (LSB)	Byte 1	to	Byte 16	Byte 17 (MSB)

* = Factory setting
MSB = most significant byte
LSB = least significant byte

6.2.6 Modbus error messages

If the Modbus slave detects an error in the request telegram from the master, it sends a reply to the master in the form of an error message consisting of the slave address, function code, exception code and check sum. To indicate that this is an error message, the lead bit of the returned function code is used. The reason for the error is transmitted to the master by means of the exception code.

The following exception codes are supported by the measuring device:

Exception codes	Description
01	ILLEGAL_FUNCTION The function code sent by the master is not supported by the measuring device (slave). ✎ Note! Description of the function codes supported by the measuring device → 🖹 24.
02	ILLEGAL_DATA_ADDRESS The register addressed by the master is not assigned (i.e. it does not exist) or the length of the requested data is too big.
03	ILLEGAL_DATA_VALUE ▪ The master is attempting to write to a register which only allows read access. ▪ The value that appears in the data field is not permitted: e.g. range limits overshot or incorrect data format.
04	SLAVE DEVICE FAILURE The slave did not respond to the request telegram from the master or an error occurred when processing the request telegram.

6.2.7 Modbus auto-scan buffer

Function description

The Modbus master uses the request telegram to access the device parameters (data) of the measuring device. Depending on the function code, the master gains read or write access to a single device parameter or a group of consecutive device parameters. If the desired device parameters (registers) are not available as a group, the master has to send a request telegram to the slave for each parameter.
The measuring device has a special storage area, known as the auto-scan buffer, for grouping nonconsecutive device parameters. This can be used to flexibly group up to 16 device parameters (registers). The master can talk to this complete data block by means of just one request telegram.

Structure of the auto-scan buffer

The auto-scan buffer consists of two data records, the configuration area and the data area. In the configuration area, a list known as the scan list specifies which device parameters should be grouped. For this purpose, the corresponding register address, e.g. the register address 2007 for mass flow, is entered in the scan list. Up to 16 device parameters can be grouped.

The measuring device cyclically reads out the register addresses entered in the scan list and writes the associated device data to the data area (buffer). The request cycle runs automatically. The cycle starts again when the last entry in the scan list has been queried. By means of Modbus, the grouped device parameters in the data area can be read or written by the master with just one request telegram (register address 5051 to 5081).

Configuration of the scan list

During configuration, the Modbus register addresses of the device parameters to be grouped must be entered in the scan list. The scan list can contain up to 16 entries. Float and Integer-type device parameters with read and write access are supported.

The scan list can be configured by means of:

1. The local display or a configuration program (FieldCare).
   The scan list is configured here by means of the function matrix:
   BASIC FUNCTION → Modbus RS485 → SCAN LIST REG. 1 to SCAN LIST REG. 16
2. The Modbus master.
   Here, the scan list is configured via the register addresses 5001 to 5016.

Scan list		
No.	**Modbus configuration Register address (data type = Integer)**	**Configuration via local operation / configuration program (BASIC FUNCTION → Modbus RS485 →)**
1	5001	SCAN LIST REG. 1
2	5002	SCAN LIST REG. 2
3	5003	SCAN LIST REG. 3
4	5004	SCAN LIST REG. 4
5	5005	SCAN LIST REG. 5
6	5006	SCAN LIST REG. 6
7	5007	SCAN LIST REG. 7
8	5008	SCAN LIST REG. 8
9	5009	SCAN LIST REG. 9
10	5010	SCAN LIST REG. 10
11	5011	SCAN LIST REG. 11

Scan list		
No.	Modbus configuration Register address (data type = Integer)	Configuration via local operation / configuration program (BASIC FUNCTION → Modbus RS485 →)
12	5012	SCAN LIST REG. 12
13	5013	SCAN LIST REG. 13
14	5014	SCAN LIST REG. 14
15	5015	SCAN LIST REG. 15
16	5016	SCAN LIST REG. 16

Access to data via Modbus

The Modbus master uses the register addresses 5051 to 5081 to access the data area of the auto-scan buffer. This data area contains the values of the device parameters defined in the scan list. For example, if the register 2007 was entered for mass flow in the scan list by means of the SCAN LIST REG. 1 function, the master can read out the current measured value of the mass flow in register 5051.

Data area				
Parameter value/Measured values		Access via Modbus register address	Data type *	Access**
Value of scan list entry No. 1	→	5051	Integer/Float	Read/Write
Value of scan list entry No. 2	→	5053	Integer/Float	Read/Write
Value of scan list entry No. 3	→	5055	Integer/Float	Read/Write
Value of scan list entry No. 4	→	5057	Integer/Float	Read/Write
Value of scan list entry No. 5	→	5059	Integer/Float	Read/Write
Value of scan list entry No. 6	→	5061	Integer/Float	Read/Write
Value of scan list entry No. 7	→	5063	Integer/Float	Read/Write
Value of scan list entry No. 8	→	5065	Integer/Float	Read/Write
Value of scan list entry No. 9	→	5067	Integer/Float	Read/Write
Value of scan list entry No. 10	→	5069	Integer/Float	Read/Write
Value of scan list entry No. 11	→	5071	Integer/Float	Read/Write
Value of scan list entry No. 12	→	5073	Integer/Float	Read/Write
Value of scan list entry No. 13	→	5075	Integer/Float	Read/Write
Value of scan list entry No. 14	→	5077	Integer/Float	Read/Write
Value of scan list entry No. 15	→	5079	Integer/Float	Read/Write
Value of scan list entry No. 16	→	5081	Integer/Float	Read/Write

* The data type depends on the device parameter entered in the scan list

** The data access depends on the device parameter entered in the scan list. If the device parameter entered supports read and write access, the parameter can also be accessed by means of the data area.

Response time

The response time when accessing the data area (register addresses 5051 to 5081) is typically between 3 and 5 ms.

Note!
It may take longer for a command to be executed in the device. The data is not updated until the command has been executed. Especially write commands are affected by this.

Example

The following device parameters should be grouped via the auto-scan buffer and read out by the master with just one request telegram:
- Mass flow → Register address 2007
- Temperature → Register address 2017
- Totalizer 1 → Register address 2610
- Actual system condition → Register address 6859

1. Configuration of the scan list

- With the local operation or a configuration program (via the function matrix):
  BASIC FUNCTION block → Modbus RS485 function group → SCAN LIST REG. function
  → Entry of the address 2007 under SCAN LIST REG. 1
  → Entry of the address 2017 under SCAN LIST REG. 2
  → Entry of the address 2610 under SCAN LIST REG. 3
  → Entry of the address 6859 under SCAN LIST REG. 4
- Via the Modbus master (the register addresses of the device parameters are written to the registers 5001 to 5004 via Modbus):
  1. Write address 2007 (mass flow) to register 5001
  2. Write address 2017 (temperature) to register 5002
  3. Write address 2610 (totalizer 1) to register 5003
  4. Write address 6859 (actual system condition) to register 5004

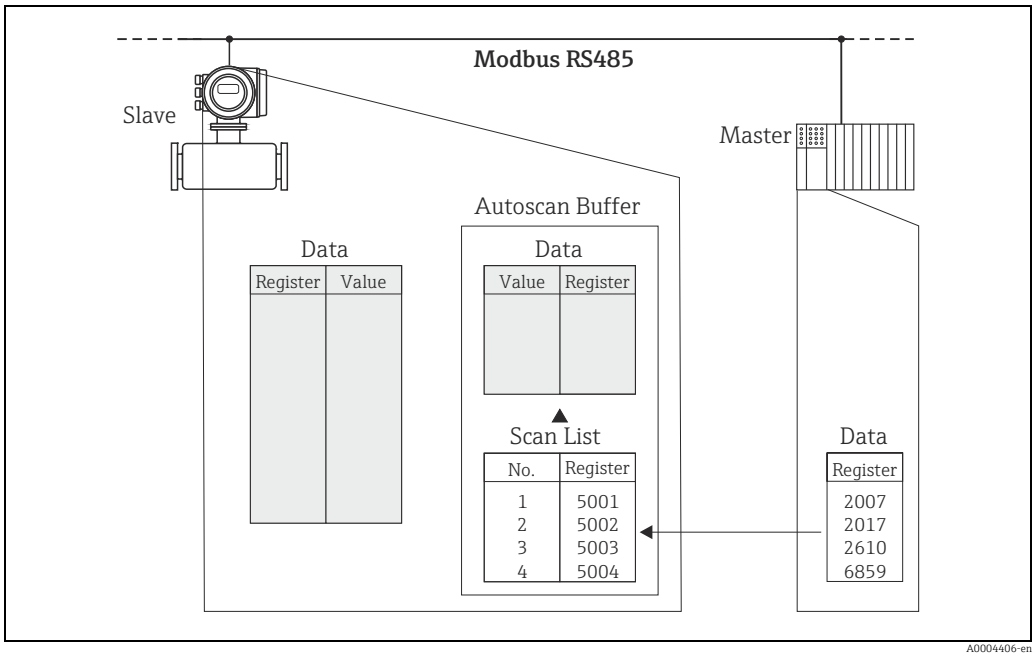

Fig. 16: Configuration of the scan list via the Modbus master

2. Access to data via Modbus

By specifying the register start address 5051 and the number of registers, the Modbus master can read out the measured values with just one request telegram.

Data area			
Access via Modbus register address	**Measuring values**	**Data type**	**Access**
5051	Mass flow = 4567.67	Float	Read
5053	Temperature = 26.5	Float	Read
5055	Totalizer 1 = 56345.6	Float	Read
5057	Actual system condition = 1 (system ok)	Integer	Read

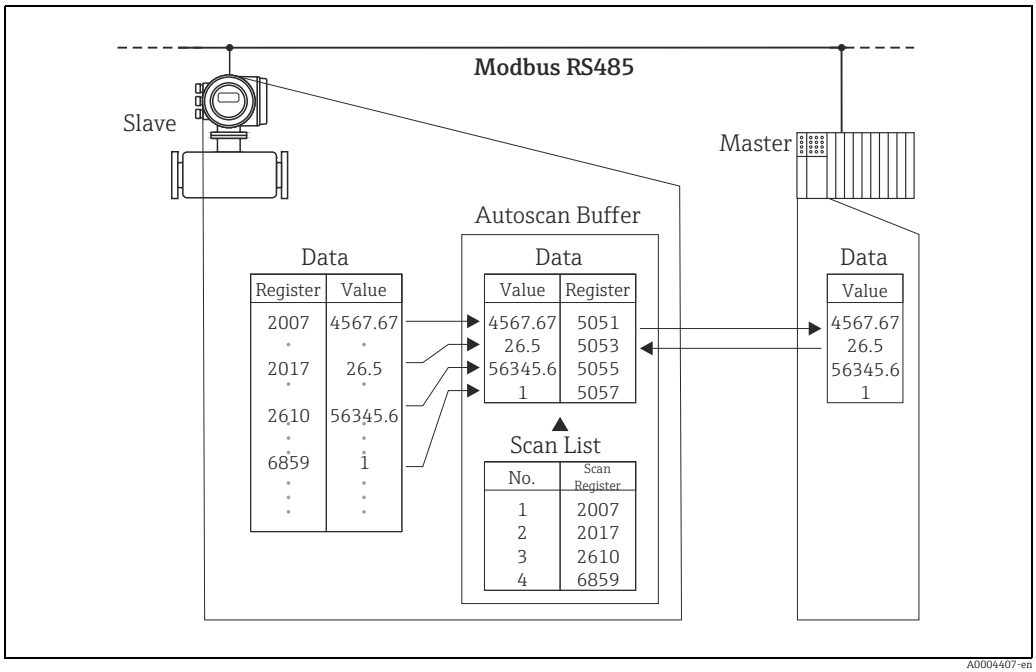

Fig. 17: With just one request telegram, the Modbus master reads out the measured values via the auto-scan buffer of the measuring device.

6.3 Operating options

6.3.1 Operating program "FieldCare"

FieldCare is Endress+Hauser's FDT-based plant asset management tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The Proline flowmeters are accessed via a service interface or via the service interface FXA291.

6.3.2 Device description files for operating programs

Operation:

Operating program/Device driver:	How to acquire:
FieldCare/ DTM	▪ www.endress.com (→Download →Software →Driver) ▪ CD-ROM (Endress+Hauser order number: 56004088)

Tester and simulator:	How to acquire:
Fieldcheck	▪ Update by means of FieldCare via flow device FXA193/291 DTM in Fieldflash module

Note!
The Fieldcheck tester/simulator is used for testing flowmeters in the field. When used in conjunction with the FieldCare software package, test results can be imported into a database, printed out and used for official certification. Contact your Endress+Hauser representative for more information.

7 Commissioning

7.1 Function check

Make sure that all the final checks have been completed before commissioning the measuring point:
- Checklist for "Post-installation check" → 15.
- Checklist for "Post-connection check" → 20.

7.2 Switching on the measuring device

Once the installation checks have been successfully completed, it is time to switch on the supply voltage. The device is now operational. The measuring device performs a number of power on self-tests. Normal measuring mode commences as soon as startup completes.

Note!
If the startup is not successful, depending on the cause, a corresponding message is displayed in the Fieldtool operating program, or the status LED flashes correspondingly (→ 39).

7.3 Zero point adjustment

All measuring devices are calibrated with state-of-the-art technology. Calibration takes place under reference operating conditions → 49. Consequently zero point adjustment is generally **not** necessary for Cubemass.

Experience shows that the zero point adjustment is advisable only in special cases:
- To achieve highest measuring accuracy also with very small flow rates.
- Under extreme process or operating conditions (e.g. very high process temperatures).

7.3.1 Preconditions for a zero point adjustment

Note the following before you perform a zero point adjustment:
- Adjustment can only be performed on homogeneous fluids.
- Zero point adjustment is performed at zero flow (v = 0 m/s). This can be achieved, for example, with shutoff valves upstream and/or downstream of the sensor or by using existing valves and gates.
  - Normal operation → valves 1 and 2 open
  - Zero point adjustment **with** pump pressure → Valve 1 open / valve 2 closed
  - Zero point adjustment **without** pump pressure → Valve 1 closed / valve 2 open

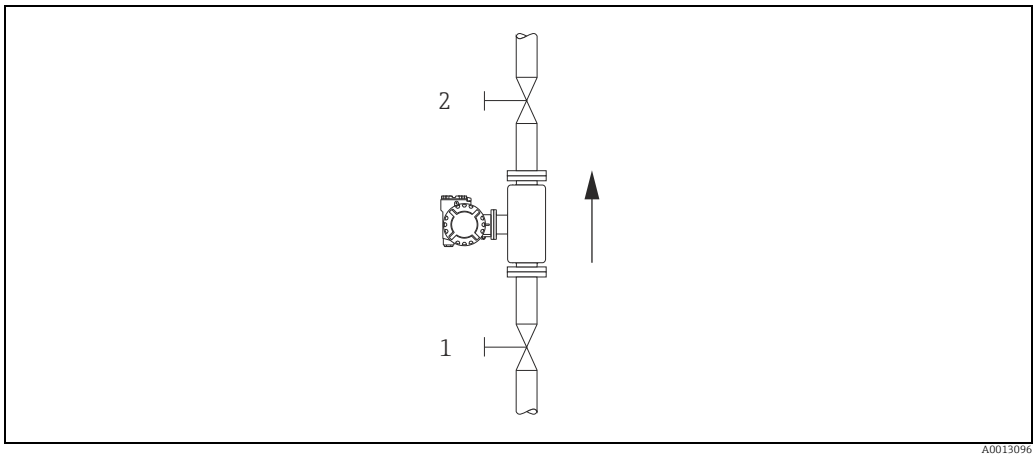

Fig. 18: Zero point adjustment and shutoff valves

Caution!
- The currently valid zero point value can be viewed using the "ZEROPOINT" function (→ "Description of Device Parameters" manual).

7.3.2 Performing a zero point adjustment

1. Operate the system until operating conditions have settled.
2. Stop the flow (v = 0 m/s).
3. Check the shutoff valves for leaks.
4. Check that operating pressure is correct.
5. Carry out the alignment using the "ZEROPOINT ADJUST" (→ "Description of Device Parameters" manual).

7.4 Purge and pressure monitoring connections

The sensor housing protects the inner electronics and mechanics and is filled with dry nitrogen. Furthermore, it also has an additional secondary containment function up to a specific measuring pressure.

Warning!
For process pressures above the specified containment pressure, the housing does not provide an additional secondary containment function. If there is a danger of the measuring tube rupturing due to process characteristics, e.g. in the event of corrosive process fluids, we recommend the use of sensors whose housings are equipped with special pressure monitoring connections (ordering option). With the help of these connections, fluid collected in the housing in the event of a tube rupture can be drained off. This reduces the risk of mechanical overload of the housing, which could lead to a housing failure and is thus associated with increased potential danger. The connections can also be used for gas purging (gas detection).
If measuring gases with high pressures, in particular, we recommend the use of sensors whose housings are fitted with a rupture element. Users can choose from a rupture disk with defined or undefined fluid exit. The burst pressure is between 10 and 15 bar (145 to 218 psi) for both options.

Note the following when working with purge and pressure monitoring connections:
- Do not open the purge connections unless the containment can be filled with a dry inert gas immediately afterwards.
- Use only low overpressure to purge. Maximum pressure 5 bar (72.5 psi).

7.5 Memory (HistoROM)

At Endress+Hauser, the term HistoROM refers to various types of data storage modules on which process and measuring device data are stored. By unplugging and plugging such modules, device configurations can be duplicated onto other measuring devices, to cite just one example.

7.5.1 HistoROM/S-DAT (sensor-DAT)

The S-DAT is an exchangeable data storage device in which all sensor relevant parameters are stored, i.e., diameter, serial number, calibration factor, zero point.

8 Maintenance

No special maintenance work is required.

8.1 External cleaning

When cleaning the exterior of measuring devices, always use cleaning agents that do not attack the surface of the housing and the seals.

9 Accessories

Various accessories, which can be ordered with the device or subsequently from Endress+Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

9.1 Device-specific accessories

9.1.1 For the Transmitter

Accessories	Description
Electronics module	Complete plug-in electronics module.

9.1.2 For the Sensor

Accessories	Description
Mounting set for sensor	Mounting set, comprising: – 2 process connections – Seals
Mounting plate for sensor	Mounting plate, comprising: – mounting plate – 4 × M5

9.2 Service-specific accessories

Accessories	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: ▪ Calculation of all the necessary data for identifying the optimum flowmeter: e.g. nominal diameter, pressure loss, accuracy or process connections ▪ Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: ▪ Via the Internet: https://wapps.endress.com/applicator ▪ On CD-ROM for local PC installation
W@M	Life cycle management for your plant. W@M supports you with a wide range of software applications over the entire process: from planning and procurement, to the installation, commissioning and operation of the measuring devices. All the relevant device information, such as the device status, spare parts and device-specific documentation, is available for every device over the entire life cycle. The application already contains the data of your Endress+Hauser device. Endress+Hauser also takes care of maintaining and updating the data records. W@M is available: ▪ Via the Internet: www.endress.com/lifecyclemanagement ▪ On CD-ROM for local PC installation
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed and used for official certification. Contact your Endress+Hauser representative for more information.

Accessories	Description
FieldCare	FieldCare is Endress+Hauser's FDT-based plant asset management tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The Proline flowmeters are accessed via a service interface or via the service interface FXA193.
FXA291	Service interface from the measuring device to the PC for operation via FieldCare.

9.3 System components

Accessories	Description
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.

10 Troubleshooting

10.1 Self-monitoring

Exceptional states that arise during operation are detected by the flowmeter and corresponding messages are output:

- Via the outputs, depending on the setting (→ "Description of Device Parameters" manual)
- Via the Modbus interface, depending on the setting (→ 🖹 28)
- Via error messages in the "FieldCare" operating program (→ 🖹 40)
- Via the status LED (→ 🖹 39, visible only when the device is open)

If multiple messages are pending, the one with the highest priority is output.

The message about a status can be assigned to a category as follows:

OFF
- When the status occurs, no message is generated

Error
- The message belongs to the "Errors" category, meaning that the measuring system cannot continue measuring operation.

Note
- The message belongs to the "Notes" category, meaning that the measuring system may be able to continue measuring operation with restrictions.

10.2 Diagnosis using light emitting diode (LED)

There is a Light Emitting Diode (LED) on the meter electronics board that allows simple fault diagnostics at any time:

- If the status output was not configured to output errors or notes.
- If fault diagnostics are no longer possible via the Fieldtool operating program.

⚠ Warning!
Risk of explosion. The electronics compartment may not be opened while there is an explosive atmosphere. This type of fault diagnostics can no longer be carried out in Ex-protected areas.

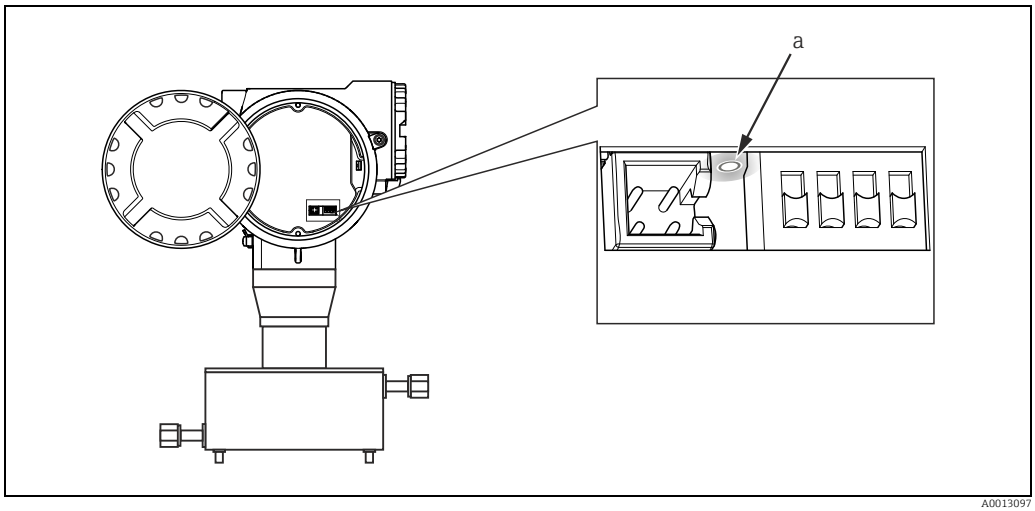

Fig. 19: Fault diagnostics using light emitting diode (a)

Status of light emitting diode (LED)	Status of measuring system
LED illuminated in green	Measuring system OK, creepage is active
LED flashes green (once per second)	Measuring system OK, operation
LED not illuminated	Measuring system no longer working
LED flashes red (three times per second)	▪ Operation not possible ▪ Error (fault message) pending
LED flashes red/green (once per second)	▪ Operation possible, but may be limited by application conditions. ▪ Notice message pending
LED flashes red/green (three times per second)	Zero point adjustment running
LED flashes green/orange (approx. 3 seconds long)	Security switched on
LED flashes red/orange (approx. 3 seconds long)	Security switched off
LED flashes red/(pause)/green (approx. 3 seconds long)	SW update active

10.3 Messages (FieldCare)

No. / error message	Cause	Remedy / spare part
# 001 CRITICAL FAIL		Replace the electronics module (→ 🖹 45). Spare parts: → 🖹 43
# 002 CONFIGURATION FAILURE	Inconsistent parameter configuration	Restore the factory settings.
# 011 AMP HW-EEPROM	Electronics module: Defective EEPROM	Replace the electronics module (→ 🖹 45). Spare parts: → 🖹 43
# 012 AMP SW-EEPROM	Electronics module: Error when accessing the EEPROM	Restore the factory settings.
# 021 HW-FRAM	Electronics module: Faulty FRAM	Replace the electronics module (→ 🖹 45). Spare parts: → 🖹 43
# 022 SW-FRAM	Electronics module: Error when accessing the FRAM	Contact your E+H service organization.
# 031 HW-DAT	Sensor DAT: 1. DAT is defective. 2. DAT is not plugged in or is missing.	1. Replace DAT. Spare parts: → 🖹 43 Check the spare part set number to ensure that the new, replacement DAT is compatible with the meter electronics. 2. Insert the DAT: → 🖹 45
# 032 SW DAT	Sensor: Error when accessing the DAT.	Restore the factory settings.
# 101 STARTUP RUNNING	Measuring instrument is running though the startup procedure.	–
# 355/356 RANGE FRQ.OUT 1/2	Frequency output: The output frequency is out of range.	1. Increase the entered full scale value 2. Reduce flow rate
# 359/360 RANGE PULSE 1/2	Pulse output: Pulse output frequency is out of range.	1. Increase the setting for pulse weighting. 2. Reduce flow rate.

No. / error message	Cause	Remedy / spare part
# 379 LOW FREQ.LIM.	The measuring tube oscillation frequency is below the permitted range. Causes: ▪ Measuring tube damaged ▪ Sensor defective or damaged	Contact your E+H service organization.
# 380 UPP.FREQ.LIM.	The measuring tube oscillation frequency is above the permitted range. Causes: ▪ Measuring tube damaged ▪ Sensor defective or damaged	Contact your E+H service organization.
# 381 MEAS. TEMP. CIRC. SHORT	The temperature sensor on the measuring tube is likely defective.	Check whether the connector of the sensor signal cable is correctly plugged into the electronics module before contacting your E+H service organization (→ 🖹 45).
# 382 MEAS. TEMP. CIRC. OPEN		
# 383 CARR. TEMP. CIRC. SHORT	The temperature sensor on the carrier tube is likely defective.	Check whether the connector of the sensor signal cable is correctly plugged into the electronics module before contacting your E+H service organization (→ 🖹 45).
# 384 CARR. TEMP. CIRC. OPEN		
# 387 SEN.ASY.EXCEED	One of the sensor coils (on the inlet or outlet side) is probably defective.	Check whether the connector of the sensor signal cable is correctly plugged into the electronics module before contacting your E+H service organization (→ 🖹 45).
# 388 ZP-COMP. INSTABILE	External process conditions	Contact your E+H service organization.
# 389 ZP-COMP. LIMIT	–	Contact your E+H service organization.
# 390 COMMUNIC.DSP	–	Replace the electronics module.
# 586 OSC.AMP.LIM	The fluid properties do not allow a continuation of the measurement.	Change or improve process conditions.
# 587 TUBE NOT OSC.	Extreme process conditions exist. The measuring system can therefore not be started. The measuring cell or electronics are defective.	Change or improve process conditions. Replace the electronics module (→ 🖹 45). Spare parts: → 🖹 43
# 692 SIM. MEASURAND	Simulation of measuring variables (e.g. mass flow)	Switch off simulation
# 700 EMPTY PIPE	The density is below the lower limit value defined for the function "EPD VALUE LOW"	Adapt the "EPD" to the prevailing process conditions.
# 701 EXC.CURR.LIM	The maximum current value for the measuring tube excitation coil has been reached. The instrument continues to work correctly.	This could be caused by liquids contained in the fluid. Change or improve process conditions.
# 702 FLUID INHOM.	The frequency control is not stable because the fluid properties are inhomogeneous.	This could be caused by liquids contained in the fluid. Change or improve process conditions.
# 703 FLUID INHOM.	The amplitude control is not stable due to inhomogeneous fluid properties.	This could be caused by liquids contained in the fluid. Change or improve process conditions.
# 704 NOISE LIMIT	The failsafe level of the sensor signal is too high.	This could be caused by liquids contained in the fluid. Change or improve process conditions.

No. / error message	Cause	Remedy / spare part
# 731 ADJ.ZERO FAIL.	The zero point adjustment is not possible.	Make sure that zero point adjustment is carried out at "zero flow" only (v = 0 m/s) (→ 🖹 34).
# 740 ZEROPOINT ADJ. RUNNING	The zero point adjustment is running.	Wait until the zero point adjustment is finished.
# 801 LOW. PROC. LIMIT TEMP	The temperature has fallen below the lower process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 802 UPP. PROC. LIMIT TEMP	The temperature has exceeded the process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 803 LOW. PROC. LIMIT DENS.	The density has fallen below the lower process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 804 UPP. PROC. LIMIT DENS.	The density has exceeded the upper process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 805 LOW. PROC. LIMIT MASSFLOW	The mass flow has fallen below the lower process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 806 UPP. PROC. LIMIT MASSFLOW	The mass flow has exceeded the upper process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 807 LOW. PROC. LIMIT VOLFLOW	The volume flow has fallen below the lower process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).
# 808 UPP. PROC. LIMIT VOLFLOW	The volume flow has exceeded the upper process limit.	Change the process condition or setting (→ "Description of Device Parameters" manual).

10.4 Errors without messages

Symptoms	Rectification
The error cannot be eliminated or another error pattern is present. In these instances, please contact your Endress+Hauser service organization.	The following solutions are possible: **Request the services of an Endress+Hauser service technician** If you request the services of a service technician, please be ready with the following information: ▪ Brief error description ▪ Nameplate data (→ 🖹 6): order code and serial number **Return the devices to Endress+Hauser** Procedures must be carried out before you return a flowmeter to Endress+Hauser for repair or calibration → 🖹 5, → 🖹 46. **Replace the transmitter electronics** Electronics module defective → order spare parts → 🖹 43.

10.5 Spare parts

The previous sections contain detailed troubleshooting instructions → 39. The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and storage of error messages that arise.

Fault rectification can entail replacing defective components with tested spare parts. For an overview of the spare parts that can be delivered → 37.

Note!
Spare parts can be ordered directly from your Endress+Hauser representative by providing the serial number printed on the transmitter's nameplate (→ 6).

Spare parts are shipped as sets comprising the following parts:
- Spare part
- Additional parts, small items (threaded fasteners etc.)
- Mounting instructions
- Packaging

10.6 Response of outputs to errors

Failsafe mode of the outputs	
Output	**Failsafe mode**
Frequency output	Note! The failsafe mode of the frequency output can be configured in various ways (→ "Description of Device Parameters" manual): FALLBACK VALUE Signal output → 0 Hz HOLD VALUE Last valid value (preceding occurrence of the fault) is output. HIGH VALUE Signal output → maximum possible frequency
Pulse output	Note! The failsafe mode of the pulse output can be configured in various ways (→ "Description of Device Parameters" manual): FALLBACK VALUE Signal output → no pulses HOLD VALUE Last valid value (preceding occurrence of the fault) is output. HIGH VALUE Signal output → maximum possible pulse rate
Status output	Note! The assignment of the status of the output can be defined (→ "Description of Device Parameters" manual). In the event of fault, note or power supply failure → status output not conductive.

Failsafe mode of the outputs	
Output	**Failsafe mode**
Totalizer	✎ Note! The failsafe mode of the totalizer can be configured in various ways (→ "Description of Device Parameters" manual): STOP The totalizers are paused until the error is rectified. HOLD VALUE The totalizers continue to count the flow in accordance with the last valid flow value (before the error occurred).
Modbus RS485	✎ Note! The failsafe mode of the Modbus RS485 output can be configured in various ways (→ "Description of Device Parameters" manual): STOP In the event of a fault, the value "NaN" (not a number) is transmitted instead of the current measured value. HOLD VALUE Last valid value (preceding occurrence of the fault) is output.

10.7 Removing and installing the meter electronics

Warning!
- Risk of explosion. The electronics compartment may not be opened while there is an explosive atmosphere.
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability.

1. Switch off power supply
2. Unscrew the hexagon socket head cap screw with the Allen screw (1) and dismount the electronics compartment cover (2).
3. Remove the securing screw (3) of the protective cover.
4. Push the side snap hooks (2× item 4) together and pull off the protective cover (5).
5. Unplug the cable connector from the electronics module:
   – Pull off the connector of the sensor signal cable (6) by pulling it forwards.
   – Pull off the connector for the power supply and signal outputs (7) by pulling them upwards.
6. Remove the HistROM/DAT connector (8).
7. Unscrew the Phillips screws (2× item 9) and pull out the electronics module (10).
8. Installation is the reverse of the removal procedure.

   Caution!
   Use only original Endress+Hauser parts.

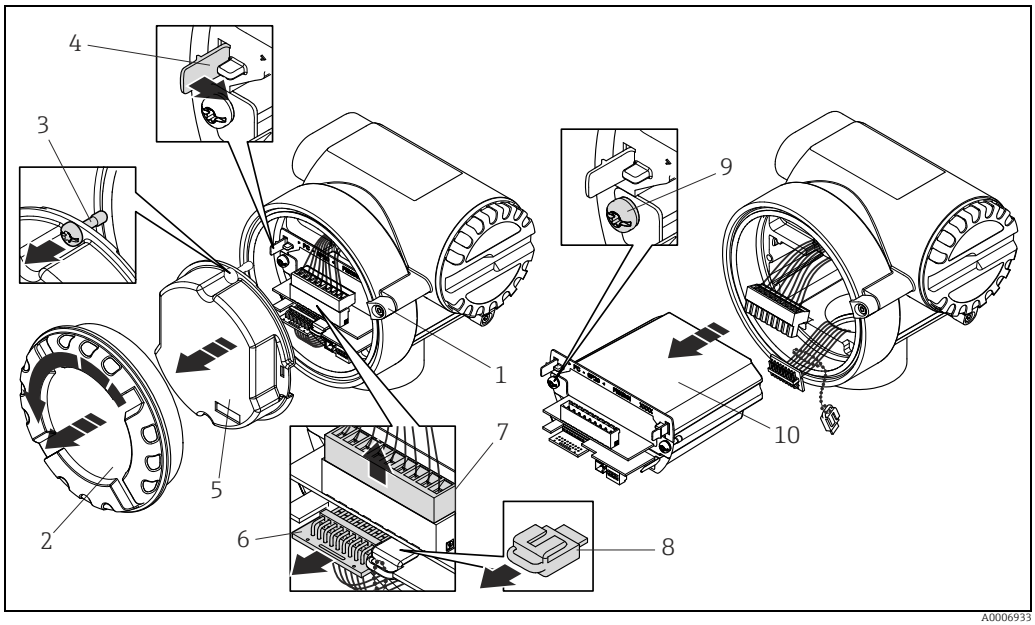

Fig. 20: Removing and installing the meter electronics

1 Allen screw
2 Electronics compartment cover
3 Securing screw of the protective cover
4 Snap hooks, 2×
5 Protective cover
6 Connector of the sensor signal cable
7 Cable connector for power supply and signal outputs
8 HistoROM/DAT connector
9 Phillips screw, 2×
10 Electronics module

10.8 Return

The measuring device must be returned if repairs or a factory calibration are required, or if the wrong measuring device has been ordered or delivered. According to legal regulations, Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with medium.

To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material.

10.9 Disposal

Observe the regulations applicable in your country.

10.10 Software history

Date	Software version	Changes to software	Operating Instructions
11.2015	1.01.xx	Original software	71235487/ 13.15
11.2009	1.01.00	Original software	71109491/ 02.10

11 Technical data

11.1 Applications

→ 📄 4

11.2 Function and system design

Measuring principle

Mass flow measurement by the Coriolis principle

Measuring system

→ 📄 6

11.3 Input

Measured variable

- Mass flow (proportional to the phase difference between two sensors mounted on the measuring tube to register a phase shift in the oscillation)
- Volume flow (calculated using mass flow and density)
- Fluid density (proportional to the resonance frequency of the measuring tube)
- Fluid temperature (via temperature sensors)

Measuring range

Measuring ranges for liquids

DN		Range for full scale values (liquids) $\dot{m}_{min(F)}$ to $\dot{m}_{max(F)}$	
[mm]	[in]	[kg/h]	[lb/min]
1	1/24"	0 to 20.00	0 to 0.735
2	1/12"	0 to 100.0	0 to 3.675
4	1/8"	0 to 450.0	0 to 16.54
6	1/4"	0 to 1000	0 to 36.75

Operable flow range

1 : 1000

11.4 Output

Output signal

Pulse/frequency output

- Passive
- Galvanically isolated
- Open collector
- Max. 30 V DC
- Max. 25 mA
- Frequency output: end frequency 100 to 5000 Hz, on/off ratio 1:1, pulse width max. 2 s
- Pulse output: pulse value and pulse polarity selectable, pulse width configurable (0.1 to 1000 ms)

Status output

- Passive
- Open Collector
- Max. 30 V DC
- Max. 25 mA

Modbus RS485

- Modbus device type: slave
- Address range: 1 to 247
- Functions codes supported: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Physical interface: RS485 in accordance with standard EIA/TIA-485
- Baud rate supported: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Transmission mode: RTU or ASCII
- Response time: typically 5 ms

Signal on alarm

Pulse/frequency output
De-energized in the event of fault or power supply failure

Status output
De-energized in the event of fault or power supply failure

Modbus RS485
De-energized in the event of fault or power supply failure

Load

→ "Output signal"

Galvanic isolation

All circuits for outputs, and power supply are galvanically isolated from each other.

11.5 Power supply

Terminal assignment

→ 🖹 18

Supply voltage

24 V DC nominal voltage (10 to 30 V DC) / 24 V AC nominal voltage (20 to 28 V AC)

Power consumption

AC: < 4.0 VA
DC: < 3.2 W

Typical switch-on current at 24 V DC nominal voltage at R_i = 0.1 W of the source.

t [ms]	I [A]
0	10.0
0.1	8.0
0.2	7.5
0.5	7.0
1.0	6.0
2.0	4.0
5.0	1.5
10.0	0.125 (operating current)

Note!
The internal resistance of the source may not exceed R_i = 10 W.

Power supply failure

Lasting min. 20 ms:
- HistoROM/S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point etc.)

Electrical connections

→ 🖹 18

Potential equalization

No measures necessary.
For explosion-protected equipment →separate Ex-documentation supplied

Cable entries

Power supply and signal cables (outputs):
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Threads for cable entries, ½" NPT, G ½"

Cable specifications

Each compatible cable, with a temperature specification at least 20°C (68 °F) higher than the ambient temperature prevailing in the application. We recommend using a cable with a temperature specification of +80°C (176 °F). Also refer to → 🖹 16.

11.6 Performance characteristics

Reference operating conditions

- Error limits following ISO 11631
- Water, typically +15 to +45 °C (+59 to +113 °F); 2 to 6 bar (29 to 87 psi)
- Specification as per calibration protocol ±5 °C (±9 °F) and ±2 bar (±30 psi)
- Data on the measured error based on accredited calibration rigs traced back to ISO 17025

To obtain measured errors, use the Applicator sizing tool *Applicator*: → 🖹 37.

Maximum measured error

Design fundamentals → 🖹 51

o.r. = of reading; 1 g/cm³= 1 kg/l; T = fluid temperature

Base accuracy

Mass flow and volume flow (liquids)

- ±0.10% o.r. (mass flow)
- ±0.10% o.r. (volume flow)

Mass flow (gases)

- ±0.5% o.r.

Density (liquids)

- Reference conditions: ±0.0005 g/cm³
- Standard density calibrations: ±0.02 g/cm³ (valid over the entire measuring range of the sensor → 🖹 53)
- Wide-range density specification: ±0.002 g/cm³ (valid range for special density calibration: +5 to +80 °C (+41 to +176 °F))

Temperature

±0.5 °C ± 0.005 · T °C (±1.0 °F ± 0.003 · (T − 32) °F)

Zero point stability

DN		Zero point stability	
[mm]	[in]	[kg/h]	[lb/min]
1	1/24"	0.0008	0.00003
2	1/12"	0.002	0.00007
4	1/8"	0.014	0.0005
6	¼"	0.02	0.0007

Flow values

Flow values as turndown parameter depending on nominal diameter.

SI units

DN [mm]	1:1 [kg/h]	1:10 [kg/h]	1:20 [kg/h]	1:50 [kg/h]	1:100 [kg/h]	1:500 [kg/h]
1	20.00	2.000	1.000	0.400	0.200	0.040
2	100.0	10.00	5.000	2.000	1.000	0.200
4	450.0	45.00	22.50	9.000	4.500	0.900
6	1000	100.0	50.00	20.00	10.00	2.000

US units

DN [in]	1:1 [lb/min]	1:10 [lb/min]	1:20 [lb/min]	1:50 [lb/min]	1:100 [lb/min]	1:500 [lb/min]
1/24"	0.735	0.074	0.037	0.015	0.007	0.001
1/12"	3.675	0.368	0.184	0.074	0.037	0.007
1/8"	16.54	1.654	0.827	0.330	0.165	0.033
1/4"	36.75	3.675	1.838	0.735	0.368	0.074

Accuracy of outputs

o.r. = of reading; o.f.s. = of full scale value

The output accuracy must be factored into the measured error if analog outputs are used, but can be ignored for fieldbus outputs (e.g. Modbus RS485).

Pulse/frequency output

Accuracy: Max. ±50 % ppm o.r.

Repeatability

Design fundamentals → 📄 51

o.r. = of reading; 1 g/cm³= 1 kg/l; T = fluid temperature

Base repeatability

Mass flow and volume flow (liquids)

- ±0.05% o.r. (mass flow)
- ±0.05% o.r. (volume flow)

Mass flow (gases)

- ±0.25% o.r. (mass flow)

Density (liquids)

- ±0.00025 g/cm³

Temperature

±0.25 °C ± 0.0025 · T °C (±0.45 °F ± 0.0015 · (T − 32) °F)

Response time

- The response time depends on the configuration (damping).
- Response time in the event of erratic changes in the measured variable (only mass flow): after 100 ms 95 % of the full scale value.

Influence of medium temperature

When there is a difference between the temperature for zero point adjustment and the process temperature, the typical measured error is ±0.0002% of the full scale value / °C (±0.0001% of the full scale value / °F).

Influence of medium pressure

The tables below shows the effect on accuracy of mass flow due to a difference between calibration pressure and process pressure.

DN		Medium pressure	
[mm]	[in]	[% o.r./bar]	[% o.r./psi]
1	1/24"	–0.001	–0.00007
2	1/12"	0	0
4	1/8"	–0.005	–0.0004
6	1/4"	–0.003	–0.0002

Design fundamentals

o.r. = of reading
BaseAccu = base accuracy in % o.r.
BaseRepeat = base repeatability in % o.r.
MeasValue = measured value (in flow units consistent with the zero point stability value → 📄 49)
ZeroPoint = zero point stability

Calculation of the maximum measured error depending on flowrate

Flowrate (in flow units consistent with the zero point stability value → 📄 49)	Maximum measured error in % o.r.
$\geq \frac{\text{ZeroPoint}}{\text{BaseAccu}} \cdot 100$ A0021332	$\pm$ BaseAccu A0021339
$< \frac{\text{ZeroPoint}}{\text{BaseAccu}} \cdot 100$ A002133	$\pm \frac{\text{ZeroPoint}}{\text{MeasValue}} \cdot 100$ A0021334

Calculation of the repeatability depending on flowrate

Flowrate (in flow units consistent with the zero point stability value → 📄 49)	Repeatability in % o.r.
$\geq \frac{½ \cdot \text{ZeroPoint}}{\text{BaseRepeat}} \cdot 100$ A0021335	$\pm$ BaseRepeat A0021340
$< \frac{½ \cdot \text{ZeroPoint}}{\text{BaseRepeat}} \cdot 100$ A0021336	$\pm ½ \cdot \frac{\text{ZeroPoint}}{\text{MeasValue}} \cdot 100$ A0021337

Example for maximum measured error

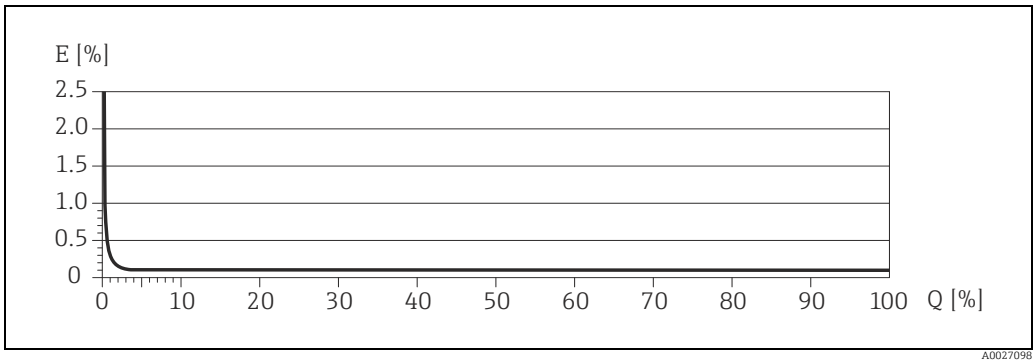

Fig. 21: E = Error: Maximum measured error as % o.r.
Q = Flow rate as %

11.7 Installation

Installation instructions

→ 🖹 10

Inlet and outlet runs

There are no installation requirements regarding inlet and outlet runs.

11.8 Environment

Ambient temperature range

Sensor and transmitter:
- Standard: −20 to +60 °C (−4 to +140 °F)

Note!
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.

Storage temperature

−40 to +80 °C (−40 to +175 °F), preferably at +20 °C (+68 °F)

Degree of protection

Standard: IP 67 (NEMA 4X) for transmitter and sensor

Shock resistance

According to IEC/EN 60068-2-31

Vibration resistance

Acceleration up to 1 g, 10 to 150 Hz, following EC/EN 60068-2-6

CIP cleaning

Yes

SIP cleaning

Yes

Electromagnetic compatibility (EMC)

As per IEC/EN 61326 and NAMUR Recommendation NE 21.

11.9 Process

Medium temperature range

Sensor

- Standard version: −50 to +200 °C (−58 to +392 °F)
- Short neck version: −50 to +125 °C (−58 to +257 °F)

Seals (only for mounting sets with threaded connections):

- Viton: −15 to 200 °C (−5 to +392 °F)
- EPDM: −40 to +160 °C (−40 to +320 °F)
- Silicone: −60 to +200 °C (−76 to +392 °F)
- Kalrez: −20 to +275 °C (−4 to +527 °F)

Medium density

0…5000 kg/m³ (0 to 312 lb/cf)

Secondary containment pressure rating

The sensor housing is filled with dry nitrogen and protects the electronics and mechanics inside.

The following secondary containment pressure rating is only valid for a fully welded sensor housing and/or a device equipped with closed purge connections (never opened, as delivered).

DN		Secondary containment rating (designed with a safety factor ≥ 4)		Burst pressure of secondary containment	
[mm]	[in]	[bar]	[psi]	[bar]	[psi]
1	1/24"	40	580	190	2780
2	1/12"	40	580	190	2780
4	1/8"	40	580	190	2780
6	1/4"	40	580	190	2780

Note!
In case a danger of measuring tube failure exists due to process characteristics, e.g. with corrosive process fluids, we recommend the use of sensors whose secondary containment is equipped with special pressure monitoring connections (ordering option). With the help of these connections, fluid collected in the secondary containment in the event of tube failure can be bled off. This is especially important in high pressure gas applications. These connections can also be used for gas circulation and/or gas detection.

Do not open the purge connections unless the containment can be filled immediately with a dry inert gas. Use only low gauge pressure to purge. Maximum pressure: 5 bar (72.5 psi).

If a device fitted with purge connections is connected to the purge system, the maximum nominal pressure is determined by the purge system itself or by the device, depending on which component has the lower nominal pressure. If, on the other hand, the device is fitted with a rupture disk, the rupture disk is decisive for the maximum nominal pressure (→ 53).

Pressure-temperature ratings

An overview of the Pressure-temperature ratings for the process connections is provided in the "Technical Information" document.

Rupture disk

To increase the level of safety, a device version with a rupture disk with a triggering pressure of 10 to 15 bar (145 to 217.5 psi) can be used. Special mounting instructions: (→ 13).

Limiting flow

→ 🖹 47, "Measuring range"

The suitable nominal diameter is determined by optimizing the settings between the required flow range and the permissible pressure loss. An overview of the maximum possible full scale values is provided in the "Measuring range" section.
- The minimum recommended full scale value is approx. 1/20 of the max. full scale value.
- In most applications, 20 to 50% of the maximum full scale value can be considered ideal.
- Select a low full scale value for abrasive substances, such as liquids with entrained solids (flow velocity < 1 m/s (< 3 ft/s)).

Pressure loss

To calculate the pressure loss, use the *Applicator* sizing tool (→ 🖹 37).

System pressure

→ 🖹 11

11.10 Mechanical construction

Design / dimensions

The dimensions and lengths of the sensor and transmitter are provided in the separate "Technical Information" document on the measuring device in question. This can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section → 🖹 56.

Weight

Compact version	
[kg]	[lb]
5.0	11.0

Material

Transmitter housing

- Aluminum housing: powder-coated die-cast aluminum

Sensor housing / secondary containment

- Acid-resistant and alkali-resistant external surface
- Stainless steel 1.4301 (304)

Process connections

Process connection	Material
4-VCO-4 coupling 4-VCO-8 coupling	Stainless steel, 1.4539 (904L);
Mounting kit: flange according to EN1092-1 (DIN 2501) Mounting kit: flange according to ASME B16.5 Mounting kit: JIS B2220, flange	Stainless steel, 1.4539 (904L); Loose flange (not wetted): stainless steel, 1.4404 (F316/316L)
Mounting kit: NPTF threaded adapter ¼" Mounting kit: NPTF threaded adapter ½"	Stainless steel, 1.4539 (904L);

Measuring tube

- 1.4539 (904L)

Seals for mounting set

- Viton
- EPDM
- Silicone
- Kalrez

Process connections → 54, process connections

11.11 Operability

Local display

Display elements

Status LED

Remote operation

Operation takes place using the "FieldCare" configuration and service program from Endress+Hauser and the Modbus RS485, which can be used to configure parameters for functions and read measuring values.

11.12 Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA).

Ex approval

Information about currently available Ex versions (ATEX, NEC/CEC etc.) can be supplied by your Endress+Hauser representative on request. All explosion protection data are given in a separate documentation, which is also available upon request → 56.

11.12.1 Modbus certification

The measuring device meets all the requirements of the Modbus/TCP conformity and integration test and has the "Modbus/TCP Conformance Test Policy, Version 2.0". The measuring device has successfully passed all the test procedures carried out and is certified by the "Modbus/TCP Conformance Test Laboratory" of the University of Michigan.

Functional safety

SIL 2: in accordance with IEC 61508/IEC 61511-1 (FDIS)

Pressure measuring device approval

The measuring devices can be ordered with or without PED (Pressure Equipment Directive). If a device with PED is required, this must be ordered explicitly. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary.

- With the identification PED/G1/III on the sensor nameplate, Endress+Hauser confirms conformity with the "Basic safety requirements" of Appendix I of the Pressure Equipment Directive 97/23/EC.
- Devices with this identification (with PED) are suitable for the following types of fluid:
  - Fluids of Group 1 and 2 with a steam pressure greater than, or smaller and equal to 0.5 bar (7.3 psi)
  - Unstable gases
- Devices without this identification (without PED) are designed and manufactured according to good engineering practice. They correspond to the requirements of Art. 3, Section 3 of the Pressure Equipment Directive 97/23/EC. Their application is illustrated in Diagrams 6 to 9 in Appendix II of the Pressure Equipment Directive 97/23/EC.

Other standards and guidelines

- EN 60529:
  Degrees of protection provided by enclosures (IP code)
- EN 61010-1:
  Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC/EN 61326:
  Electromagnetic compatibility (EMC requirements)
- NAMUR Recommendation NE 21: Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment
- NAMUR Recommendation NE 43:
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR Recommendation NE 53:
  Software of field devices and signal-processing devices with digital electronics

11.13 Accessories/spare parts

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11.14 Documentation

- Flow measurement (FA00005D/06)
- Description of Device Parameters (GP00005D/06)
- Operating Instructions Modbus RS485 (BA00142D/06)
- Technical Information (TI00106D/06)
- Ex-Supplementary documentation ATEX (II2G): (XA00146D/06)
- Ex-Supplementary documentation NEC/CEC (Div. 1): (XA00147D/06)
- Ex-Supplementary documentation NEPSI (Zone 1, Zone 21): (XA00148D/06)

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